DOE/EIS-0138S

FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

FOR THE

SUPERCONDUCTING SUPER COLLIDER

VOLUME 1: MAIN REPORT

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TITLE

Final Supplemental Environmental Impact Statement (SEIS) for the Superconducting Super Collider

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ABSTRACT

The proposed action evaluated in the SEIS is the construction and operation of the Superconducting Super Collider (SSC), the largest scientific instrument ever built, in Ellis County, Texas. The SSC would be a laboratory facility designed to investigate the basic structure of matter. It would be a particle accelerator capable of accelerating each of two counter-rotating beams of protons to an energy of 20 trillion electron volts. The two

proton beams would then be made to collide, and the results of these collisions (at energies up to 40 trillion electron volts) would be studied by scientists.

On November 10, 1988, the Secretary of Energy identified the Texas site as the preferred alternative for the location of the SSC. The DOE published a final EIS in December 1988, and a Record of Decision was signed that documented DOE's decision to proceed with the SSC and to formally select the site in Ellis County. In the EIS and the Record of Decision, the DOE committed to prepare a supplemental EIS prior to construction in order to analyze more fully impacts based on a site-specific design and to assess alternative measures to mitigate potentially adverse impacts. Public hearings were held in the vicinity of the site during September 1990. This final SEIS reflects comments received during those hearings and in written letters.

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1 SUMMARY

1.1 OVERVIEW

The U.S. Department of Energy (DOE)* has proposed that the United States build the Superconducting Super Collider (SSC), a state-of-the-art laboratory facility for the study of high-energy physics. The proposed SSC would be the largest scientific instrument ever built.

On November 10, 1988, the Secretary of Energy identified the Texas site as the preferred alternative for the location of the SSC. The DOE published a final environmental impact statement (FEIS) in December 1988, and a Record of Decision (ROD) was signed that documented DOE's decision to proceed with the SSC and to formally select the site in Ellis County. In the EIS and the ROD, the DOE committed to prepare a supplemental EIS (SEIS) prior to construction in order to analyze more fully impacts based on a site-specific design and to assess alternative measures to mitigate potentially adverse impacts.

This SEIS has been prepared to take into account design modifications that have been made to the SSC since the ROD was published. These modifications have been made both to accommodate technical improvements to the SSC and to adapt the SSC conceptual design to the Texas site. Wherever possible, and particularly where no significant changes have occurred in the SSC design since the ROD, this SEIS relies on the analyses and assessments presented in the December 1988 EIS. This chapter summarizes the information in this SEIS, emphasizing any changes that have occurred since publication of the EIS.

The basic purpose of the SSC is to gain a better understanding of the fundamental structure of matter. This machine will be capable of accelerating two beams of subatomic particles (protons) to an energy of 20 trillion electron volts (TeV). The two beams will then be made to collide, and the results of these collisions (at 40 TeV) will be studied by scientists. The SSC could create particle collisions at energies 20 times higher than can be achieved at existing accelerators. This means that the SSC could probe the properties of matter at distances 20 times smaller than can now be done with existing and planned particle accelerators. The SSC will enable the United States to maintain its world leadership in the field of high-energy physics.

The SSC is expected to result in other benefits as well. Besides providing scientific data, the SSC could be a source of spin-off technology with applications in other fields. Within the past 10 years, the technology developed for high-energy physics has made new products possible, such as equipment used for medical diagnostics and therapy, improved computer components, and new superconducting magnet materials.

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*Appendix A contains a glossary and a list of acronyms and abbreviations.

Projecting to the future, discoveries resulting from the SSC may lead to benefits that are currently impossible to envision. Looking back in time, one sees that research in subatomic physics over the last 80 years was essential to the development of technology, including portions of computers, that constitutes a significant portion of our current gross national product. On a broader scale, the wonder and excitement resulting from discoveries made possible by the SSC may provide inspiration for young people to enter careers in science and engineering. This atmosphere could contribute to maintaining America's economic competitiveness in an increasingly technological world.

1.2 PROPOSED ACTION AND MODIFICATION OF ORIGINAL PROPOSED ACTION AND ALTERNATIVES

The proposed action assessed in this SEIS is to construct and operate the SSC at the selected site in Texas. This SEIS relies heavily on the analyses and assessments presented for the Texas site in the final EIS (FEIS). As was anticipated in the FEIS (Vol. I, Section 3.1.1), some design details have been modified to accommodate environmental and technical aspects of the Texas site. These modifications are discussed in general terms below.

The proposed layout, or *footprint*, of the SSC, which identifies land areas above and below ground, was developed by responding to environmental and operating requirements and by adapting the required SSC configuration to the specific geological and topographical features of the Texas site. Variances in these requirements from those set forth in the site proposal from the state of Texas (Texas National Research Laboratory Commission 1987) and in the initial conceptual design (SSC Central Design Group 1986a) (which together provided the basis for the EIS assessment) have arisen from developments in the design of the accelerator and from the evolution of the requirements for the experimental program since the Invitation for Site Proposals (ISP) was issued by the DOE in 1987. In addition, analysis of geotechnical data has led to the currently proposed slight shift and counterclockwise rotation of the facility on the site compared with the placement described in the Texas site proposal.

Once the optimal ring footprint was established on the basis of the collider lattice and geological concerns, additional minor adjustments were made to minimize impacts to the environment and surface conditions. The current footprint reflects efforts to minimize surface impact without compromising the geotechnical and safety aspects of the facilities. However, some additional flexibility is still possible with respect to the location of surface facilities.

Composites were prepared by overlaying maps of floodplains, land use, land parcelization,* slopes, and soils for use in the preliminary siting of buildings. Viewsheds,

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*The term *land parcelization* is used in this document to refer to the distribution of lands into parcels by ownership and use. The principal consideration here was to avoid (to the extent possible) siting SSC surface facilities in such a way as to divide a large, single-owner land parcel into two or more smaller, divided parcels and thus lower the value and utility of the land.

watersheds, noise receptors, and access were taken into consideration during development of each site concept. View and noise receptors were considered relative to strategic placement of berms and plantings. Access was evaluated in terms of the most direct suitable alignments. Watershed data were used to place facilities, berms, and ponds.

More detailed descriptions of and comparisons between the current plans and those addressed in the FEIS are presented in Section 2.1.1 of this SEIS.

No new technical or programmatic alternatives to construction of an SSC have arisen since issuance of the EIS. The no-action alternative has changed from the description provided in Section 3.3 (Vol. I) of the EIS in that the SSC Laboratory (SSCL) has been created, and approximately 900 employees are anticipated to be on the payroll by the end of fiscal year (FY) 1990 (Section 2.3). The impacts associated with the loss of these positions and the positions at the Texas National Research Laboratory Commission if the SSC project were to be canceled will be evaluated in the no-action alternative.

1.3 PURPOSE AND NEED FOR THE PROPOSED ACTION

The purpose and need for the SSC have not changed from those described in the FEIS (Vol. I, Chapter 2). In January 1990, a High-Energy Physics Advisory Panel (HEPAP) Subpanel on SSC Physics was convened to review the technical changes discussed in Section 1.2 of this SEIS and to investigate the potential usefulness of an SSC with somewhat reduced energy. In a letter transmitting the HEPAP subpanel's 1990 report to the DOE, HEPAP Chairman Francis E. Low (1990) stated:

> Timely completion of the Superconducting Super Collider (SSC) remains the highest priority of the national High Energy Physics program. The physics research to be done with the SSC is essential to the improvement of present human understanding of the fundamental forces of nature and the underlying constituents of the physical universe in which we live. The SSC is certain to be a focus of worldwide scientific attention for decades to come.

The subpanel's report (DOE 1990) contains the following statements:

> The very spirit of physics is to explore the unknown. This makes it impossible for us to predict precisely what we will discover in the future. Based on our present knowledge, however, we are confident that the SSC will explore a region in which major new discoveries will be made. The SSC specifications were established with this goal in mind, and experience gained since 1983 has strengthened our conviction of the importance of constructing a proton-proton collider with the beam energy of 20 TeV and luminosity of 10^{33} cm^{-2} sec^{-1}, as originally proposed.

and

> . . . Based on recent experimental and theoretical findings, the SSC Laboratory judges these technical changes (higher injection energy and a larger magnet aperture) to be required for reliable operation. We have reviewed these technical changes and the reasons for making them, and we conclude that implementing them will ensure confidence in reliable and timely operation of the SSC.

The HEPAP report thus reiterates and reemphasizes the purpose and need for the proposed action as described in Chapter 2 (Vol. I) of the FEIS and supports the modifications described in this SEIS.

1.4 ENVIRONMENTAL CONSEQUENCES

Table 1.1 summarizes the potential environmental impacts associated with construction and operation of the SSC. The assessed impacts of the conceptual design as presented in the FEIS are provided for comparison with the assessed impacts of the site-specific conceptual design. The differences in impacts can be attributed to (1) the use of additional site-specific data not available for the assessments conducted for the EIS; (2) the application of more refined or sophisticated technical approaches, where appropriate; and (3) changes in the location of areas of surface disturbance.

1.5 FEDERAL PERMITS, LICENSES, AND OTHER ENTITLEMENTS

The DOE has examined the federal permits, licenses, and other entitlements that may be necessary to construct and operate the SSC in Texas. Various federal environmental statutes impose environmental protection and compliance requirements upon DOE, including compliance with applicable state and local regulations.

Chapter 5 discusses federal statutes that may apply to construction and operation of the SSC, including the Clean Water Act, the Clean Air Act, the Safe Drinking Water Act, the Solid Waste Disposal Act, the National Historic Preservation Act, the Endangered Species Act, the Farmland Protection Policy Act, and the Uniform Relocation and Real Property Acquisition Policies Act.

1.6 CHANGES IN THE SUPPLEMENTAL EIS FROM THE EIS

This SEIS includes site-specific analyses relevant to an exact location (i.e., a *footprint*) for the SSC project facilities. Specific design requirements developed since publication of the EIS and information gained from additional geotechnical test borings taken at the Texas site have resulted in a more exact location for the collider ring, service areas, east and west campus areas, utility lines, access roads, and other project features.

TABLE 1.1 Comparison of Potential Environmental Impacts Associated with Constructing and Operating the SSC — EIS versus SEIS

Impact	SEIS	EIS
Earth Resources		
Loss of oil and gas wells	None	None
Loss of metallic resources	None	None
Loss of quarries	None	None
Water Resources		
Surface water use	Use of small increment of excess supply	Use of small increment of excess supply
Groundwater use	Use is projected to be about 14% of total use in Ellis County in 1986	Increase groundwater withdrawal by 915 to 954 acre-ft/yr
Floodplains	Some surface facilities at 4 of the 18 service areas would be subject to flooding during the 100-year or greater flood	Some surface facilities at four external beam access areas and two service areas could be affected by floodplains
Air Resources		
Air quality (PM_{10} NAAQS)[a]	Impacts are similar to EIS assessment	Small, incremental addition to regional air emissions; PM_{10} fugitive dust impact from construction activity is of a temporary and intermittent nature and will vary from location to location
Noise		
Number of people living in areas with intermittent 70-75-dBA levels during construction	0 (with mitigation)	25
Number of people living in areas with intermittent 60-70-dBA levels during construction	40 (with mitigation)	314

TABLE 1.1 (Cont'd)

Impact	SEIS	EIS
Noise (Cont'd)		
Number of people living in areas with a 55-60-dBA background during operations	0 (with mitigation)	19
Biotic Resources		
Habitat loss: sensitive communities, commercial and recreational	Minor impact to riparian areas; no blackland prairie loss; no significant commercial/ recreational loss; no impact to threatened or endangered species	Mostly cultivated; some blackland prairie loss possible
Wetlands	10 isolated (includes 14 acres); 2 forested (includes 7 acres)	3 acres
Radiation[b]		
Increase in dose to maximally exposed individual (% of background)	<0.03	<0.004
(% of limit 40 CFR 61)	0.3	0.008
Increase in dose (% of background) to collective population	2×10^{-5}	1×10^{-3}
Incremental annual dose (person rem) to each truck driver due to low-level radioactive waste transport[c]	0.17	0.575
Increase in dose (% of background) to collective population due to low-level radioactive waste transport[d]	<0.001	<0.001

TABLE 1.1 (Cont'd)

Impact	SEIS	EIS
Land Use[e]		
127 Prime and unique farmlands converted for SSC use (acres)	4,632	3,389
Ratio of prime and unique farmlands converted for SSC use to affected county inventory	0.017	0.012
Scenic/Visual	Impacts would be important only to a small number of local residents/ recreationists near seven service/ access areas	All local except one; views from a regionally important recreational lake may be affected
Cultural and Paleontological Resources		
Historical sites	Nineteen significant historic structures eligible for the National Register[f]	To be identified
Prehistoric/archaeological sites	Nineteen archaeological sites (artifact scatters and historic farmsteads)	To be identified
Socioeconomics[g]		
Number of jobs		
Direct, peak year		
Construction	3,893	3,819
Increase (%)	<1	<1
Indirect, peak year		
Construction	5,497	5,923
Increase (%)	<1	<1
Direct, first year		
Operations	3,248	3,248
Increase (%)	<1	<1
Indirect, first year		
Operations	2,458	3,265
Increase (%)	<1	<1

TABLE 1.1 (Cont'd)

Impact	SEIS	EIS
Socioeconomics (Cont'd)		
Number of Jobs (Cont'd)		
Total SSC-related earnings, peak year		
Construction (10^6 $)	261.7 (1990 $)	304.6 (1988 $)
Increase (%)	<1	<1
Total SSC-related earnings, first year		
Operations (10^6 $)	134.8 (1990 $)	186.4 (1988 $)
Increase (%)	<1	<1
Direct SSC sales demand, peak year		
Construction (10^6 $)	239.8 (1990 $)	230.4 (1988 $)
Direct SSC sales demand, first year		
Operations (10^6 $)	122.8 (1990 $)	144.5 (1988 $)
Total SSC-related sales, peak year		
Construction (10^6 $)	469.9 (1990 $)	446.7 (1988 $)
Total SSC-related sales, peak year		
Operations (10^6 $)	228.8 (1990 $)	267.9 (1988 $)
Total population impact, peak year[h]		
Construction	8,988	9,884
Increase (%)	<1	<1
Total population impact, first year[h]		
Operations	7,491	7,961
Increase (%)	<1	<1
Housing demand, peak year		
Construction	2,473	2,700
Housing demand, first year		
Operations	1,891	1,880
School enrollments, peak year		
Construction	1,696	2,031
Increase (%)	<1	<1
School enrollments, first year		
Operations	1,449	1,900
Increase (%)	<1	<1
Additional teachers needed, peak year		
Construction	98	113
Increase (%)	<1	<1

TABLE 1.1 (Cont'd)

Impact	SEIS	EIS
Socioeconomics (Cont'd)		
Number of Jobs (Cont'd)		
Additional teachers needed, first year		
Operations	85	106
Increase (%)	<1	<1
Infrastructure		
Miles four-lane highway	5.4	5.0
Miles two-lane road	10.9	22.0
Miles road upgrades	9.5	23.0
Miles one-lane road	0.0	4.0
Upgrades interchanges	1.0	1.0
Indirect traffic increase (%)	<3	3.0

[a]PM_{10} NAAQS = national ambient air quality standards for suspended particulates with mean aerodynamic diameter less than 10 μm.

[b]Dose calculations for SEIS and EIS are based on effective dose equivalent (EDE) and dose equivalent (DE), respectively. The 40 CFR 61 limit changed on December 15, 1989, from 25 mrem/yr DE (FEIS, Vol. I, Section 3.5) to 10 mrem/yr EDE.

[c]Assumes 2 truck drivers making 12 trips per year to Richland, Washington.

[d]Assumes transport of low-level radioactive waste to Richland, Washington.

[e]These estimates assume none of the land will be leased for cultivation. The EIS estimates were made assuming leaseback for cultivation.

[f]Historic and prehistoric/archaeological surveys have not been completed at the Texas site.

[g]All direct job and infrastructure impacts pertain to Ellis County; the affected area for all other socioeconomic impacts is the eight-county area (i.e., Dallas, Ellis, Hill, Johnson, Kaufman, Navarro, Rockwall, and Tarrant counties). The percentage increase refers to impacts related to SSC impacts compared with increases from other sources.

[h]Numbers include natural increase and in-migration.

Given the proposed location of SSC project components, the DOE was able to define the infrastructure requirements more accurately than had been done for the EIS. Infrastructure as used in this document includes roads, transmission lines, substations, distribution lines, natural gas pipelines, water supply lines, and telecommunication lines. The impacts associated with infrastructure are addressed in this SEIS in appropriate sections of Chapter 4. The impact analyses reflect the addition of 8 service areas, for a total of 18 service areas, compared with the 10 service areas analyzed in the EIS. Also, plans now are for each service area to cover about 50 acres, rather than the 5.7 acres specified in the EIS. The proposed size has been increased to accommodate, with some degree of flexibility, disposal of spoils and construction of cooling ponds. The preferred option for disposing of spoils produced from shaft and tunnel excavation is to place the materials in each service area (with the exception of service area E8) and use appropriate techniques to create berms that blend with the existing contours. Detailed analyses of impacts from placement, construction, and operation of cooling ponds at each service area are presented in this SEIS.

The SEIS also contains a more detailed analysis of construction-related impacts than was presented in the siting EIS. Establishment of a proposed SSC footprint made it possible to collect more detailed site-specific environmental data on cultural resources (i.e., archaeological and historic sites), vegetation, soils, groundwater and surface water resources, and wetlands. Because of DOE's commitment to giving special attention to projects involving potential loss of wetlands, this topic receives additional evaluation in this SEIS.

The secondary impacts associated with the SSC are considered in greater detail in this SEIS than in the EIS. Cumulative impacts of the commercial development associated with the SSC are addressed for both the west (main) campus and east campus areas.

Table 1.2 provides a comparison of changes made in SSC system element and facility requirements since publication of the FEIS. The changes primarily result from the site-specific evolution of the SSC conceptual design. These revisions, along with the detailed site-specific environmental data, form the basis for the impact assessments in this SEIS. The two proposed conceptual design changes having the most influence on the design of other system elements and the site-specific data needs for the impact assessment are the expansion of the proton injector energy from 1 TeV to 2 TeV and the new SSC footprint. The SSC footprint is the required land surface area and subsurface volume as determined by specific SSC design requirements and adaptations of those requirements to site-specific geologic and topographic features.

The 2-TeV injector increased the circumferences of the low-energy booster (LEB), medium-energy booster (MEB), and high-energy booster (HEB) by more than 80%, which contributed to the change in the collider footprint. The remaining changes to the SSC footprint, as against what was proposed by the state of Texas (Texas National Research Laboratory Commission 1987) and the original Conceptual Design Report (SSC Central Design Group 1986a, 1986b), arose from other evolutionary developments in the SSC design and from analysis of geotechnical data.

TABLE 1.2 Comparison of Major SSC System Design Elements and Infrastructure, EIS versus SEIS

SSC System Design Element	SEIS[a]	EIS[b]
I. Collider Physics/Engineering Design Parameters		
A. Collision energy (TeV)	20	20
B. Circumference (mi)	54.1	53.0
C. Tunnel cross-sectional radius (m)	3.7	3.1
D. Luminosity[c] (particles/$cm^2 \cdot s$)	1×10^{33} (1×10^{34} optimized scenario)	1×10^{33}
E. Dipole magnets		
1. Number	8,662 (7,986 long, 676 short)	7,680
2. Length (m)	15.63 (long), 13.13 (short)	17.34
F. Quadrupole magnets		
1. Number	1,564	1,776
2. Length (m)	5.85	4.34
G. Location and elevation		
1. Center coordinates	252,561 ft north, 2,213,072 ft east	253,713 ft north, 2,212,866 ft east
2. Elevation (ft)	357	
H. Orientation[d]		
1. Obliquity	N18.77°W	N13.27°W
2. Strike	N13.7°E	N28.01°E
3. Dip	0.17°	0.23°
II. West Campus (WC) and East Campus (EC) Facilities		
A. Injector facilities (WC)		
1. Linear accelerator (Linac)		
(a) KE_m^e (MeV)	600	600
(b) Length (m)	243	151
(c) Depth (m)	11.3	6
2. Low-energy booster (LEB)		
(a) KE_m^e (GeV)	12	6
(b) Circumference (m)	540	250
(c) Depth (m)	10.1	4
3. Medium-energy booster (MEB)		
(a) KE_m^e (GeV)	200	100
(b) Circumference (km)	4	2
(c) Depth (m)	8	5

TABLE 1.2 (Cont'd)

SSC System Design Element	SEIS[a]	EIS[b]
II. West Campus (WC) and East Campus (EC) Facilities (Cont'd)		
4. High-energy booster (HEB)		
(a) KE_m[e] (TeV)	2	1
(b) Circumference (km)	11	6
(c) Depth (m)	61	20
B. Experimental halls		
1. Number (K areas)		
(a) West campus	2	4
(b) East campus	2	2
(c) Total	4	6
2. Size	2 large, 2 medium	2 large, 4 medium
3. Assembly areas	None	4
4. Depth (m)		
(a) Large	55, 70	N/A[f]
(b) Medium	50, 55	N/A
C. Test beam halls (WC)	Three low-energy (20-GeV) targets; upgrade option includes consideration of three high-energy (2-TeV) target piles	Six targets, none fixed; unspecified energies
D. Underground beam and monitoring areas (WC)		
1. J areas	0	6
2. M areas	8	0
3. I areas	9	0
4. K areas	0	6
III. Service and Access Areas		
A. Service (E) areas	10	10
B. Access (F) areas	8	10
C. Total (E + F)	18	20
IV. Roads		
A. New construction (mi)	8	31
B. Upgrades (mi)	20	23

TABLE 1.2 (Cont'd)

SSC System Design Element	SEIS[a]	EIS[b]
V. Electric Power Supplies		
A. Design loads (MWe)		
1. Injector facilities		
(a) Linac		
Nominal	3.1	1.2
Peak	N/A	1.2
(b) LEB		
Nominal	2.0	1.4
Peak	N/A	2.5
(c) MEB		
Nominal	5.2	10.0
Peak	N/A	28.0
(d) HEB		
Nominal	16.3	14.4
Peak	N/A	16.2
(e) Test beam facility		
Nominal	16.3	3.2
Peak	N/A	5.2
2. Experimental halls		
Nominal	52.9	1.6
Peak	N/A	1.6
3. Campus facilities		
Nominal	14.5	5.0
Peak	N/A	5.0
4. Collider		
Nominal	74.6	77.4
Peak	N/A	126.1
5. Facility total		
Nominal	185	116
Peak	213	184
B. System features		
1. Number of substations	2	2
2. Number of transformers	4 west, 1 east	5 west, 2 east
3. Number and voltage of new lines to SSC substations	Two 345-kV lines	Two 345-kV lines
VI. Water Supply		
A. West campus	12-mi municipal pipeline from Tarrant Co. to booster pump station	9-mi municipal pipeline from Tarrant Co. surface water

TABLE 1.2 (Cont'd)

SSC System Design Element	SEIS[a]	EIS[b]
VI. Water Supply (Cont'd)		
B. East campus	1,500-ft main raw water line that bisects the site	7-mi line, new wells and new municipal fields
C. Service areas	8 new wells	New wells
VII. Natural Gas Supply		
A. West campus	Available on site	7-mi pipeline
B. East campus	Available on site	5-mi pipeline
VIII. Waste Disposal		
A. Sewage treatment	On-site plants;	On-site plants --
B. Spoils	all to be used to establish visually appealing landscaped berms at each generation site	50% to Midlothian area, 5 mi northeast of E2; 50% on about 65 acres at various locations within 2 mi of generation sites
C. Chemical and mixed waste	Off-site disposal	On-site disposal
D. Low-level radioactive waste (LLW)	Two options evaluated: (1) Hanford, Wash., repository, and (2) Hudspeth County Texas local LLW/Compact site	Hanford, Wash., repository
IX. Land Acquisition		
A. SSC site		
1. Acreage		
(a) Fee simple	10,283	8,650
(b) Stratified fee	6,270	8,098
(c) Total	16,553	16,748
2. Number of parcels		
(a) Fee simple	457	318
(b) Stratified fee	804	296
(c) Total	1,261	614
B. Transportation and infrastructure (acres)	367 (number of individual sites not known)	65 (10 sites)

TABLE 1.2 (Cont'd)

SSC System Design Element	SEIS[a]	EIS[b]
X. Land Ownership		
A. Fee simple (acres)		
1. Federal	3	104
2. State	0	168
3. Local	1	21
4. Private	10,279	8,167
5. Other	0	189
6. Total	10,283	8,649
B. Stratified fee (acres)		
1. Federal	200	206
2. State	0	32
3. Local	2	36
4. Private	5,855	7,656
5. Other	213	169
6. Total	6,270	8,099
C. Total (acres)		
1. Federal	203	310
2. State	0	200
3. Local	3	57
4. Private	16,134	15,823
5. Other	213	358
6. Total	16,553	16,748

[a]SSCL 1990; Texas National Research Laboratory Commission 1990.

[b]DOE 1988.

[c]A measure of the number of potentially interacting particles available in two colliding beams.

[d]The orientation of the ring is defined by its obliquity, defined as the angle between the major axis of the ring and grid north. The plane of the ring is defined by its strike and dip. Strike (rotational axis of the dip) is the bearing line of constant elevation in the plane; the dip (or tilt) is the angular rotation about the strike axis.

[e]Maximum kinetic energy of protons at exit point.

[f]N/A = information not available.

In addition to the land area changes resulting from the increased injector energies, new land area needs arose from (1) modification of the lattice design, (2) inclusion of experimental area bypasses, and (3) design changes for the calibration and test beams. These changes caused a slight increase in the circumference of the ring and a rearrangement of the land areas in the west and east campuses. The analysis of geotechnical data indicated a need for a slight shift (i.e., ring center moved 1,170 ft south-southeast of the ISP position) and rotation (i.e., 8° counterclockwise) in the ring as against what was described in the Texas site proposal (Table 1.2).

Three major SSC elements are identified as potential areas for future expansion -- (1) three 2-TeV test beam target halls; (2) four experimental halls; and (3) a high-energy, fixed-target physics program. None of these planned areas of potential expansion are included in the impact assessment of this SEIS. Future decisions regarding the need for these expansion facilities will be made under full compliance with the National Environmental Policy Act of 1969 (NEPA) process.

1.7 SUMMARY OF PUBLIC INVOLVEMENT IN THE EIS

In January 1988, after examining materials received in response to the ISP for the SSC issued in April 1987, the DOE announced a list of the seven best qualified site proposals. These *best qualified sites*, analyzed as reasonable siting alternatives in the EIS, included locations in Arizona, Colorado, Illinois, Michigan, North Carolina, Tennessee, and Texas.

Public participation was initiated with the onset of EIS scoping. The DOE issued an Advance Notice of Intent to prepare the SSC EIS (52 FR 16304, May 4, 1987), which was followed by issuance of a Notice of Intent (53 FR 1821, January 22, 1988). Scoping meetings were held near each of the seven alternative sites. A draft EIS (DEIS) prepared in August 1988 provided analysis of environmental issues raised during the EIS scoping process. The U.S. Environmental Protection Agency (EPA) published a Notice of Availability (53 FR 34148, September 2, 1988), initiating a 45-day public review and comment period on the DEIS. During that period, public hearings were held near each of the seven sites. The DOE received about 7,000 oral and written comments on the DEIS from approximately 5,700 commenters. Most comments received related to socioeconomics and infrastructure, water resources, ecological resources, policy issues, combined land acquisition and land resources, and radiation and health impacts. About 500 of the comments received pertained to the Texas site. Comments and responses were included in Volumes IIA and IIB, respectively, of the FEIS.

Public involvement in the EIS process at the Texas site began in January 1988 with EIS scoping. A public scoping meeting was held at Waxahachie on February 16, 1988, to receive oral and written comments from the public. A public hearing to obtain public comment on the DEIS was held on September 26-27, 1988, in Waxahachie.

On November 10, 1988, the Secretary of Energy identified the Texas site as the preferred alternative for location of the SSC. The DOE published the FEIS in December 1988; a ROD was signed by the Secretary of Energy, documenting DOE's decision to proceed with the SSC and to select the Texas site. The ROD also included DOE's

decision to prepare a SEIS before construction in order to analyze impacts based on a site-specific design and assess alternative measures to mitigate potentially adverse impacts.

In addition to considering the comments received during the EIS process, the DOE has taken into account comments received at several local public meetings held by the Texas National Research Laboratory Commission to identify additional potential environmental issues related to the SSC. The DOE then published a Notice of Preparation (55 FR 23585, June 11, 1990).

This SEIS was distributed in draft form for public comments, and hearings were held on September 19 and 20, 1990, to give the public the opportunity for further comment. Appendix D contains the DOE responses to the public comments, and Vol. 2 of this SEIS contains the public comment submissions. The testimony submissions were numbered 104 through 139, and the comment letters were assigned numbers 1 through 103 and 140 through 231. Changes to the DSEIS are indicated by a vertical bar in the left-hand margin. When the change is specifically the result of a public comment, the number of the related submission is given. (See Vol. 2 for reproductions of the submissions.)

1.8 REFERENCES FOR SECTION 1

DOE, 1988, *Final Environmental Impact Statement, Superconducting Super Collider*, U.S. Department of Energy Report DOE/EIS-0138, Washington, D.C., Dec.

DOE, 1990, *Report of the HEPAP Subpanel on SSC Physics*, U.S. Department of Energy Report DOE/ER-0434, Washington, D.C., Jan.

Low, F.E., 1990, Chairman, High-Energy Physics Advisory Panel, Cambridge, Mass., letter to J.F. Decker, Office of Energy Research, U.S. Department of Energy, Washington, D.C., Jan. 12.

SSC Central Design Group 1986a, *SSC Conceptual Design*, Report SSC-SR-2020, March.

SSC Central Design Group, 1986b, *Conventional Facilities*, Attachment C to SSC Conceptual Design, Report SSC-SR-2020C, March.

SSCL, 1990, *Superconducting Super Collider Site-Specific Conceptual Design*, Superconducting Super Collider Laboratory Report SSC-SR-1056, Dallas, July.

Texas National Research Laboratory Commission, 1987, *Texas Response to Invitation for Site Proposals*, Austin, Sept.

Texas National Research Laboratory Commission, 1990, letter from M. Smith to M. Lazaro, Argonne National Laboratory, Argonne, Ill., May 17.

2 PROPOSED ACTION AND ALTERNATIVES

This chapter describes the proposed action and alternatives. Where appropriate, planned impact mitigation measures are presented. Site-adapted conceptual design details and design changes developed since the FEIS was published are included in the description of the proposed SSC facility. The most significant design change is an increase in the energy level of the HEB from 1 to 2 TeV. This change was deemed necessary on the basis of recently developed computer simulations indicating that, at 1 TeV, an unacceptably large fraction of the protons injected into the main storage rings would be lost even before the acceleration cycle began. Increasing the HEB energy level to 2 TeV significantly reduces this fractional loss. The impacts of doubling the HEB energy level are assessed throughout this SEIS. A 1-TeV HEB is no longer technically acceptable and is not considered a reasonable option.

The various technical and procedural alternatives for the SSC that were considered and evaluated for the FEIS (Vol. I, Section 3.3) are not analyzed in this document. The no-action alternative is the continuation of current conditions and trends that would take place in Texas if the SSC were not constructed. Impacts of the no-action alternative are presented in Section 2.3 and subsections of Chapter 4.

2.1 PROPOSED ACTION

The proposed action is to construct and operate the SSC (a 20-TeV particle accelerator with its supporting systems and facilities), which would serve as a U.S. national laboratory for high-energy physics experiments. The five phases of the proposed project are:

- *Siting.* The siting phase consisted of DOE issuing its *Invitation for Site Proposals* (ISP), evaluating those proposals to develop the *best qualified list* (BQL) of seven sites, identifying the preferred site in the EIS, and selecting a site in the *Record of Decision* (ROD).

- *Preconstruction.* The preconstruction phase consists of activities at the selected site to confirm geotechnical conditions, to validate site engineering parameters, to acquire the necessary land parcels, and to perform the assessments or surveys necessary to verify site data for site-specific project design.

- *Construction.* The construction phase would include continued design, as well as physical establishment of the tunnel, fabrication of technical components (including magnets, detectors, and support systems), construction of surface facilities and campus areas, and creation of infrastructure connections (roads and utility corridors).

- *Operations.* This primary and long-term phase would involve use of the SSC facilities for physics experiments. The operating life of the SSC is expected to be 25-35 years.

- *Decommissioning.* The decommissioning phase would involve removal, closure, decontamination, and other activities designed to remove the SSC, including its support facilities, from service. Additional NEPA review will be required before decision making on decommissioning can start.

Siting and preconstruction, as well as conceptual descriptions of construction and operating activities, were covered in the EIS. This SEIS discusses additional site-specific and conceptual design developments since the FEIS was published. It also addresses issues raised during the public comment period for the DEIS that were not addressed in detail in the FEIS.

2.1.1 Description of the Proposed SSC

2.1.1.1 Project Overview

The general features of the SSC accelerator and associated facilities have not changed since publication of the FEIS in December 1988; however, some design details have been altered, including those intended to adapt the plans to the features at the Texas site. Changes that have occurred since EIS publication are summarized in the following sections and, when possible, compared with the features assessed in the EIS.

The principal feature of the proposed SSC is the collider ring, a 54-mi-long oval tunnel. (The EIS assessment was for a 53-mi-long tunnel.) Approximately 10,000 superconducting magnets in the form of two rings, one atop the other, would focus and guide two proton beams around the tunnel. Within the magnets, the two proton beams (one in each magnet ring) would be accelerated in opposite directions to an energy of 20 TeV and made to collide with a combined energy of 40 TeV. Special facilities intermittently spaced around the collider ring would provide the power supplies to energize the magnets and the cryogenic system to keep the superconducting magnets cooled to a temperature near absolute zero.

Other prominent features of the proposed SSC design are the experimental areas, the injector facilities, and the campus areas. The experimental areas would contain the detectors used to record particle collision products, support buildings, and support facilities. The injector facilities would consist of four separate cascading accelerators in which the proton beams first would be formed and then accelerated to the required energy for injection into the ring magnets in the collider tunnel. The campus areas would include the main laboratory and administration building, the auditorium, warehouses, support facilities, and a number of shop buildings.

2.1.1.2 Conventional Facilities

Site and Infrastructure

The Texas proposed layout of the SSC project in response to the ISP is shown in Figure 2.1. This layout was the *footprint* used for impact assessment in the EIS. The *site-specific footprint* is shown in Figure 2.2. General access to the SSC site would be provided by adding two lanes to Texas Farm-to-Market Road 66 (F.M. 66), which links to Interstate Highway 35 (I-35). The principal roads within the project boundaries would be those servicing the facilities along the collider ring and local roads within the campus areas.

Campus Areas

There would be two campus areas to accommodate SSC Laboratory (SSCL) activities, one on the east for experimental detector operations associated with the east set of collision points and the major campus area on the west to accommodate the injector, general laboratory and administrative support activities, technical support activities, and the experimental detector operations associated with the west collision points. SSCL (1990, Table 6.1.1-2) lists approximately 857,000 ft^2 of building space, excluding the injector, to accommodate these functions and personnel in the west campus area, including 425,000 ft^2 for central laboratory office and support functions; 310,000 ft^2 of industrial-type space for equipment assembly, fabrication, and testing; 105,000 ft^2 of warehouse space; and 63,000 ft^2 for shops, emergency response, and waste handling. This table reflects the type and level of activities required to carry out the fully scoped SSCL program. An artist's rendering of how these facilities might be arranged is shown in Figure 2.3. In this layout, the warehousing (including general warehousing), accelerator parts and supplies, and magnet storage (MAAS) would be grouped near the west experimental area, as would the industrial buildings, including accelerator shop building (ASB), magnet development laboratory (MDL), and detector development. The final design of the area will take advantage of existing landscape features and avoid wetlands and floodplains.

A different optimization of the west campus area functions is shown in Figure 2.4. Major industrial-type activities are grouped around the E1 service area to make use of the existing refrigeration plant at that location for early magnet testing (MTL) and systems development (ASST). This arrangement potentially reduces the impact by reducing the heavy concentration of facilities near the area. It also eliminates the need for separate helium facilities for the test facilities.

As originally proposed, the campus complex (A area in the EIS) would contain approximately 20 large buildings and would be located in the 7,376-acre west campus area. The buildings, which would provide work space for approximately 2,725 employees and 475 visiting scientists, would probably include the central office and laboratory building, six heavy works buildings, three shop buildings, and several support buildings.

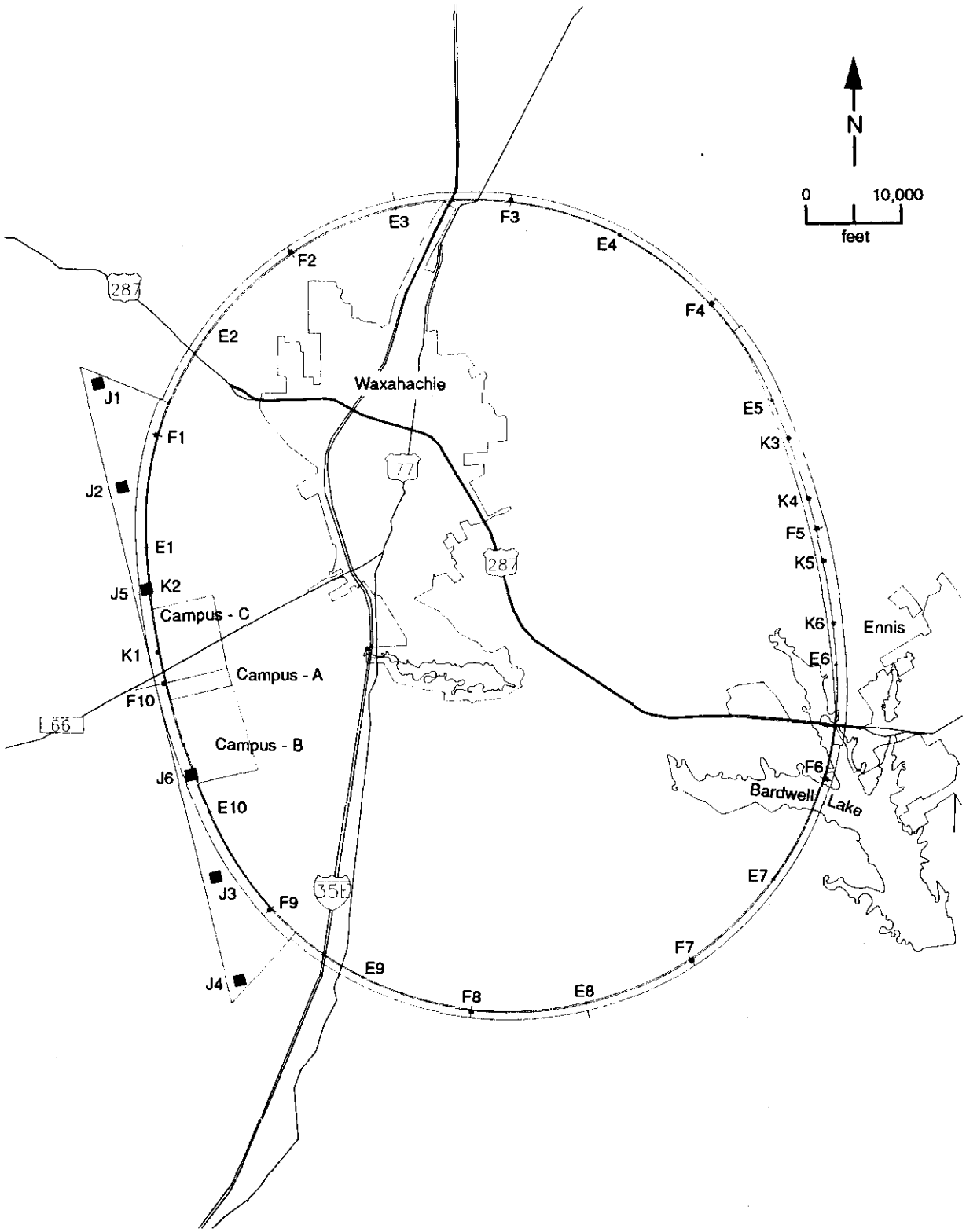


FIGURE 2.1 Texas Proposed Footprint

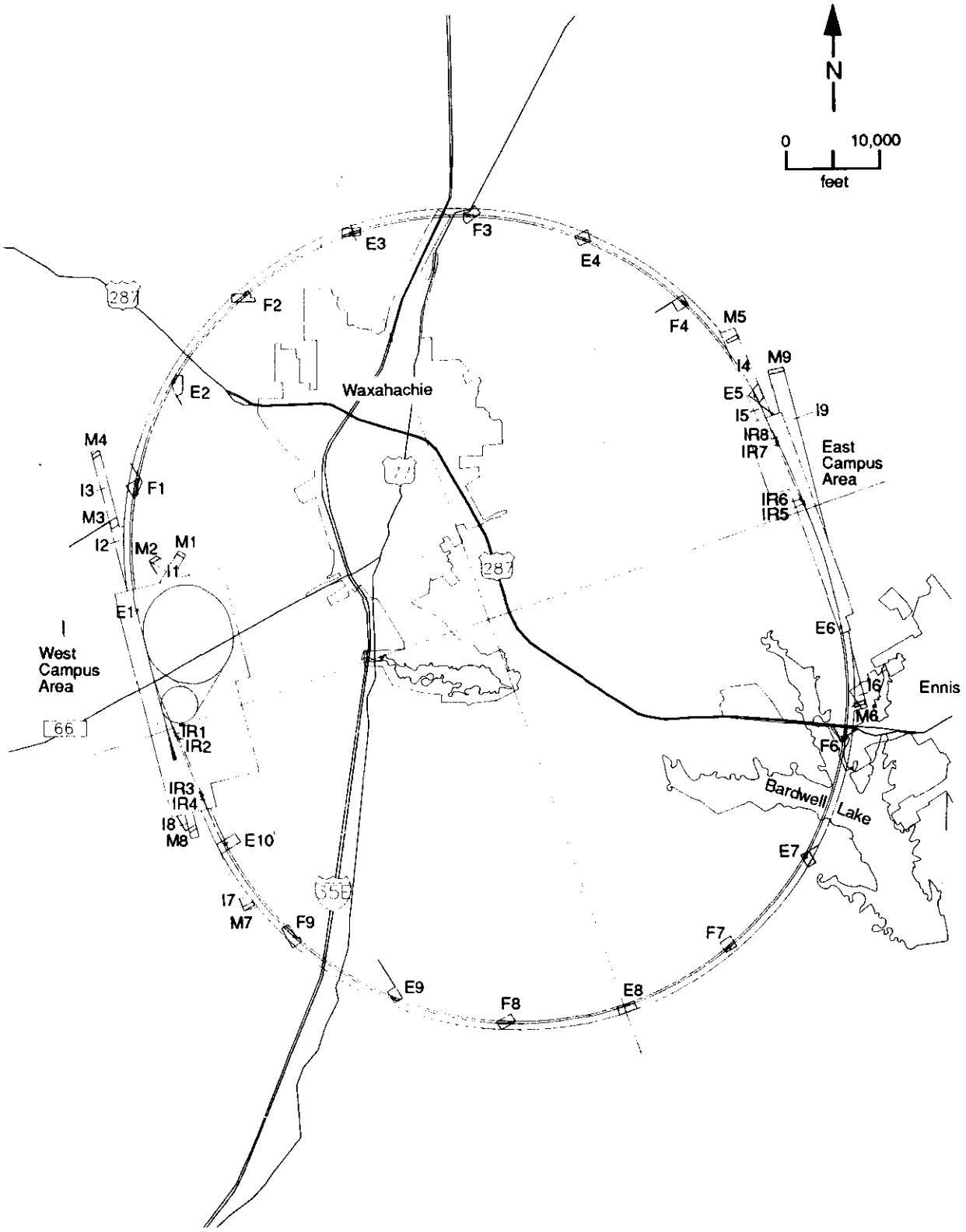


FIGURE 2.2 Site-Specific Footprint

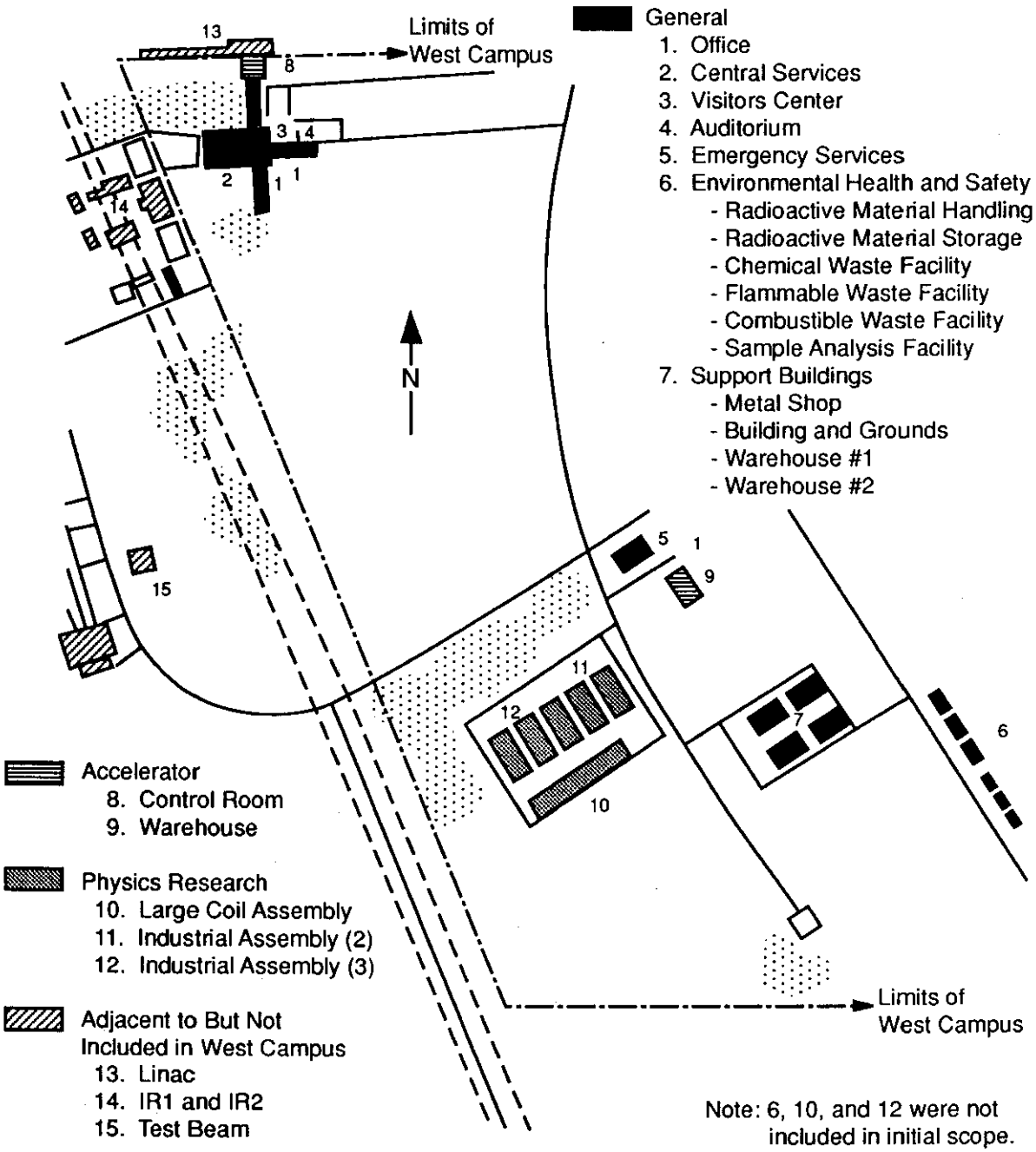
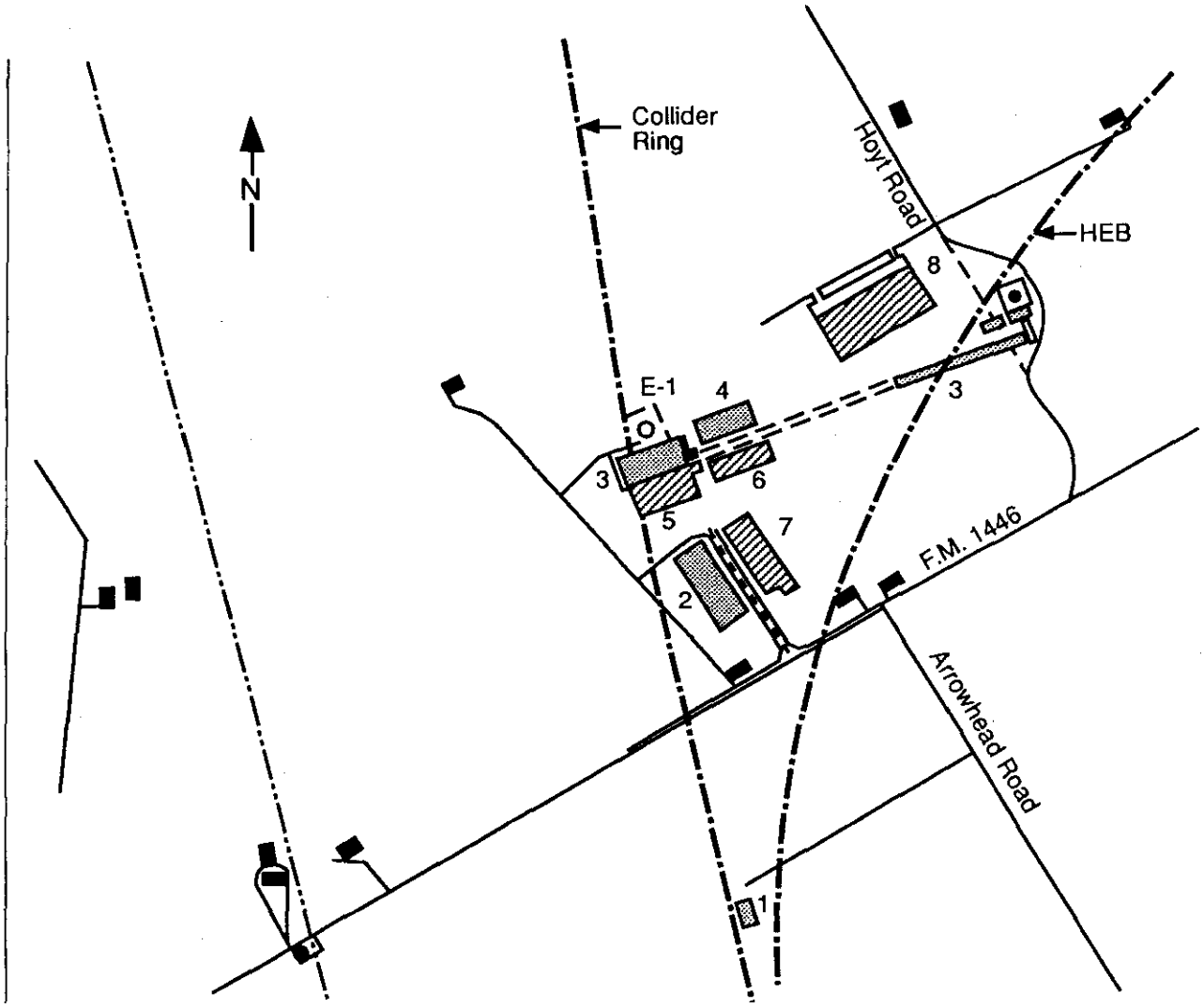


FIGURE 2.3 Artist's Rendering of West Campus Showing Surface Facilities (Source: SSCL 1990)



1. Collider Radio Frequency Hall
2. ASB
3. ASST
4. ASST Compressor
5. MTL
6. MTL Compressor
7. MAAS
8. MDL

Existing Building

FIGURE 2.4 Artist's Rendering of West Campus Showing North Area Detail (Source: SSCL 1990)

Parking spaces would be provided for about 1,800 vehicles. The areas around the surface buildings would be landscaped, and sensitive project areas would be protected by fences.

A large-scale rendering of the west campus is shown in Figure 2.5. As illustrated, several cooling ponds would be required. A surface area totaling approximately 160 acres (SSCL 1990) would be required for cooling ponds in the west campus. Exact locations and configurations will be determined during detailed design plans. The ponds would be lined with a geotextile polymer mat fabric or equivalent liner to prevent leakage. The liner would be covered with a crushed layer (average thickness of 2 ft) of Austin chalk placed on the pond bed and riprap along the banks to stabilize the pond. The water would be cooled by water fountains used for aeration. Pond water temperatures are expected to vary between 85° and 100°F.

The east campus area would encompass about 1,861 acres. The conceptual design layout is shown in Section 2.2. There would be about 15 buildings in the northeast and southeast experimental halls and east central assembly area. The east campus area would have six to eight cooling ponds having a total surface area of less than 50 acres.

The original SSC configuration, as described in the EIS, included six buried beam zone access areas called the "J" areas. These areas, totaling 240 acres, were to be held in reserve for future experimental programs that could not be defined at the time the ISP was issued. Similarly, the present layout of the SSC includes area M9 of approximately 15 acres adjacent to the east campus. This area is to be held in reserve for a possible future fixed-target experimental program. Slow extraction of the main collider beam has been studied and found to be feasible (Colton et al. 1984; Wenzel 1984); however, a specific configuration for a possible fixed-target facility has not been defined. If such a facility is proposed in the future, appropriate NEPA documentation will be prepared.

Injector

The proposed injector (B area in the EIS; now included in A area) would encompass the surface and subsurface structures containing the technical systems that generate, accelerate, and inject the protons into the collider ring. These structures are the linear accelerator (Linac), low-energy booster (LEB), medium-energy booster (MEB), and high-energy booster (HEB), including test beams from both the MEB and HEB. Cut-and-cover techniques will be used to construct the Linac and LEB. The HEB will be constructed with tunneling techniques. The MEB will utilize one-third cut-and-cover and two-thirds tunneling techniques.

Present plans are for the HEB to be a 2-TeV accelerator rather than the 1-TeV machine discussed in the conceptual design report and the EIS. The 2-TeV design would approximately double the diameter of the HEB ring. Because of the surface topography in the planned HEB area, the higher-energy booster would be housed in a tunnel excavated with a tunnel-boring machine rather than just below the surface, as described in the EIS. Impacts from this change are included in the assessments of total land requirements and spoils generation presented in Sections 4.1 and 4.4. In addition, the configuration of the injector system is now planned to be "flipped" from the

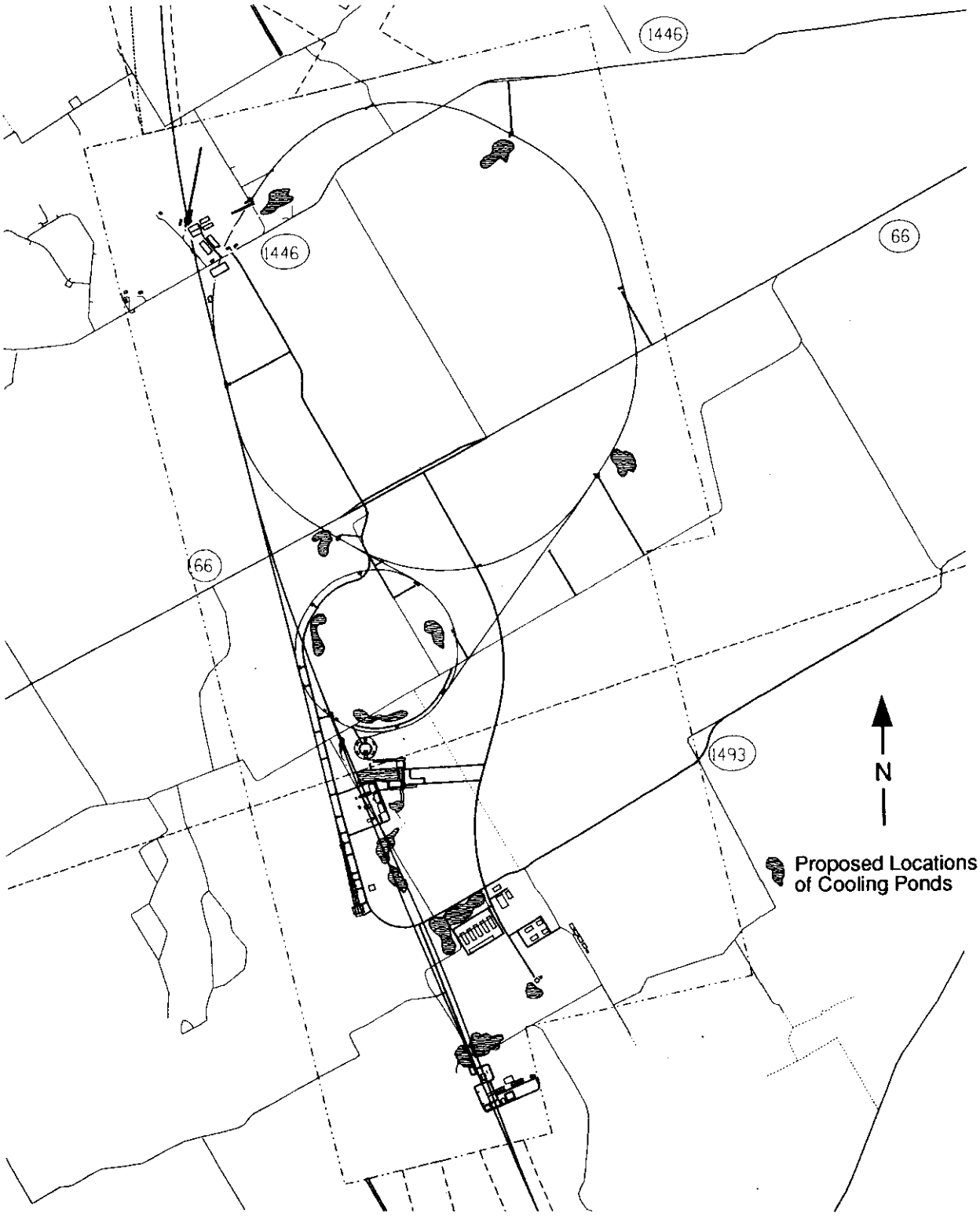


FIGURE 2.5 Large-Scale Artist's Rendering of Possible Configuration of the SSC West Campus Area

configuration discussed in the EIS. The expanded area for the HEB encompasses the C area and most of the A area described in the ISP. The ISP B area would include the main campus.

The Linac enclosure would be 800 ft long and would have inside dimensions of 12 ft by 12 ft. It would be 20 ft below ground, would have three 8 ft by 12 ft exit/vent shafts, and would be connected to the LEB by a 364-ft-long transfer tunnel (SSCL 1990).

The LEB would be installed in a ring-shaped tunnel having a circumference of 1,771 ft and inside dimensions of 12 ft by 12 ft. It would be 25 ft below ground and would be connected to the MEB by a 720-ft-long transfer tunnel. The LEB would have two 12 ft by 12 ft exit/vent shafts and several surface buildings.

The MEB would be installed in a ring-shaped tunnel having a circumference of 12,989 ft and a 10-ft-diameter circular cross section. It would be a minimum of 25 ft below ground and would have two transfer tunnels connecting it to the HEB. The MEB ring would have two 15-ft-diameter, three 8-ft-diameter, and one 30-ft-diameter intermediate-access shafts and associated surface buildings.

The HEB would be installed in a ring-shaped tunnel having a circumference of 35,719 ft and a 12-ft-diameter cross section. It would be approximately 200 ft below ground and would have two transfer tunnels connecting it to the collider ring. Situated at equal intervals along the HEB ring would be several clusters of underground enclosures and associated surface buildings. These features would include the following major facilities: three, 3-ft-diameter power supply shafts, four 15-ft-diameter exit/vent shafts, two 30-ft-diameter exit/vent shafts, intermediate access shafts, service areas (compressor and refrigeration buildings, power supply, and cooling ponds), inject/eject facilities, beam backstops, and radio-frequency enclosures.

The test beam facility would consist of a 7,329-ft-long, 10-ft-diameter future tunnel; 29 underground magnet enclosures; 3,308 ft of 6-ft-diameter interconnecting concrete pipe; 2,238 ft of 16-in.-diameter interconnecting stainless steel pipe; one future 2-TeV target hall; three 200-GeV target halls; one calibration hall; and 15 utility buildings.

Collider Ring

The proposed collider ring (D area) would include the 54-mi-long tunnel housing the main accelerator plus surface areas supporting operational functions such as refrigeration, ventilation, personnel and materials access and exit, and beam inject/extract facilities (Section 2.2.1.3). The collider ring tunnel would have a cross section as shown in Figure 2.6. This figure illustrates the various components of the collider ring. The tunnel lining might consist of shotcrete, reinforced concrete, or precast concrete segments, as required by local geology. The tunnel floor would accommodate the support frames for the superconducting magnets, provide sufficient work space, and allow adequate clearance for magnet transport vehicles.

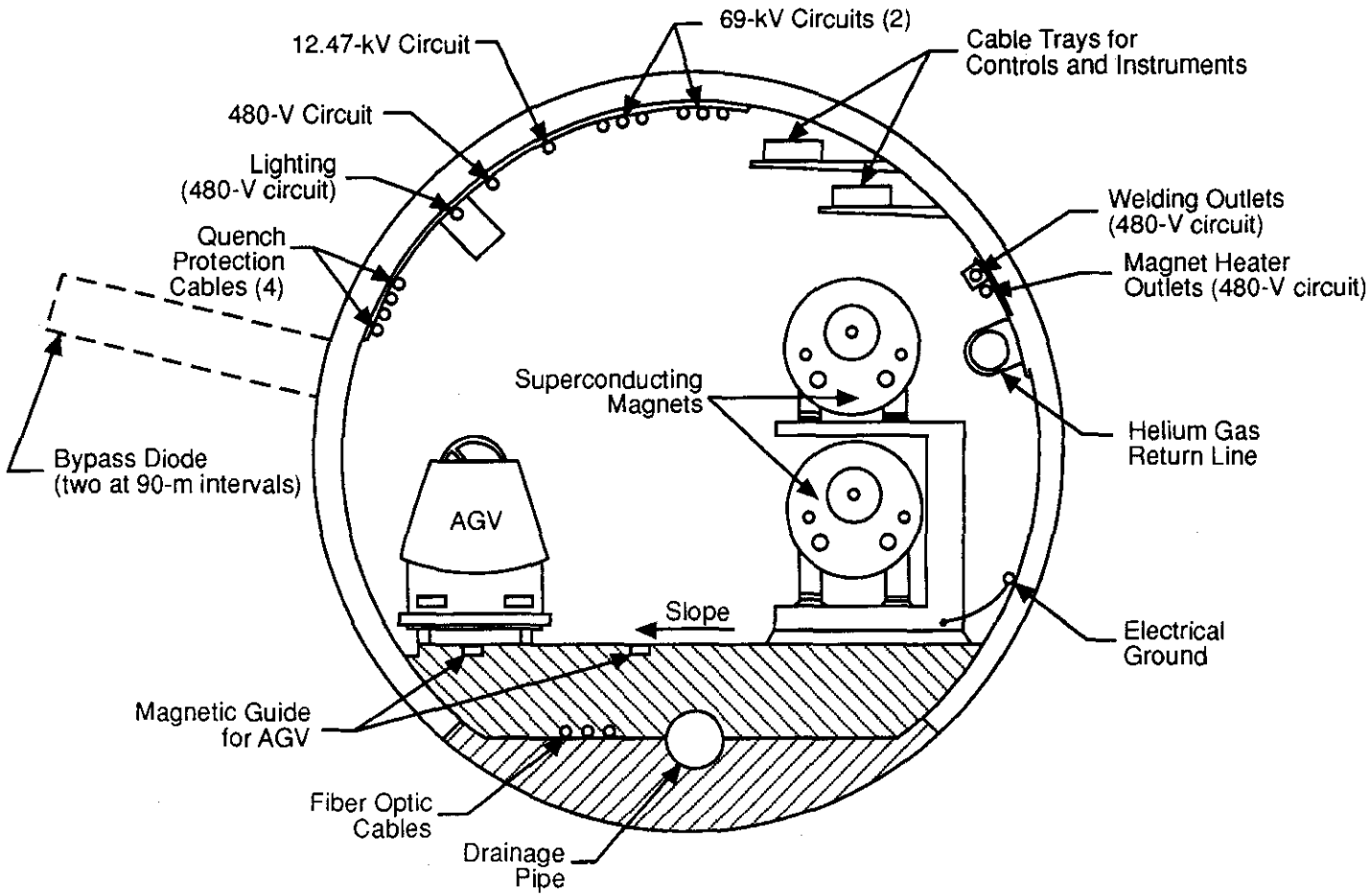


FIGURE 2.6 Collider Ring Tunnel Cross Section (Source: SSCL 1990)

The depth of the tunnel below the surface would range from 50 ft to approximately 240 ft, with an average depth of about 150 ft. The tunnel would be in a tilted plane with a dip angle of 0.17°; thus, the variation in depth from the surface would be related to both the variation in altitude of the surface topology and the dip angle. Near its connections to the HEB, the collider ring would contain a cluster of facilities involving proton beam injection, acceleration, and beam extraction.

Experimental Facilities

Interaction regions (IR) would be provided within each of the two collider ring segments to connect the upper and the lower areas. Up to four such areas would be located on the west and four on the east. Space for future experimental facilities would be provided in the east cluster. Particles from the two beams would collide at the interaction points. To study these collisions, the collision point would be surrounded with a detector capable of registering the matter and energy of particles produced by the collisions while at the same time allowing the free flow of protons along the beam line.

As mentioned in the FEIS (Vol. I, Section 3.2.3), beam bypasses in conjunction with interaction areas have been studied extensively. It has been concluded that bypasses will be important for operating efficiency and will reduce the need for "off-line" underground assembly areas. The present conceptual design provides for these bypasses.

The individual SSC detectors are expected to weigh as much as 50,000 tons each. The dimensions of such detectors have not yet been defined, but a range of sizes and shapes is considered possible. Maximum detector sizes probably would be limited by the maximum feasible cavern sizes or excavations that could be constructed in specific geological site locations. The current conceptual design of a representative detector hall is shown in Figure 2.7.

2.1.1.3 Other Facilities

Utilities and other support requirements are essentially unchanged from those described in the EIS. Primary electrical distribution around the collider ring would be at 69 kV.

2.1.1.4 Land Acquisition

Prior to initiation of construction activities, the state of Texas will take title to the land and transfer ownership to the U.S. Government. Acquisition of land may require removal, modification, preservation, and demolition of existing improvements such as buildings and utilities. Additional details are presented in Sections 4.4 and 4.9.

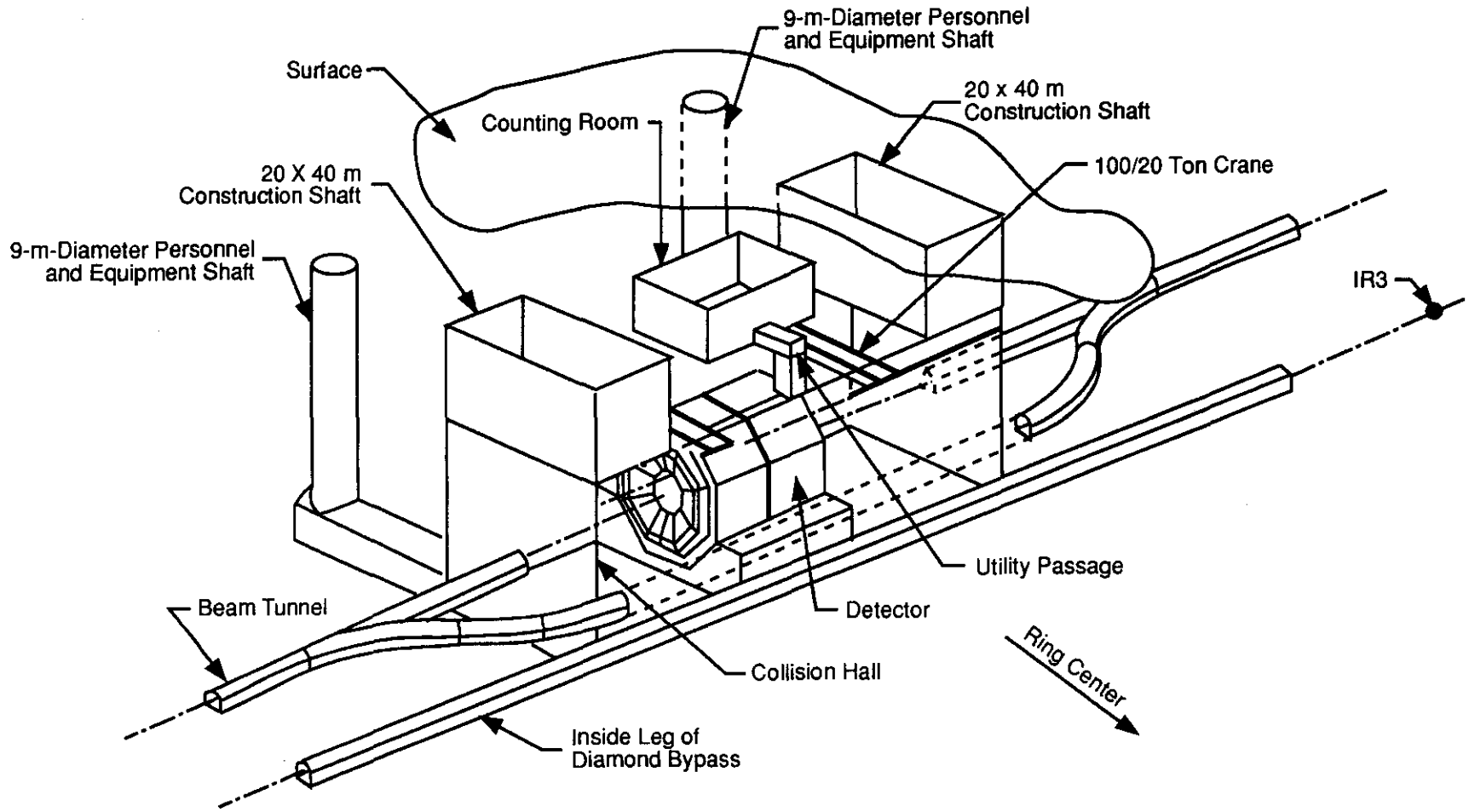


FIGURE 2.7 Conceptual Design of a Representative Large Detector Hall

2.1.2 Construction

Site construction is planned to begin in the spring of 1991 and end in 1998. Construction is expected to start with the upper arc, the west campus, and the injector. Subsequent activities are then anticipated in the upper and lower arcs. Major construction activities would include the following:

- Cut-and-cover excavation and tunneling for installation of some features of the injector facility.
- Vertical excavation of access shafts for the several tunnel access areas, at approximately 2.7-mi increments around the ring.
- Tunnel boring using tunnel boring machines for the 54-mi ring.
- Excavation of four interaction halls by cut-and-cover and caverning techniques.
- Creation of disposal sites for spoils generated from the excavation.
- Installation of services, including power, cryogenics, water, and waste treatment, at the several service areas.
- Construction of campus facilities and service area facilities around the ring.
- Startup and testing of magnets, detectors, and other technical systems.
- Construction of access roads, site service roads, utility substations, and utility corridors.

A proposed construction schedule and cost estimate is contained in the site-specific conceptual design document (SSCL 1990). This schedule is subject to final design considerations.

2.1.3 Operations

SSC operations would begin in late 1998 and continue for 25-35 years. Some test beam operations for the testing of detector components are expected to start in 1996 when the MEB becomes operational. Operations would include beam testing and the following routine activities:

- Use of collider rings for high-energy physics research or accelerator and development studies (250 days per year).

- Use of HEB accelerator to generate beams for testing detector components (independent of collider operations).

- Scheduled machine and detector maintenance and repair (115 days per year).

For conciseness, specific aspects of operations are described in Chapter 4 as part of the relevant impact analyses.

2.1.4 Future Expansion

The ISP specified that a future expansion area (C area) of approximately 1,450 acres be provided in fee simple title. The surface and near-surface areas above the HEB would be unoccupied except for several service areas along the circumference. In addition, not all of the west campus area will be occupied by facilities. Thus, much of this area would be available for future expansion. It is unlikely that future construction and operation would be different in nature from the present design for construction and operation of the SSC. Experience at other accelerator laboratories (e.g., Fermilab, SLAC, and CERN) is that an accelerator, once built, is not a fixed entity throughout its useful life. On the contrary, as new discoveries are made through use of such accelerators, new ideas emerge for modifying and improving these machines for different classes of experiments. On a machine at the forefront of knowledge such as the SSC, it is inevitable that such ideas for enhancement of capabilities will emerge. Further NEPA review would be performed for any proposal for development in these areas.

2.1.5 Decommissioning

When decommissioning of the SSC facility is proposed, additional NEPA review will be performed. The DOE has prepared a preliminary decommissioning plan for the SSC and has estimated order-of-magnitude costs for implementing such a plan. This plan is summarized and the potential environmental impacts are evaluated in the FEIS (Vol. IV, Appendix 3). This preliminary evaluation indicates that decommissioning would be technically, economically, and environmentally feasible.

2.2 DESCRIPTION AND LOCATION OF ANCILLARY FACILITIES

During preparation of site-specific design adaptations and incorporation of design mitigations, plans for a number of ancillary facilities and project-related activities have been changed as against those discussed in the EIS. The following subsections provide summary descriptions of ancillary facilities and modifications to the design.

2.2.1 Service Areas

Under the current design, the near-semicircular upper and lower arcs of the collider ring would consist of 10 tunnel sectors (5 in each arc) separated by 8

intermediate access facilities (hereafter referred to as F areas) and 10 service areas (hereafter referred to as E areas) located at the mid-point of each sector.

Considerable effort has gone into service area siting to mitigate and minimize adverse environmental impacts and, where possible, to enhance environmental characteristics. To define the SSC footprint, including service area locations, DOE consulted with representatives from the Texas National Research Laboratory Commission. Fifty acres surrounding each shaft location were identified and the boundaries adjusted to minimize the number of landowners affected. Each proposed service area has been studied in detail with regard to access roads, floodplains, wetlands, soils, slopes, present land use, access, viewshed, watershed, noise receptors, and parcelization. Maps of each of these parameters were prepared for each service area. A composite map was then prepared for each area that indicated all gradations from least suitable to most suitable for locating facilities. Figure 2.8 shows graphically the service area evaluation process for each environmental feature. Specific plans for each service area were then prepared to optimize, to the extent possible, facility locations at each area. Details of the service area siting process are contained in SSCL (1990).

The E areas would be located at 5.4-mi intervals around the ring. Each such area would include buildings, storage facilities for cryogenic (i.e., coolant) liquids and gases, a cooling pond, a 30- or 55-ft-diameter shaft, and a system of tunnels connected to the collider ring tunnel. Each F area would include a surface building, a 15-ft-diameter shaft, and a system of tunnels connected to the collider ring. The F areas may eventually contain the same facilities as the E areas. The need for development would be based on the amount of refrigeration needed. Further details on design features of the facilities and equipment proposed for E and F areas are included in SSCL (1990). Figure 2.9 is a schematic diagram showing the spatial relationship of the facilities at E7, which was selected as the example service area to be included in the impact analysis discussion for all technical disciplines. The same level of environmental characterization was conducted for all other service areas (except for E8), as presented in SSCL (1989).

Service area E8 is sited in the floodplain of Little Onion and Big Onion creeks. A detailed engineering analysis is being performed to determine the most feasible alternative for final siting and design. At this time, five alternatives are under consideration (Figure 4.3). The technically optimal location would place the surface facilities associated with the E8 cryogenics, headhouse access road, and cooling ponds in the floodplain. This placement would result in a disturbed area of approximately 20 acres, of which 5-10 acres would be elevated above the floodplain approximately 12-15 ft. Surplus spoils would be placed outside the floodplain. The preferred location for placing the facility outside of the floodplain is option 1. The land area boundary for this option is shown in Figure 3.6j (area E8a). Specific hydrologic analysis and assessment of floodplain and wetland impacts will be performed prior to development of this alternative. The four additional alternatives place all facilities outside the floodplain, with additional underground construction for the connection to the collider ring.

All E and F areas would require about 50 acres each to allow the necessary flexibility in siting surface facilities, including spoils disposal berms and cooling ponds.

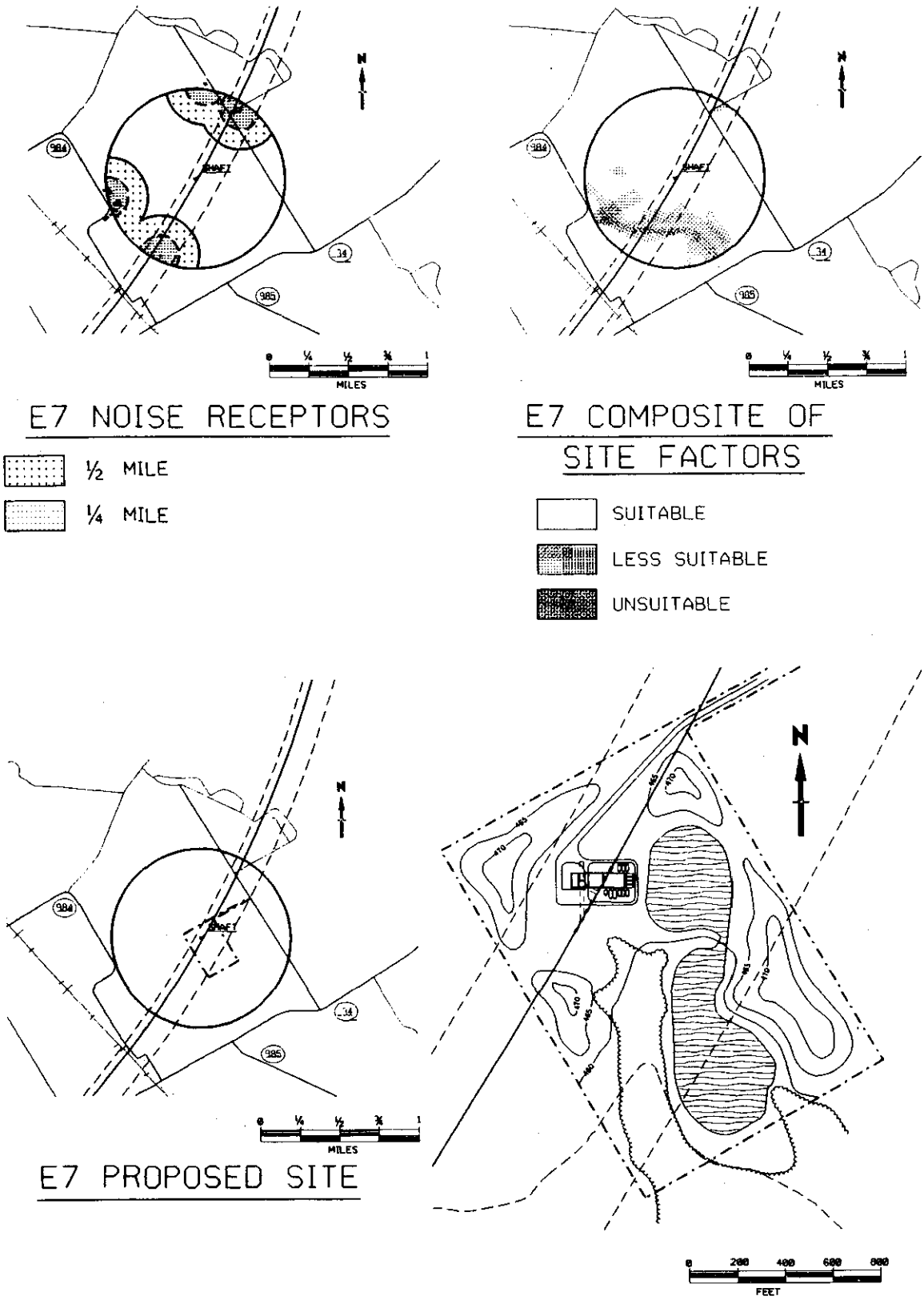
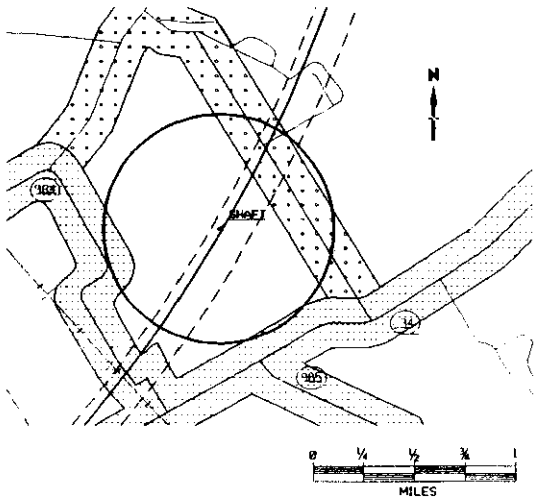


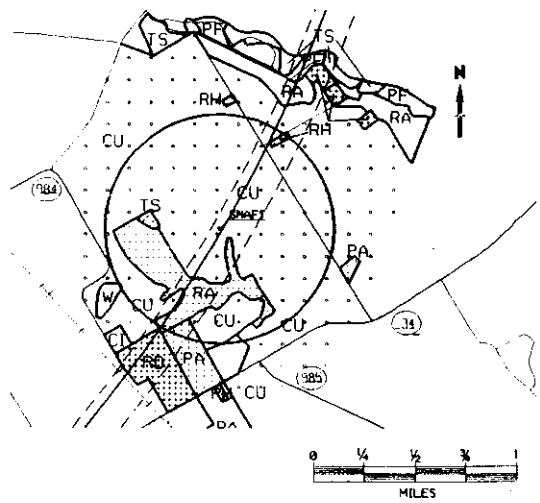
FIGURE 2.8 Schematic Depiction of Evaluation Process for E7 Area



E7 ACCESS

LIGHT DUTY

MEDIUM DUTY



E7 LAND USE

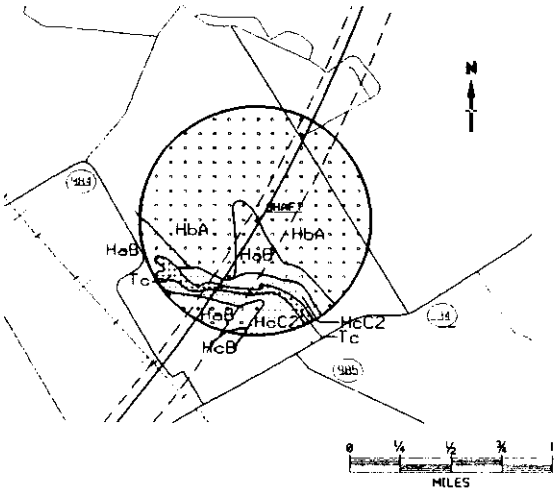
CULTIVATED FIELD

RESIDENTIAL

RANGE

TREES & SHRUBS

PASTURE

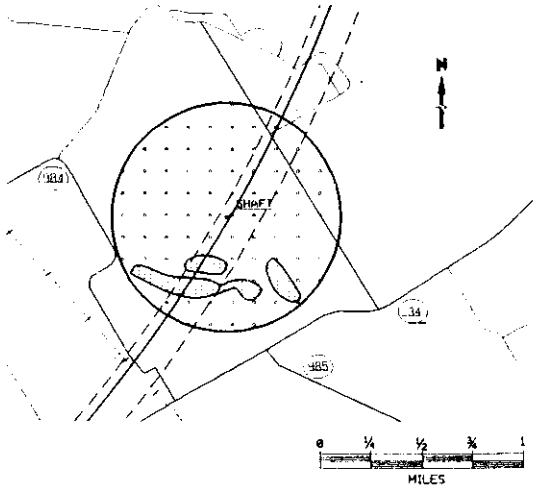


E7 SOILS

MOST SUITABLE

ACCEPTABLE

UNSUITABLE

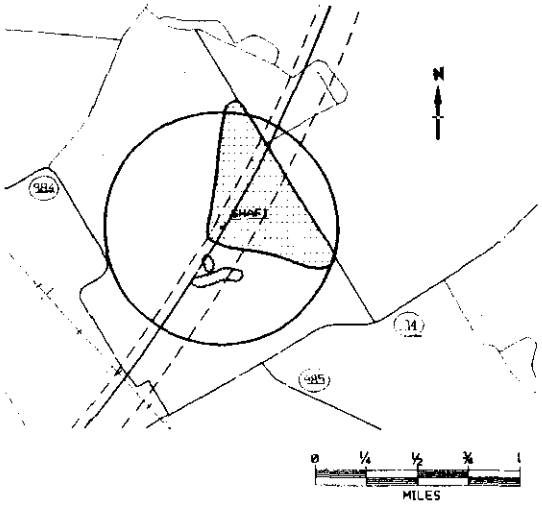


E7 SLOPE

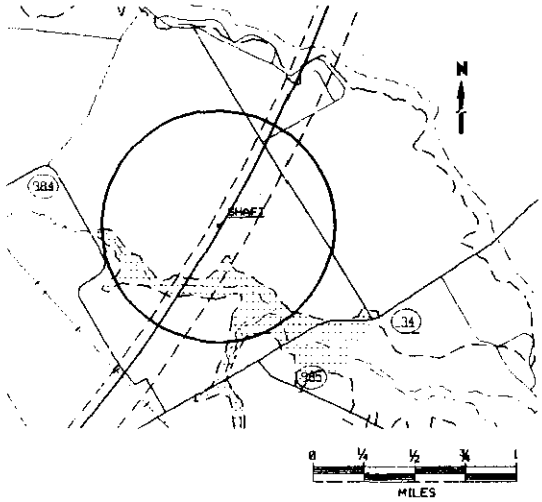
5 - 10 %

0 - 5 %

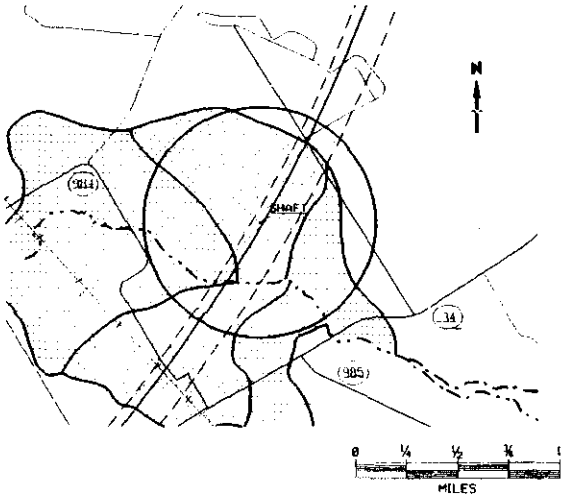
FIGURE 2.8 (Cont'd)



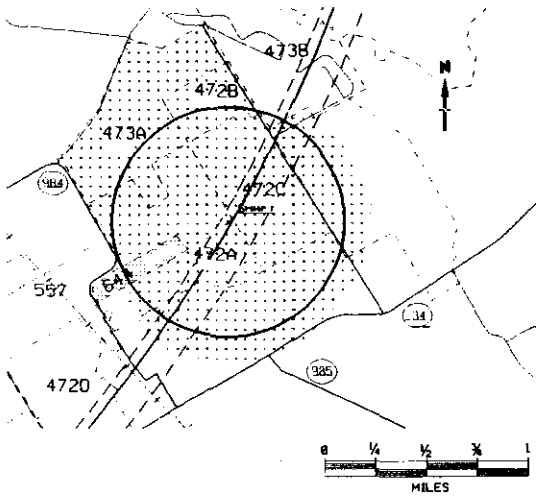
E7 VIEW SHED



E7 FLOODPLAIN



E7 WATERSHEDS



E7 PARCELIZATION

> 50 ACRES

20 - 50 ACRES

FIGURE 2.8 (Cont'd)

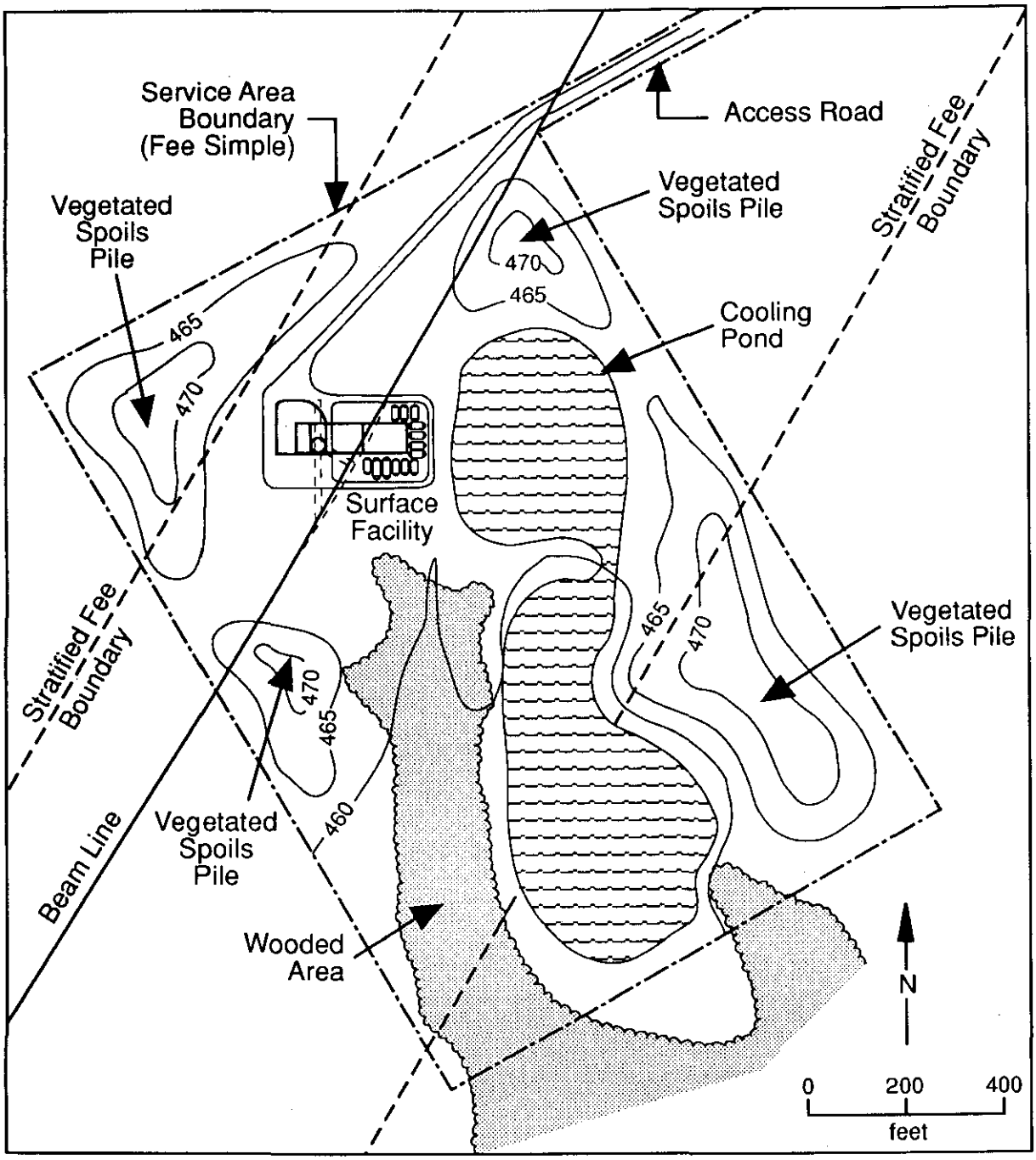


FIGURE 2.9 Schematic Diagram of Facilities at E7 Area

An artist's rendering of the E7 area is given in Figure 2.10. This rendering reflects a likely design layout for the area.

Two design changes in the SSC project since the EIS was published necessitated an increase in land requirements for the E and F areas. One change is to dispose of tunnel and shaft borings (i.e., spoils) at the service areas rather than in nearby abandoned quarries, as was discussed in the FEIS (Vol. I, Section 3.4). The other change is the proposed use of cooling ponds rather than mechanical-draft cooling towers for heat dissipation. Cooling ponds serve to cool SSC refrigerators and power supplies. These two changes increased land area requirements for each service area from an estimated 1-6 acres to approximately 50 acres. The use of quarries for spoil disposal was eliminated from further consideration because of the impacts associated with transport and the potential impacts to wetlands currently found at the quarries.

2.2.1.1 Heat Rejection Systems: Cooling Ponds versus Cooling Towers

It is now proposed to use cooling ponds to dissipate heat from SSC technical systems at each of the service areas rather than the mechanical-draft cooling towers proposed in the conceptual design document (SSCL 1990). This design modification was partly based on Fermilab's successful experience with cooling ponds and on a comparison of the characteristics of and impacts associated with the two cooling options (Table 2.1). Of particular importance was the wish to avoid the noise impacts of cooling tower fans (FEIS, Vol. IV, Appendix 9, Section 9.1.3). (The cooling tower option is assessed in detail in the FEIS [Volume IV, Appendixes 1, 7, and 9].) In addition, cooling ponds were determined to be less expensive than cooling towers to construct and operate. Cooling ponds are also comparably efficient, given the relatively low humidity in Ellis County. However, the cooling tower option could again be considered during the final design phase.

Each cooling pond will cover approximately 7-10 acres and will have an average depth of 10-20 ft. Maximum depths will range from 20 to 30 ft. A 7-acre pond of 10-ft average depth will have a storage volume of approximately 3,050,000 ft^3. Heat exchangers at each service area will consist of both open- and closed-loop circuits. The open loop will be fed at the inlet with water from the pond bottom. The water temperature at this depth is expected to remain at 85°F. Outlet temperatures from the open loop will be approximately 100°F, requiring spraying to dissipate heat during the summer. The water temperature will change from 90° to 110°F and from 90° to 120°F for the helium compressor and the power supply system closed cooling loops, respectively. Makeup water for the cooling ponds will come from surface supplies or
106 from wells penetrating the Woodbine or Twin Mountains aquifer. In the event groundwater is used, the makeup water will be approximately 100°F, and spraying will be required to lower the water temperature. Cooling pond temperature will range from approximately 85° to 100°F, depending on depth and time of year. The cooling ponds will be revegetated along their peripheries, to create an attractive visual arrangement (Figure 2.10).

Algae will be controlled through application of the biodegradable compound triazine (2-chlor-4, 6-bis (ethylamine)-5-triazine). This algicide has been used effectively at Fermilab in northern Illinois.

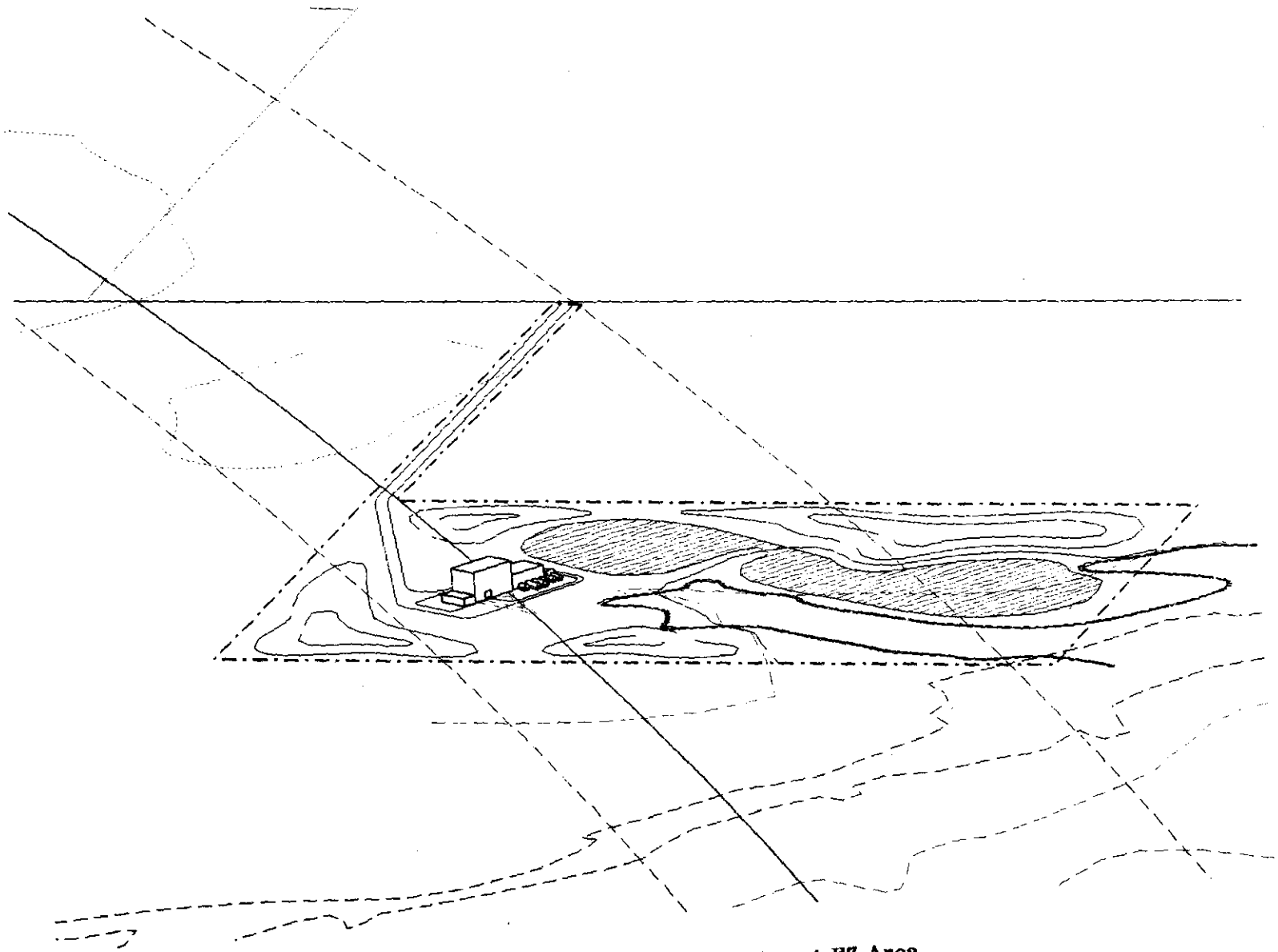


FIGURE 2.10 Artist's Rendering of Likely Layout and Landscaping at E7 Area

TABLE 2.1 Comparison of the Impacts Associated with Mechanical-Draft Cooling Towers and Cooling Ponds

Characteristic	Comparison
Area	Cooling ponds typically require a significant area (i.e., roughly 1 acre per MWt); cooling towers typically require a much smaller area for the structure and associated piping.
Water loss	Depending on their location, cooling towers or ponds can lead to more water loss. In the southwestern United States, cooling ponds usually lead to lower water losses.
Visible vapor plumes	Cooling towers produce longer and higher visible plumes than cooling ponds. Small cooling ponds can lead to short vapor plumes at ground level under extremely cold and humid conditions. These plumes are much shorter than cooling tower vapor plumes.
Deposition of salts and water	Salt deposition can occur close to small cooling towers (tens of meters). The use of sprays in summer can lead to nearby off-pond deposition of water and salts.
Fogging and icing	Isolated fogging and ground icing can occur under extreme conditions very close to cooling towers (tens of meters). Icing from ponds is unlikely, but fogging is possible in early-morning conditions (few meters).
Noise	Cooling towers are inherently noisier than cooling ponds. Noise from cooling towers near site boundaries could lead to exceedance of ambient levels by 10 dBA. Sprayers associated with cooling ponds also produce noise; further, because the sound is propagated over water, close-in residences could experience moderate noise impact.
Visual	Visual impacts from cooling towers and cooling ponds (with associated buildings) will be similar. Cooling tower plumes would be visible off-site under certain weather conditions.

TABLE 2.1 (Cont'd)

Characteristic	Comparison
Reliability	Cooling ponds are more reliable than cooling towers because of their simpler design and fewer components. Spray systems in the cooling ponds are the least reliable component but are used only in summer.
Groundwater contamination	Such contamination would occur only if the pond bottom were to leak.
Corrosion	More expensive piping is likely to be used for cooling ponds because there are fewer materials for controlling corrosion. The water required for heat exchangers is costly because of the need to add anti-corrosion materials.

2.2.1.2 Spoils Disposal

The EIS stated that Austin chalk from tunneling could be disposed of by sale to local cement plants for use in constructing roads or other facilities and that Taylor marl was to be disposed of in abandoned quarries or on-site spoils piles. Disposal of Eagle Ford shale was not addressed (FEIS, Vol. I, Section 3.4). In fact, local cement plants apparently have adequate supplies of Austin chalk and have not expressed interest to the SSCL or the state of Texas in buying chalk from the SSC tunneling operations. It is unlikely that local contractors would become interested in the chalk because it would come from the tunnel ungraded, that is, not in a form immediately useful to them. Most of the abandoned quarries in the area now contain wetlands or have the potential for wetland development. Therefore, a design mitigation strategy was developed that involves using all three types of spoils in landscaped berms at the E and F areas. Topsoil removed during surface preparation and cooling pond excavation will be stored and used as cover material on the berms.

2.2.1.3 Movement of E and F Areas

The locations of the E and F areas have changed from those indicated in the Texas application in response to the ISP and in the EIS. The new locations are necessary given the approximately 8° counterclockwise rotation of the ring necessitated by the findings of geotechnical borings taken in 1989 at various locations around the ring. The rotation allows more of the experimental halls in the west campus area to be positioned

in the Austin chalk, which is a more stable substrate than the Eagle Ford shale that occurs generally in the western and northwestern portions of the proposed collider ring footprint.

2.2.1.4 Detailed Description of Service Area

The following discussion provides detailed information on E7, the example service area, relative to construction and operation activities. The layout of facilities and spoils disposal areas is described in detail to provide a representative picture of a service area site. The respective impact sections in Chapter 4 address construction and operations impacts at E7 and other service areas anticipated to have potentially significant environmental impacts.

The surface construction activities at E7 are expected to last about one year. During that period, vegetation and topsoil would be removed at specific locations for surface facilities and cooling ponds. Topsoil would be stockpiled and used as cover material upon completion of construction activities. Sediment control basins would be constructed, as necessary, to control runoff from disturbed areas. An access shaft would be constructed to the collider ring tunnel. Tunneling would result in 134,000 yd^3 of spoils (Section 4.1) being brought to the surface. The spoils material would be contoured into the existing topography by deposition in berms. The berms are not expected to be higher than 10 ft, and their slopes generally would not exceed 5:1 (i.e., 5 ft horizontal to 1 ft vertical). The berms would be compacted, graded, and covered with topsoil to a depth suitable for revegetation. The berms would be seeded with a mixture of native prairie grasses, forbs, and shrubs. The plant species to be used in revegetation of disturbed areas at the service and campus areas are discussed in detail in Sections 4.3 and 4.10.

The cooling pond at E7 would be about 7-10 acres in surface area (SSCL 1990). The pond would have riprap around the perimeter, slopes of 4:1, and a maximum depth no greater than 20 ft. The pond would be lined with a geotextile polymer mat, or an equivalent, and covered with compacted chalk. Fountains would be constructed for aeration below the normal operating water level. Debris would be cleaned from the water intake screens and elsewhere as required. Addition of makeup water to replace losses from evaporation and seepage is anticipated. Cooling is expected to require approximately 100,000 gal of makeup water per day for each service area during operation.

The service area would have two buildings typically with insulated metal walls and roof panels. The compressor building would consist of acoustically treated paneled siding with sound-control baffles to reduce noise emission. The compressor building would cover an area of 50 ft by 120 ft and would have a steel superstructure with a span of 50 ft that supports a 5-ton bridge crane. Ten helium gas storage tanks, two liquid-helium storage tanks, and one liquid-nitrogen storage tank would be located along three sides of the compressor building. The second building, used for electrical power supply and refrigeration, would be approximately 60 ft tall and cover a surface area ranging from 9,000 to 15,300 ft^2. The building would have a structural steel superstructure, a portion of which would support a bridge crane traveling over the tunnel shaft and adjacent staging area.

A 20-car parking area would be located adjacent to the buildings. Additional design details for E and F areas are provided in SSCL (1990, Vol. II, Chapter 6).

2.2.2 Roads

Projected SSC construction and operational requirements for, and impacts on, Texas roads were described in the FEIS (Vol. I, Chapter 5, Section 5.1.8.6; Vol. IV, Appendix 14, Section 14.2.1). Generally, those descriptions remain valid. However, because the planned locations of E and F areas have changed from those described in the EIS and because locations for monitoring (M) areas have been added to the plans, some of the details of road locations and access roads have changed. Table 2.2 lists currently proposed roadway improvement requirements. The requirements are the same for both construction and operations. Figure 2.11 shows existing roads in the area of the site, and Figure 2.12 shows required roadway improvements and new access roads. An estimated 7.5 mi of new access roads would be required for construction and operation of the SSC; about 8.9 mi of major reconstruction of roads would be needed; and about 11 mi of upgrading would be necessary (Table 2.2).

New roads would be required at both the east and west campuses. Conceptual designs of campus facilities are shown in Figures 2.13 and 2.14. The actual road system would depend on exact locations of individual buildings at these campuses. These new roads would all be within the fee simple area of the SSCL. Considerable flexibility exists in the placement of campus buildings (except for interaction halls and injection facilities). Thus, roads would be designed and located not just to avoid any wetlands or floodplains, but also to enhance the aesthetics of the campus areas to the extent possible. Noise and air quality impacts of construction of campus roads are included in the sections of this SEIS that cover impacts and additional mitigation.

2.2.3 Water

Since publication of the EIS, development of site-specific plans has included reevaluation of SSC water requirements. A more detailed study has been made of cooling water requirements. The results, summarized in Tables 2.3, 2.4, and 2.5, show that total and individual site requirements for water remain approximately the same as those analyzed in the EIS.

Water for the west campus area would be supplied from either of two Tarrant County Water Control and Improvement District No. 1 raw water pipelines in the vicinity of F.M. 664 north of the city of Waxahachie. A booster pumping station would be constructed near the point of connection to the 72- or 90-in. raw water pipelines. The pumping station would require three 1,500-gal/min, 150-hp pumps housed in a building covering approximately 32 ft by 24 ft.

The proposed 61,000-ft-long, 18-in. waterline would be installed in the rights-of-way of F.M. 664, I-35E, F.M. 876, and F.M. 1493 to the west campus. The water would be pumped through the 18-in. waterline to a 1-million-gal storage facility at the

TABLE 2.2 Estimated Traffic Flows and Proposed Roadway Improvements

Route	Segment	Type of Improvement	Length (mi)	1988 Average Daily ADT[a]	SSC Added ADT	Construction Year
Reconstruction						
F.M. 66	I-35E to SSC campus	Reconstruct from two to four lanes, divided; additional ROW[b] (100 ft exist); replace bridge at I-35E	5.4	3,400	3,300	1
Wright Road	I-35E at F.M. 329 to F9 site	Reconstruct	1.5	N/A[c]	100	3
Long Branch Road	F.M. 1387 to F2 site	Reconstruct	2.0	N/A	100	3
Upgrading						
Skinner/Honeysuckle roads	F.M. 875 to Honeysuckle Road/Skinner Road to E2 access road	Upgrade	1.5	N/A	100	3
Bozek Lane	S.H.[d] 34 to E7 access road	Upgrade	0.9	N/A	100	3
Gun Club Road	I-35E to Patrick Road	Replace bridge at North Grove Creek; reconstruct 0.5 mi	0.6	N/A	200	3
Loma Linda/ Pritchett roads	F.M. 813 to E4 site	Upgrade; replace bridge	0.8	N/A	100	3
Holder Road	U.S. 77 to E9 access road	Upgrade and profile improvement at RR crossing	0.8	N/A	100	3

TABLE 2.2 (Cont'd)

Route	Segment	Type of Improvement	Length (mi)	1988 Average Daily ADT[a]	SSC Added ADT	Construction Year
Upgrading (Cont'd)						
Bethel Road	F.M. 876 to E10 site	Upgrade; culvert crossing; bridge replacement	0.8	N/A	100	3
F.M. 1493	F.M. 876 to end of SDHPT[e] maintenance	Add shoulders	2.2	680	2,000	1
F.M. 876	I-35E at Prong Creek	Replace bridge at Prong Creek	0.1	1,100	2,100	1
F.M. 876	F.M. 1493 at Onion Creek	Replace bridge at Onion Creek	0.1	360	100	3
U.S. 287	At F.M. 878	Revise northbound exit and southbound entrance ramps (geom.)	0.1	N/A	N/A	1
F.M. 878	U.S. 287 to F.M. 813	Replace bridge at Bone Branch, upgrade 1 mi	8	2,800	850	1
F.M. 1722	F.M. 879 to Turner Road	Profile improvement at RR crossing	2.0	460	100	3
Total			26.8			
New Construction						
E2 access	Honeysuckle Road to E2 site	New construction on new ROW	0.8	N/A	100	3
E5 access	F.M. 878 to E5 site	New construction on new ROW	0.5	N/A	100	3
E6 access	F.M. 1722 to E6 site	New construction on new ROW	0.5	N/A	100	3

TABLE 2.2 (Cont'd)

Route	Segment	Type of Improvement	Length (mi)	1988 Average Daily ADT[a]	SSC Added ADT	Construction Year
New Construction (Cont'd)						
E7 access	Bozek Lane to E7 access	New construction on new ROW	0.5	N/A	100	3
E8 access	S.H. 34 to E8 site	New construction on new ROW	0.5	N/A	100	3
E9 access	Holder Road to E9 site	New construction on new ROW	0.8	N/A	100	3
F1 access	F.M. 875 to F1 site	New construction on new ROW	1.0	N/A	100	3
F4 access	F.M. 813 to F4 site	New construction on new ROW	0.5	N/A	100	3
M1 access	Carroll Road to M1 site	New construction on new ROW	0.2	N/A	N/A	3
M2 access	Lone Elm Road to M2 site	New construction on new ROW	0.3	N/A	N/A	3
M3 access	Hoyt Road to M3 site	New construction on new ROW	1.1	N/A	N/A	3
M4 access	F.M. 663 to M4 site	New construction on new ROW	0.1	N/A	N/A	3
M5 access	F.M. 813 to M5 site	New construction on new ROW	0.1	N/A	N/A	3
M6 access	Nerida Road to M6 site	New construction on new ROW	0.1	N/A	N/A	3
M7 access	F.M. 876 to M7 site	New construction on new ROW	0.1	N/A	N/A	3

TABLE 2.2 (Cont'd)

Route	Segment	Type of Improvement	Length (mi)	1988 Average Daily ADT[a]	SSC Added ADT	Construction Year
New Construction (Cont'd)						
M8 access	Campus boundary south of Greathouse Road to M8 site	New construction on new ROW	0.4	N/A	N/A	3
Subtotal			7.5			

[a]ADT = average daily traffic.

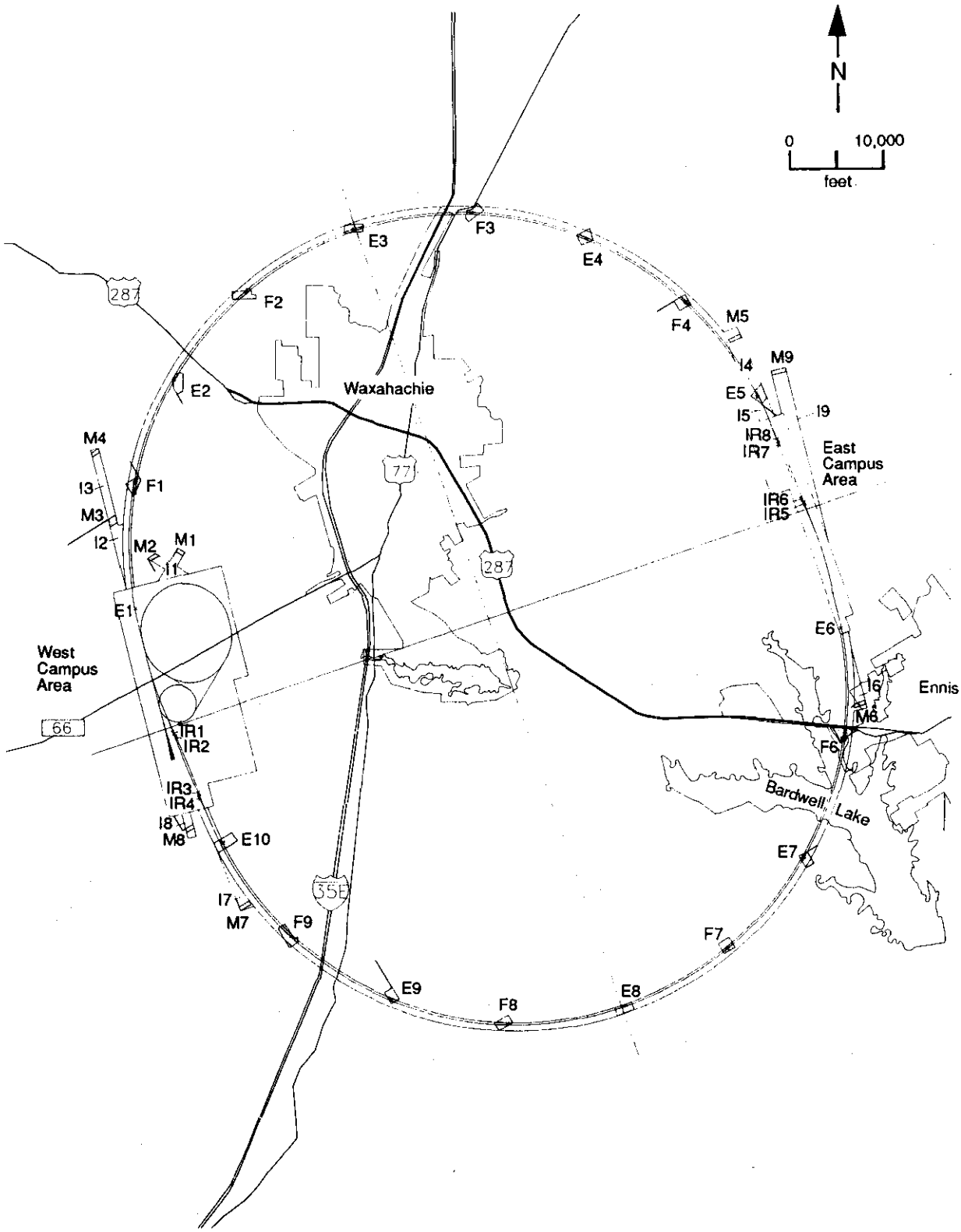
[b]ROW = right-of-way.

[c]N/A = not available.

[d]S.H. = state highways.

[e]SDHPT = State Department of Highways and Public Transportation.

Note: Other roadway improvements are scheduled in Ellis County that are unrelated to the SSC project but that will benefit the SSC. Also, it should be noted that the State Department of Highways and Public Transportation is currently coordinating with the Texas National Research Laboratory Commission to establish a master plan of roadway improvements for the entire SSC area. Information in this table could be modified once the plan is published.



179 **FIGURE 2.11 Existing Major Highways Network in Vicinity of SSC Site (F.M. 878, F.M. 879, and I-45 shown in Figure 2.12)**

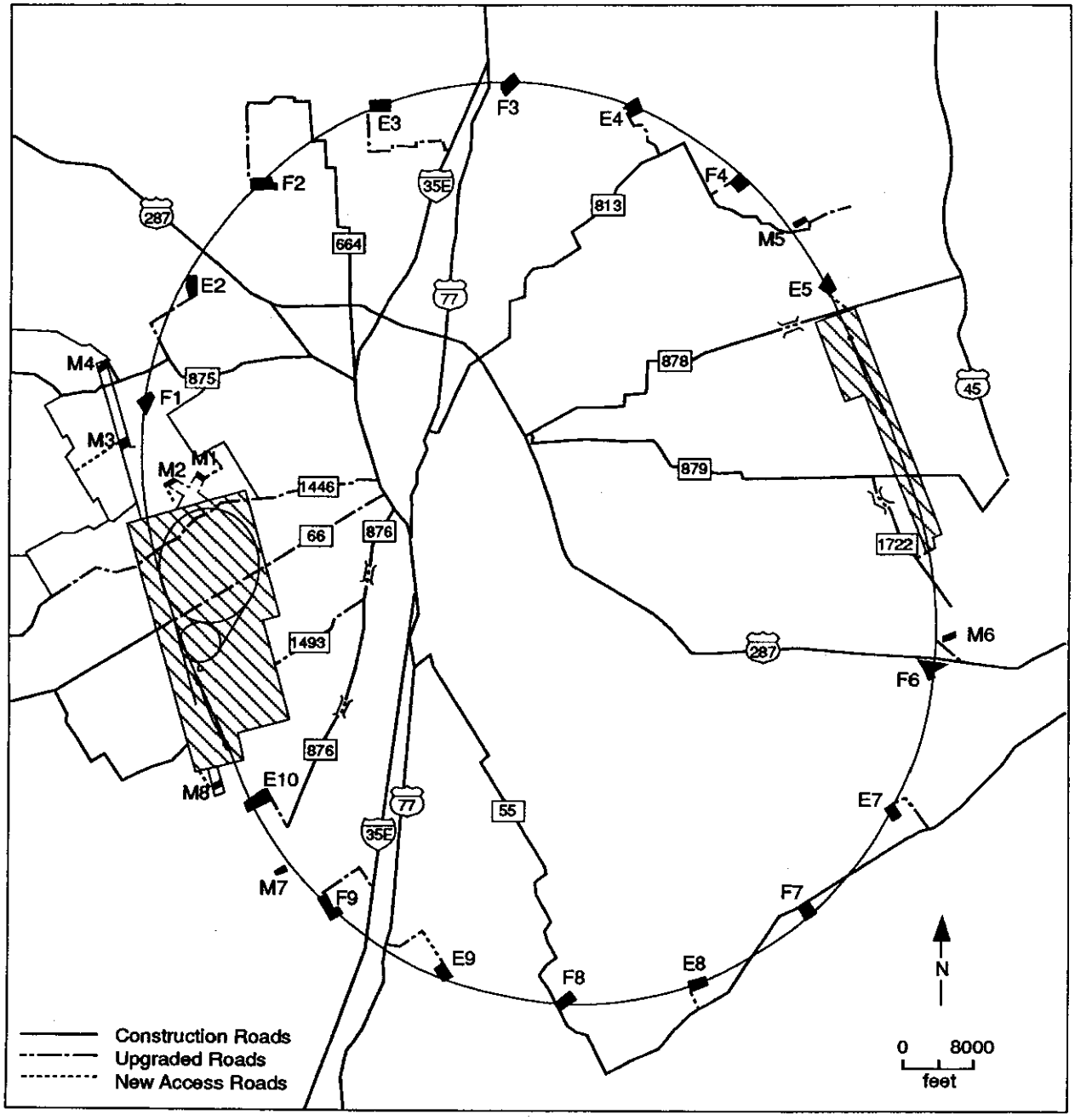


FIGURE 2.12 Proposed Roadway Improvements in Vicinity of SSC Site (all State Department of Highways and Public Transportation improvements not shown) (Source: Schwitters 1990)

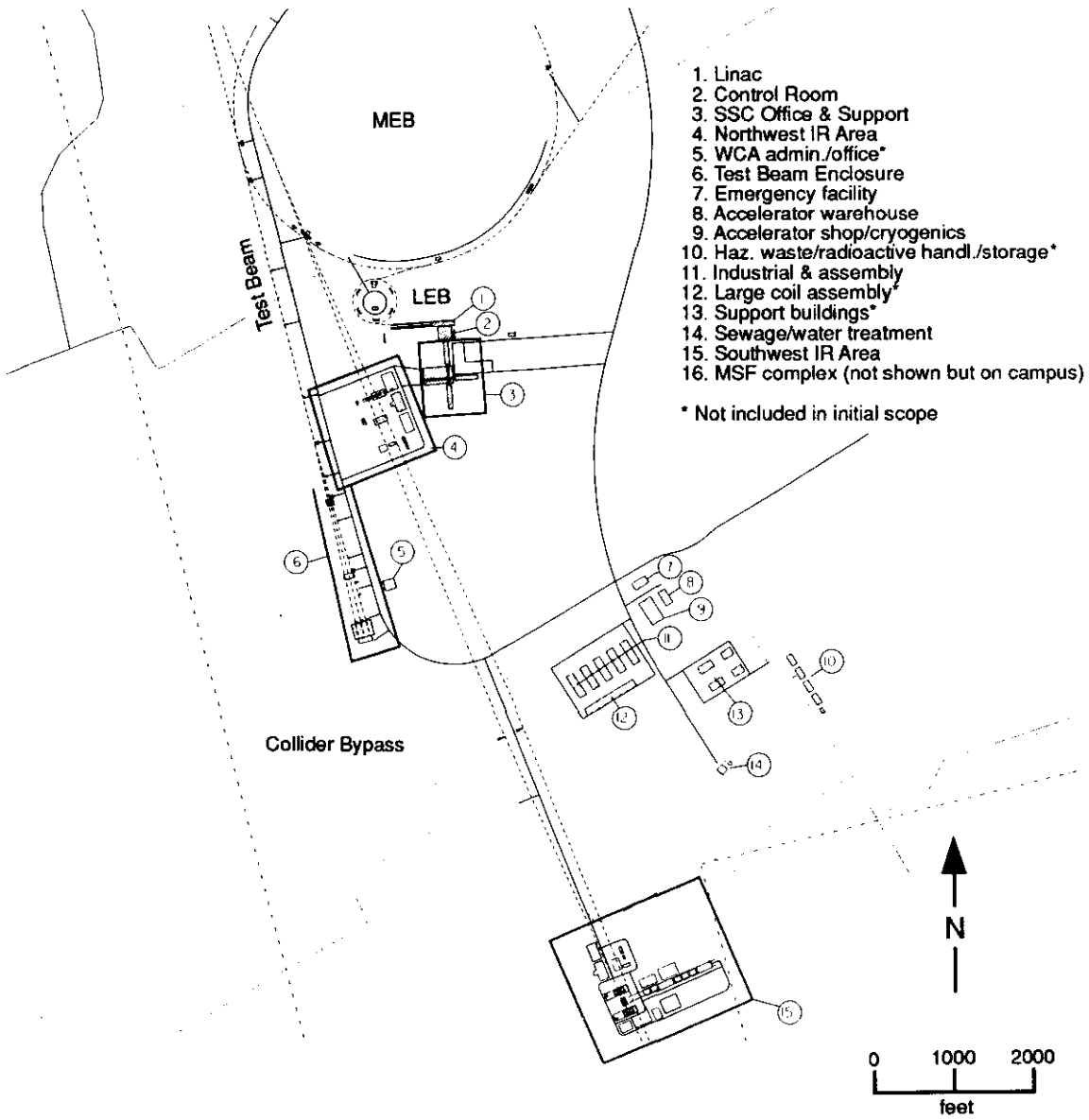


FIGURE 2.13 Proposed Conceptual Design Layout of West Campus Surface Facilities

campus. A 500,000-gal/d water treatment plant and a 250,000-gal storage facility would be constructed to supply potable water for domestic uses.

Water at the east campus would be provided from the 72- or 90-in. raw water pipelines located near the site. A pumping station constructed near the raw water pipelines would send the water through 1,500 ft of 8-in. waterline to a 400,000-gal storage facility. The pumping station would require three 430-gal/min, 10-hp pumps housed in a building of about 200 ft^2. This will require that a water treatment plant be located on the east campus.

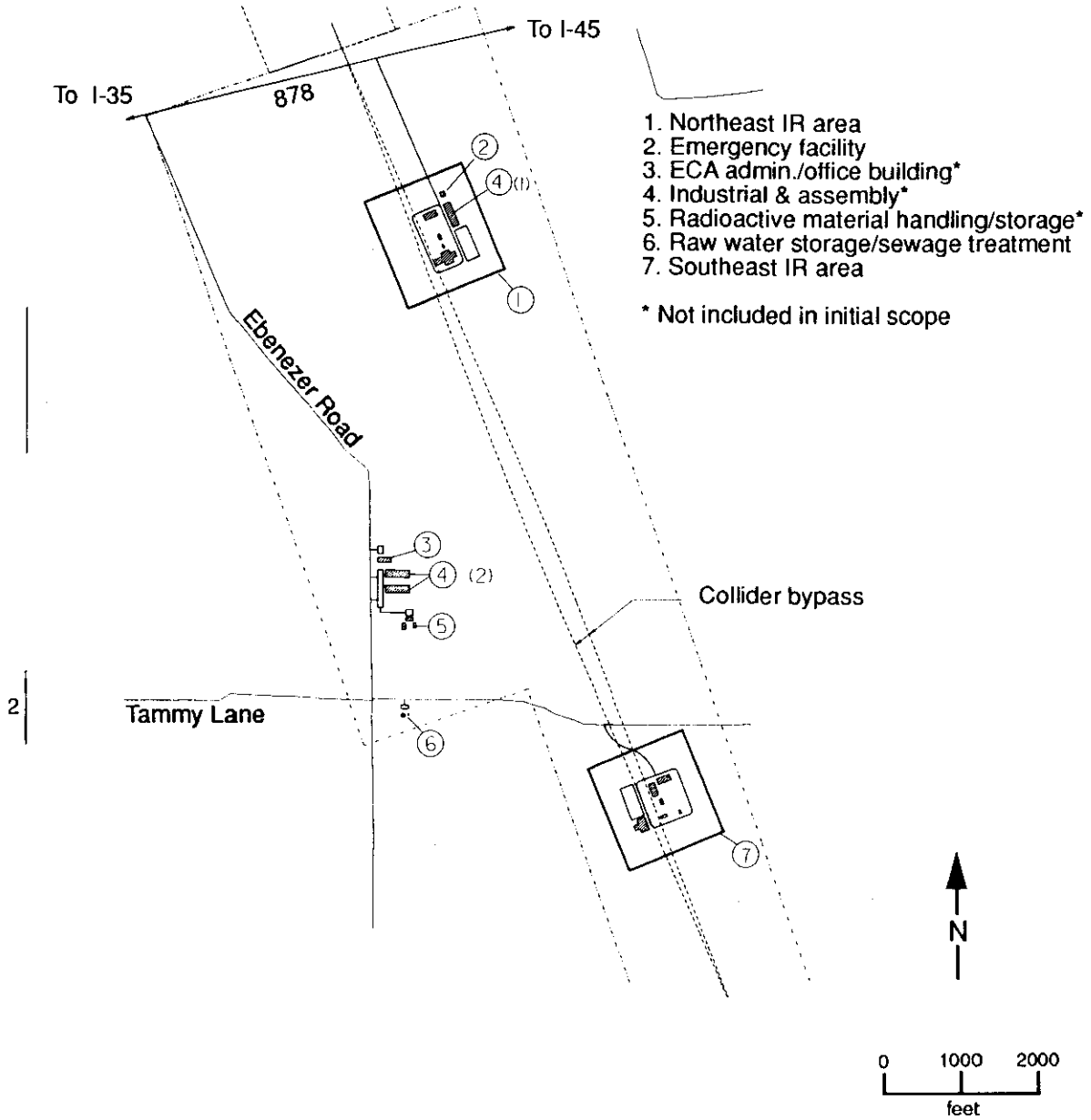


FIGURE 2.14 Conceptual Design Layout of East Campus Surface Facilities

The DOE will assure that appropriate mitigative measures are taken by the SSCL to ensure minimal impact to the environment from construction of water pipelines and pumping stations. The following measures will be a basis for developing a mitigation plan on water pipeline construction:

- Use aerial maps and proposed pipeline rights-of-way walkovers to identify sensitive areas, such as remnant prairie vegetation, stream or creek crossings, steep slopes, and cultural resource sites.

- Meet with representatives of the Texas National Research Laboratory Commission and of the area water supply districts to develop a plan to identify options and routes for minimizing impacts to sensitive areas.

- Identify areas of high erosion potential where runoff protection measures, such as siltation fences, soil stabilizers, and mulching, should be used and specify in writing the specific areas to be protected.

- Prepare a revegetation plan.

- Provide the services of an SSCL or contractor employee at the construction site to address site-specific environmental questions posed by the construction contractor.

TABLE 2.3 Summary of Average Cooling Makeup Water Requirements

Location/Facility	Makeup Water (gal/min)[a]
Injector complex	
Linac	4
LEB	44
MEB	170
HEB	148
Test beams	17
Collider ring	
F sites	0
E1 and E6 sites	317
8 other E sites	562
Collision halls	
IR1	106
IR4	278
IR5	91
IR8	62
HVAC	400
Total	2,199

[a]Average values.

Source: SSCL 1990.

Water for sector service areas E1 and E10 would be provided by the industrial water system servicing the west campus. However, as an alternative, a well would be drilled at each of the eight remaining E sites to obtain water from the Woodbine or Twin Mountains aquifers. The water would be pumped to water purification systems and into a pond at each site. Water would be drawn from the pond for cooling the technical equipment heat exchangers and for irrigation and fire suppression. Seven of the wells could deliver a peak flow of 325 gal/min, with an average flow of 75 gal/min, to provide cooling water makeup, to offset the water lost to evaporation and irrigation, and to replenish water used for fire protection. The well at sector service area E6 would deliver a peak flow of 400 gal/min, with an average flow of 150 gal/min, to satisfy the additional requirements for cooling the nitrogen separation plant (SSCL 1990). Surface water either collected as runoff or delivered by pipeline would be preferentially used where available.

Each pond would be designed for a minimum of 120,000 gal of fire-suppression storage. Fire-suppression water would be screened and pumped by three 500-gal/min fire pumps installed on a concrete pad near the pond.

TABLE 2.4 Summary of Irrigation Water Requirements

Unit	Unit Area (acres)	Rate (in./wk)	Peak Requirement (gal/d)
West campus	11.5	1.5	69,000
East campus	2.0	1.5	12,000
Total requirement			81,000[a]

[a]Adjustment for seasonal variations results in an average of 27,000 gal/d.

Source: SSCL 1990.

Because the sector service areas would not be occupied except for brief periods during normal operation, water for domestic purposes would not be required.

2.2.4 Sewage Disposal

The EIS discussed use of an on-site sewage treatment plant in the campus area and use of septic tanks at service areas. However, an on-site sewage treatment plant is now planned for the east campus. No septic facilities are planned for the service areas. Because the service areas normally would not be occupied during operations, it is neither necessary, nor planned, to provide for permanent sewage facilities at those locations.

TABLE 2.5 Summary of Domestic Water Requirements

Location/Facility	Average Flow (gal/d)[a]
West campus	180,000
East campus	54,000
Total	234,000

[a]Based on an assumed average population of about 3,200 and approximately 75 gal/d/person.

Source: SSCL 1990.

2.2.5 Natural Gas

The possible supply sources for natural gas were assessed in the FEIS (Vol. I, Chapter 5, Section 4.9.2.2; Vol. IV, Appendix 14, Section 14.2.2.3). The FEIS did not discuss potential natural gas requirements for SSC operation at the Texas site. Current estimates of maximum hourly natural gas requirements are provided in Table 2.6.

The requirements for natural gas would be satisfied by service from local gas mains. Mains would be installed as required from the large natural gas transmission pipelines in the vicinity of the SSCL. A gas main would be installed to the west complex from the 36-in. Valero Gas Co. transmission main, which is located one mile south of the main SSCL campus in the west complex. Service to the east complex would be from the 30-in. Lone Star Gas Co. transmission main, which is immediately north of the site.

TABLE 2.6 Major SSC Natural Gas Requirements

Facility	Requirements (ft^3/h)
Injector complex	
Linac	500
LEB	275
MEB	545
HEB	-
Test beams	3,350
Experimental areas	
West complex	19,600
East complex	11,700
MSFC[a]	8,750
West campus other	20,200
Total	64,920

Source: SSCL 1990.

[a]Magnet support facility complex.

The SSCL will take the following mitigative actions to ensure that natural gas pipelines are constructed so as to minimize environmental impact:

- Conduct a walkover of the proposed routes to identify environmentally sensitive areas, such as prairie vegetation remnants, cultural resource sites, stream or creek crossings, and steep slope areas.
- Meet with representatives from the Texas National Research Laboratory Commission and the natural gas supplier to develop a mitigation plan.
- Meet with the DOE to discuss the plan prior to pipeline construction.
- Provide the services of an SSCL employee or contractor to address site-specific environmental questions and issues that arise during the construction process.

2.2.6 Electrical Power

Electrical power requirements and impacts for construction and operation of the SSC were assessed in the FEIS (Vol. I, Chapter 5, Sections 5.1.8.7 and 5.2.13; Vol. IV, Appendix 14, Section 14.2.2). Overall power requirements have increased from 115 MW as reported in the EIS to 185 MW average daily load based on standard 24-hour operation (SSCL 1990). The east and west campus areas have been reconfigured, and proposed locations for both substations and new power lines have been changed.

Texas Utilities Electric Co. (TU Electric) will supply construction or short-term power to the SSC project at multiple points (E and F sites) designated around the ring. In addition, several sites will need short-term power within the west and east campus areas. In four areas around the ring (E1, E4, F4, and F7), TU Electric does not have a Certificate of Convenience and Necessity to provide electric service. In these areas, TU Electric will coordinate, for construction and interim power requirements only, with the appropriate Rural Electrification Administration Cooperative (i.e., Hill County Electric or Navarro County Electric) to assure that sufficient power is provided in a timely manner.

Service to the construction sites will be provided by existing or proposed substations. Facilities constructed to the required sites will generally consist of standard overhead 12.5-kV or 24.9-kV lines, wood pole construction, and rights-of-way obtained along state or county roads or on private property through easement access. Facilities will be designed in accordance with National Electric Safety Code and TU Electric's company standards.

Operational electrical power for the SSC would be obtained from the TU Electric transmission network. Under current plans, a double-circuit transmission line would be extended from a 345-kV overhead transmission line about 4 mi west of the west complex area to the SSC to provide a feed from TU Electric's Venus and Big Brown transmission substations. The SSC east complex main substation would be served by a proposed 345-kV transmission line to provide feeds from the Watermill and Limestone substations. This TU Electric 345-kV line would pass through the east complex fee simple area and would not require additional right-of-way (Figure 2.15). The transmission lines to the SSC substations would be constructed by TU Electric.

The proposed transmission lines to the west complex substation would require a 160-ft-wide right-of-way, which would be provided by the utility. The new line may parallel F.M. 66. During construction of the transmission line, the right-of-way would be cleared of all standing timber, structures, and other surface perturbations. The rights-of-way and transmission lines would be owned and maintained by the utility company.

Transmission line towers would be of a double-circuit, lattice-steel type. The perimeter of the tower footprint would be about 20 ft by 60 ft. The centerline of the support structures would be along the centerline of the right-of-way and spaced on 1,100-ft centers. In some instances, the towers might be spaced closer together, but it is not anticipated that this distance would be less than 800 ft. Tower height would be about 120 ft to the highest point of the structure and below two shield wires.

Current-carrying conductors would consist of two 795 MCM, ACSR cables per phase, with three phases per circuit. The conductors would maintain a minimum of 32 ft of clearance from the lower conductor to the ground and would be designed to meet the requirements of the National Electric Safety Code. Design, construction, and right-of-way acquisition procedures would be in accordance with the rules and standards of the Texas Public Utility Commission. All construction must be approved by the Texas Public Utility Commission.

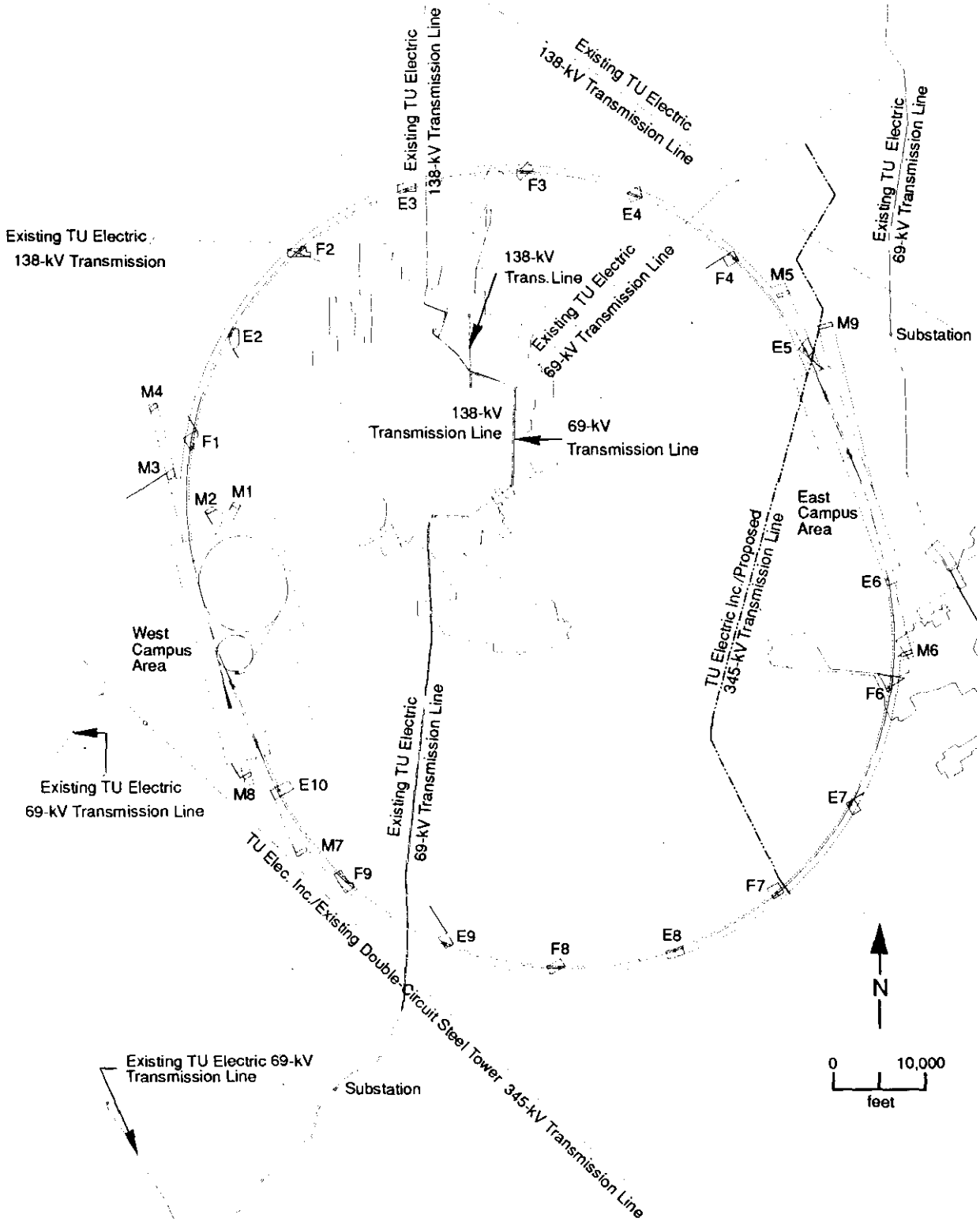


FIGURE 2.15 Electrical Transmission Line Routings

The electric field intensity at ground level would be less than 10 kV/m within the right-of-way and less than 2 kV/m at the right-of-way edge, which is 40 ft from the centerline of the towers.

2.3 NO-ACTION ALTERNATIVE

The description of the no-action alternative in the FEIS (Vol. I, Section 3.3) continues to be valid. However, as of January 1990, the SSCL had been in existence near the Texas site for nearly a year and was operating with a staff of about 450 people. The staff is expected to double by the end of FY 1990. In addition, the Texas National Research Laboratory Commission was operating with a staff of about 50 people. At the end of 1990, 30 DOE staff members will be employed at the DOE SSC project office in Texas. Potential impacts of the no-action alternative on these sources of employment are discussed in Section 4.8. Also, by the end of 1990, the SSC project will have acquired an initial set of fee simple land parcels. If a decision were made to adopt the no-action alternative, this property would be disposed of in consultation with the state of Texas and in accordance with applicable laws and regulations.

2.4 REFERENCES FOR SECTION 2

Colton, E., et al., 1984, *Fixed-Target Option for the SSC*, Proc. of the 1984 Summer Study on the Design and Utilization of the Superconducting Super Collider, R. Donaldson and J.G. Morfin, eds., Snowmass, Colo., June 23-July 12.

Schwitters, R.F., 1990, SSCL, Dallas, letter to E.C. Bingler, Texas National Research Laboratory Commission, Austin, April 17.

SSCL, 1989, *Supplemental Environmental Impact Statement Data Requirements*, Vol. 1, Superconducting Super Collider Laboratory, Dallas, Oct. 20.

SSCL, 1990, *Superconducting Super Collider Site-Specific Conceptual Design*, Superconducting Super Collider Laboratory Report SSC-SR-1056, Dallas, July.

Wenzel, W.A., 1984, *Secondary Beams from Internal Targets*, SSC Fixed Target Workshop, The Woodlands, Texas, Jan. 26-30, pp. 15-18.

3 AFFECTED ENVIRONMENT

3.1 EARTH RESOURCES

The following discussion summarizes material originally presented in the DEIS (Vol. IV, Appendix 5c) and provides additional information on faults near the site (Section 3.1.3).

3.1.1 Physiography and Topography

The SSC site is in the Western Gulf Coast section of the Coastal Plains physiographic province. The area is characterized by submature to mature erosion of southeast-dipping strata. The eroded surface contains low, west-facing escarpments separated by flat to rolling prairies. The prairies follow the dip direction of the underlying rocks, generally sloping gently to the southeast.

Much of the site has a relatively flat to slightly rolling prairie surface, grading to rolling prairie at a few incised drainages. Elevations in the area range from 840 ft mean sea level (msl) at the crest of the White Rock escarpment to 360 ft msl where Waxahachie and Onion creeks depart to the southeast. The largest drainage, Waxahachie Creek, is incised 80-120 ft below the prairie surface.

The site is traversed by the tributaries and main stems of Red Oak, Waxahachie, Onion, and Chambers creeks, all of which flow southeast to join the Trinity River. Except for Waxahachie and Onion creeks, most of the streams flow intermittently where they cross the tunnel footprint and campuses.

3.1.2 Stratigraphy

Table 3.1 provides a summary description of the major sedimentary units within and surrounding the site. The bedrock formations of the site are dominated by massive beds of chalk and shale, all of Cretaceous age. The Cretaceous units are part of a 1,750- to 4,400-ft-thick wedge of sediment that strikes north-northeast and dips southeast. The alluvium overlies the Cretaceous sediments and is composed of unconsolidated accumulations of gravel, sand, silt, and clay deposited as terraces along stream channels and in the floodplain. Units that will be affected by construction are, from oldest to youngest, the Eagle Ford shale, the Austin chalk, the Taylor marl, and alluvium.

3.1.3 Geologic Structure

The revised information presented in this section summarizes the current state of knowledge of faults at the SSC site. Recent mapping and drilling (for site geotechnical characterization) has doubled the number of known, mappable faults since

TABLE 3.1 Lithologic Description of Selected Geologic Units at SSC Site, as Described in the EIS

Formation	Lithology	Other Characteristics
Recent alluvium	Gravel, sand, silt, silty clay, and organic matter	Principally unconsolidated floodplain deposits
Terrace deposits	Calcareous gravel, sand, silt, and clay	Commonly stratified and weakly cemented
Taylor marl	Only two lowermost members are recognized at the site	
Wolf City formation	Principally marl, sand, sandstone, and mudstone; upper part contains fine-grained, calcareous, yellowish gray sand and silt; lower portion is predominantly calcareous dark gray shale	Partially eroded at site
Ozan formation	Blocky calcareous shale interbedded with thin limestone lenses in lower portion; includes glauconite, phosphate pellets, hematite, and pyrite nodules	
Austin chalk	Primarily gray chalk with interbedded calcareous claystone and bentonite; upper and lower portions are mostly massive light ray chalk, with some interbeds and partings of calcareous clay; middle portion typically thin-bedded gray marl and calcareous shale with interbeds of massive chalk; marcasite/pyrite nodules are common	
South Bosque formation (Eagle Ford shale)	Shale with some calcareous concretions; includes platy, medium to dark gray, locally bentonitic beds of sandstone and sandy limestone in upper and middle portions	Base of unit marked by hard limestone bed
Woodbine sands	Fine-grained, well sorted, cross-bedded reddish brown sandstone; includes some clay, lignite, and gray shale	

the FEIS was published. However, the general character of faulting at the site is unchanged from what was described in the DEIS:

- The faults all trend north-northeast to northeast.
- The faults are all normal faults or grabens.
- The faults are ancient and inactive.
- None of the new faults has an offset larger than the offsets already reported in the DEIS.

The SSC site lies along the eastern margin of the Texas Craton in a thick sedimentary sequence with a shallow southeasterly dip. The sediments are exposed at the surface as broad, northeast-trending belts that are progressively older to the west. A geologic map showing 18 fault areas in the vicinity of the site is presented in Figure 3.1 (revised map and keyed to Table 3.2); a cross section along the ring is presented in Figure 3.2 (revised profile).

Rapid and abundant deposition of sediments in the Gulf of Mexico basin and associated subsidence of the Gulf region resulted in several arcuate zones of faults subparallel to the edge of the basin along the margin of the Texas Craton. These zones of faults in the Cenozoic and Mesozoic sediments generally consist of inactive, northeast-trending, steeply dipping normal faults of moderate displacement. The closest of these zones to the site are the Mexia-Talco fault zone to the east of the site and the Balcones fault system to the southwest. The majority of the mapped Balcones faults occur in a broad belt that stretches from Valverde County in southwestern Texas to Waco in McLennan County, south of the site. However, the northeastern limit of this fault belt appears to extend into the site area and coincides with the local northeast-trending faults and associated grabens (Reaser 1961; Reaser and Collins 1988; Texas Bureau of Economic Geology 1987).

The characteristics of mappable faults in the vicinity of the site (shown in Figure 3.1) are summarized in Table 3.2. The mappable faults commonly trend north-northeast to northeast (paralleling the Balcones trend), with steep dips and normal offsets. These faults are mapped on the basis of subtle photo lineaments and the occurrence of calcite. Offsets on the faults (based on drilling or correlations of offset units at the surface) commonly range from 25 to 75 ft, and some appear to have offsets greater than 100 ft. Several of the mapped faults are grabens, which is consistent with the tectonics of the Balcones fault system.

In addition to mappable faults, small-scale faults are commonly observed in outcrops of Austin chalk. Displacements on the small-scale faults are commonly up to several feet. The reported abundance of small-scale faults throughout the chalk, as well as the extension of the Balcones system of larger-scale faults into the site area, suggests that additional faults not recognized to date may be identified in the future.

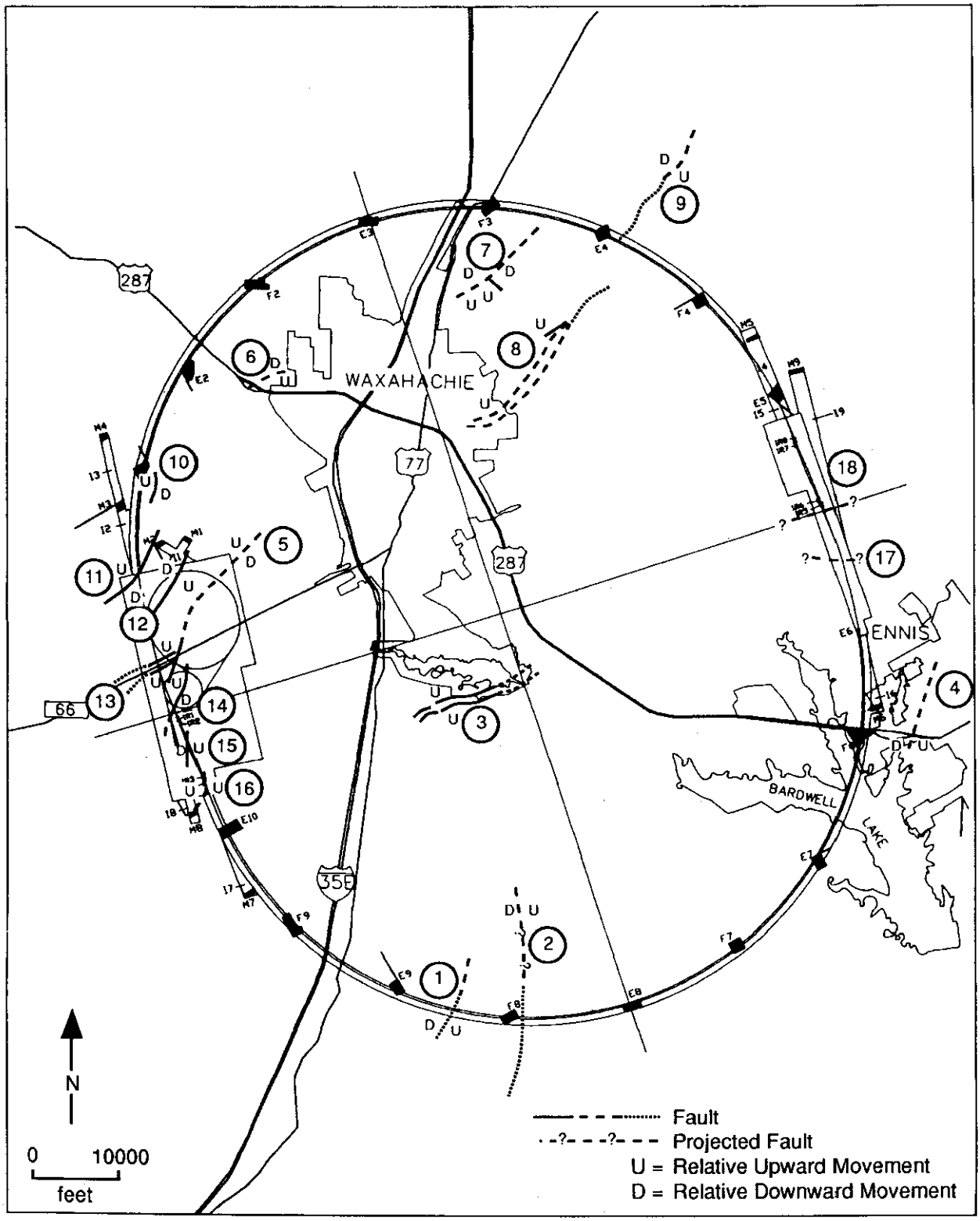


FIGURE 3.1 Locations of Faults in the Vicinity of the Proposed Site (Source: Based on data from Reaser and Collins 1988; The Earth Technology Corp. 1989a-j)

TABLE 3.2 Summary Characteristics of Faults near the SSC Site

ID No.[a]	Fault	Location[b]	Strike	Dip	Thickness	Displacement	References[c]
1	Possible northern extension of Italy graben	Crosses ring on south; 2.5 mi east of I-35	N15°E	Steeply SW	-	~25 ft down to the west	1-3
2	Unnamed fault	Crosses ring on south; 4.5 mi east of I-35	N15°E-N5°W	Steeply NW to SW	-	~15 ft down to the west	1-3
3	Lake Waxahachie graben	Center of ring; south shore of Lake Waxahachie	N70°E	North fault dips steeply SE; south fault dips 50-70°NW	-	>60 ft	1, 4
4	Unnamed fault	1.2 mi east of ring; west side of Ennis	N15°-20°E	-	-	Down to the west	5
5	Unnamed fault	1 mi inside west side of ring; 4 mi west of Waxahachie on F.M. 1446	N45°E	Steeply SE	-	Down to the northwest	6
6	Sardis fault	1 mi inside northwest side of ring; 0.4 mi north of Sardis	N65°E	Steeply to the NW ~60°	-	~90 ft down to northwest	1, 2, 4, 6

TABLE 3.2 (Cont'd)

ID No.[a]	Fault	Location[b]	Strike	Dip	Thickness	Displacement	References[c]
7	Sterrett fault	0.5-1 mi inside north end of ring; 2.5 mi south of Red Oak	N50°E	Steeply NW	-	>100 ft down to northwest	1, 7
8	Rockett graben	1-2 mi inside north arc; near Rockett	N30°E	North fault steeply SE; south fault steeply NW	-	>100 ft of offset in the graben	1, 2, 7
9	Bear Creek fault	1 mi inside northeast side of ring; about 4 mi east of Red Oak	N40°E	~63°NW	-	>90 ft of offset down to the northwest	1, 8, 9
10	SE1.5 fault	Crosses ring on northwest side; 1 mi south of S.R. 875	N10°E	Moderately steep SE	~4 ft	4 ft down to east	10

TABLE 3.2 (Cont'd)

ID No.[a]	Fault	Location[b]	Strike	Dip	Thickness	Displacement	References[c]
11	SE1 graben	Crosses ring on west side; 1 mi north of F.M. 1446	N10°-30°E	North fault ~44° SE; south fault steep to the NW	North fault is >2 ft but <19 ft	Northwest fault 23 ft down to southeast; southeast fault 25 ft down to the northwest	11
12	SF10.6 fault	Crosses ring on west side; 6 mi west of Waxahachie, near the corner of Hoyt Road and F.M. 1446	N10°-20°E	Steep to the NW	>10 ft but <50 ft	10 ft down to west	12
13	SF10.1 graben	Crosses ring on southwest side; 0.3 mi north of S.R. 66	N65°E	North fault steeply SE; south fault steeply NW	Graben is approximately 350 ft wide; each fault <5 ft wide	25 ft on north fault; 57 ft on south fault	13
14	SE10.9 fault	Crosses ring on southwest side; 0.4 mi south of S.R. 66	Average trend N28°E	Steep to SE	~300 ft	33-43 ft down to southeast	14

TABLE 3.2 (Cont'd)

ID No.[a]	Fault	Location[b]	Strike	Dip	Thickness	Displacement	References[c]
15	SE10.7 fault	Crosses ring on southwest side; trending north from Boz	Due north to N5°E	65°-90° west	<30 ft	30-35 ft down to west	15
16	SIR3 graben	Crosses ring on southwest side; 1 mi south of Boz	N10°E-N60°E	South fault 70°-75°NW	Graben is less than 430 ft wide; south fault is ~5 ft wide; north fault not observed	Graben; south fault 73 ft down to north; north fault 64 ft down to south	16
17	SE5.2 fault	Crosses ring on east side; 0.1 mi north of S.R. 879	E-W	-	-	Tenuous correlation suggests 8 ft down to south	17

TABLE 3.2 (Cont'd)

ID No.[a]	Fault	Location[b]	Strike	Dip	Thickness	Displacement	References[c]
18	SF5.8 fault	Crosses ring on east side; 1.3 mi north of S.R. 879	E-W	-	-	Tenuous correlation suggests 8 ft down to south	18

[a]ID numbers are keyed to Figure 3.1.

[b]F.M. = farm-to-market; S.R. = state route.

[c]References: 1 = Reaser 1961; 2 = Reaser and Collins 1988; 3 = The Earth Technology Corp. 1989j; 4 = Reaser 1989; 5 = Texas Bureau of Economic Geology 1987; 6 = Read 1957; 7 = Peabody 1961; 8 = Pitkin 1958; 9 = Reaser 1957; 10-18 = The Earth Technology Corp. 1989a-1989i.

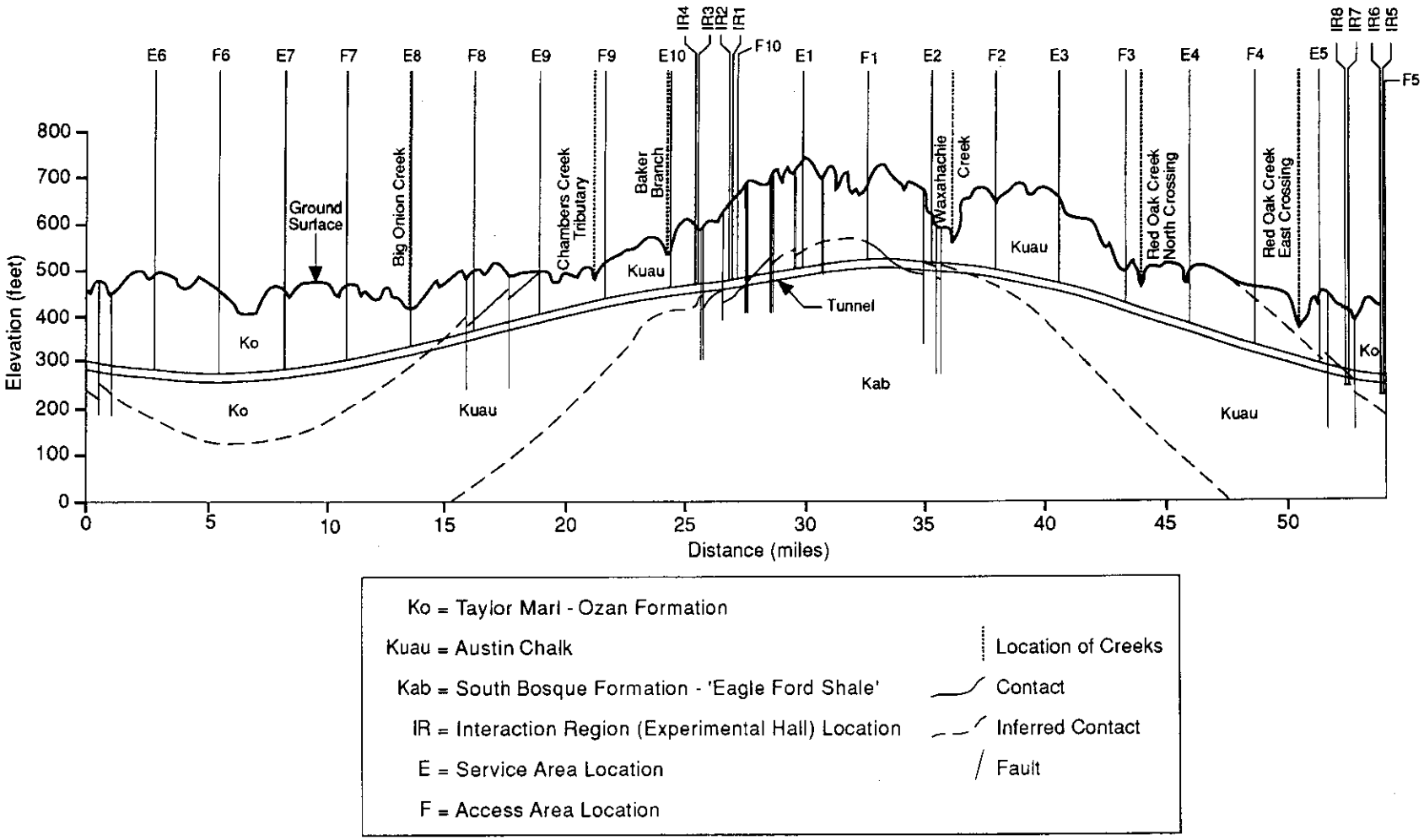


FIGURE 3.2 Geologic Cross Section along SSC Ring

3.1.4 Geologic Hazards

Seismicity in the site region is among the lowest in the United States; the site is within Zone 0 of the Uniform Building Code seismic risk map. This zone is characterized as an area where earthquake damage is not expected. Only four historic earthquakes have occurred within 100 mi of the site, and none of these had a magnitude larger than 4.0. All had epicentral Modified Mercalli (MM) intensity of less than or equal to VI. No faults near the site have been active in Quaternary time (Reaser and Collins 1988).

No other geologic hazards are expected at the site. Ground subsidence caused by withdrawal of water or hydrocarbons is not expected. No volcanic activity is expected to occur in the area. The site topography is sufficiently subdued so that landslides are not expected. The rocks at tunnel depth are not known to contain gas that would create a hazard.

3.1.5 Economic Geologic Resources

Although cement is produced in large amounts in the vicinity of Waxahachie, sources of high-quality aggregate are limited. Oil and gas are the only known potentially significant energy resources in the region, although no oil and gas production occurs in the vicinity of the site.

3.1.6 Earthen Construction Materials

In Ellis and Dallas counties, the Austin chalk crops out extensively and is used in the manufacture of abundantly available cement. However, chalk lacks the strength and abrasion characteristics required for use as aggregate for high-strength concrete and commonly contains potentially expansive clays. Sources of gravel include operations along the Trinity River in northeastern Ellis County and southeastern Dallas County. In 1986, cement production in Dallas, Tarrant, and Ellis counties totaled 2.55 million tons, compared to an annual production capacity of 4.4 million tons. The operating plants are all between 10 and 50 mi from the site.

3.1.7 Energy Resources

Most of the oil and gas production in the area is limited to the Corsicana Shallow and the Corsicana-Powell oil fields to the east and south of the SSC site. Three abandoned oil wells are located on or inside the proposed ring location, and 35 wells are within 5 mi of the site. One well, about 10 mi southeast of the site, is reportedly producing oil. With the exception of a temporarily abandoned well and a service well, all other wells in the area have been permanently abandoned. Oil occurrences have been defined through regional exploration efforts; no producing wells are known within the immediate vicinity of the site and the probability of undiscovered occurrences beneath the site is small.

Other energy resources have not been identified in the area. No known geothermal resources, lignite deposits, or uranium deposits occur within the region.

3.1.8 Metallic Resources

No economic metallic deposits have been identified in the region.

3.1.9 Other Resources

No significant geologic resources other than those discussed in this section have been identified at the site.

3.2 WATER RESOURCES

The description of water resources in the project area is divided into surface water and groundwater systems. Their interrelationships are discussed where appropriate.

3.2.1 Surface Water Hydrology and Quality

The surface hydrologic system for the project area has been described in the EIS. This section provides additional water quality data and updates information on the SSC surface facilities in relation to streams, wetlands, and floodplains.

3.2.1.1 Streams and Lakes

The SSC site is located in the central part of the Trinity River basin in east-central Texas (Figure 3.3). Major tributaries of the Trinity River draining the project site include Red Oak, Waxahachie, Onion, and Chambers creeks (Figure 3.4). The drainage areas of these streams at the crossings of the current tunnel footprint are shown in Table 3.3. Red Oak Creek, originating in southern Dallas County, crosses the tunnel footprint near area F3 and, further downstream, near area E5 (Figure 3.5). The creek's major tributary to the south, Grove Creek, crosses the footprint at the east campus.

Waxahachie Creek originates in Ellis County northwest of the project site. It crosses the tunnel footprint near service area E2, flows southeast through the city of Waxahachie, and discharges into Bardwell Lake northwest of service area E7. Mustang Creek, a tributary of Waxahachie Creek, also joins Bardwell Lake near the southeast footprint crossing west of area F6. Other major tributaries to Waxahachie Creek include North Prong Creek, which joins Waxahachie Creek at the northwest footprint crossing near E2, and South Prong Creek, which joins Waxahachie Creek between the city of Waxahachie and Bardwell Lake. Waxahachie Creek Discharges into Chambers Creek about 3.2 mi downstream from Bardwell Dam.

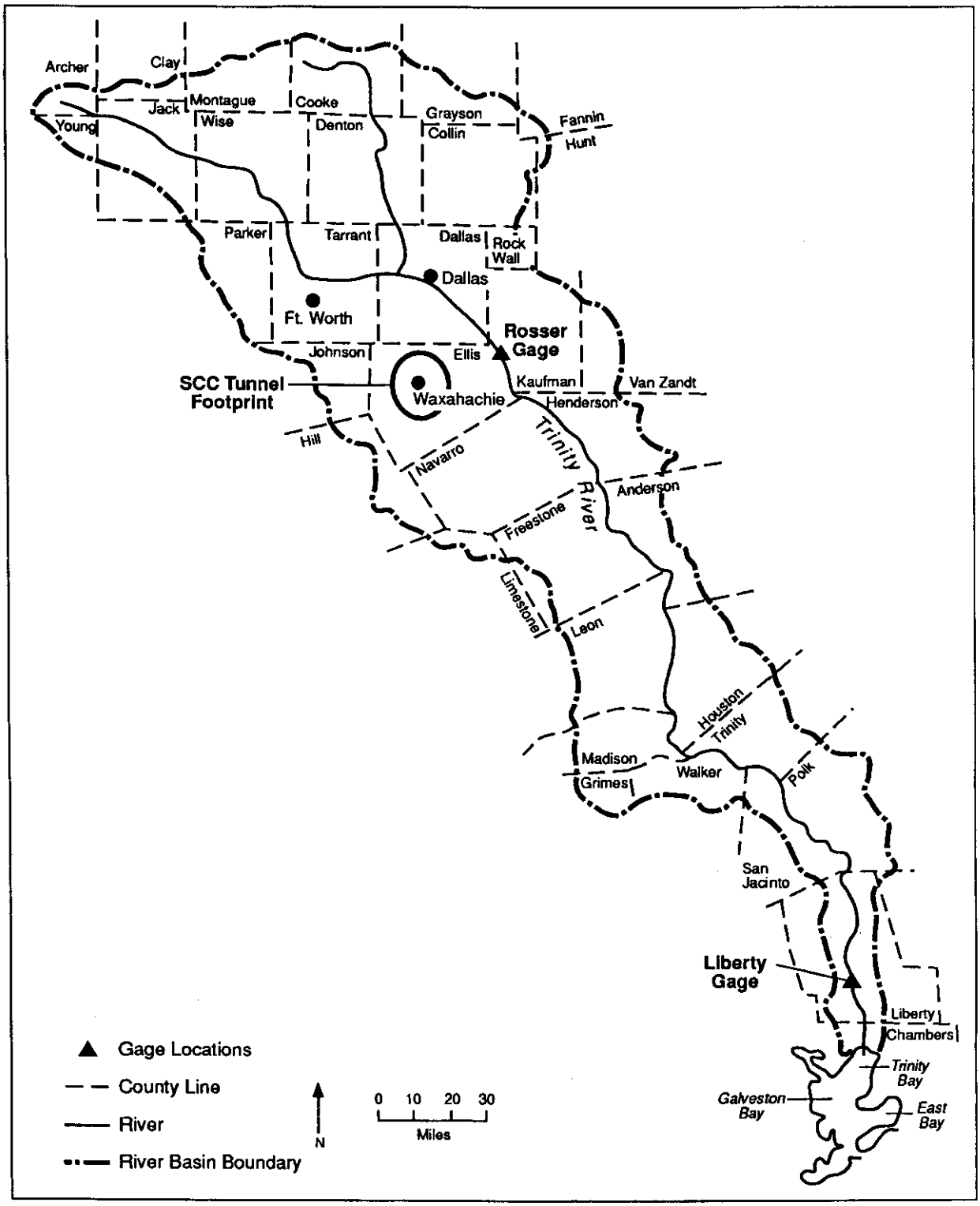


FIGURE 3.3 Location of SSC Site within Trinity River Basin (Source: Modified from FEIS, Vol. IV, Appendix 5, Figure 5.7.2-1)

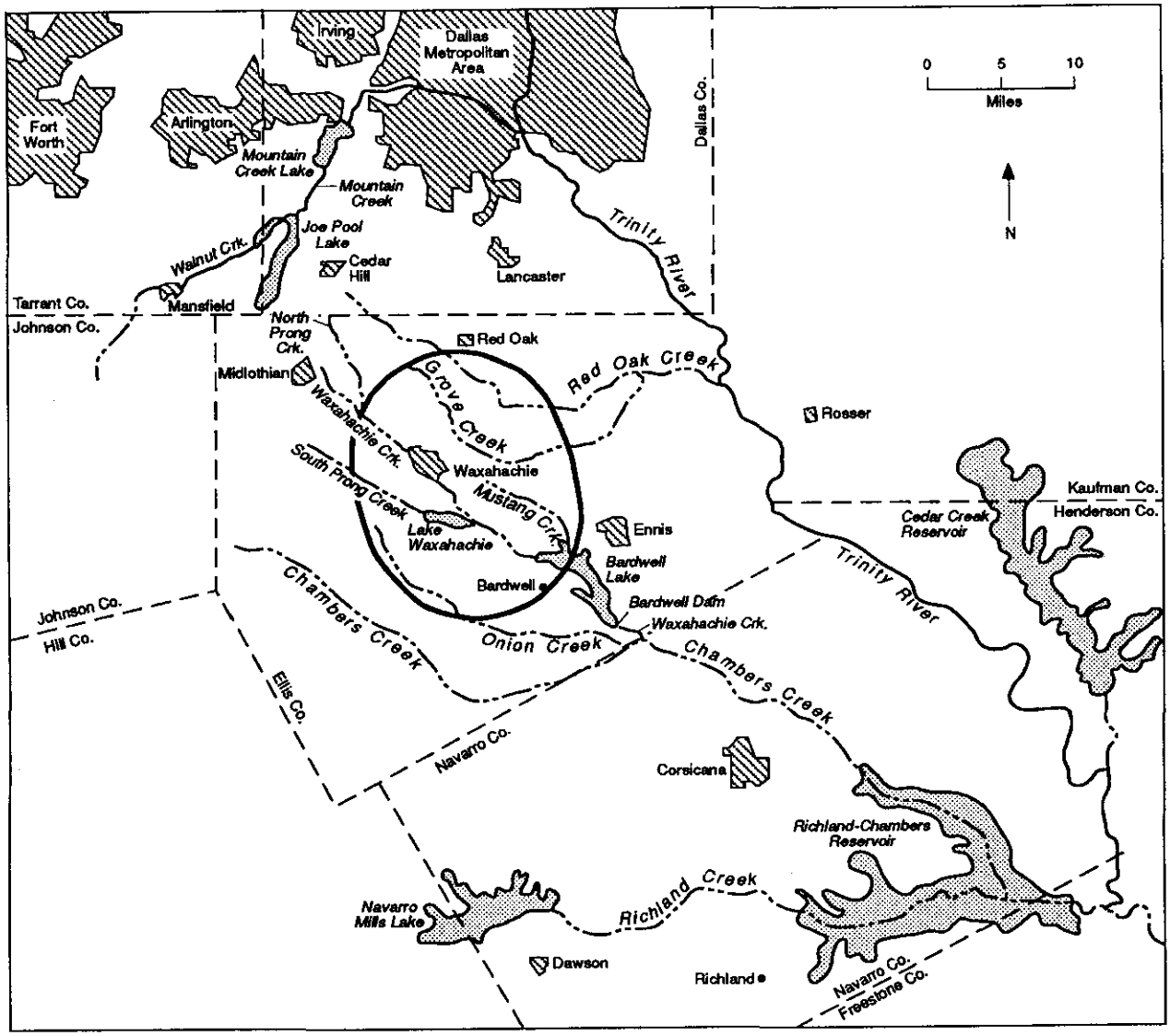


FIGURE 3.4 Principal Hydrological Features near the SSC Site (Source: Modified from FEIS, Vol. IV, Appendix 5)

Onion Creek originates as Big Onion Creek in the SSC west campus area. It flows to the southeast and crosses the tunnel footprint near its confluence with Little Onion Creek at E8 and then joins Chambers Creek about 0.7 mi upstream from the confluence of Waxahachie Creek and Chambers Creek. Chambers Creek rises in Johnson County, west of the project site, and flows to the southeast about 77 mi to its confluence with Richland Creek about 17 mi southeast of Corsicana.

Two large reservoirs exist in the project area: Bardwell Lake and Lake Waxahachie. Bardwell Dam, which forms Bardwell Lake, is located about 3 mi east of service area E7. The spillway crest is at elevation 439.0 ft msl, and the normal pool elevation is 421.0 ft msl. The lake is used for flood control and water supply (U.S. Army Corps of Engineers 1976; U.S. Geological Survey 1978). South Prong Dam, which forms

TABLE 3.3 Stream Characteristics at the Crossings of SSC Tunnel Footprint

Stream and SSC Location	Drainage Area (mi^2)	Width of Floodplain (ft)
Red Oak Creek near F3	43.5	900
Red Oak Creek near E5	60.9	1,800
Grove Creek at East Campus	39.6	1,200
Cottonwood Creek at southeast IR	4.8	1,000
Waxahachie Creek near E2	17.5	250
Waxahachie Creek at Bardwell Dam[a]	178	-
Long Branch near F2	2.7	150
North Prong Creek near E2	13.3	300
South Prong Creek near F1	6.3	200
Onion Creek at E8	40.9	2,400
Chambers Creek[b]		
Baker Branch at E10	4.0	200
Mill Branch near E9	3.1	250

[a]Four miles downstream of the tunnel footprint.

[b]The main stem of Chambers Creek does not cross the tunnel footprint.

Source: Based in part on Federal Emergency Management Agency 1987.

Lake Waxahachie, was constructed in 1956 on South Prong Creek about 4 mi southeast of Waxahachie. The reservoir is used for flood control and water supply (Dowell and Petty 1973).

Gaged streamflow records are available at five U.S. Geological Survey gages in the project vicinity (Table 3.4). Runoff measured along Waxahachie Creek is influenced by storage, evaporation, diversions from Lake Waxahachie, and (beginning in 1965) diversions from Bardwell Lake. Streamflow data indicate that flow generally diminishes to zero each year at these stations, including Chambers Creek, which has a drainage area of nearly 1,000 mi^2 (U.S. Geological Survey 1989).

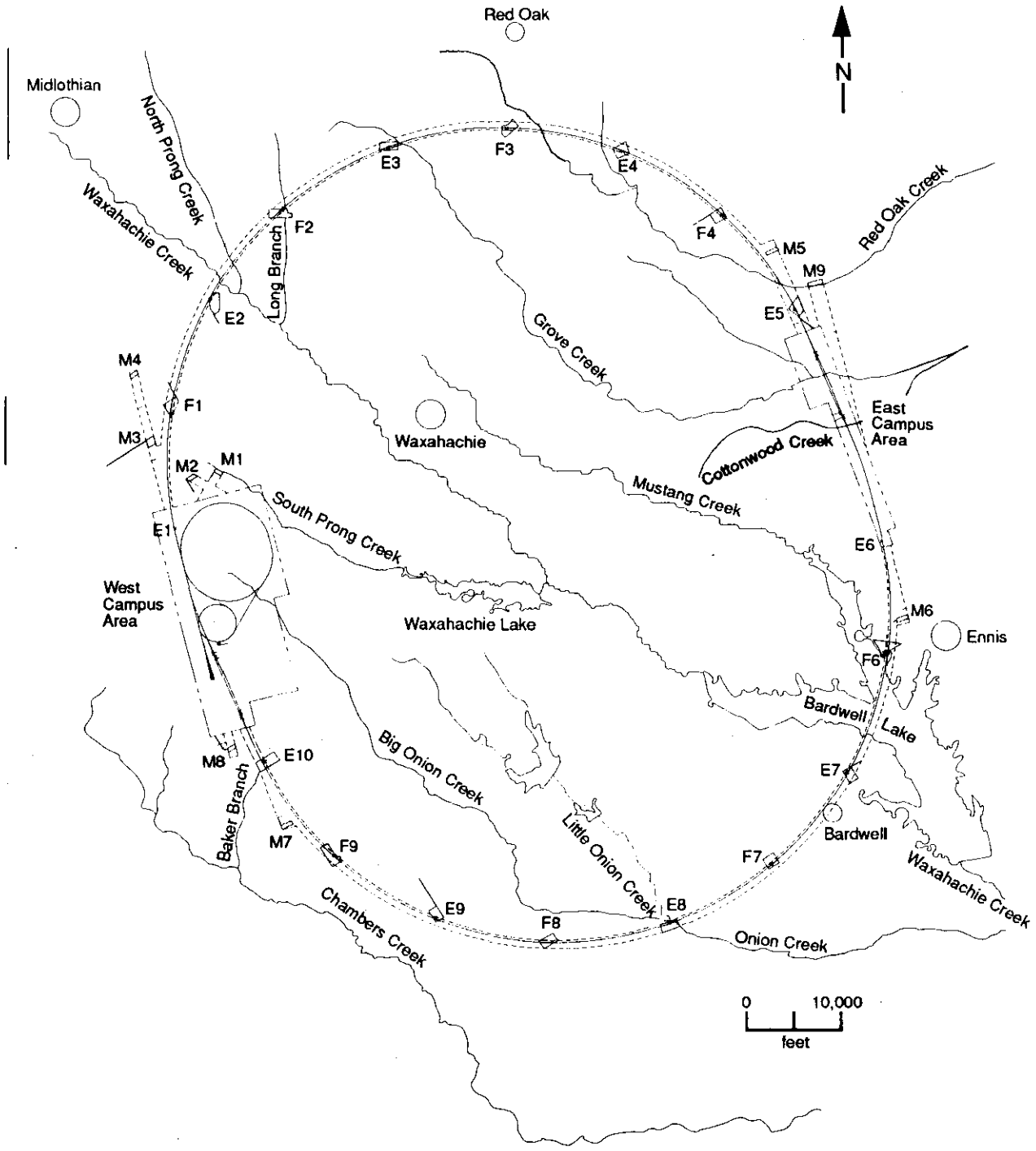


FIGURE 3.5 Hydrologic Map Showing Principal SSC Facilities

TABLE 3.4 Gage Data in the Vicinity of the SSC Project

Gage	Drainage Area (mi^2)	Period of Record (mo/yr)	Length of Record (yr)	Flow (ft^3/s)		
				Maximum	Minimum	Average
Waxahachie Creek near Bardwell (08063800)[a]	178	10/63-9/88	25	2,960	0	71.5
Chambers Creek near Corsicana (08064500)	963	3/39-9/84	45	48,000	0	423
Richland Creek near Dawson (08061300)	333	10/60-9/88	28	25,500	0	141
Walnut Creek near Mansfield (08049700)	62.8	10/60-9/88	28	9,570	0	14.4
Mountain Creek near Cedar Hill (08049600)	119	10/60-9/84	24	28,300	0	45.7

[a]Numbers in parentheses are U.S. Geological Survey gage numbers.

Source: U.S. Geological Survey 1989.

3.2.1.2 Flooding and Floodplains

Flooding has been a common problem in both the Chambers Creek and Red Oak Creek watersheds. As of October 1, 1987, the Soil Conservation Service completed construction of 72 flood-retarding structures in Ellis County with total storage capacities in excess of 85,000 acre-ft (FEIS, Vol. IV, Appendix 5c). Most of the 72 structures are located in the Chambers Creek watershed. Because of rapid changes in land use from agricultural to urban in the Red Oak Creek watershed, flood-retarding structures can no longer be installed as planned (U.S. Soil Conservation Service 1984). Because of extreme variation of streamflow, as discussed in the preceding subsection, and the inability to install additional flood-retarding structures, flash flooding in the Red Oak Creek watershed is more likely to occur.

In 1987, a flood insurance study was completed for the unincorporated area of Ellis County (Federal Emergency Management Agency 1987). Detailed studies, including floodplain delineation and flood profile determination, were completed for Red Oak Creek and its tributary Grove Creek. Approximate studies, which provide less accurate boundaries for the 100-year flood, were completed for the other major streams in the project area. Approximate widths of the 100-year floodplain near the SSC project facilities are listed in Table 3.3.

3.2.1.3 Wetlands

Wetlands are not a dominant feature in the site vicinity. Most wetlands in the area have been created by excavation or impoundment to function as small stock ponds or water-retention impoundments, although several forested wetlands, mostly confined to riparian areas along streams, also occur. In fact, hydric soils, which are indicators of natural wetlands, are only found at E8 and in the east campus along Cottonwood Creek. Most of the wetlands are subject to grazing and/or agricultural runoff and, as a result, are somewhat degraded. The forested wetlands are the least disturbed wetlands present, although agricultural clearing has restricted much of these wetlands to the immediate vicinity of the stream banks.

The EIS stated that only 14 wetlands were associated with the proposed fee simple areas for the original SSC footprint. One large (more than 30-acre) wetland associated with Chambers Creek was considered to be high-quality habitat. Several small stock ponds were associated with locations for other project facilities. Detailed information on wetlands associated with the originally proposed alignment and surface facility site acreages are presented in the FEIS (Vol. IV, Appendix 11, Section 11.3.7.3).

Design modifications, including reorientation of the ring and an increase in acreage associated with service facilities, have affected the number and acreage of wetlands associated with proposed locations of project facilities. Several surface facilities will no longer be associated with wetlands, while other surface facilities will now potentially encroach upon wetlands. The Chambers Creek wetland area would not be affected under the current ring orientation and facility design.

Figures 3.6a-3.6m illustrate the wetlands associated with service areas, the east and west campuses, and the M sites (except M3, M5, and M7, which are each located more than 1,200 ft from any wetlands). The illustrations are derived from overlays of the surface facility boundaries upon U.S. Fish and Wildlife Service national wetland inventory maps. Where appropriate, alterations (e.g., addition of ponds or forested wetlands) were made on the basis of walkover surveys and study of large-scale aerial photographs. Most wetlands are livestock watering ponds or small flood-retention impoundments. These types of wetlands are numerous throughout the entire project area. Less common are wetlands located along the shorelines of streams and rivers (riparian habitats). These riparian areas represent important wildlife habitat. Wetlands associated with the larger reservoirs also occur in the project area, but not within the boundaries of any of the surface facility sites. Table 3.5 summarizes information from the wetland figures and also provides wetland acreages for the sites.

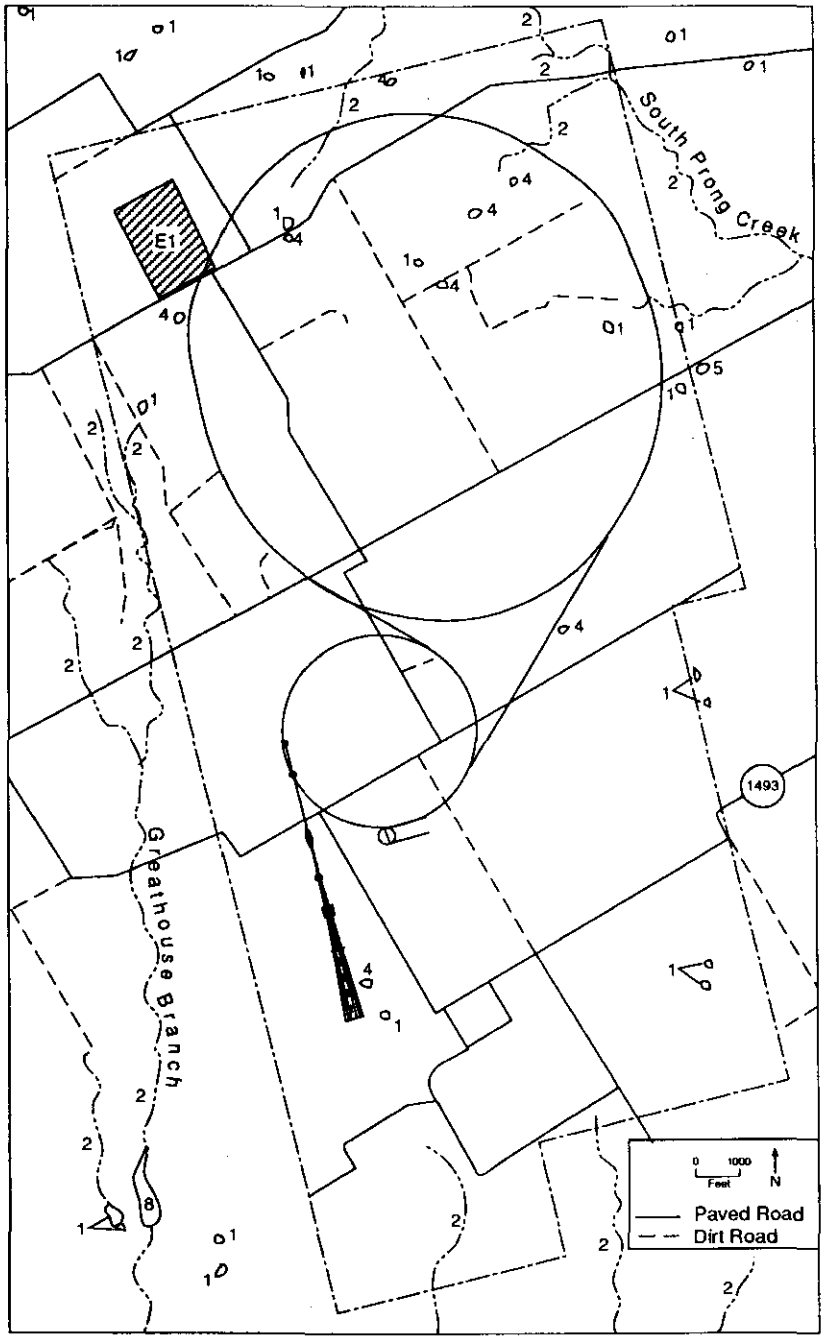
There are 16 isolated wetlands (essentially livestock and flood-retention ponds) within the borders of the west campus and 33 similar wetlands within the east campus site. This type of wetland also occurs within the boundaries of several service facility sites (one each at E4, E5, F2, F3, F7, and F8, and three at F6) and at M sites (two at M9). One such wetland also occurs in the proposed location of the E8a alternative site. Wetlands associated with streams occur along the site boundaries of F2, F9, and M1, and within the boundaries of F1, E8, alternative E8a, both campus sites, and M8. In total, the fee simple sites contain 77 wetlands totaling about 271 acres. This total would slightly exceed 300 acres if the forested areas along Big Onion and Onion creeks within E8 were considered. (These areas are not identified as wetlands on the U.S. Fish and Wildlife national wetland inventory maps. During walkover surveys, a predominance of obligate wetland plants was not observed.) In addition to the above, most sites have wetlands located within 1,000 ft of their boundaries.

3.2.1.4 Water Quality

Several government agencies have collected water quality data from streams and reservoirs in the project area since 1975. Data for Waxahachie Creek near Waxahachie, for Bardwell Lake, and for Chambers Creek near Corsicana were provided in the FEIS (Vol. IV, Appendix 5 errata, Table 5.7.2-3), along with the water quality standards adopted for the designated uses for those stream segments.

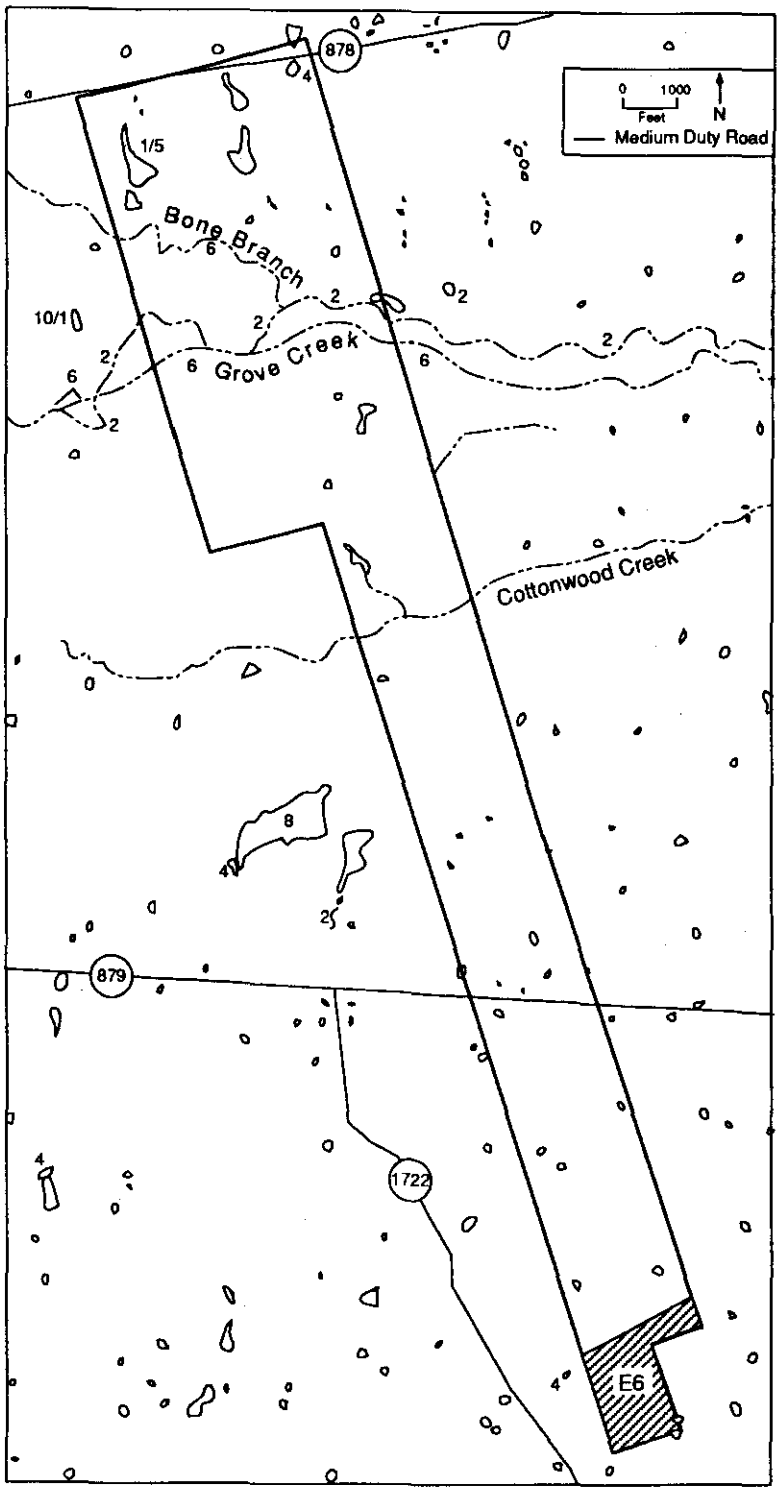
Table 3.6 summarizes Lake Waxahachie water quality data not provided in the EIS, and Table 3.7 presents more recent data than those presented in the EIS for Bardwell Lake. The tables also list water quality standards established by the Texas Water Commission (1988).

The dissolved oxygen levels below a depth of 20 ft in both lakes often drops below 5.0 mg/L during the summer months (Texas Water Commission 1989a). In each lake, one of the seven sulfate analyses exceeded the water quality standard of 50 mg/L. Data on concentrations of dissolved solids are not available, but can be estimated to be 55-75% of the reported specific electric conductance (Hem 1989). Data in the tables indicate that the dissolved solids contents of the lakes apparently meet the water quality standard. All other parameters for which standards are available also are within those standards.



1. Palustrine open water, permanently flooded, excavated or diked impounded
2. Palustrine forested, seasonally or temporarily flooded
4. Palustrine emergent, persistent, seasonally or temporarily flooded
5. Palustrine emergent, persistent, semipermanently flooded
8. Lacustrine limnetic open water, permanently flooded, excavated or diked impounded

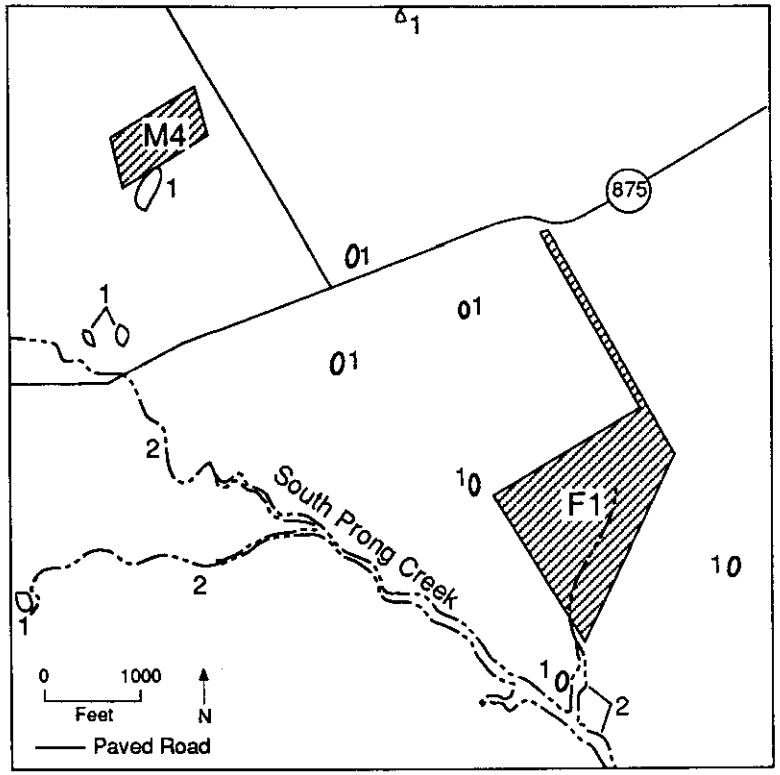
FIGURE 3.6a Wetlands Associated with Campus and Service Areas; Part A — West Campus and E1 Areas (Source: U.S. Fish and Wildlife Service national wetland inventory maps 1985)



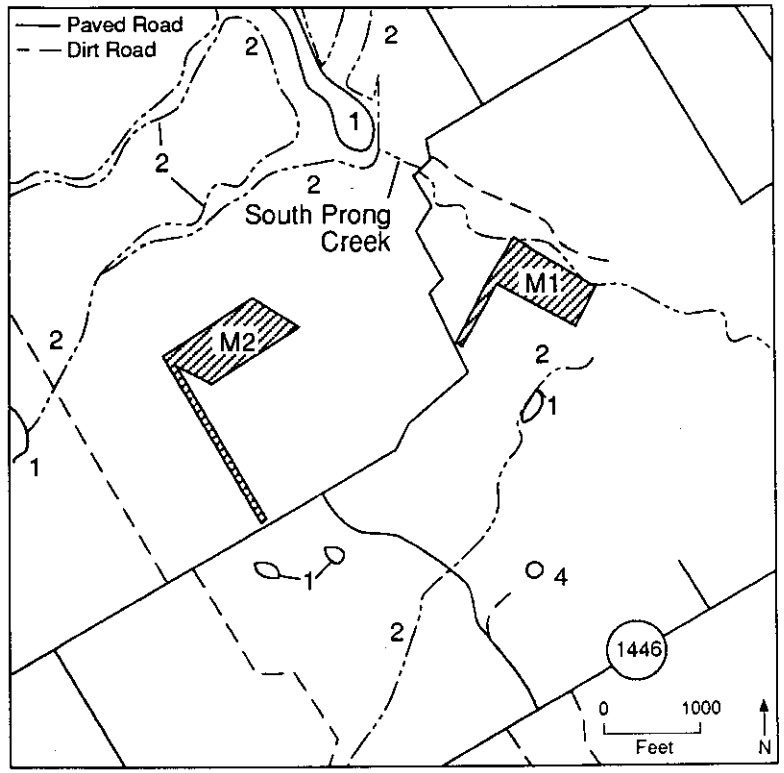
Note: All wetlands are type 1, unless indicated otherwise

1. Palustrine open water, permanently flooded, excavated or diked impounded
2. Palustrine forested, seasonally or temporarily flooded
4. Palustrine emergent, persistent, seasonally or temporarily flooded
5. Palustrine emergent, persistent, semipermanently flooded
6. Riverine intermittent, streambed, seasonally flooded
8. Lacustrine limnetic open water, permanently flooded, excavated or diked impounded
10. Palustrine aquatic bed, routed vascular, semipermanently flooded, diked impounded

FIGURE 3.6b Part B — East Campus and E6 Areas (Source: U.S. Fish and Wildlife Service national wetland inventory maps 1985)

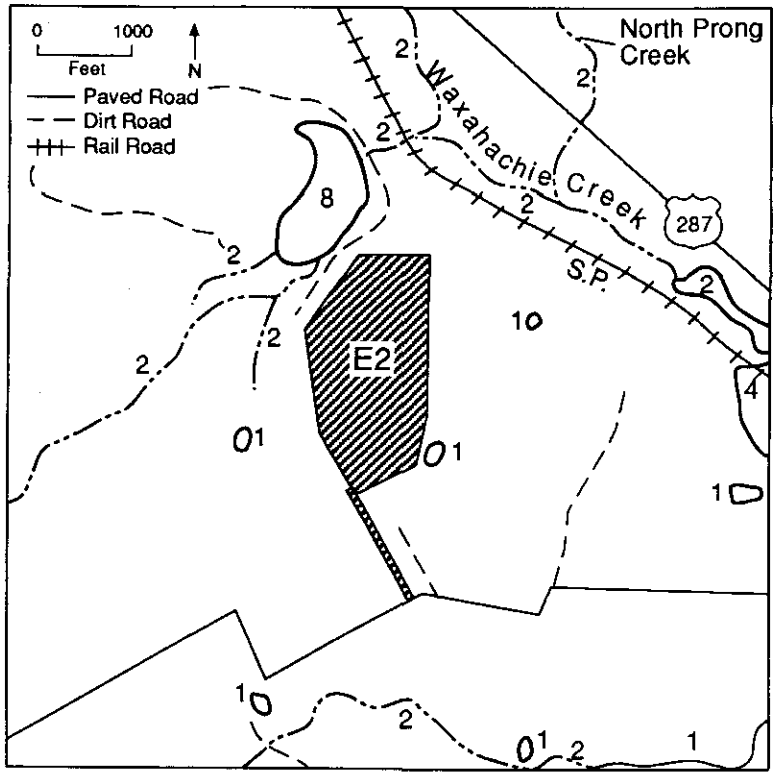


1. Palustrine open water, permanently flooded, excavated or diked impounded
2. Palustrine forested, seasonally or temporarily flooded

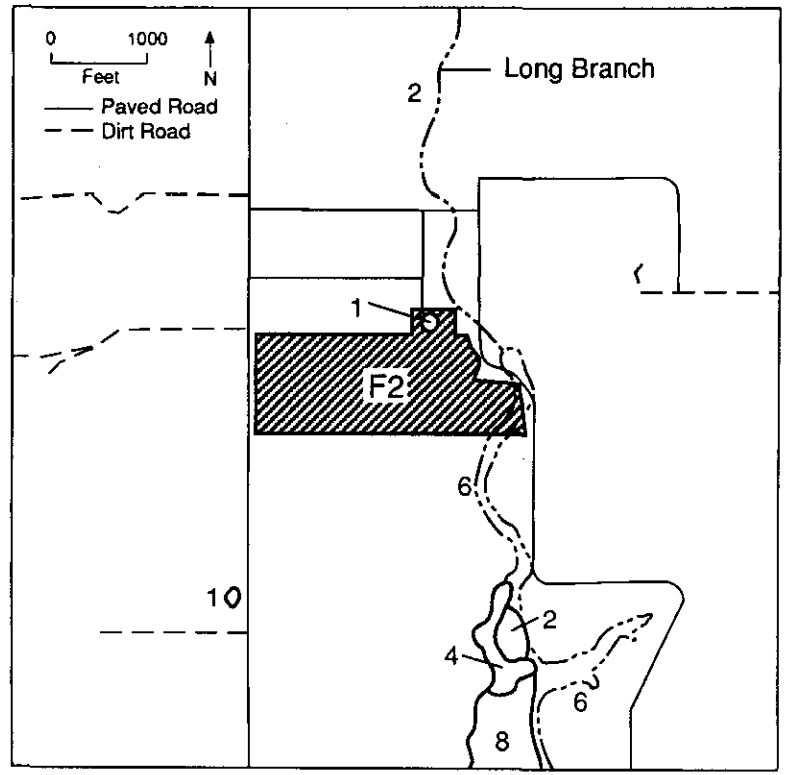


1. Palustrine open water, permanently flooded, excavated or diked impounded
2. Palustrine forested, seasonally or temporarily flooded
4. Palustrine emergent, persistent, seasonally or temporarily flooded

FIGURE 3.6c Part C — Areas F1, M1, and M2 (Source: U.S. Fish and Wildlife Service national wetland inventory maps 1985)

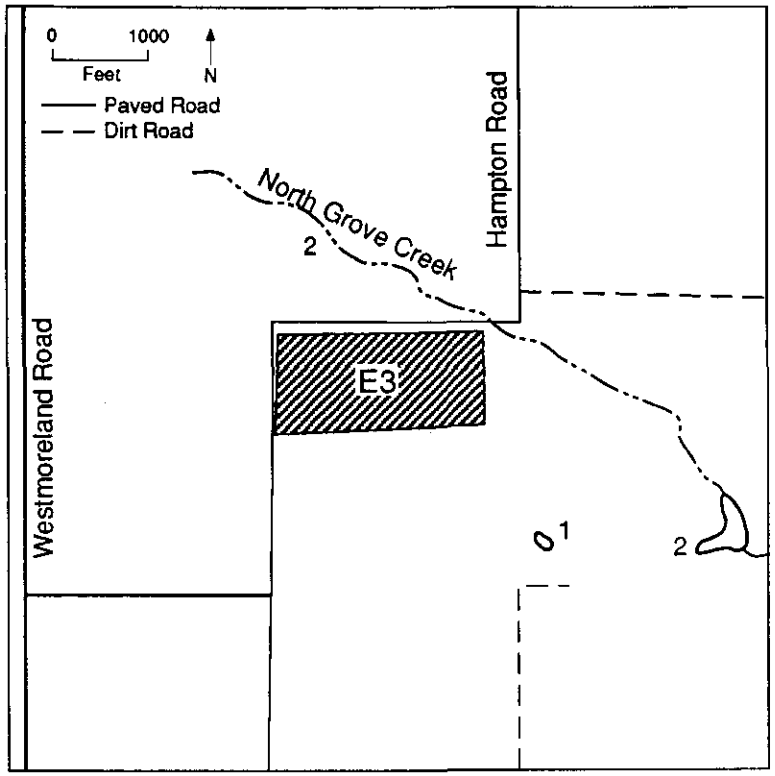


1. Palustrine open water, permanently flooded, excavated or diked impounded
2. Palustrine forested, seasonally or temporarily flooded
4. Palustrine emergent, persistent, seasonally or temporarily flooded
8. Lacustrine limnetic open water, permanently flooded, excavated or diked impounded

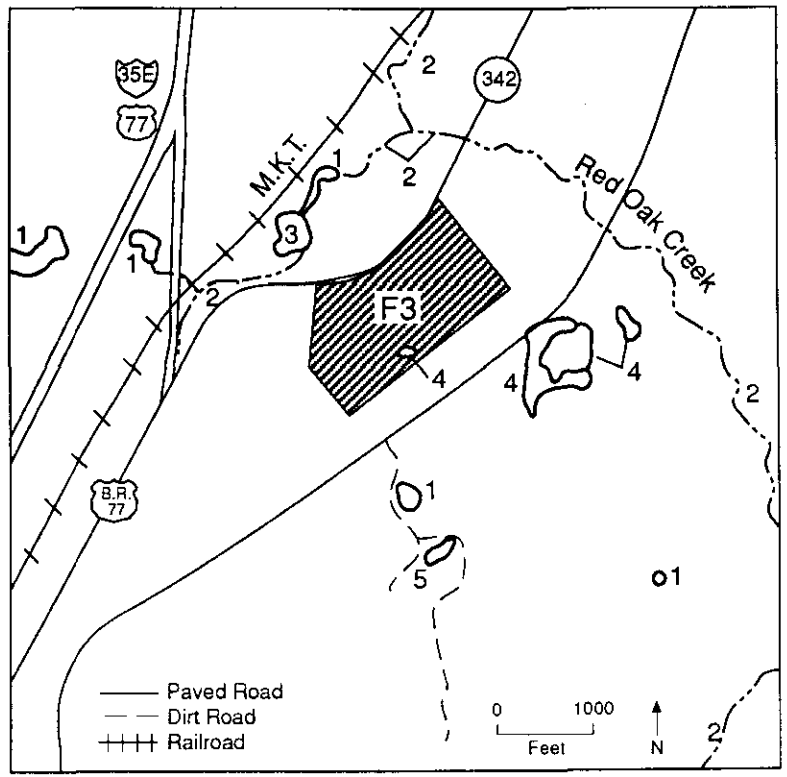


1. Palustrine open water, permanently flooded, excavated or diked impounded
2. Palustrine forested, seasonally or temporarily flooded
4. Palustrine emergent, persistent, seasonally or temporarily flooded
6. Riverine intermittent, streambed, seasonally flooded
8. Lacustrine limnetic open water, permanently flooded, excavated or diked impounded

FIGURE 3.6d Part D — Areas E2 and F2 (Source: U.S. Fish and Wildlife Service national wetland inventory maps 1985)

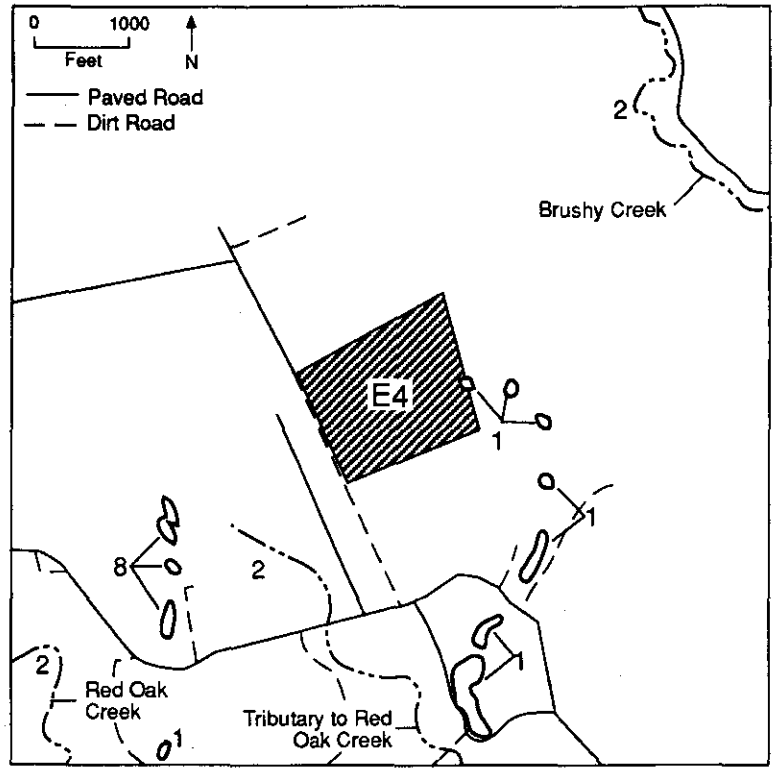


1. Palustrine open water, permanently flooded, excavated or diked impounded
2. Palustrine forested, seasonally or temporarily flooded

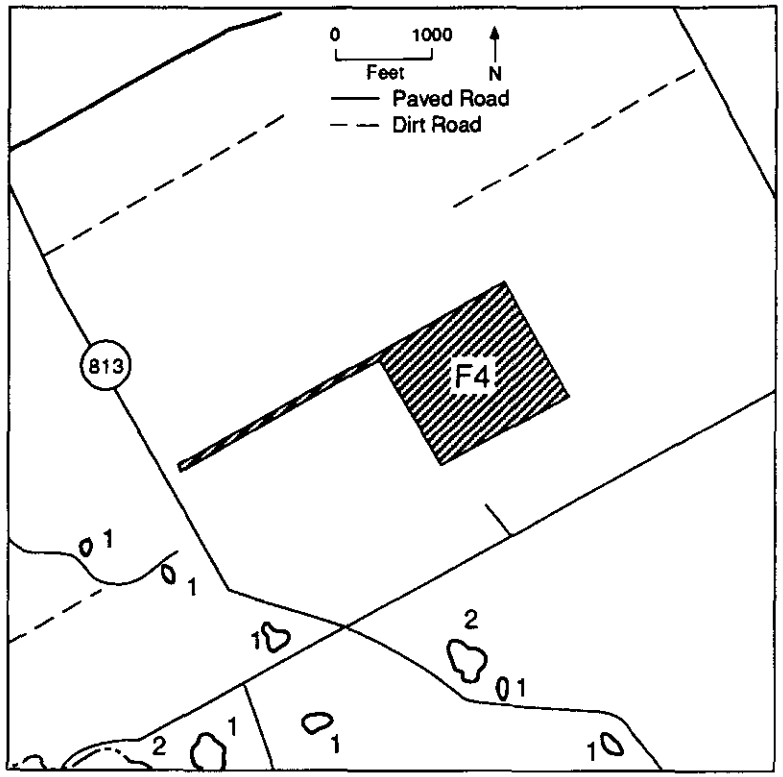


1. Palustrine open water, permanently flooded, excavated or diked impounded
2. Palustrine forested, seasonally or temporarily flooded
3. Palustrine forested, semipermanently flooded
4. Palustrine emergent, persistent, seasonally or temporarily flooded
5. Palustrine emergent, persistent, semipermanently flooded

FIGURE 3.6e Part E — Areas E3 and F3 (Source: U.S. Fish and Wildlife Service national wetland inventory maps 1985)

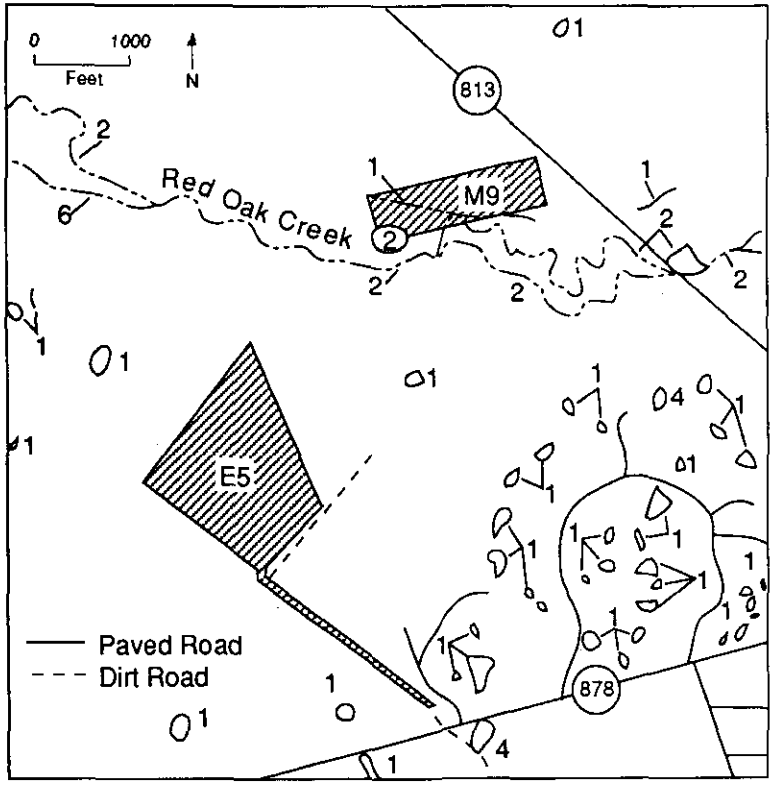


1. Palustrine open water, permanently flooded, excavated or diked impounded
2. Palustrine forested, seasonally or temporarily flooded
8. Lacustine limnetic open water, permanently flooded, excavated or diked impounded

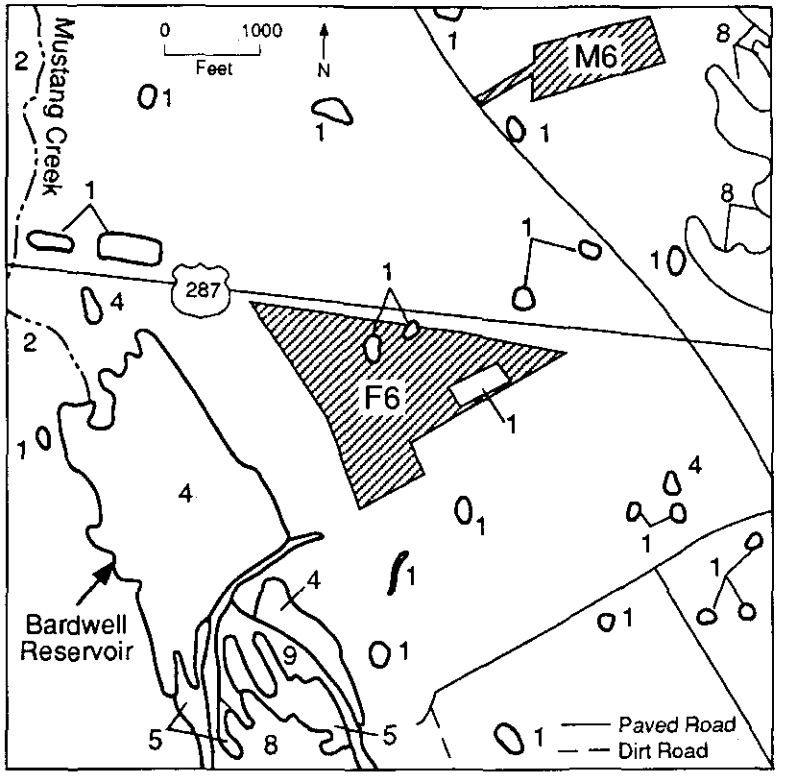


1. Palustrine open water, permanently flooded, excavated or diked impounded
2. Palustrine forested, seasonally or temporarily flooded

FIGURE 3.6f Part F — Areas E4 and F4 (Source: U.S. Fish and Wildlife Service national wetland inventory maps 1985)

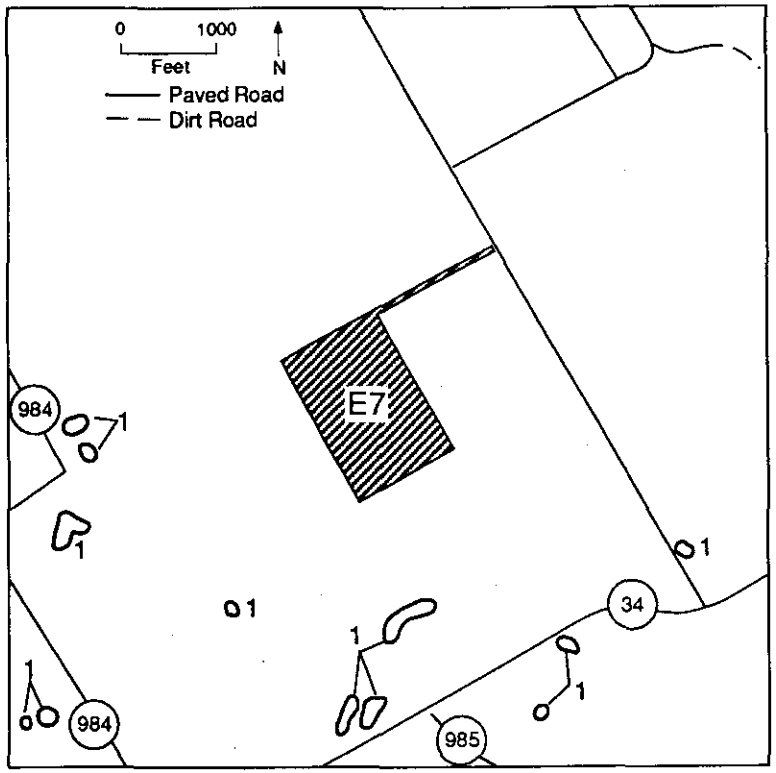


1. Palustrine open water, permanently flooded, excavated or diked impounded
2. Palustrine forested, seasonally or temporarily flooded
4. Palustrine emergent, persistent, seasonally or temporarily flooded
6. Riverine intermittent, streambed, seasonally flooded

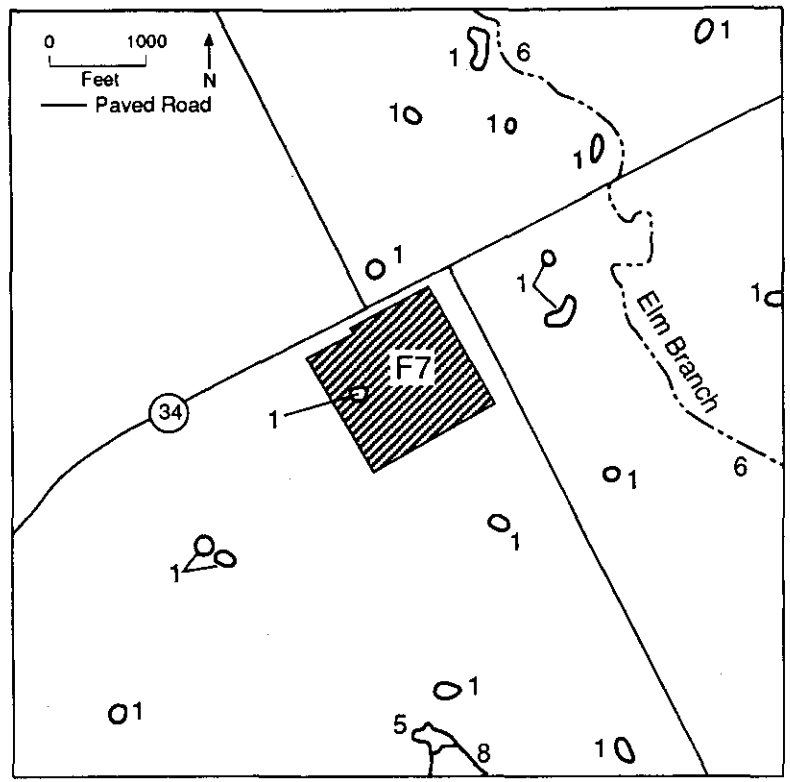


1. Palustrine open water, permanently flooded, excavated or diked impounded
2. Palustrine forested, seasonally or temporarily flooded
4. Palustrine emergent, persistent, seasonally or temporarily flooded
5. Palustrine emergent, persistent, semipermanently flooded
8. Lacustrine limnetic open water, permanently flooded, excavated or diked
9. Lacustrine littoral, unconsolidated shore, seasonally flooded

FIGURE 3.6g Part G — Areas E5, M9, F6, and M6 (Source: U.S. Fish and Wildlife Service national wetland inventory maps 1985)

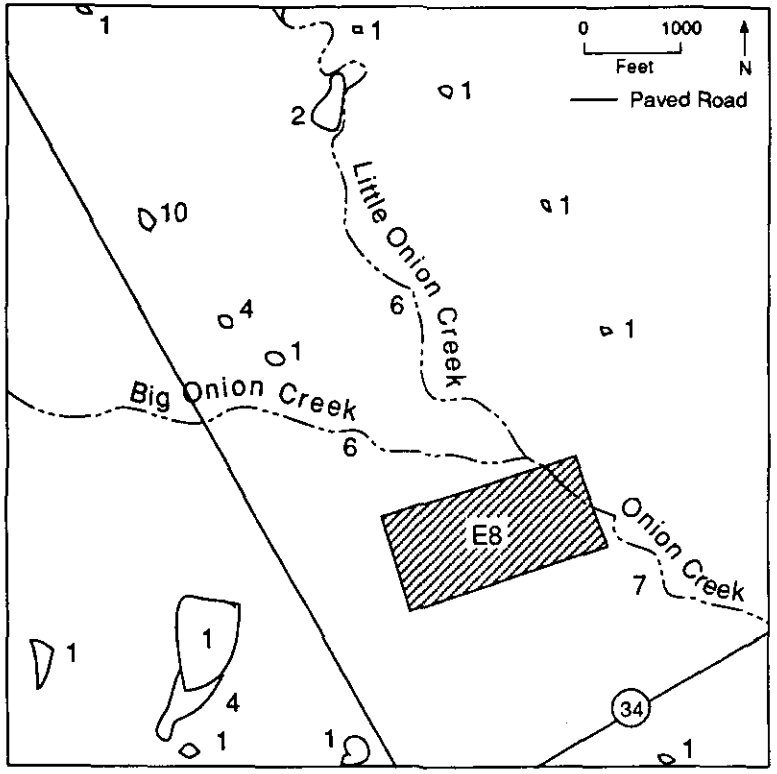


1. Palustrine open water, permanently flooded, excavated or diked impounded

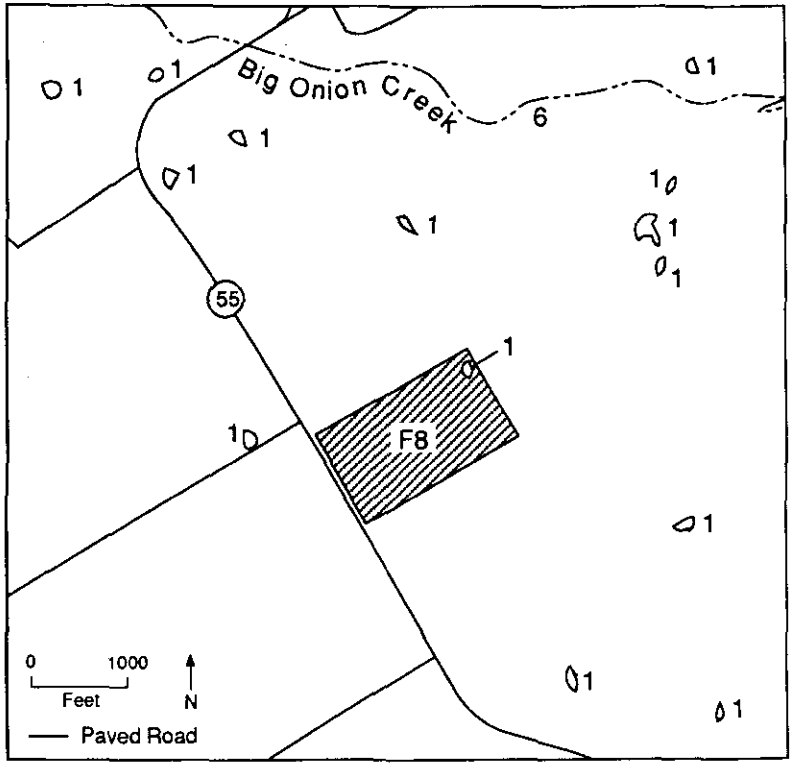


1. Palustrine open water, permanently flooded, excavated or diked impounded
5. Palustrine emergent, persistent, semipermanently flooded
6. Riverine intermittent, streambed, seasonally flooded
8. Lacustrine limnetic open water, permanently flooded, excavated or diked impounded

FIGURE 3.6h Part H — Areas E7 and F7 (Source: U.S. Fish and Wildlife Service national wetland inventory maps 1985)

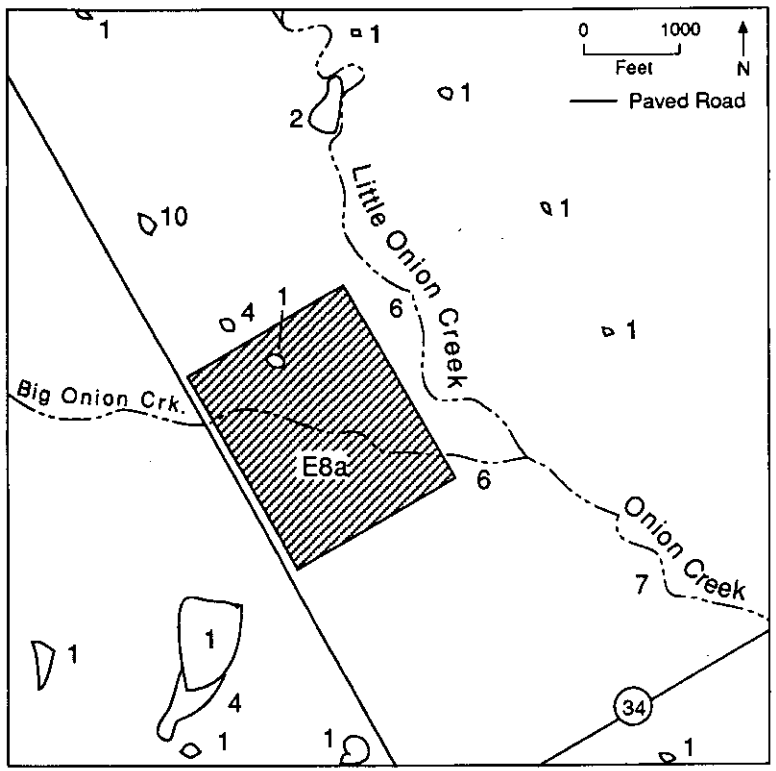


1. Palustrine open water, permanently flooded, excavated or diked impounded
2. Palustrine forested, seasonally or temporarily flooded
4. Palustrine emergent, persistent, seasonally or temporarily flooded
6. Riverine intermittent, streambed, seasonally flooded
7. Riverine lower perennial open water, permanently flooded
10. Palustrine aquatic bed, rooted vascular, semipermanently flooded, diked impounded

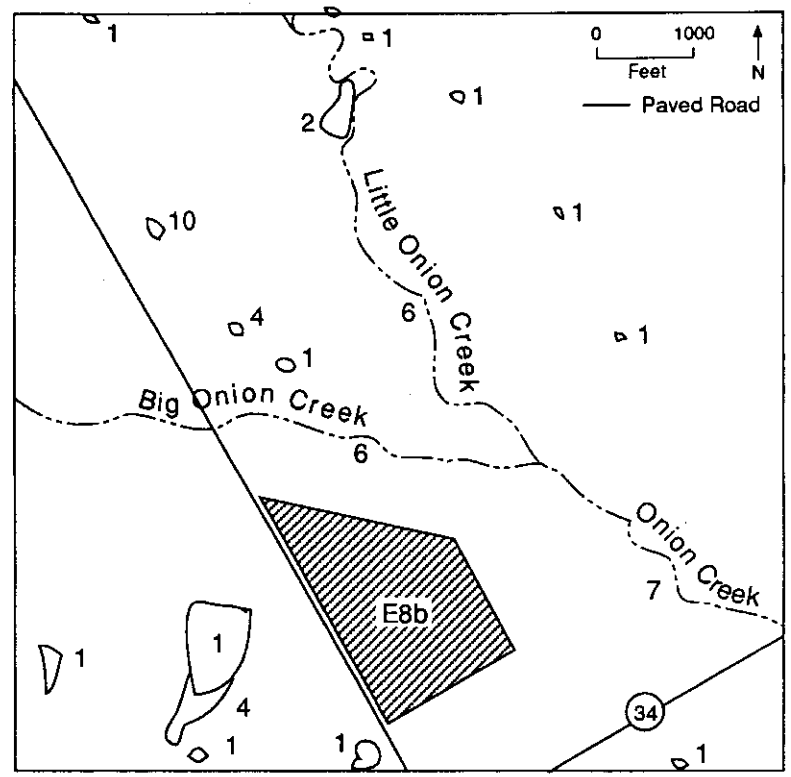


1. Palustrine open water, permanently flooded, excavated or diked impounded
6. Riverine intermittent, streambed, seasonally flooded

FIGURE 3.6i Part I — Areas E8 and F8 (Source: U.S. Fish and Wildlife Service national wetland inventory maps 1985)

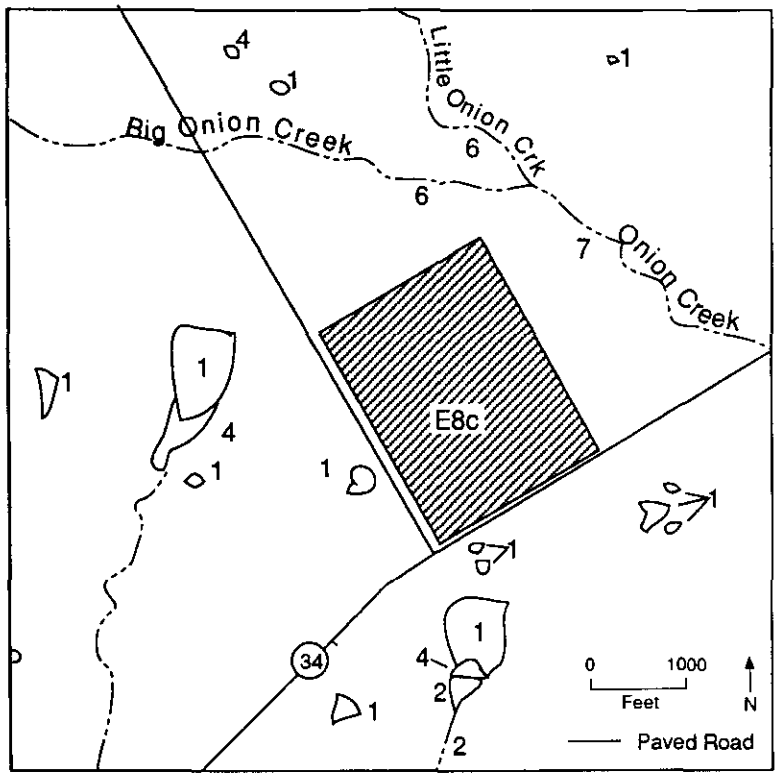


1. Palustrine open water, permanently flooded, excavated or diked impounded
2. Palustrine forested, seasonally or temporarily flooded
4. Palustrine emergent, persistent, seasonally or temporarily flooded
6. Riverine intermittent, streambed, seasonally flooded
7. Riverine lower perennial open water, permanently flooded
10. Palustrine aquatic bed, rooted vascular, semipermanently flooded, diked impounded

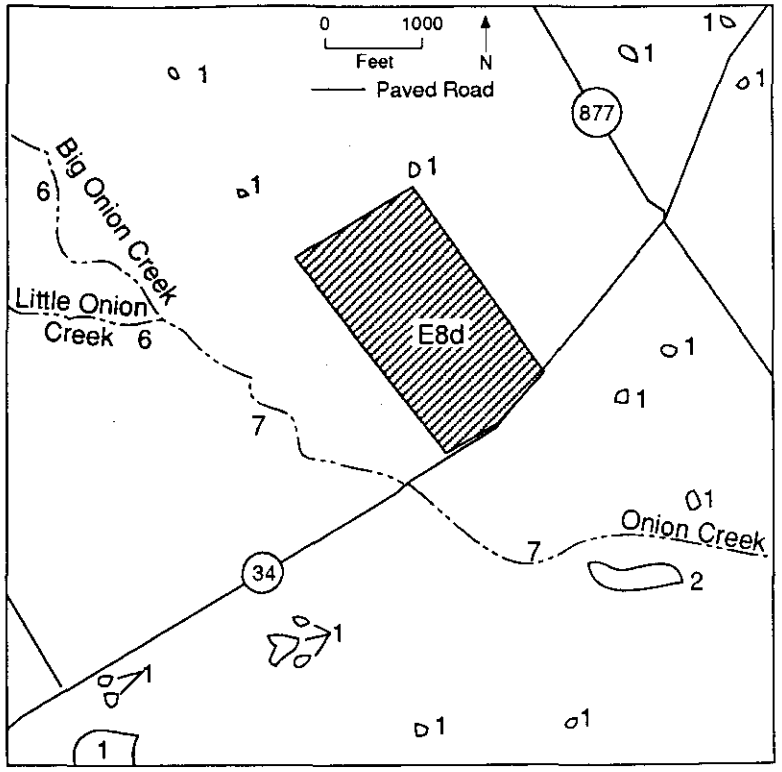


1. Palustrine open water, permanently flooded, excavated or diked impounded
2. Palustrine forested, seasonally or temporarily flooded
4. Palustrine emergent, persistent, seasonally or temporarily flooded
6. Riverine intermittent, streambed, seasonally flooded
7. Riverine lower perennial open water, permanently flooded
10. Palustrine aquatic bed, rooted vascular, semipermanently flooded, diked impounded

FIGURE 3.6j Part J — Areas E8a and E8b (E8a is current preferred location) (Source: U.S. Fish and Wildlife Service national wetland inventory maps 1985)

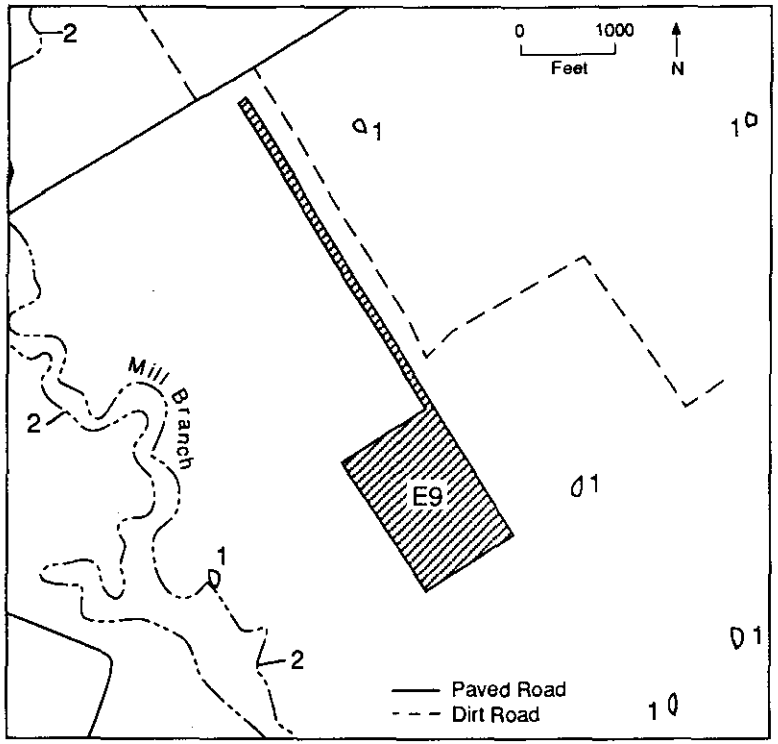


1. Palustrine open water, permanently flooded, excavated or diked impounded
2. Palustrine forested, seasonally or temporarily flooded
4. Palustrine emergent, persistent, seasonally or temporarily flooded
6. Riverine intermittent, streambed, seasonally flooded
7. Riverine lower perennial open water, permanently flooded

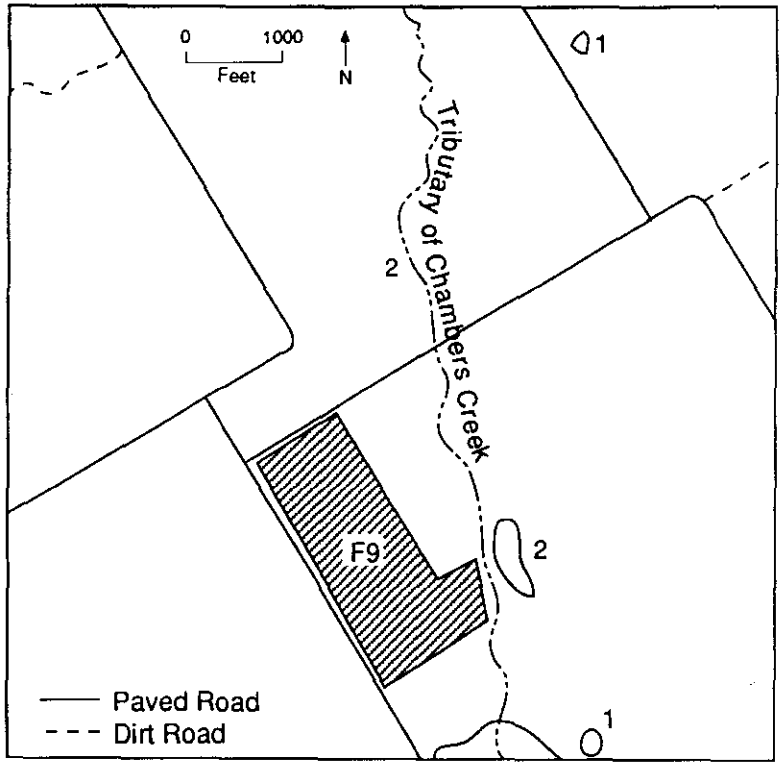


1. Palustrine open water, permanently flooded, excavated or diked impounded
2. Palustrine forested, seasonally or temporarily flooded
6. Riverine intermittent, streambed, seasonally flooded
7. Riverine lower perennial open water, permanently flooded

FIGURE 3.6k Part K — Areas E8c and E8d (Source: U.S. Fish and Wildlife Service national wetland inventory maps 1985)

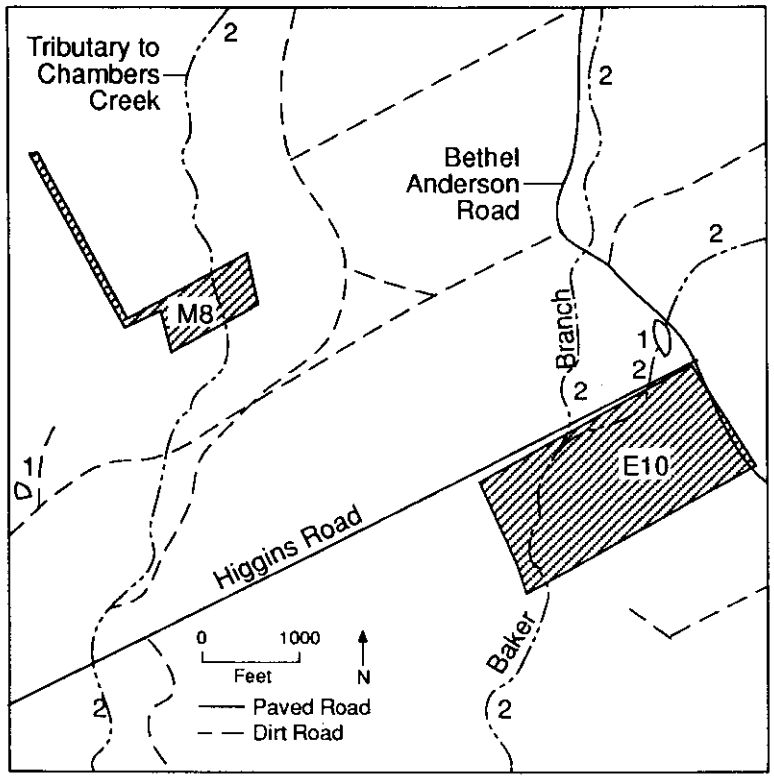


1. Palustrine open water, permanently flooded, excavated or diked impounded
2. Palustrine forested, seasonally or temporarily flooded



1. Palustrine open water, permanently flooded, excavated or diked impounded
2. Palustrine forested, seasonally or temporarily flooded

FIGURE 3.61 Part L — Areas E9 and F9 (Source: U.S. Fish and Wildlife Service national wetland inventory maps 1985)



1. Palustrine open water, permanently flooded, excavated or diked impounded
2. Palustrine forested, seasonally or temporarily flooded

FIGURE 3.6m Part M — Areas E10 and M8 (Source: U.S. Fish and Wildlife Service national wetland inventory maps 1985)

3.2.2 Groundwater Hydrology and Quality

Groundwater hydrology and quality in the project area are largely determined by the geologic setting. The general southeastward slope of the land surface, together with the regional eastward dip of geologic units of varied lithology, defines the groundwater flow system and the geochemical setting in which water quality is determined. Groundwater withdrawals from wells in Ellis and adjacent counties have altered the natural system, influencing both the flow and quality of groundwater.

3.2.2.1 Hydrology

Each of the geologic units described in Section 3.1.2 is recognizable in outcrop and in well cuttings; each has hydrogeologic properties that affect the occurrence of groundwater and the rate of groundwater movement. For this reason, each geologic unit

TABLE 3.5 Wetlands Occurring in Proposed Fee Simple Sites (number of sites [acres])[a]

Site	Open Water	Wetlands[b]			
		Emergent	Forested	Riverine	Total
West campus	8 (8)	8 (8)	7 (79)	-	23 (95)
East campus	32 (49)	1 (2)	2 (62)	1 (9)	36 (122)
F1	-	-	1 (12)	-	1 (12)
F2	1 (1)	-	-	1 (2)	2 (3)
F3	-	1 (1)	-	-	1 (1)
E4	1 (1)	-	-	-	1 (1)
E5	1 (1)	-	-	-	1 (1)
F6	3 (5)	-	-	-	3 (5)
F7	1 (1)	-	-	-	1 (1)
E8a[c]	1 (1)	-	-	1 (2)	2 (3)
F8	1 (1)	-	-	-	1 (1)
F9	-	-	1 (1)	-	1 (1)
E10	-	-	1 (20)	-	1 (20)
M8	-	-	1 (1)	-	1 (1)
M9	2 (4)	-	-	-	2 (4)
Total	51 (72)	10 (11)	13 (175)	3 (13)	77 (271)

[a]Proposed sites that do not contain wetlands are not listed.

[b]Open water = palustrine open water, permanently flooded, excavated or diked imponded; emergent = palustrine emergent, persistent, seasonally or temporarily flooded; forested = palustrine forested, seasonally or temporarily flooded; and riverine = riverine intermittent, streambed, seasonally flooded, except for E8, which is riverine lower perennial open water, permanently flooded.

[c]Excludes 24 acres of forested riparian area not identified as wetland on U.S. Fish and Wildlife Service national wetland inventory maps (1985).

TABLE 3.6 Surface Water Quality Data for Lake Waxahachie, Mid-Lake near Dam, October 27, 1981 - August 18, 1988

Parameter	Water Quality Standard	No. of Samples	Maximum	Minimum	Average
Water temperature (°C)	32.8[a]	68	30.4	5.5	21.9
Specific conductance (μmho/cm)	-	68	378	246	293
pH (units)	6.5-9.0[b]	68	8.7	6.7	7.5
Dissolved oxygen (mg/L)	5.0[c]	68	12.0	0	4.6
Dissolved solids (mg/L)	300[d]	0	-	-	-
Chloride (mg/L)	50[d]	7	15	4	8
Sulfate (mg/L)	50[d]	7	51	11	24
Nitrate-N (mg/L)	10	7	0.39	0.02	0.15
NH_3-N (mg/L)	-	7	0.31	0.020	0.083
Total phosphorous (mg/L)	-	7	0.30	0.010	0.079
Dissolved phosphorous (mg/L)	-	7	0.30	0.010	0.053
Fecal coliform bacteria (No./100 mL)	200[e]	4	20	4	8
Chlorophyl A (μg/L)	-	7	7.3	1.3	3.5

[a]Not to exceed this temperature.

[b]Absolute minimum and maximum pH.

[c]24-hour mean minimum concentration.

[d]Annual average not to exceed this concentration.

[e]30-day geometric mean not to exceed this count.

Source: Texas Water Commission 1989a.

is referred to as a hydrogeologic unit. Individual hydrogeologic units and their properties are described in Table 3.8. Similarities allow individual hydrogeologic units to be grouped into three hydrostratigraphic units. Listed in order of increasing depth, these hydrostratigraphic units are as follows:

- A shallow, unconfined aquifer system of Quaternary alluvium and weathered near-surface bedrock, including weathered portions of the Austin chalk.

- A regional confining system that includes geologic units from the lower Taylor marl, the Austin chalk, and the Eagle Ford shale.

TABLE 3.7 Surface Water Quality Data for Bardwell Reservoir, Mid-Lake near Dam, October 27, 1981 - August 18, 1988

Parameter	Water Quality Standard	No. of Samples	Maximum	Minimum	Average
Water temperature (°C)	32.8[a]	44	31.0	4.7	23.6
Specific conductance (μmho/cm)	-	44	407	266	302
pH (units)	6.5-9.0[b]	44	8.6	6.7	7.6
Dissolved oxygen (mg/L)	5.0[c]	44	12.2	0	5.4
Dissolved solids (mg/L)	300[d]	0	-	-	-
Chloride (mg/L)	50[d]	7	23	10	14
Sulfate (mg/L)	50[d]	7	78	25	39
NH_3-N (mg/L)	-	7	0.72	0.02	0.16
NO_3-N (mg/L)	10	7	0.40	0.02	0.11
Total phosphorous (mg/L)	-	7	0.050	0.030	0.043
Dissolved phosphorous (mg/L)	-	7	0.050	0.010	0.024
Fecal coliform bacteria (No./100 mL)	200[e]	5	16	4	9
Chlorophyl A (μg/L)	-	7	24.4	4.3	11.0

[a]Not to exceed this temperature.

[b]Absolute minimum and maximum pH.

[c]24-hour mean minimum concentration.

[d]Annual average not to exceed this concentration.

[e]30-day geometric mean not to exceed this count.

Source: Texas Water Commission 1989a.

- A deep regional confined aquifer system that includes, in order of increasing depth, the Woodbine, Paluxy, and Twin Mountains aquifers.

The relationships among these hydrostratigraphic units are schematically illustrated in Figure 3.7. As illustrated in Figure 3.8, recharge to the shallow aquifer system occurs across Ellis County, and recharge to the deep, confined aquifer system occurs west of Ellis County where the aquifers crop out. In general, groundwater flow is from west to east. The depth to the deep, confined aquifers increases from west to east.

TABLE 3.8 Summary Description of Hydrogeologic Units in the Vicinity of the SSC Site

Hydrogeologic Unit	Thickness (ft)	Description	Hydraulic Conductivity (cm/s)	Other Hydraulic Properties[a]	Water-Bearing Characteristics
Alluvial deposits	<45	Moderately to well sorted mixture of rounded and angular gravel, sand, silt, and clay	1×10^{-1} -1×10^{2}	N/A[b]	May yield up to 75 gal/min of fresh water suitable for domestic livestock and irrigation use
Taylor marl	<626	Clay, marl, and chalk, with some sand and sandy marl	1×10^{-9} -1×10^{-8}	N/A	Where weathered, yields small amounts of fresh to slightly saline hard water for domestic and livestock use
Weathered Austin chalk	<15	Weathered chalk	4.3×10^{-1}	N/A	Small amounts of hard water for domestic and livestock use
Unweathered Austin chalk	<508	Chalk, marl, and limestone, with interstratified silty to sandy shale	1.6×10^{-8} -7×10^{-8}	N/A	Not known to yield water in the vicinity of the site

TABLE 3.8 (Cont'd)

Hydrogeologic Unit	Thickness (ft)	Description	Hydraulic Conductivity (cm/s)	Other Hydraulic Properties[a]	Water-Bearing Characteristics
Eagle Ford shale	<467	Moderately fossiliferrous, gray to black, calcareous to noncalcareous, bentonitic shale, with thin, laminated beds of sandstone and limestone	$<1.8 \times 10^{-8}$	N/A	Where weathered, yields small amounts of poor water in the outcrop for domestic and livestock use
Woodbine formation	250-375	Lenticular, cross-bedded, loose to slightly consolidated, fine-grained, ferruginous sand and sandstone interbedded with laminated clay	5×10^{-4} -9×10^{-3}	T = 700-11,600 S = 0.00002-0.0002	A primary source of water in the region; yields 10-450 gal/min of fresh water for domestic, livestock, and public supply use
Washita group	320-543	Interbedded limestone, shale and sandy to calcareous shale	N/A	N/A	Yields small amounts of water in the outcrop; not known to yield water to wells in Ellis County
Fredericksburg group	185-271	Limestone; shale; and calcareous, silty and sandy shale	N/A	N/A	Not known to yield water to wells in Ellis County

TABLE 3.8 (Cont'd)

Hydrogeologic Unit	Thickness (ft)	Description	Hydraulic Conductivity (cm/s)	Other Hydraulic Properties[a]	Water-Bearing Characteristics
Paluxy sand	120-160	Fine-grained sand and poorly consolidated sandstone with varying amounts of clay, shale, and lignite	1.7×10^{-3} -2.2×10^{-3}	T = 3,000-5,700 S = 0.000087-0.000034	A secondary aquifer in the region; yields 80-160 gal/min of slightly saline water for domestic livestock use
Glen Rose limestone	470-620	Medium to thick-bedded, dense and marly limestone with some sandstone, shale, sandy shale, and anhydrite	N/A	N/A	May yield small amounts of moderately saline water in localized areas; not known to yield water in vicinity of site
Travis Peak formation	400-800	Coarse to fine sandstone interlensed with shale, clay, and thin limestone lenses	5.4×10^{-3}	T = 2,600-28,000 S = 0.000045-0.00013	Small to moderate quantities of water may be available; not known to yield water in vicinity of site

TABLE 3.8 (Cont'd)

Hydrogeologic Unit	Thickness (ft)	Description	Hydraulic Conductivity (cm/s)	Other Hydraulic Properties[a]	Water-Bearing Characteristics
Twin Mountains formation	550-850	Medium- to coarse-grained sand, with some clay and shale	1×10^{-3} -8×10^{-3}	T = 5,440-16,545	A primary aquifer in the region; yields 65-550 gal/min in vicinity of site

[a]T = transmissivity (gal/d-ft); S = storage coefficient.

[b]N/A = data not available.

Sources: Thompson 1967; Freeze and Cherry 1979; Mason, Johnson and Assoc. 1987; Nordstrom 1982; William F. Guyton Assoc. 1987; Southwestern Laboratories 1987; Texas Water Commission 1963.

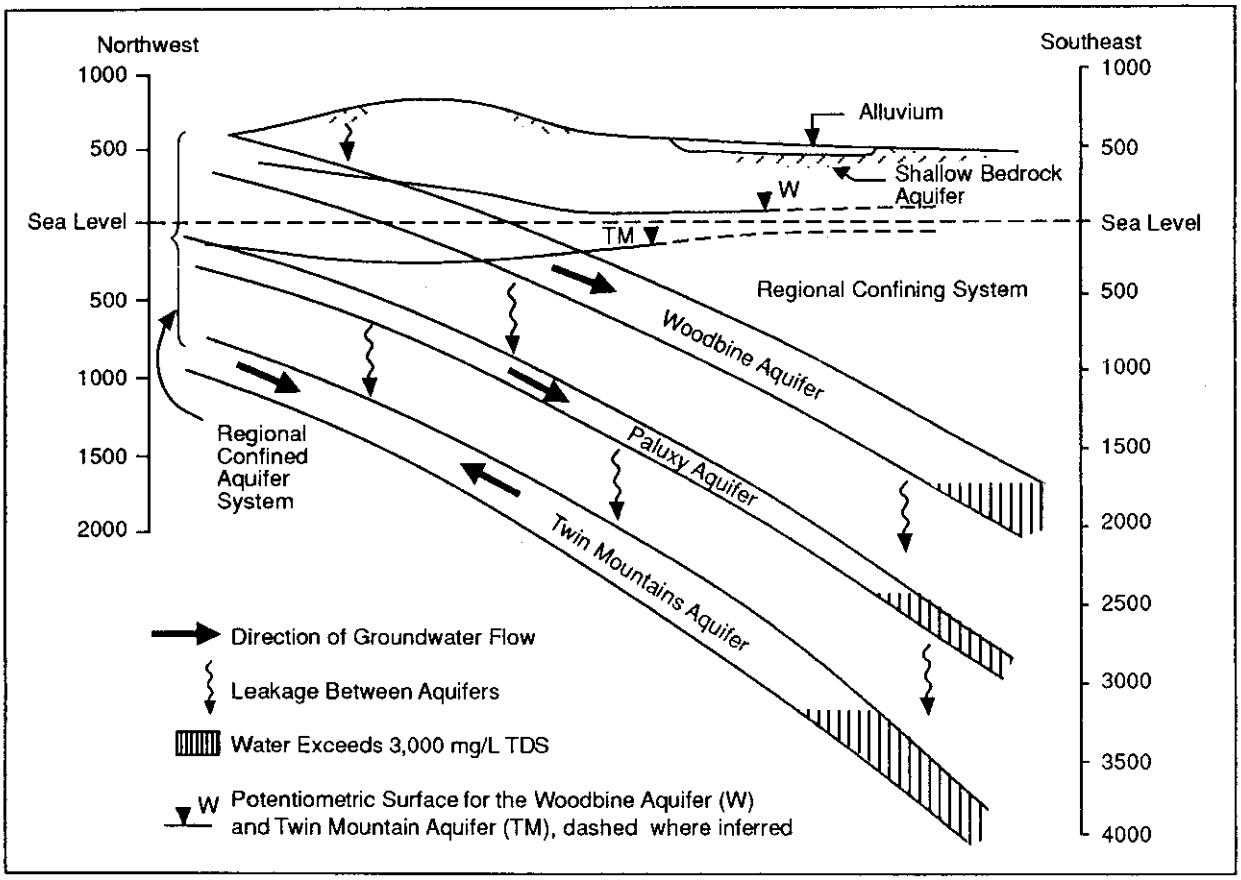


FIGURE 3.7 Schematic Hydrogeologic Cross Section of Ellis County (Source: Based on Thompson 1967; William F. Guyton Assoc. 1987; Texas Water Commission 1989b)

Shallow Aquifer System

The primary water-bearing units in the shallow system are (1) the Quaternary alluvium and terrace deposits located adjacent to the major surface water drainages and (2) near-surface bedrock that has been fractured and weathered. Bedrock hydrogeologic units in this shallow aquifer are the Taylor marl, Austin chalk, and Eagle Ford shale.

Recharge to the shallow, unconfined system is by direct precipitation and infiltration. Water levels can decline significantly during dry periods. In general, water in the alluvium and terrace deposits can be expected to move toward and along the adjacent stream channel in the direction of surface water flow. In shallow bedrock, the direction of groundwater flow can be expected to be highly variable and depend on the local topography and the direction and intensity of fracturing and weathering. Where elevations of the water table are above the adjacent stream, groundwater in the shallow system will contribute to the base flow of the stream.

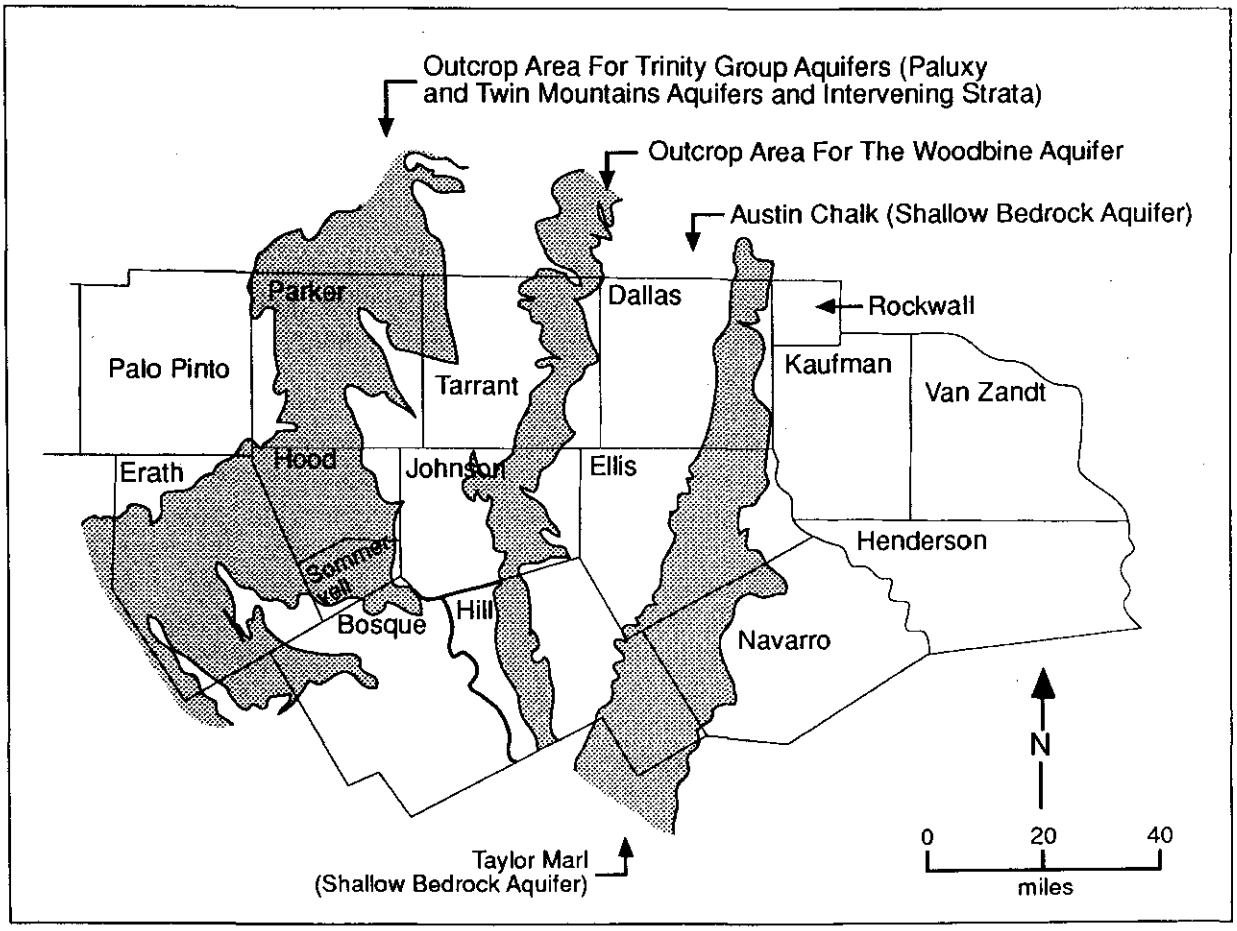


FIGURE 3.8 Recharge Areas for Major Aquifers in the Vicinity of Project Site (Source: Texas Water Commission 1989b)

Regional Confining System

The regional confining hydrostratigraphic unit separates the shallow, unconfined aquifer system from the deeper confined system and consists primarily of the thick (about 1,100 ft) sequence of the shale in the Taylor marl, Eagle Ford shale, and unweathered or unfractured portion of the Austin chalk. The vertical component of groundwater flow through the confining system appears to be downward. On a regional basis, this leakage may be an important source of recharge to the regional confined aquifer system (Rapp 1988).

Regional Confined Aquifer System

The regional confined aquifer system is generally recognized as containing three aquifers: the Woodbine, the Paluxy, and the Twin Mountains. The Woodbine and Twin Mountains aquifers are the primary sources of groundwater in this region.

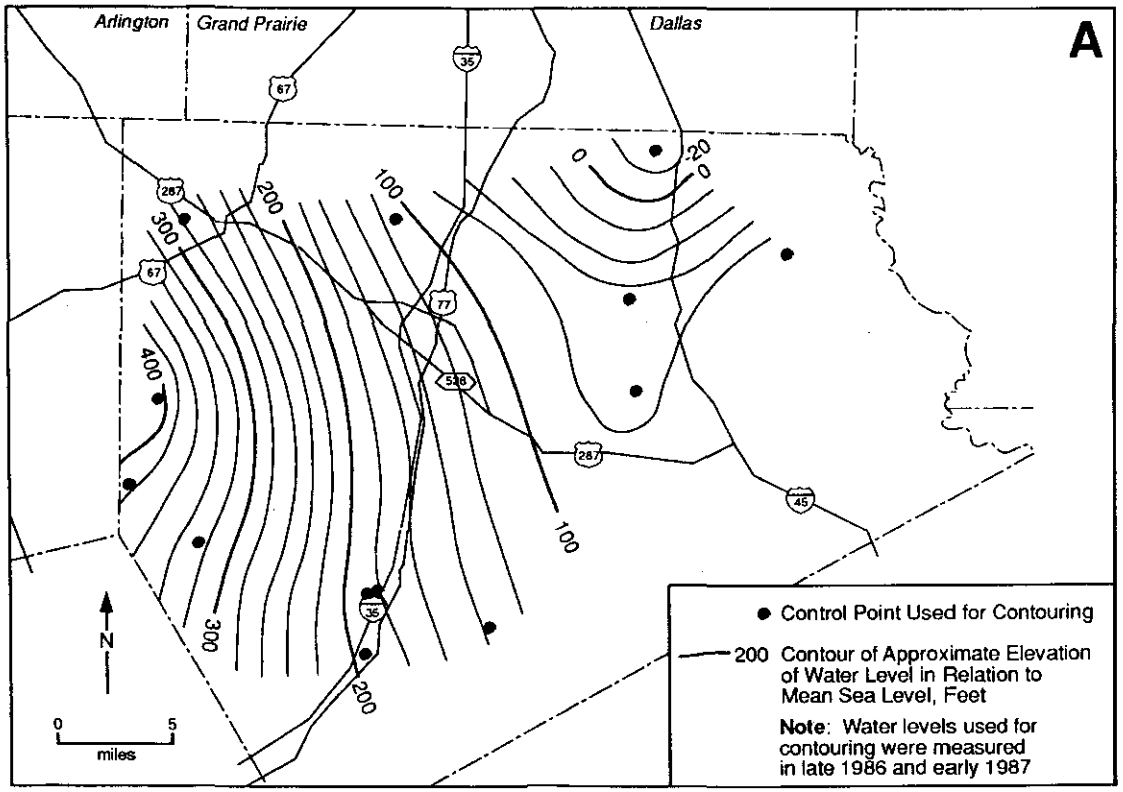
The Paluxy aquifer is thin relative to the Woodbine and Twin Mountains aquifers and is rarely used as a water source. Recharge to the Paluxy aquifer is most likely to occur from direct precipitation on the outcrop area west of Ellis County and leakage through the overlying confining unit. Potentiometric data are not available to define the direction of groundwater flow in the Paluxy, but the regional hydrogeologic setting suggests that flow is likely to follow the structural dip of the formation toward the east.

Wells completed in the Woodbine and Twin Mountains aquifers are located throughout most of Ellis County. However, because of increasing depth and deteriorating water quality from west to east, few wells are completed in the Twin Mountains aquifer in the eastern third of Ellis County. Figure 3.9 shows the general potentiometric surfaces for the Woodbine and Twin Mountains aquifers.

The Woodbine is the uppermost major aquifer in the deep regional aquifer unit. Dipping to the east from outcrop areas in eastern and central Johnson County, the Woodbine aquifer ranges in depth from 100 to 1,400 ft beneath Ellis County (Thompson 1967). Recharge to the aquifer is by direct precipitation on the outcrop area and leakage through the overlying confining units (Texas Water Commission 1989b). Heavy pumping of the Woodbine aquifer has lowered potentiometric levels in the aquifer, and recently compiled water-level data (William F. Guyton Assoc. 1987) indicate that groundwater flow beneath the county is now toward the east and north-northeast (Figure 3.9a). Pumping in the northeastern portion of the county near Ferris and Palmer significantly influences the flow direction.

Twin Mountains is the second major aquifer in the deep regional unit. Located 1,400-2,000 ft below the top of the Woodbine aquifer, and separated from it by a thick sequence of limestone and shale, the Twin Mountains aquifer is the deepest of the regional aquifers in this area (Thompson 1967). Recharge to the aquifer is from direct precipitation on outcrop areas located about 30 mi to the west in Hood County and adjacent counties (Figure 3.8). Regionally significant recharge to the Twin Mountains aquifer may also be occurring from leakage through the overlying confining unit (Rapp 1988). Water levels in the Twin Mountains have declined as a result of heavy pumping in Tarrant and Dallas counties. Published potentiometric data from 1986 and 1987 (William F. Guyton Assoc. 1987) indicate that (1) the regional direction of groundwater flow in the Twin Mountains aquifer has been reversed, and (2) beneath Ellis County, flow is toward the northwest (Figure 3.9b). Pumping from wells near Midlothian and Maypearl has caused local cones of depression to form in the Twin Mountains aquifer, influencing the local direction of groundwater flow in these areas (Figure 3.9b).

The large declines in water levels observed since the 1930s, both in the Woodbine and Twin Mountains aquifers, do not appear to have caused ground subsidence. These aquifers are relatively old and well consolidated, and they are not prone to compaction as the hydraulic head is lowered or as the formation is dewatered. Land surface subsidence is more common (and generally more severe) in young, poorly consolidated aquifers and oil reservoirs, such as those of the Gulf Coast region about 140 mi south of Ellis County (Texas Water Commission 1989b). In the vicinity of Houston, groundwater withdrawals (and to a lesser extent oil production) between 1906 and 1978 resulted in widespread land surface subsidence of 0.2-9 ft (Texas Water Commission 1989b). The subsidence observed in the coastal plain is the closest area of documented subsidence to Ellis County.



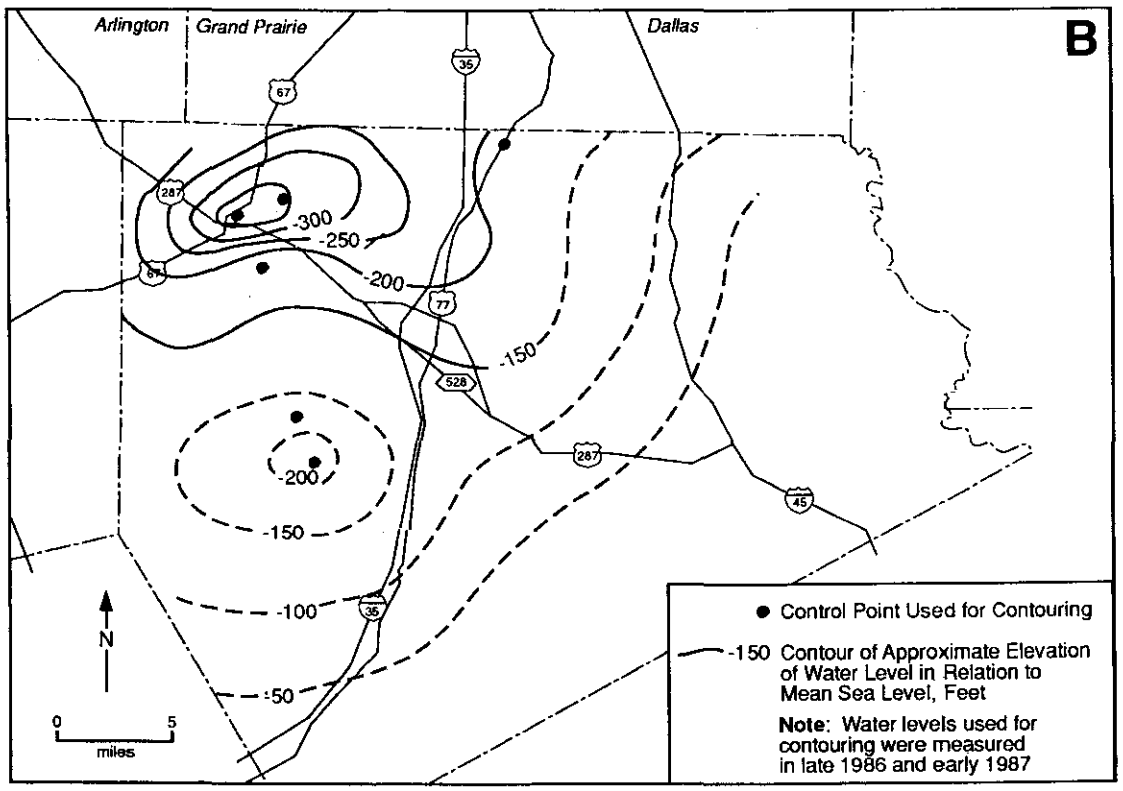


FIGURE 3.9 Potentiometric Maps of the Woodbine (part A) and Twin Mountains (part B) Aquifers in Ellis County (Source: William F. Guyton Assoc. 1987)

3.2.2.2 Groundwater Quality

The quality of groundwater in the project area varies between aquifers. Within each aquifer, water quality generally deteriorates from west to east (William F. Guyton Assoc. 1987; Texas Water Commission 1989b). Variations in water quality between aquifers reflect lithologic differences in the soil and rock through which the water has passed. Downgradient deterioration of water quality within a given aquifer is generally attributable to increases in dissolved solids resulting from the prolonged contact of water with soluble portions of the rock mass.

The range of groundwater quality in Ellis County is summarized and compared with selected water quality standards in Table 3.9. In general, water in the Twin Mountains aquifer is of better quality than water from other aquifers in the area. The concentrations of dissolved solids range from 310 mg/L in the alluvium to 3,040 mg/L in the Paluxy sand. Except for water from the alluvium, most of the water from the Paluxy, Woodbine, and Twin Mountains aquifers in Ellis County exceeds the EPA drinking water standard for total dissolved solids (TDS) of 500 mg/L. Groundwater in the county is generally of the sodium-bicarbonate type (Thompson 1967).

Limited data on groundwater quality are available for the shallow aquifer system of Ellis County. Water from the shallow aquifer is generally low in TDS but is very hard. Significant variations in water quality are to be expected within the shallow system. Because the aquifer is shallow and is recharged directly from precipitation, the system is subject to degradation by activities on the surface (Texas Water Commission 1989b). The shallow aquifer also is discontinuous and often includes weathered bedrock of varying lithology, resulting in naturally occurring variations in water quality.

Regional Confined Aquifer System

Water quality in the regional confined aquifer system reflects the lithologic differences between aquifers. In each of the regional confined aquifers, water quality decreases in the direction of groundwater flow.

Water in the Paluxy sand is generally high in TDS and can be classified as slightly saline. The relatively high levels of sulfate suggest the existence of sulfur-bearing minerals within the groundwater flow path of the aquifer.

Water from the Woodbine aquifer generally is more highly mineralized than that from the other aquifers, but the Woodbine water is usually soft and not high in nitrates. The quality of water in the Woodbine deteriorates toward the east, reflecting the solution of soluble minerals in the rock mass. Water temperature ranges from 71° to 97°F, on the basis of the 28 measurements made in 1961-1985 (Table 3.9). The lithology of the aquifer is described as thin- to massive-bedded sandstone interbedded with shale and sandy shale.

Groundwater in the Twin Mountains aquifer is generally lower in TDS than water from the shallower Woodbine aquifer, but is harder and warmer. The relative hardness of water in the Twin Mountains aquifer can be attributed to the marl and limestone

TABLE 3.9 Range of Groundwater Quality in Ellis County, Texas

Parameter	Drinking Water Standard	Groundwater Quality (mg/L)[a]				
		Alluvium	Fractured Bedrock[b]	Paluxy Sand	Woodbine Aquifer	Twin Mountains Aquifer
Total dissolved solids	1,000[c]	310-1,787 (2)	44-994 (2)	1,250-3,040 (2)	606-2,970 (54)	575-1,440 (59)
Calcium	None	128-156 (2)	12-38 (2)	7.2 (1)	1-14 (54)	1-26 (59)
Magnesium	None	5.5-12 (2)	3.4-15 (2)	4.4 (1)	0-25 (54)	0-4 (59)
Sodium	None	23-178 (2)	314-477 (2)	696 (1)	208-1,200 (53)	241-551 (59)
Bicarbonate	None	254-364 (6)	376-778 (9)	628-666 (2)	370-1,060 (59)	0-640 (59)
Carbonate	None	-	-	83 (1)	0-38 (35)	0-279 (17)
Sulfate	250[c]	11-1,460 (5)	16-684 (9)	354-930 (2)	22-656 (59)	70-500 (59)
Chloride	300[c]	2.4-240 (6)	12-174 (9)	54-85 (2)	17-1,290 (59)	67-405 (59)
Fluoride	2[d]	0.1-0.2 (3)	0.5-1.5 (2)	5.4 (1)	0.05-7.9 (53)	0.6-3.0 (59)
Nitrates as NO_3	45[d]	1.8-231 (3)	0.2-2 (3)	0.04-8.3 (2)	0-10 (54)	0-5.0 (53)
Hardness	None	236-965 (6)	44-610 (9)	15-40 (2)	4-70 (58)	7-110 (59)
Temp. (°F)	None	-	-	-	71-97 (28)	92-110 (14)
Year(s)[e]	-	1965	1965	1965	1961-1985	1943-1986

[a]Numbers in parentheses are the number of samples/analyses available to calculate range.

[b]Primarily water from the Taylor Marl.

[c]Texas-recommended secondary constituent level for all public water systems (Texas Water Commission 1989b).

[d]Maximum constituent level for community-type systems in Texas (Texas Water Commission 1989b).

[e]Period of years during which samples used to calculate range were collected.

Source: Thompson 1967; William F. Guyton Assoc. 1987; Nordstrom 1982; Texas Water Commission 1989b.

interbeds within the massive sandstone of the aquifer. Water temperatures that commonly range from 100° to 110°F are the result of water circulating to depths as great as 4,000 ft in a geothermal gradient averaging 1° to 1.5°F per 100 ft.

The Texas Water Commission (1989b) suggests that deteriorating water quality in the Twin Mountains aquifer in Dallas and Ellis counties may be an indirect result of the reversal of groundwater flow direction caused by heavy pumping. Water downgradient of Ellis County is higher in TDS than water currently being extracted in the county. The reversal of groundwater flow is apparently allowing the poor-quality water to migrate westward. This trend is expected to continue as long as water levels in the aquifer continue to decline.

3.2.3 Water Use

3.2.3.1 Surface Water Use

In 1985, Ellis County reported a total water use of 18,400 acre-ft, of which 53% was derived from surface water sources. The cities of Waxahachie and Ennis used 5,220 and 2,340 acre-ft, respectively, in that year (Texas Water Development Board 1988).

Major water supply reservoirs in the project vicinity include Lake Waxahachie on South Prong Creek and Bardwell Lake on Waxahachie Creek. Lake Waxahachie, with a storage capacity of 13,500 acre-ft, supplies water to the city of Waxahachie, which has an annual authorized use of 2,810 acre-ft. Bardwell Lake, with a water supply storage capacity of 54,900 acre-ft, supplies water to the cities of Waxahachie and Ennis. The combined authorized annual use from Bardwell Lake for these two cities is 9,600 acre-ft. The projected annual water use by both cities is 9,770 acre-ft from both reservoirs through the year 2020. Thus, the two cities have a total available reserve capacity of 2,640 acre-ft per year from the two reservoirs (SSCL 1989, Vol. I, Section G).

Two major reservoirs -- the Cedar Creek and Richland-Chambers reservoirs -- are located southeast of Waxahachie and supply water to the Fort Worth area (Figure 3.4). The Cedar Creek Reservoir, located about 38 mi from Waxahachie, has a storage capacity of 679,000 acre-ft and a firm yield of 150 million gal/day. The Richland-Chambers Reservoir, located 46 mi from Waxahachie, was completed in 1989. The new reservoir has a storage capacity of 1,135,000 acre-ft and a firm yield of 187 million gal/day. The Tarrant County Water Control and Improvement District No. 1 operates a 72-in.-diameter water pipeline extending from the Cedar Creek Reservoir and a 90-in. pipeline from the Richland-Chambers Reservoir to convey water to the Fort Worth area. The pipelines have a total capacity in excess of 300 million gal/day (SSCL 1989, Vol. I, Section G).

Projected water use in Ellis County without the SSC project is shown in Table 3.10. The projections indicate increasing reliance on Tarrant County Water Control and Improvement District No. 1 and other existing and new reservoirs for future water supplies.

TABLE 3.10 Projected Water Use in Ellis County

Source	Quantity (acre-ft/yr)		
	Year 2000	Year 2020	Year 2030
Groundwater	6,190	6,190	5,480
Surface water			
Lake Waxahachie	2,400	2,400	2,400
Bardwell Lake	8,300	7,370	6,900
TCWCID and TRA[a]	2,690	9,500	18,240
Local supplies	1,390	1,390	1,420
Other surface water	5,710	12,440	10,730
Total	26,680	39,290	45,170

[a]TCWCID = Tarrant County Water Control and Improvement District No. 1; TRA = Trinity River Authority.

Source: Texas Water Development Board 1988.

3.2.3.2 Groundwater Use

Groundwater use from the shallow alluvial aquifer in Ellis County has not been studied, and meaningful data regarding the aquifer are difficult to obtain (Manchester 1989). A review of published reports (Thompson 1967; Nordstrom 1982; Brune 1975; Mason, Johnson and Assoc. 1987; Southwestern Laboratories 1987) and driller's logs on file with the Texas Department of Water Resources identified 75 wells completed in the alluvium or shallow bedrock of the shallow aquifer. Other wells not recorded in the state's files also are likely to exist in the county.

Figure 3.10 shows the locations of the recorded shallow wells in Ellis County and indicates the geologic units in which they are completed. Most of the wells completed in the alluvium are located along the Trinity River at the eastern edge of the county. Isolated alluvial wells also have been identified along Red Oak and Waxahachie creeks. A group of five wells known to be completed in both the alluvium and the underlying Austin chalk is located about 5 mi northeast of Waxahachie along Red Oak Creek. Wells completed in shallow bedrock are most frequently found in the eastern third of the county, and most of these wells (about 24% of the recorded shallow wells in the county) are reported to be completed in the Taylor marl. Wells in the vicinity of the town of Red Oak are generally completed in the shallow Austin chalk. The source of water for about 25% of the shallow wells is undetermined.

The shallow aquifer system is an important local source of groundwater for users with small water requirements. Wells in the shallow aquifer are estimated to yield as

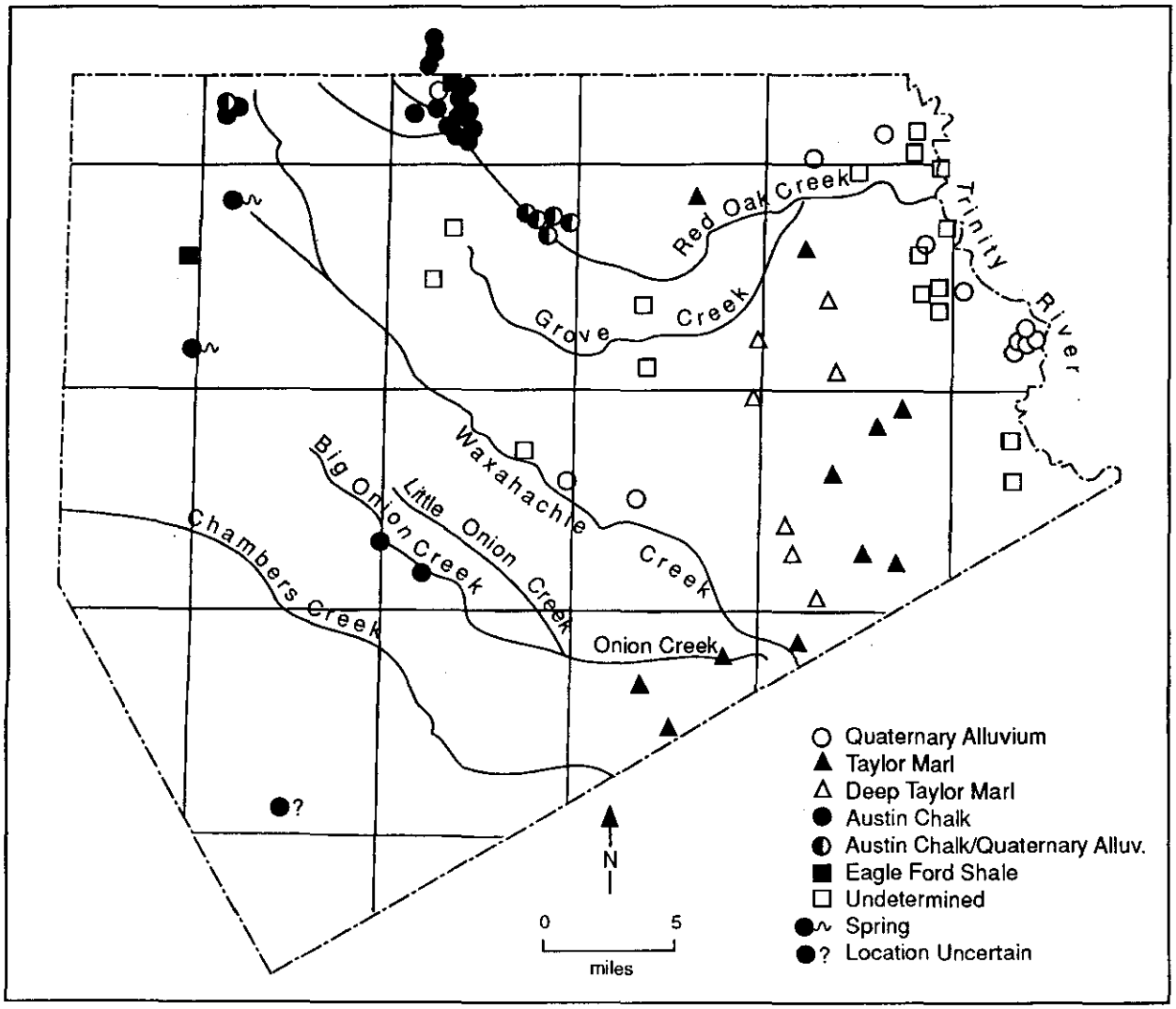


FIGURE 3.10 Locations of Recorded Shallow Wells in Ellis County (Source: Based on data from Thompson 1967; Nordstrom 1982; Brune 1975)

little as 1 gal/min from the Austin chalk to as much as 75 gal/min from the alluvium adjacent to the Trinity River. Estimates of total countywide groundwater withdrawals from the shallow aquifer are not available (Manchester 1989).

Historical groundwater use for counties in the project vicinity during the period 1974-1986 is summarized in Table 3.11. Total groundwater pumpage in Ellis County for 1985 is reported by the Texas Water Development Board (1988) to be about 8,700 acre-ft. About one-third of this was pumped from the Woodbine aquifer and two-thirds from the Twin Mountains aquifer. Approximately two-thirds of the total groundwater production in Ellis County in 1985 was for municipal use. Most of the remaining one-third was used for manufacturing; less than 3% of the total production was used for irrigation and livestock.

TABLE 3.11 Groundwater Use (acre-ft/yr) by County, 1974-1986

County	1974	1977	1980	1984	1985	1986
Dallas	23,040	23,972	16,398	18,633	19,249	16,224
Ellis	4,341	5,215	5,715	7,788	8,706	7,499
Henderson	2,162	4,163	4,245	5,830	5,934	5,881
Hill	3,802	4,079	3,767	2,829	2,717	2,837
Johnson	3,925	5,039	6,812	7,234	7,469	7,213
Kaufman	4,444	500	650	331	314	252
Navarro	758	585	327	498	384	357
Tarrant	18,455	18,024	19,747	17,111	18,813	15,541

Source: Texas Water Development Board 1988.

Major pumping centers that produce from the Woodbine and Twin Mountains aquifers in Ellis County were identified by William F. Guyton Assoc. (1987) and are shown in Figure 3.11. In 1985, these pumping centers produced approximately 5,370 acre-ft of groundwater, approximately 60% of the total production identified for the same year by the Texas Water Development Board (1988). Production from the Woodbine aquifer occurs over a wide area of the county. A potentiometric map (Figure 3.9a) prepared by William F. Guyton Assoc. (1987), who used data from late 1986 and early 1987, suggests that pumping from the Woodbine in the vicinity of Ferris and Palmer is causing an elongated trough of depression to develop. The combined production of wells at these two sites is estimated to be 470,000 gal (1.44 acre-ft) per day. A similar decline in water levels might be expected as a result of production from the Woodbine at Red Oak, but data from this region are not used on the potentiometric map.

Pumping from the deeper Twin Mountains aquifer is heaviest in the northwestern portion of the county. A water-level contour map of the Twin Mountains aquifer suggests that pumping has resulted in two large cones of depression (Figure 3.9b). The deepest cone of depression is centered on Midlothian, where water was pumped at an estimated rate of more than 1 million gal/day from the Twin Mountains aquifer by the City of Midlothian and the Sardis-Lone Elm Water Supply Co. The second cone of depression is centered northeast of Maypearl on wells operated by the Buena Vista Bethal Water Supply Co. at rate of 150,000 gal (0.46 acre-ft) per day. A third cone of depression might be expected in the vicinity of Rockett, where an estimated 1.23 million gal (3.77 acre-ft) per day is pumped by the Rockett Water Supply Co. from a series of four wells completed in the Twin Mountains aquifer. However, data from these wells are not used in the water-level map.

Groundwater use in Ellis County is projected to decrease by the year 1990 and remain constant through the year 2020 (Table 3.12). The projected reduction results from the current trend of municipalities within the county to convert to surface water sources. The larger communities have already converted to surface water. Waxahachie discontinued the use of wells in 1984 and now relies solely on water from Lake

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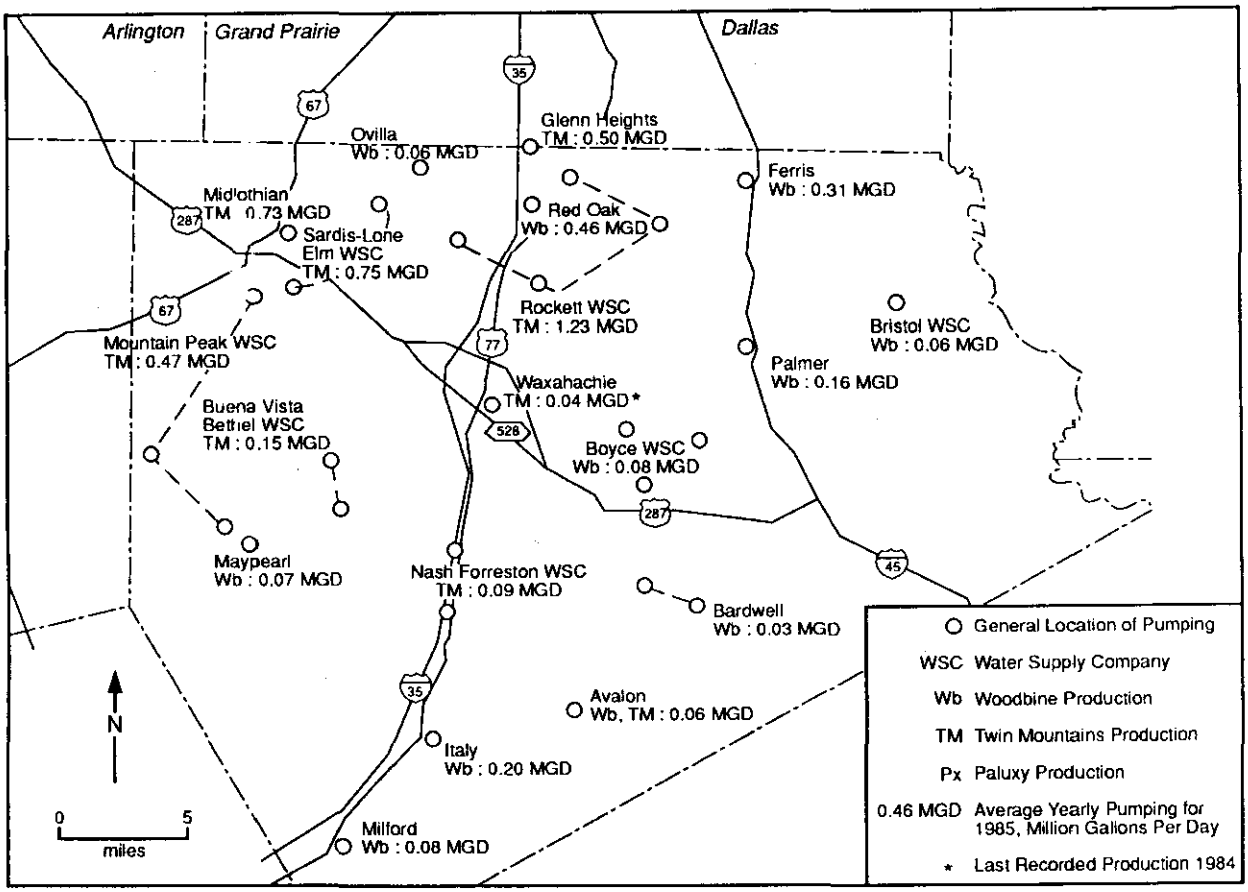


FIGURE 3.11 Principal Municipal Groundwater Use in Ellis County Area (Source: Adapted from William F. Guyton Assoc. 1987)

Waxahachie and Bardwell Lake. The city of Ennis also utilizes Bardwell Lake. Midlothian has recently (1988) converted to a surface water supply, withdrawing water from Joe Pool Lake. Corollary with this trend, a recent regional water study for Ellis County and southern Dallas County concluded that groundwater supplies in the area are limited and are dwindling. In addition, it was noted that the area of study is within a larger area that has been designated by the Texas Water Commission and the Texas Water Development Board for study and potential incorporation of all or some portion of the area as a critical groundwater management area. Groundwater was not considered a primary water supply alternative in the study (Espey, Huston & Assoc. 1989).

3.3 BIOTIC RESOURCES

3.3.1 Terrestrial Ecosystems

A generalized overview of the habitats and biota likely to occur in the vicinity of the SSC was provided in the EIS. Most of the site is occupied by cultivated grasslands

TABLE 3.12 Historic and Projected Groundwater Use (acre-ft/yr) in Ellis County

Year	Municipal	Industrial	Mining	Livestock	Total
1960	1,440	215	-	-	1,655
1972	2,026	1,457	-	-	3,483
1980	3,765	1,805	0	146	5,716
1985	5,788	2,739	87	92	8,706
1990-2020	4,699	1,318	0	172	6,189
2030	4,234	1,105	0	144	5,483

Source: Texas Water Development Board 1988.

and croplands. These habitats have replaced nearly all of the natural blackland prairie grasslands that once occurred in the area (Section 3.3.4). Major crops grown in Ellis County include wheat, hay, grain sorghum, corn, and upland cotton. Various vegetables, pecans, oats, and peaches are also produced on a more limited scale (FEIS, Vol. IV, Appendix 5c, Section 5.7.9.2). Between 200,000 and 250,000 acres of Ellis County are devoted to livestock pasture. Within the site area, the elm-hackberry habitats, which result from secondary succession on retired cropland last used as pasture, are fairly common along streams where grazing pressure continues. Mesquite woodlands and grasslands occur over about half of the site area. The mesquite, sometimes in conjunction with elm and juniper, invade the grasslands that are not actively mowed for hay. Realignment and facility sizing changes have not significantly altered the composition of plant communities included in the project area.

Numerous wildlife species occur in the site area. Detailed listings of vertebrate species were provided in the DEIS (Vol. IV, Appendix 5c, Section 5.7.9.2); however, those lists were found to require updating and revision. Revised lists of vertebrate species that would be expected to occur in the project area are provided in Appendix B. The lists include brief descriptions of the principal habitats used by each species and indicate the availability of those habitats in the project area.

3.3.2 Aquatic Ecosystems

Aquatic habitats in the SSC site area include livestock watering ponds; flood-retention impoundments; water-supply reservoirs; and ephemeral, intermittent, and perennial streams and rivers. (See Sections 3.2.1.1 and 3.2.1.3 for a description of surface waters, including wetlands.) A number of fish species occur in these habitats (Appendix B, Table B.1). The watering ponds, flood-retention reservoirs, and Waxahachie and Bardwell reservoirs also are important migratory bird support areas (Texas National Research Laboratory Commission 1988).

No biotic surveys of the ponds and impoundments in the area have been conducted. Nevertheless, these bodies of water can support warm-water fish populations. Farm ponds are often stocked with bass, sunfish, or catfish. These species also are often stocked in flood-retention impoundments, although species indigenous to the impounded streams may also occur. Because the upper reaches of many of the streams in the area are dry for a good portion of the year, these impoundments function as a haven for fish. A number of other wildlife species also inhabit or utilize the ponds and impoundments that are numerous in the area (Appendix B).

Macroinvertebrates usually dominate the aquatic fauna of intermittent and ephemeral streams. Generally, only a few highly tolerant (e.g., of broad fluctuations in oxygen concentrations, temperatures, water flow rates, and other parameters) fish species occur in these streams, although these species may be present in high numbers. During periods of flow, intermittent stream reaches may also serve as important spawning and nursery habitats for fish species that inhabit lower, perennial reaches of the streams (Zale et al. 1989). Information is not available on fish populations of streams in the area of the SSC. However, fish that would be expected to occur include several species of bullheads, sunfish, minnows, and suckers. Game fish such as bass and crappie may also occur, but in low numbers, when the streams are at high flow. Most fish migrate to lower perennial stream reaches when flows diminish, although some fish stay in the permanent pools that remain during periods of no flow. In general, a greater number of species and individual fish can be harbored as pool size increases, because the larger pools tend to be more physicochemically stable (Zale et al. 1989).

3.3.3 Commercially and Recreationally Important Species

Recreational hunting, commercial trapping, and fishing occur within the project area. Principal game species include eastern cottontail rabbit, fox squirrel, northern bobwhite, mourning dove, and a number of waterfowl species. White-tailed deer also are hunted, but the county population of deer is low because of the lack of suitable habitat (Texas National Research Laboratory Commission 1988). Both agriculture and urban development have contributed to the deer population decline in the area. The 1989 estimated deer population is only 225 for Ellis County, with suitable habitat limited to some drainages and isolated wooded areas in transitional habitats (Gore and Reagan 1989). Raccoon, opossum, and striped skunk are trapped in the area, and commonly hunted waterfowl include green-winged teal, gadwall, and mallard.

Sport fishing for bass, catfish, crappie, and sunfish occurs primarily in the ponds and reservoirs throughout the area (FEIS, Vol. IV, Appendix 5c, Section 5.7.9.4; Appendix 11, Section 11.3.7.4). Bardwell Lake, the largest lake in Ellis County (3,570 acres), provides recreational fishing for white crappie, channel catfish, blue catfish, largemouth bass, white bass, striped bass, and sunfish. The 690-acre Lake Waxahachie, located about 4 mi northwest of Bardwell Lake, also provides recreational fishing for channel catfish, white crappie, and largemouth bass (Texas National Research Laboratory Commission 1988; FEIS, Vol. IV, Appendix 5c, Section 5.7.9.4). The small livestock watering ponds and flood-retention impoundments can also provide recreational

fishing opportunities. However, without management, fish in the small ponds often become stunted.

Concerns were expressed during the DEIS comment period over system reliability and human safety issues associated with the red imported fire ant (*Solenopsis invicta*). Information on the life history of the red imported fire ant can be found in many documents. Excellent summaries are provided by Vinson and Sorensen (1986) and Drees and Vinson (1988). Therefore, only information (including life history aspects) germane to the SSC are presented in this SEIS (Section 3.8.2.2).

3.3.4 Sensitive and Unique Terrestrial/Aquatic Communities

Most of the SSC site consists of cultivated grasslands and croplands. Thus, other habitats that are present hold a special significance, either because of their uniqueness or, more importantly, because of their importance as habitat to biota. Key among such habitat types are riparian forest lands that occur as strips along streams and rivers and that are not heavily grazed. The highest biotic diversity in the area is associated with riparian habitats along Red Oak, Grove, Mustang, Waxahachie, South Prong, Onion, and Chambers creeks (FEIS, Vol. IV, Appendix 11, Sections 11.3.7.1 and 11.3.7.3).

Riparian areas are important because (1) they provide permanent or seasonal sources of water; (2) structural diversity of plant species is typically greater than in surrounding areas; (3) interspersion of riparian habitats among upland habitats maximizes wildlife diversity through the resulting edge effect; (4) they contain a higher diversity of microhabitats, including wildlife breeding and feeding areas; and (5) they provide significant movement and migratory corridors (Zale et al. 1989). These factors contribute to a greater number of wildlife species inhabiting or utilizing riparian areas compared with surrounding areas. The importance of riparian areas is magnified by the adverse impacts of agricultural activities on many wildlife species throughout the area. Riparian habitat is limited within the fee simple areas (Section 3.2.1.3).

No wildlife refuges or sanctuaries occur in the vicinity of either the proposed or realigned site.

Blackland prairie grasslands are rare because of agricultural practices and urbanization that have occurred over the years. Blackland prairie grasslands were not reported to occur in the immediate area of the ring (FEIS, Vol. IV, Appendix 11, Section 11.3.7.1). However, confirmatory surveys for such grasslands were not conducted prior to preparation of the FEIS.

The vegetative climax community of the blackland prairie grassland is dominated by little bluestem (*Andropogon scoparius*), big bluestem (*Andropogon gerardii*), indiangrass (*Sorghastrum avenaceum*), switchgrass (*Panicum virgatum*), sideoats grama (*Bouteloua curtipendula*), tall dropseed (*Sporobolus asper*), and Texas wintergrass (*Stipa leucotricha*); only the last two species are reported as dominant in the proposed area of the SSC (FEIS, Vol. IV, Appendix 5c, Section 7.7.9.2). The only large tract (about 30 acres) of prairie remnant in the area is Kachina Prairie in Ennis. The prairie is located on a spit jutting into Lake Clark. The prairie currently is protected by an

easement from the city; however, it has not been maintained by burning and is being invaded by trees and scrub.

3.3.5 Federal Government and State Protected Species

During the preparation of the EIS, both the U.S. Fish and Wildlife Service and the Texas Parks and Wildlife Department were consulted concerning the potential presence of federally listed and candidate species and state protected species, respectively. Table 3.13 lists the species potentially present on the basis of the original design and siting of SSC facilities. No designated critical habitats for federally listed species were reported to be present. However, habitats that could attract several of the listed species were concluded to be present.

Of the species listed by the FWS, only the black-capped vireo is a resident. The black-capped vireo is known to nest in adjacent counties. The migratory nature of the other species makes it unlikely that they would be affected by construction or operation of the SSC (FEIS, Vol. IV, Appendix 11, Section 11.3.7.2).

Black-capped vireo habitat consists of a few small trees (typically oak or juniper) scattered among clumps of bushes (usually oak or sumac). These bushes are typically in the open, with branching structure that reaches the ground (Curtis 1988). Breeding populations have not been reported recently from Ellis County, and a cursory survey of the originally proposed SSC site failed to locate appropriate nesting habitat (FEIS, Vol. IV, Appendix 11, Section 11.3.7.2; Wahl 1988).

None of the Category 2 species listed in Table 3.13 was known to breed in the areas that would have been disturbed by the originally proposed locations of SSC surface facilities. Both state listed reptiles (timber rattlesnake and Texas horned lizard) have been confirmed from Ellis County, although population levels and distribution within the county are unknown. Section 4.3.6 further discusses the above-mentioned species in light of the realignment and acreage modifications of the project.

No federal government or state listed plant species are known to occur in the site vicinity (FEIS, Vol. IV, Appendix 5c, Section 5.7.9.5).

3.4 LAND RESOURCES

3.4.1 Historic Land Uses

Siting the SSC in Ellis County places it in one of the most important natural regions in Texas, that is, the Blacklands Prairies (Baylor University 1990). This crescent-shaped zone stretches from the Red River Bottomland through Denison, Dallas, Waco, Temple, and Austin to the Rio Grande plain in the San Antonio area. The region's name derives from its soil, which is heavy, productive, and black.

TABLE 3.13 Status of Federal Government and State Protected Species in Ellis County

Common and Scientific Names	Regulatory Status[a]		Habitats Utilized	Occurrence in Ellis County	TPWD County Status[b]
	Federal	State			
Wood stork (*Mycteria americana*)	E	T	Wet meadows; swamps and marshes	Nonbreeding, casual visitor	Pro.
American peregrine falcon (*Falco peregrinus anatum*)	E	N	Large cliffs near diverse topography and water	Nonbreeding, casual visitor	ND
Arctic peregrine falcon (*Falco peregrinus tundrius*)	T	T	Winters on coast, Gulf of Mexico	Migrates through area	C
Bald eagle (*Haliaeetus leucocephalus*)	E	E	Winters in Texas along rivers and reservoirs	Winter resident	C
Whooping crane (*Grus americana*)	E	E	Winters in isolated wetlands along Texas coast	Migrates through area	Pro.
Interior least tern (*Sterna antillarum anthalassos*)	E	E	Barren or sparsely vegetated alluvial islands or sandbars	Not verified but potential visitor or breeder	Pot.
Black-capped vireo (*Vireo atricapillus*)	E	E	Open oak/juniper woodlands	Historic breeding without recent records; habitat, if any, in western edge of county	C

TABLE 3.13 (Cont'd)

Common and Scientific Names	Regulatory Status[a]		Habitats Utilized	Occurrence in Ellis County	TPWD County Status[b]
	Federal	State			
White-faced ibis (*Plegadis chihi*)	C2	T	Marshes and wet meadows	Casual visitors - breeds coastal areas of Texas and SE U.S.	C
American swallow-tailed kite (*Elanoides forficatus*)	C2	T	Mature riparian near wet prairie/ shrub lands	Breeding currently restricted to Florida	Pro.
Golden-cheeked warbler (*Dendroica chrysoparia*)	E[c]	T	Mature juniper-oak woodlands; nests in trees on steep slopes of canyons, scarps, and creek beds	Historic records in adjacent counties; habitat, if any, in western edge of county	Pot.
Swainson's hawk (*Buteo swainsini*)	C2	N	Prairie and riparian woodlands; nests in trees on prairies	Potential breeder in county	ND
Western snowy plover (*Charadrius alexandrinus nivosus*)	C2	N	Coastal and lake shorelines	Casual visitor	ND
Mountain plover (*Charadrius montanus*)	C2	N	Upland shortgrass prairies and plateaus	Casual visitor	ND

TABLE 3.13 (Cont'd)

Common and Scientific Names	Regulatory Status[a]		Habitats Utilized	Occurrence in Ellis County	TPWD County Status[b]
	Federal	State			
Long-billed curlew (*Numenius americanus*)	C2	N	Shortgrass prairies, meadows, golf courses, coastal wetlands, and prairie ponds/lakes	Casual visitor	ND
Migrant loggerhead shrike (*Lanius ludovicianus*)	C2	N	Open/semiopen land; nests in scattered trees, thorn scrub, hedgerows, and margins of woodlands	Species common in county but little known for subspecies distribution.	ND
Timber rattlesnake (*Crotalus horridus*)	N	T	Riparian woodlands	Single record in county; resident population level unknown	C
Texas horned lizard (*Phrynosoma cornutum*)	N	T	Dry, open areas with loose and sandy soils	Population levels and distribution in county unknown	C

[a]E = endangered; T = threatened; N = none; C2 = category 2 review.

[b]County status according to Texas Parks and Wildlife Department: C = confirmed; ND = not determined; Pot. = potential; Pro. = probable.

[c]Emergency listing.

Source: Texas National Research Laboratory Commission 1988.

The regional landscape has been transformed by successive waves of settlers who have capitalized on the area's natural resources. Included are the vast, open-range, cattle-grazing operations prior to 1860; the Cotton Empire era that blossomed in the 1870s and collapsed prior to and during the Great Depression; and the present period of ongoing urban growth. The Blacklands region is host to 38% of the state's population on about 7.6% of its land (Baylor University 1990). Details are provided in a supporting technical document (Higman 1990).

3.4.2 Land Ownership Patterns

Land ownership patterns in Ellis County generally reflect the changes in land apportionment that occurred throughout the state's early history, as various governments promoted their goals by offering land to private individuals to induce settlement. In its first century of statehood, Texas disposed of land as a means of settling boundary disputes, of encouraging improvement, and of financing public schools and state colleges. As a result, a mosaic of private land ownership developed that was based on land grants and patent surveys of various shapes and sizes (Slonaker 1989).

3.4.3 Land Use Patterns

Land use patterns in Ellis County present a complex mosaic of conditions, as natural suitabilities have been modified over time in response to various economic and social forces. Urban growth, which was once dictated by the location of rail transportation corridors, is now guided by proximity to Interstate highways (Baylor University 1990). As a result, urban development patterns radiating from Dallas along either I-35 as far south as Waxahachie or I-45 as far south as Ennis are transforming northern Ellis County into distant city suburbs, even though both Waxahachie and Ennis are important economic centers. Housing subdivisions are being tucked into pockets of what used to be a predominately rural landscape. South of Waxahachie and Ennis, land patterns are decidedly rural, with larger land holdings held exclusively for agricultural purposes. This pattern extends to the south, well beyond county borders.

3.4.4 Agricultural Land Uses

The U.S. Department of Agriculture, Soil Conservation Service, estimates that Ellis County has 464,873 acres of farmable land, which acres account for 76.2% of the total county area. Of the farmable total, 378,607 acres (62.1%) is defined as being either prime or unique, or of statewide or local importance under the Farmland Protection Policy Act. As indicated in the EIS, this total includes 272,497 acres of prime farmland and 106,110 acres of additional farmland of statewide importance.

Recent annual agricultural income statistics for Ellis County indicate that the most important cash crops are (listed in declining order): hay, cotton, corn, sorghum, nursery production, and wheat. Beef calf production yields the highest income for nonagricultural production, followed by milk production and other types of cattle operations (Texas Electric Utilities 1989).

Trends in agricultural production are changing in Ellis County such that there are fewer full-time farm operators, larger-acreage operating units, and larger increases in per-acre crop yields. This last trend can be attributed to increasingly widespread use of more effective soil and crop management techniques (Gearner et al. 1990).

3.4.5 Land Use Planning

Land use regulation in Texas takes place at state, county, and municipal levels of government. The Texas Highway Commission represents a state agency in Ellis County that has jurisdictional control over specified lands under its control.

The state of Texas has established the following types of regionally oriented land use planning organizations: regional planning commissions in the form of councils of governments and special-purpose districts. Ellis County is one of 16 counties centered around the Dallas-Fort Worth Metroplex affiliated with the North Central Texas Council of Governments. Its purpose and current planning activities are discussed in a supporting technical document (Higman 1990). Special-purpose districts have been established to regulate almost every type of land use imaginable, including school districts, special levee districts, water districts, water improvement districts, utility districts, water conservation districts, soil conservation districts, and subsidence districts. Ellis County has a full complement of such special-purpose districts.

The state of Texas has not traditionally provided for county land use control except for areas of road construction and maintenance (Jacobus 1989). The 1983 Texas legislature, however, created some major changes by providing for county regulation in areas not within either a city's limits or its extraterritorial jurisdiction. As a result, Ellis County can regulate subdivisions through platting, plat revision, and plat cancellation requirements. In addition, the 1989 Texas legislature authorized the Ellis County Commissioners Court to control land use up to 10 mi around the SSC project area. The Texas National Research Laboratory Commission is providing the services of a local planning consultant to aid the Ellis County Commissioners Court and Ellis County Planning Commission in developing a comprehensive land use plan and associated land use controls. Details are provided in a supporting technical document (Higman 1990).

The state of Texas has authorized cities to regulate land use through zoning statutes; indirect municipal land use controls (e.g., building codes, utility extensions, street maintenance or construction, and subdivision regulations); deed restriction enforcement; and certain powers of annexation, including certain rights within their extraterritorial jurisdictions. These extraterritorial jurisdictional rights are determined by a city's type of incorporation and the size of its population. Details are provided in a supporting technical document (Higman 1990).

Comprehensive land use plans are in effect in the following six Ellis County cities: Waxahachie, 1983; Ennis, 1985; Palmer, 1986; Bardwell, 1987; Midlothian, 1989; and Red Oak, 1988. All five cities have zoning ordinances or subdivision regulations in effect.

3.4.6 Facility-Specific Land Use Descriptions

A supporting technical document (Higman 1990) contains site-specific land resources descriptions of major fee simple areas. The document covers land acquisition; soil types; on-site land uses; and off-site (adjacent) land uses. It identifies historic resources, nearest sensitive noise receptors, and critically sensitive viewing positions. It describes existing surface land uses of stratified fee areas. The fee simple land acquisition and on- and off-site land use descriptions are briefly summarized below.

3.4.6.1 West Campus

The plan is to construct the 7,376-acre west campus in the unincorporated western portion of the county. The campus is roughly bounded on the north by land located to the north of F.M. 1446, on the south by the community of Bethel, on the east by the upper reaches of the South Prong Creek-Big Onion Creek drainage basin, and on the west by the Greathouse Branch drainage basin. The west campus will be acquired in fee simple estate. The acquisition will consist of 314 parcels owned by 241 private landowners, necessitating relocation of 180 household relocations (Texas National Research Laboratory Commission 1990). An Ellis County estimate of 2.7 persons per household (North Central Texas Council of Governments 1989) indicates that these relocations will involve 486 persons.

The high-energy booster (HEB) ring will be located in the northeast corner of the west campus and will be bisected on the north by F.M. 1446 and on the south by F.M. 66. Land uses along F.M. 1446 from roughly the Lone Elm Road intersection on the east to the Hoyt Road intersection on the west represent a mix of rural residential uses and farm operations on both sides of the road. Aside from three occupied areas, land use south of F.M. 1446 to F.M. 66 consists of agricultural production.

Land uses along F.M. 66 west of roughly South Prong Creek to Ewing Road include close to several dozen subdivided rural residences located on the north side of the road. Five of the homes fronting F.M. 66 support a variety of small, service-oriented businesses. Properties located on the south side of F.M. 66 along this same stretch are long-established farm operations.

Land uses along F.M. 66 west of Ewing Road to Greathouse Branch Creek on the north side of the road include several large farm operations and some subdivided rural residences. Properties located on the south side of F.M. 66 along this same stretch include a continuation of farming operations toward the east and subdivided rural residences toward the west. The rest of the interior of the HEB ring between F.M. 66 and its southern extension is under agricultural production.

The medium-energy booster (MEB) ring will be located in the center section of the west campus and will be bisected on the south by Old Maypearl Road. The low-energy booster (LEB) ring and the linear accelerator (Linac) are located farther to the south of the MEB. The entire area is under agricultural production, with several scattered farm residences.

The area south of Old Maypearl Road to the community of Boz is under agricultural production to the north, with rural residential use to the south. Boz contains three subdivisions and constitutes the area with the greatest number of required household relocations. This same type of rural residential land use continues south of Boz to the community of Bethel. Two subdivisions will need to be relocated, as well as a Texas longhorn cattle operation.

Off-site (adjacent) land uses, while similar to on-site land uses, include many more rural residential areas on the western edge. Included are the Emerald Forest residential enclave on the north, two Grande Casa subdivisions, and a number of rural residences as far south as the Greathouse Branch water impoundment facility.

3.4.6.2 East Campus

The 1,861-acre east campus area will be located in the unincorporated eastern portion of the county, being roughly bounded by F.M. 878 on the north and Turner Road on the south. The western border roughly parallels Ebenezer Road south to Price Road, where the fee simple area narrows. From here, the east campus area parallels F.M. 1722 to the east. Its eastern border parallels the built-up area south of F.M. 878 before traversing open land down to its southern extension. The entire east campus will be acquired in fee simple estate. The acquisition will consist of 46 parcels owned by 39 private landowners, necessitating 10 household relocations (Texas National Research Laboratory Commission 1990). An Ellis County estimate of 2.7 persons per household (North Central Texas Council of Governments 1989) indicates that these relocations will involve 27 persons.

The locations of east campus facilities have not yet been fully determined; therefore, a generalized description of land uses is provided here. Land uses along F.M. 878 west of the city limits of Palmer City include cattle and sheep ranching on the south side of the road to the Ebenezer Road intersection. Ranching activities continue farther to the south. Land in the vicinity of Price Road is under agricultural production. Combined agricultural and rangeland use continues as far south as F.M. 879.

Land uses along F.M. 879 represent a mix of rural residential and small cattle operations. The area located south of the Southern Pacific Railroad tracks has a more rural residential and agricultural character, with increasing levels of residential development intensity occurring to Turner Road and beyond.

Off-site (adjacent) land uses, while similar to on-site land uses, include many more rural residential areas on the northeast edge, just inside the city limits of Palmer City. This area represents a fairly large residential enclave that consists of both individually built residences and three subdivisions. Other off-site (adjacent) residential land uses occur on both sides of F.M. 879 and along F.M. 1722 south of the Southern Pacific Railroad tracks.

3.4.6.3 Service Areas

There are 18 proposed service areas, two of which are collocated in either the west campus (E1) or the east campus (E6). The remaining 16 service areas (8 E sites and 8 F sites) will require fee simple estate acquisition of 1,046 acres in 37 parcels owned by 14 separate private landowners; one household relocation at the F2 site will be necessary (Texas National Research Laboratory Commission 1990). An Ellis County estimate of 2.7 persons per household (North Central Texas Council of Governments 1989) indicates that these relocations will involve 3 persons.

Table 3.14 provides land acquisition and on- and off-site land use descriptions for all 18 proposed service areas.

3.5 CLIMATE AND METEOROLOGY

The regional climate of northeast Texas can best be described as humid and subtropical, with hot summers and mild winters. In summer, the semipermanent western Atlantic anticyclone (Bermuda High) extends its dominant influence over the entire area. The prevailing southerly winds from the Gulf of Mexico provide a rich source of moist, tropical maritime air, which often results in afternoon thundershowers. When westerly to northerly winds occur in summer, periods of hotter and drier weather interrupt the moist, subtropical climate of the area. In winter, this area is subject alternately to maritime tropical and polar continental air masses for periods of varying length. The modifying effect of the Gulf of Mexico contributes to relatively mild and humid winters. Local meteorology in the vicinity of the SSC site, in terms of winds, temperature, humidity, and severe weather, has been described in the FEIS (Vol. I, Section 4.3; Appendix 5, Section 5.7.3).

Meteorological data used in an air quality modeling analysis must be representative of the atmospheric transport and dispersion conditions within the region of interest. The representativeness of the meteorological data depends on (1) the proximity of the meteorological measuring stations to the study area, (2) the complexity of the terrain in the study area, (3) the exposure of the meteorological measuring stations, and (4) the period of time during which the meteorological data are collected. The meteorological data required for a detailed air quality modeling analysis include wind direction, wind speed, atmospheric stability, ambient temperature, and mixing height. One year of on-site or five years of off-site meteorological data are generally considered a representative data base for regulatory applications (EPA 1987).

Because of the lack of any data that would be considered *on-site*, five years (1982-1986) of surface air observations from the National Weather Service (NWS) station at the Dallas-Fort Worth Airport and the coincident mixing height data from the NWS Stephenville station were used to model the potential SSC construction air quality impacts and exposure associated with routine releases of air activation products during SSC operation. (See Section 4.7 for a discussion of radiological impacts.) The Dallas-Fort Worth station is located about 20 mi north of the SSC west campus site, and the Stephenville station is about 65 mi southwest. These are the NWS surface and upper air observation stations closest to the proposed facility. Because of relatively flat terrain

TABLE 3.14 Land Use Characteristics in the Immediate Vicinity of Proposed SSC Service Areas

Service Area	Size (acres)	Location	On-Site Land Use	Adjacent Area Land Use
E1	Part of west campus	Extreme NW corner; 0.2 mi W of F.M. 1446 and Hoyt Rd.	Agricultural cultivation	Four dairy farm operations; two subdivisions with a total of 22 homes
F1	54	~2,600 ft S of F.M. 879 and McAlperin Rd. W of Lone Elm	Rangeland	Rangeland
E2	61	NW of Sardis; next to SCS Watershed Impoundment Project #7	Noncommercial forest; rangeland	Two rural residences N and W; picnic facility on property of one residence; cultivated agricultural land to the S; noncommercial forest to the E
F2	63	S of Daniels Rd.	Agricultural cultivation; transmission line traverses northern portion of service area; underground natural gas pipeline traverses northern portion	Residential; approx. 50 residences with extensive acreage and some cattle and horses to the N and NE
E3	51	1,400 ft N and on opposite side of road as Rockett WC water tower	Agricultural cultivation	Same as on-site use
F3	53	2,000 ft S of state highway (S.H.) 342 and Possum Trot Rd.	Agricultural cultivation	Red Oak Valley Golf Course and Golf Club to the immediate N and W of service area; approx. 70 residences SE, S, and W; 55 of 70 residences in Magnahomes Deercreek subdivision; gravel and asphalt company W of service area

TABLE 3.14 (Cont'd)

Service Area	Size (acres)	Location	On-Site Land Use	Adjacent Area Land Use
E4	51	1,200 ft S of Pritchett Rd. and upper Bell's Chapel Rd. intersection	Agricultural cultivation	Cultivated agricultural land N, E, and S of service area; approx. 100 residences S of Bell's Chapel Road
F4	52	2,600 ft E of F.M. 813 and 1,000 ft N of Farrer Rd.	Agricultural cultivation	Agricultural cultivation; Brazos Electric Cooperative substation near F.M. 813 and Farrer Road intersection
E5	54	1,000 ft NW of Coffee and F.M. 878 intersection	Open space use	Residential small ranch use to SE; cotton farm operation to immediate W
E6	In east campus area		Agricultural cultivation	Residential; small ranch sites
F6	69	S of S.H. 287 and W of Nesuda Rd.	Agricultural cultivation; noncommercial forest	Similar to site; Ennis Municipal Airport and Lake Bardwell are major land uses in the vicinity
E7	46	S of Waxahachie Creek State Park	Agricultural cultivation	Agricultural cultivation
F7	49	S of S.H. 34 and W of Farmer Rd.	Agricultural cultivation	Agricultural cultivation
E8	50	N of S.H. 34 and 1,000 ft E of Maloney Dr.	Noncommercial forest or agricultural cultivation	Agricultural cultivation

TABLE 3.14 (Cont'd)

Service Area	Size (acres)	Location	On-Site Land Use	Adjacent Area Land Use
F8	50	E of S.H. 55 and Odum Rd. intersection S of Big Onion Creek	Agricultural cultivation	Agricultural cultivation
E9	47	SSE of Lumkins	Agricultural cultivation	Agricultural cultivation; also some noncommercial forest
F9	69	1.5 mi S of Five Points	Agricultural cultivation	Agricultural cultivation; also some noncommerical forest
E10	76	Bethel Church Rd.; 4,800 ft N of F.M. 876	Agricultural cultivation; pasture	Cultivated agricultural land W of service area; historic site -- Bethel United Methodist Church, tabernacle, parsonage, and cemetery

and the absence of major topographic features or large bodies of water between the meteorological stations and the proposed facility, the data collected at these stations are determined to be most representative of the meteorological conditions at the SSC site.

The surface air observations consist of hourly measurements of wind direction, wind speed, and ambient temperature, and estimates of ceiling height and cloud cover. The upper air station provides daily morning and afternoon mixing height values derived from twice-daily radiosonde measurements (Holzworth 1972). These surface and upper air data are processed using the standard EPA-recommended approach (i.e., the RAMMET program) into a format suitable for use in a variety of EPA air quality simulation models. This approach utilizes the atmospheric stability classification scheme developed by Turner (1970) to estimate the dispersive capacity of the atmosphere. Each hourly atmospheric stability is derived from the hourly surface wind speed, cloud cover, and estimated solar insolation (based on solar altitude). Hourly mixing height values are interpolated from (1) twice-daily mixing height values derived from the radiosonde observations, (2) local standard time of sunrise and sunset, and (3) hourly atmospheric stability.

3.6 AIR RESOURCES

3.6.1 Ambient Air Quality

Ellis County is designated as attainment or unclassifiable for all criteria pollutants (EPA 1986). Criteria pollutants are those for which National Ambient Air Quality Standards (NAAQS) have been established by EPA to protect public health and welfare. Included are sulfur dioxide (SO_2), thoracic particulates (particulate matter with aerodynamic diameters less than or equal to 10 μm, or PM_{10}), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), and lead (Pb). With the exception of Dallas and Tarrant counties, which are designated nonattainment for ozone, all counties surrounding Ellis County also have excellent air quality and are designated attainment or unclassifiable for all criteria pollutants.

No ambient air quality monitoring data are available for Ellis County after 1985. From the period 1976 through 1984, the Texas Air Control Board maintained two air quality monitoring stations in Ellis County -- one in Waxahachie and the other in Midlothian. These stations measured SO_2, total suspended particulates (TSP), NO_2, CO, O_3, and Pb. Table 3.15 summarizes the air quality monitoring data collected during this period. Except for TSP, all measured concentrations are well below their applicable NAAQS. Since there were few combustion sources and industrial facilities in Ellis County during the period, the measured TSP concentrations, which included those occurring during dust storms, were likely associated with rural fugitive dust emissions. The ambient NAAQS standards for TSP recently have been replaced by the PM_{10} standards. Background PM_{10} concentrations from anthropogenic sources in the vicinity of the proposed SSC site are estimated to be low. An explanation of the methodology for
169 estimating contributions to background PM_{10} from both natural and anthropogenic sources and the results of the analysis are provided below.

TABLE 3.15 Summary of Air Quality Monitoring Data from Ellis County[a]

Measured Pollutant	Monitor Location	Averaging Period	Concentration by Year ($\mu g/m^3$)									NAAQS	
			1976	1977	1978	1979	1980	1981	1982	1983	1984	Primary	Secondary
Ozone	Waxahachie	24 hours[b]	222[c,d]	-[e]	-	-	-	-	-	-	-	235	235
Sulfur dioxide	Waxahachie	3 hours[b]	-	-	-	-	-	-	-	-	-	-	1,300
		24 hours[b]	2[c]	2	20	60	28	13[f]	-	-	-	365	-
		Annual	2[c]	2	7	15	17	7[f]	-	-	-	60	-
Nitrogen dioxide	Waxahachie	Annual	8[c]	17	21	23	27	-	-	-	-	100	100
Lead	Midlothian	Quarterly	-	-	-	-	-	0.23	0.17	0.20	0.16	1.5	1.5
Total suspended particulates[i]	Waxahachie	24 hours[b]	69[c]	300[g]	108	90	98	75[f]	-	-	-	150[h]	150[h]
	Waxahachie	Annual	46[c]	57	55	47	46	51[f]	-	-	-	50[h]	507[h]
	Midlothian	24 hours[b]	-	-	-	-	-	108	170	123	119	150[h]	150[h]
	Midlothian	Annual	-	-	-	-	-	68	80	69	70	50[h]	50[h]

[a]No data are available from local monitoring for CO levels.

[b]Refers to the second highest measured concentration for each year.

[c]1976 data for last seven months of the year.

[d]Data are for total oxidants rather than strictly ozone and are 24-hour averages; the NAAQS are 1-hour averages.

[e]"-" means no data are available.

[f]1981 data are for first four months of the year.

[g] Dust storm data are included.

[h] Refers to the PM_{10} standards.

[i] The particulate matter standards have been changed to the PM_{10} standards, which are 50 $\mu g/m^3$ for annual averages and 150 $\mu g/m^3$ for 24-hour averages.

Source: Texas National Research Laboratory Commission 1988, Table 2.4-2.

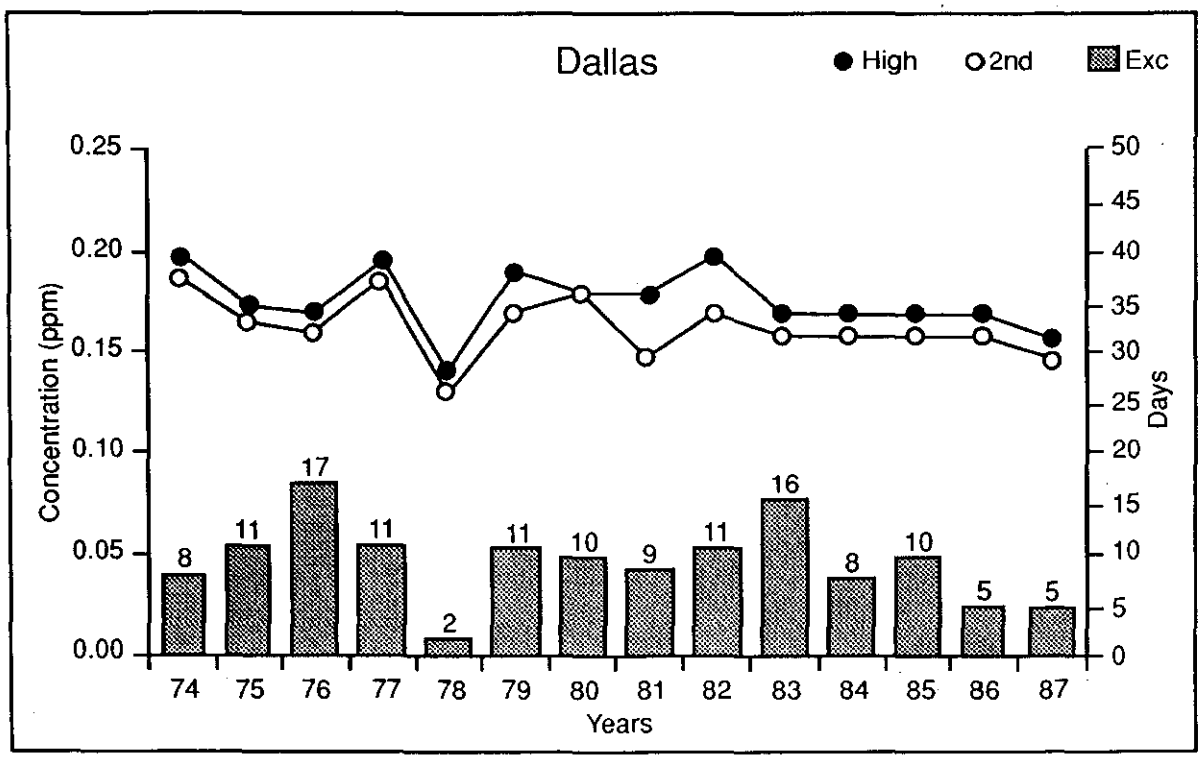
Conditions affecting air quality and a list of some representative regional measurements of criteria air pollutant concentration levels are presented in the FEIS (Vol. I, Section 4.4).

Because no regional monitors could be used to establish representative rural background PM_{10} concentration levels for the proposed facility and vicinity, the following procedures, recommended by EPA Region VI (Dallas) were instituted:

- Select a rural background PM monitoring station in Texas where concurrent 24-hour average PM_{10} and TSP measurements are available.
- Determine the ratio of measured PM_{10} concentration to measured TSP concentration for each concurrent 24-hour period.
- Compute the overall average PM_{10} to TSP concentration ratio.
- Multiply this overall average ratio by the measured annual mean and second highest 24-hour TSP concentrations at the rural TSP monitoring station closest to the proposed facility.

EPA Region VI (Dallas) provided four years (1986-1988) of measured 24-hour PM_{10} and TSP data from the Texas City monitor. A total of 140 concurrent 24-hour measurements were identified from this data base. The computed overall average PM_{10} to TSP concentration ratio was 0.514. The Waco TSP monitor, located about 60 mi south-southwest of the SSC site, was identified by the Texas Air Control Board (1990a) as the closest regional background TSP monitoring station. The annual mean and the second-highest 24-hour measured TSP concentrations at this monitor, averaged over the most recent four-year data period (1983-1986), are 43 $\mu g/m^3$ and 80.25 $\mu g/m^3$, respectively. These values were multiplied by the overall average PM_{10}-to-TSP values of 0.514 to arrive at the estimated background PM_{10} concentrations of 22.1 $\mu g/m^3$ for the annual mean and 41.2 $\mu g/m^3$ for the 24-hour average in the vicinity of the proposed facility.

Attainment of the NAAQS for ozone has been a problem in most large metropolitan areas throughout the country. The ozone nonattainment status in Dallas and Tarrant counties, which include the Dallas-Fort Worth metropolitan area, is caused primarily by emissions of volatile organic compounds (VOC) from motor vehicles. According to a report by the Texas Air Control Board (1988), automobiles contribute 59% of the total VOC emissions in Dallas County, while minor and area sources contribute 37% and industrial sources contribute 4%. Similar VOC emission source distributions are anticipated in Tarrant County. Statistical summaries of measured ozone concentrations and excursion days for the period 1974-1987 are presented graphically in Figure 3.12. To bring ozone into attainment, the Texas Air Control Board has developed a state implementation plan (SIP), which relies heavily on implementation of VOC emission controls on motor vehicles, minor sources, and area sources in these two counties. The control measures already in place include (1) antitampering vehicle inspection and maintenance program, and (2) transportation control measures, such as bus lanes, synchronized signal lights, and car/van pools.



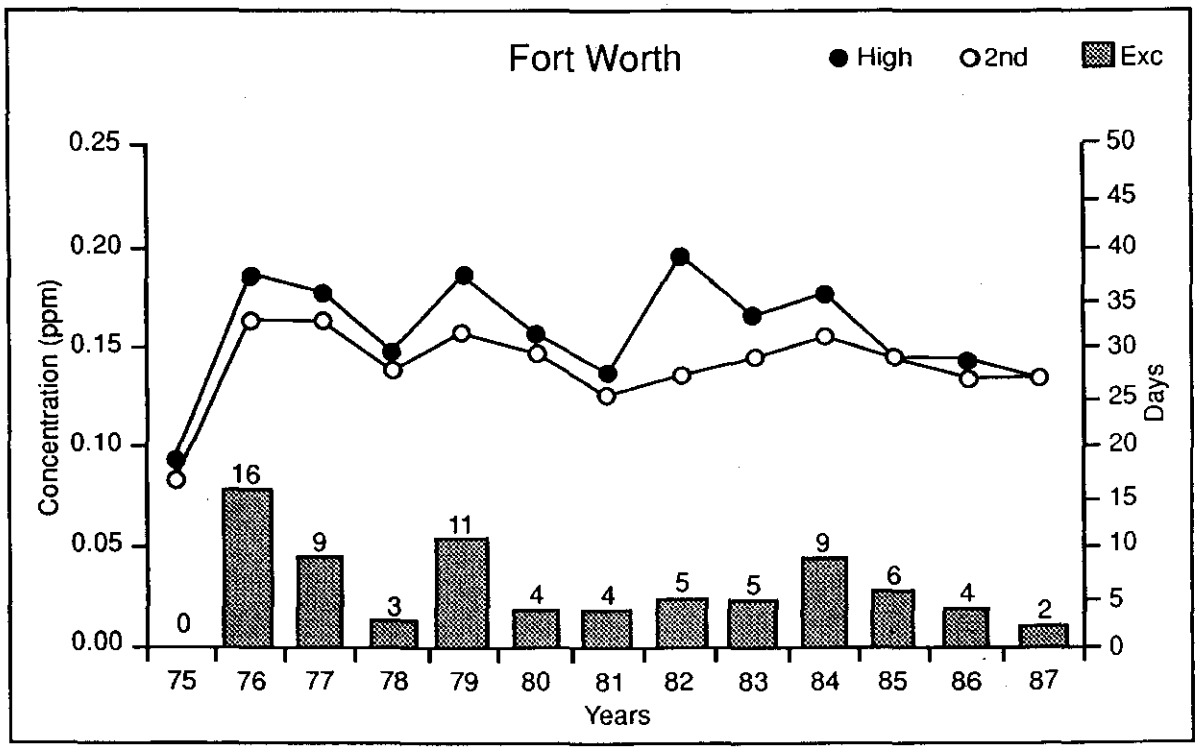


FIGURE 3.12 Ozone Air Quality Trends in the Dallas and Fort Worth Areas for the Period 1975-1987 (Exc = number of times the 0.12-ppm federal standard for ozone was exceeded) (Source: Texas Air Control Board 1988)

3.6.2 Regional Air Pollutant Sources

Emission inventories of existing air pollutant sources within Ellis County were obtained from the Texas Air Control Board's point source data base. The pollutant sources and hourly emission rates are listed in Table 3.16. Figure 3.13 shows the locations of these sources relative to the ISP-proposed SSC footprint. Among the 21 identified air pollutant sources, only four (one in Dallas County and three in Ellis County) have emission rates exceeding 1,000 lb/h of any criteria pollutant. These large emission sources are located either north or north-northwest of the SSC site. Because the prevailing wind is from the south in this region, these emission sources are expected to

TABLE 3.16 Air Pollutant Emission Sources in the Vicinity of the SSC Facility

Map ID[b]	Source Name	Emission Rate (lb/h)[a]				
		SO_2	TSP[c]	NO_x	CO	VOC
1	Texas Utilities Electric Power	-	1,121.1[c]	-	-	-
2	Chaparral Steel	73.1	96.7[c]	-	653.0	-
3	Elk Corp.	3.6	1.8	2.2	0.5	7.9
4	Gifford Hill Cement	1,072.2	170.8[c]	1,158.0	310.3	32.2
5	Owens Corning Fiberglass	-	134.3[c]	-	-	-
6	Texas Industries	8,325.0	591.3[c]	3,050.3	-	-
7	Eubank Ready Mix	-	5.0[c]	-	-	-
8	City of Waxahachie	0.2	10.0[c]	2.3	-	-
9	Southwest Aluminum	-	0.4	0.1	-	-
10	International Extrusion	-	4.9[c]	3.8	3.8	0.6
11	City of Waxahachie	-	5.8[c]	2.2	-	-
76 12	Box-Crow Cement	762.3	86.76[c]	1,090.0	-	-
13	Boyce Gin and Grain Co.	-	8.7[c]	-	-	-
14	Koch Materials	-	7.3[c]	-	71.9	1.6
15	Industrial Metals	-	1.0	1.3	-	-
16	R.W. McKinney and T.L. Jones & Co.	-	47.8[c]	-	-	-
17	J. Lee Milligan, Inc.	-	10.5[c]	-	-	-
18	Chemical Reclamation Services	7.3	-	12.6	15.5	0.8
19	Universal Tank & Iron Works	-	-	-	-	17.0
20	Flintkote	-	-	-	-	0.2
21	Cargill Inc.	-	-	-	-	1.6

[a]Texas National Research Laboratory Commission 1988, Table 2.4-3.

[b]Locations are shown by ID number in Figure 3.13.

[c]Total suspended particulate (allowable emission limits) (Texas Air Control Board 1990b).

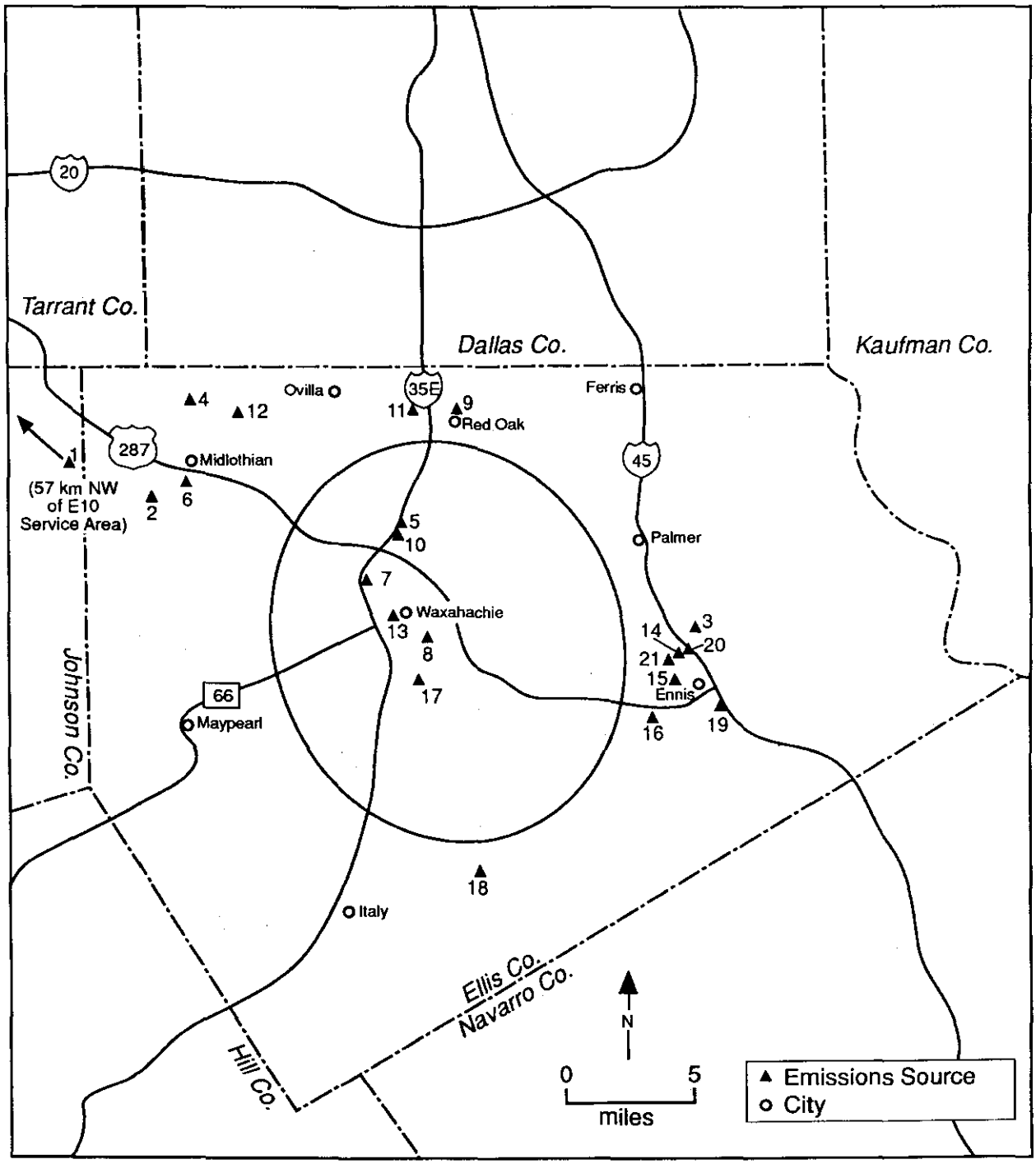


FIGURE 3.13 Existing Air Pollutant Emission Sources in the Vicinity of the SSC Site (emission source ID numbers are keyed to list in Table 3.16) (Source: Texas National Research Laboratory Commission 1988; Texas Air Control Board 1990b)

have small impact on air quality at the SSC site. Furthermore, Table 3.16 reveals that no major industrial VOC emission sources are near the SSC site.

3.6.3 Global-Scale Conditions (Air Pollutant Sources and Concentrations)

The release of chemicals into the atmosphere has grown significantly over the past 50 years. This trend is primarily due to increased reliance on fossil fuels, synthetic chemicals, biomass burning, and deforestation. It is contributing to an important global change in the chemical composition of the atmosphere. Two major environmental consequences of this change are the potential for global warming and reduction in stratospheric ozone concentrations.

Global climate warming can be induced by increases in concentrations of trace gases, such as carbon dioxide (CO_2), that are strong absorbers of infrared radiation (i.e., solar spectrum reflected from earth's surface). As a group, these gases are known collectively as greenhouse gases.

Stratospheric ozone (triatomic molecule of oxygen, O_3) absorbs short-wavelength ultraviolet solar radiation that can be harmful to human health (i.e., cause skin cancer) and animal and plant life. A protective ozone layer (ultraviolet absorber) exists in the stratosphere approximately 20-35 km above the earth's surface. The concentration of ozone is maintained by a balance of photochemical processes in the stratosphere. This important balance can be disrupted (i.e., the concentration of O_3 can be reduced) by the introduction of certain chlorine, nitrogen, and other catalyst species. Several of the chemicals that are potential contributors to global warming are also implicated in the depletion of stratospheric O_3. Collectively, these gases are referred to here as radiatively important trace gases.

Studies of climate impact due to projected increases in CO_2 levels have received substantive attention from researchers and policymakers over the past decade. Potential global surface air temperature warming between 1.5 and 4.5°C has been predicted as a result of a projected doubling in the current concentrations of CO_2 in the atmosphere (DOE 1985). However, it can be inferred from several recent studies (Ramanathan et al. 1985) that the combined warming effect of other greenhouse gases can be potentially as large as from CO_2 alone. The other greenhouse gases with the most significant global warming potential are methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons, Halon-1301 ($CBrF_3$), and tropospheric ozone (O_3).

The most significant groups of man-made CO_2 sources are fossil-fueled power plants and internal combustion engines. Methane production occurs naturally through anaerobic decomposition in biological systems. Major anthroprogenic CH_4 sources include agricultural activities, biomass burning, natural gas consumption, and emissions from solid wastes (Wuebbles 1989). Chloroflurocarbons are synthetic in origin and are used as refrigerants, propellants in foam blowing, and solvents in the electronic industry. Halon-1301 is used as a fire extinguisher.

Ozone formation in the troposphere is a complex photochemical process involving sources of hydrocarbons, nitrous oxides (NO_x), and carbon monoxide (CO).

Concentrations of radiatively important trace gases in the atmosphere vary significantly by time of day, by season, by geographic location, and with latitude and altitude.

The role of chlorofluorocarbons in destroying the ozone layer has been studied and debated since their influence in stratospheric O_3 chemistry was first hypothesized in 1974. The chemical stability of these compounds allows for long atmospheric life and permits vertical transport from the troposphere to the stratosphere. Once in the stratosphere, intense ultraviolet radiation causes them to break apart and release chlorine (a process known as photolysis). Chlorine, oxygen, and nitrogen and hydrogen oxides then serve as catalysts in chemical reactions leading to a net reduction in O_3. The major O_3-reducing chlorofluorocarbons are CFC-11, -12, -22, and -113. Other significant O_3-modifying substances released through human activity are methyl chloroform (CH_3CCl_3), carbon tetrachloride (CCl_4), N_2O, CO_2, CH_4, and Halon-1301 and -1211 (Miller and Mintzer 1986).

Table 3.17 gives current global estimates of what are thought to be the most significant radiatively important trace gas emissions, with regard to their potential to disrupt global radiative-energy balance, and atmospheric concentrations of these gases. The major sources of CO_2, CH_4, and N_2O are both natural and man-made; the major sources of chlorofluorocarbons, CH_3CCl_3, and CCl_4 are solely man-made.

3.7 BASELINE NOISE AND VIBRATION

3.7.1 Baseline Data Requirements

In the initial assessment of alternative SSC sites for the FEIS (Vol. IV, Section 9.1.2.1.B.2), community noise environments were quantified in terms of the day-night average sound level (L_{dn}), expressed as A-weighted sound-pressure level values in decibel (dBA) units.* The L_{dn} descriptor was adopted for that initial screening study on the basis of published recommendations by the EPA (1982). For the EIS purposes of site screening and selection, the average preconstruction noise level at each candidate site assessed was approximated as either 40 dBA or 50 dBA L_{dn} (FEIS, Vol. IV, Sections 9.1.3.2.A and B). A noise level of 40 dBA L_{dn} was identified in the FEIS as typical of the average day-night sound level throughout the region of the Texas site. Subsequent field measurements have verified that approximation (Section 3.7.2.3).

Although suitable for EIS site screening, the L_{dn} descriptor is not appropriate for characterizing noise impacts to individual residents in a quiet rural environment, such as the Ellis County SSC site. The correlation of L_{dn} levels with "percent (of the community) highly annoyed" (FEIS, Vol. IV, Section 9.1.3.2.A) has only been established for stated percentages of the residents in a densely populated community. An example is the correlation between the collective average annoyance reactions of urban residents to aircraft and traffic noise, which includes many loud intermittent noises (e.g., jet aircraft

*dB is unweighted decibel, and dBA is A-weighted decibel. The reference for all sound levels given in this SEIS is 20 micropascals.

TABLE 3.17 Atmospheric Concentrations and Emissions of Global Energy-Balance Trace Gases

Chemical	Chemical Formula	Global Average Concentration (ppb_v)[a]	Global Average Emission (10^6 kg/yr)[b]	Growth Rate (%/yr)[a]	Estimated Average Residence Time (yr)[a]
Carbon dioxide	CO_2	339,000	5,200,000 (10^6 kg of C/yr)[c]	2.4	2
Methane	CH_4	1,550	5,000 (10^6 kg of C/yr)[d]	1[d]	5-10
Nitrous oxide	N_2O	301	4,500 (10^6 kg of N/yr)[e]	N/A[f]	120
Chlorofluorocarbons					
Trichlorofluoromethane	$CFCl_3$ (F-11)	0.17	265	3	65
Dichlorodifluoromethane	CF_2Cl (F-12)	0.28	412	3	110
Chlorodifluoromethane	CHF_2CL (F-22)	0.06	72	5	20
Trichlorotrifluoromethane	$C_2Cl_3F_3$ (F-113)	0.025	N/A	N/A	90
Methyl chloroform	CH_3CCl_3	1.4[b]	455	5	8
Carbon tetrachloride	CCl_4	1.6[b]	131	2	25-50

[a]Ramanathan et al. 1985; Bolle et al. 1986, except as noted.

[b]Perry 1986, except as noted.

[c]Rotty 1984.

[d]Abelson 1986.

[e]Kavanaugh 1987.

[f]N/A = not available.

flybys and heavy truck passbys) (Schultz 1978). The correlation of L_{dn} level with community annoyance reaction is typically not more than 0.5. This value implies that three-quarters or more of the variance in this correlation is related to factors other than acoustic magnitude, such as sociological conditions (Fidell 1979).

Assessing environmental noise impact in an urban community is a distinctly different problem than predicting the probability that a newly introduced (intrusive) noise source will represent a specific level of annoyance to an individual resident of a very quiet, sparsely populated (rural) community (Fidell and Teffeteller 1978; Schultz 1982). Under the latter circumstances, predicting levels of annoyance with a useful degree of confidence (e.g., >50% probability) requires consideration of psychological and sociological, as well as physical, factors (Miller et al. 1978; Thompson and Wood 1984; Fidell and Teffeteller 1978; Fidell et al. 1987, 1988). Furthermore, in a rural area with ambient (baseline) L_{dn} levels much below 55 dB, the intrusiveness and annoyance of SSC construction and operational activities will be a function of the *audibility* of those activities (Schultz 1982).

Audibility is directly affected by the masking effect of baseline environmental sound levels. Consequently, the frequency distributions (spectra) of the baseline sound levels must be taken into account. That is not done when L_{dn} values are used to characterize impact. In addition, it has been demonstrated that use of the L_{dn} value alone to predict community annoyance reaction is not valid in sparsely populated localities. The reason is that as L_{dn} level drops below approximately 60 dBA, the population density required, for statistical validity of the "percent highly annoyed" prediction, increases radically to urban densities (Tatge 1973).

The physical data needed to assess audibility of intrusive noise at a specific noise-sensitive location (NSL) (e.g., a residence) include frequency-band spectra of baseline residual environmental sound levels as a function of probability of occurrence (i.e., data indicating the probability of noise exceeding a given level in each frequency band). Consequently, the baseline acoustical environment typifying all SSC site locations for which impact is to be assessed has been quantitatively characterized by determining both baseline L_{dn} levels and baseline statistical hourly sound-level spectra. Necessary impact descriptors can be computed from these data.

In addition, current vehicle traffic counts (frequency of passby by vehicle category) have been determined for roads expected to experience increased use related to construction or operation of the SSC. This information is required to compute expected noise levels near those roads.

Baseline meteorological data also are needed to estimate the effects of meteorological conditions on sound propagation. The data required include the seasonal and diurnal temperature, humidity, and wind speed and direction. Wind data collected at the Dallas-Fort Worth Airport over the period 1982-1986 were adapted to the statistical format needed in modeling residual environmental ambient sound propagation.

Two Pasquill atmospheric stability classes are appropriate in analyzing sound propagation in the Texas site area during periods when baseline sound levels are minimal: Class C in the daytime and Class F in the nighttime. Figures 3.14 and 3.15 present

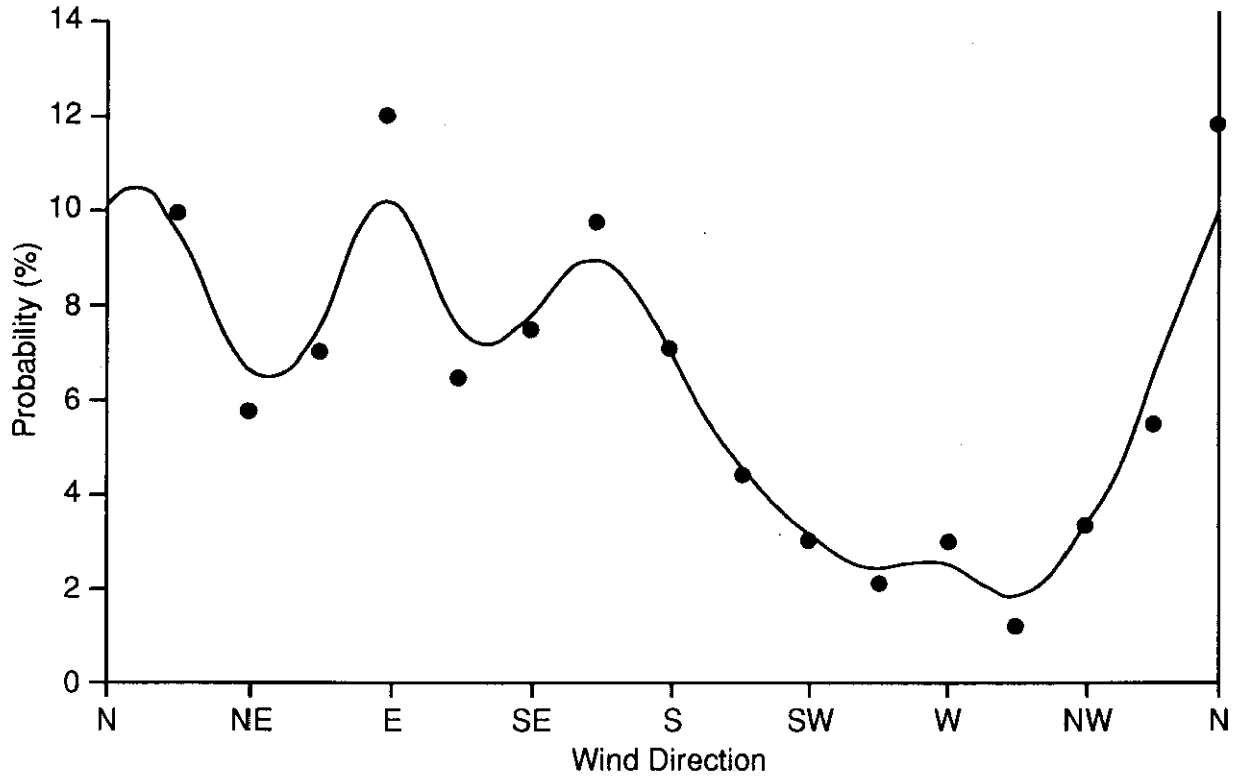


FIGURE 3.14 Probability of Wind Direction for Pasquill Stability Class C, 1-3 Knots (Source: Based on 1982-1986 Dallas-Fort Worth Airport data)

histograms of the probability of occurrence of 1- to 3-knot winds as a function of direction for these two Pasquill classes. These plots reveal that during periods of minimal sound level, the median prevailing wind directions are east in the daytime and southeast in the nighttime.

3.7.2 Baseline Noise Levels

3.7.2.1 Design-Critical Noise-Sensitive Locations

An NSL is defined as any aboveground site of a single-family residence, apartment building, mobile home, hotel, motel, hospital, or institutional residence, as well as any school, other educational institution, religious institution, park, nature preserve, or any locally regulated quiet zone. For purposes of this analysis, design-critical NSLs (DC-NSLs) are defined as the one or more NSLs closest to major SSC construction or operational activity noise sources.* Recent field surveys revealed

*Or that, because of other physical factors (e.g., noise source directionality), they are considered likely to be the most severely noise-impacted NSLs proximate to a major SSC construction or operational activity noise source.

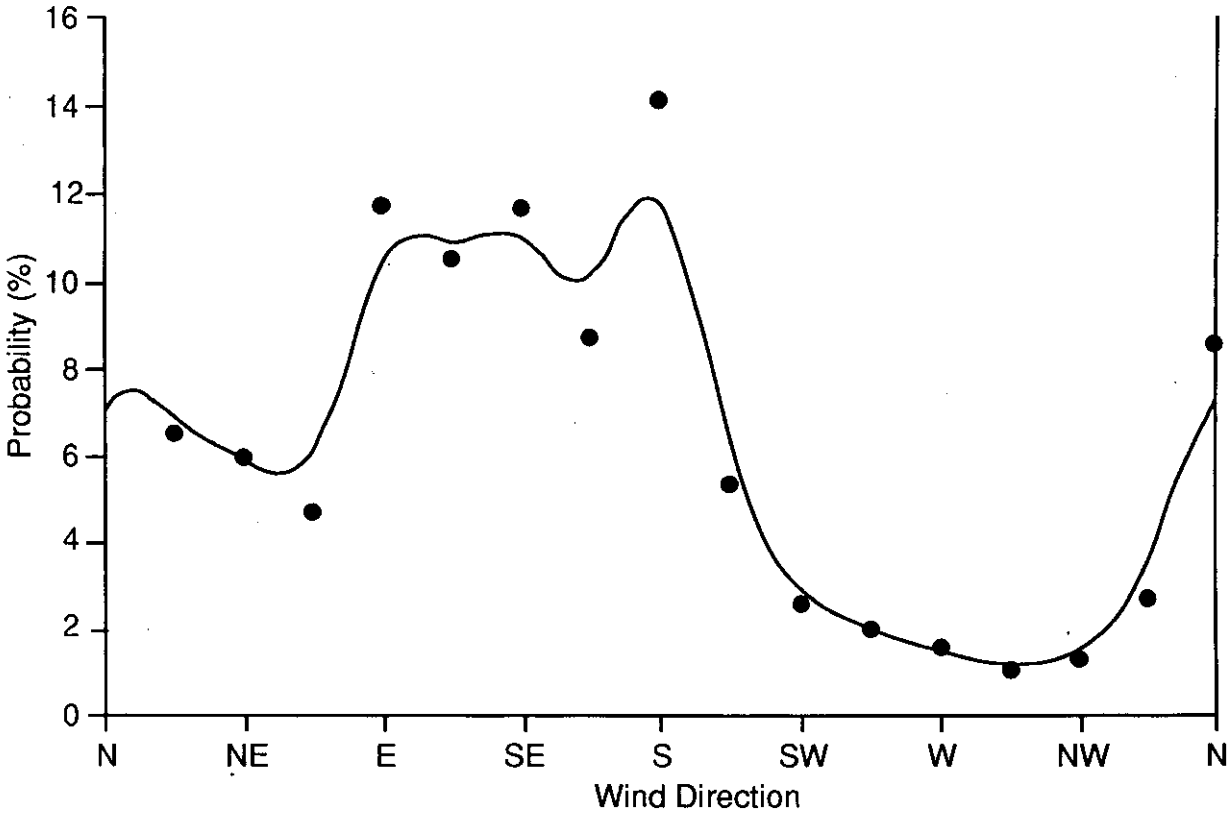


FIGURE 3.15 Probability of Wind Direction for Pasquill Stability Class F, 1-3 Knots (Source: Based on 1982-1986 Dallas-Fort Worth Airport data)

that about 26 such DC-NSLs occur near the proposed sites of the 18 service areas, about 21 DC-NSLs occur near the west campus area, and about 13 DC-NSLs occur near the east campus area. In addition, it was found that approximately 31 roads having nearby NSLs would be constructed or improved, or would likely experience increased traffic as a result of SSC construction or operational activities (SSCL 1990).

3.7.2.2 Field Measurements of Baseline Environmental Sound Levels

Because of the combined effects of variations in environmental factors, the statistical baseline sound-level spectra that occur during any hour of the day in a particular rural community cannot be estimated with accuracy from published generic data. Contributing to this condition are variations in wind speed profiles and direction, temperature gradient, and humidity, as well as seasonal changes in sounds of natural origin, human activity patterns, ground cover, and foliage (Keast 1974). Therefore, a field program was developed to measure environmental sound levels at 10 locations throughout the SSC project area. The locations were selected to represent essentially every category of acoustical environment existing at all of the approximately 60 DC-NSLs. This approach justified assignment of the data obtained at 1 of the 10 measurement locations to each DC-NSL as representative of that DC-NSL's baseline noise environment (Rodman and Liebich 1990).

3.7.2.3 Day-Night Average Sound Levels (L_{dn})

Accurate determination of seasonal-average or yearly average L_{dn} levels (as recommended in EPA 1982) requires a statistically significant and randomly sequenced number of measurements collected during each 24-hour period of the day during conditions of relatively calm wind (speed not exceeding 3 knots in locations as quiet as rural Ellis County) and no threat of rain. Sufficient data were obtained during the four calendar weeks available for field measurements to validate that at all 10 locations, baseline L_{dn} levels are less than 55 dBA and, in fact, have a median L_{dn} value of only 39 dBA. The baseline L_{dn} value is calculated from a set of 24 hourly average-energy levels (L_{eq}), one for each hour of the day (EPA 1982). Typical hourly L_{eq} values of sound level throughout rural Ellis County, based on the medians of measured values, are listed in Table 3.18 for service area, west campus, and east campus localities (Rodman and Liebich 1990). The daily minima occur in the late afternoon (3-4 p.m.), early evening (8 p.m.), and very early morning hours (3-4 a.m.).

TABLE 3.18 Typical Hourly Preconstruction Ambient Environmental Sound Levels[a] at Rural Ellis County Locations

Hour	L_{90} (dBA)	L_{eq} (dBA)
Midnight	28	33
1 a.m.	27	30
2 a.m.	26	29
3 a.m.	25	28
4 a.m.	25	29
5 a.m.	27	31
6 a.m.	30	34
7 a.m.	33	37
8 a.m.	34	38
9 a.m.	34	38
10 a.m.	35	38
11 a.m.	35	38
Noon	35	38
1 p.m.	32	37
2 p.m.	29	34
3 p.m.	27	30
4 p.m.	25	30
5 p.m.	27	31
6 p.m.	29	32
7 p.m.	30	33
8 p.m.	26	29
9 p.m.	27	30
10 p.m.	27	31
11 p.m.	27	32

[a]A-weighted decibels referenced to 20 micropascals.

3.7.2.4 Statistical (Percentile Exceedance) Levels (L_x)

As discussed in Section 3.7.1, evaluation of the audibility and annoyance of intrusive noise in rural areas with ambient L_{dn} levels below 55 dBA requires that ambient environmental sound level spectra be obtained in a certain statistical manner. Specifically, the data must be obtained in a way that makes it possible to determine the percentage of the time that noise emitted by proposed new facilities will be audible during periods of low wind speed and absence of extraneous preconstruction ambient noise sources.

If, for example, the intrusive noise is audible 10% of the time and, conversely, is masked by the ambient environmental sound 90% of the time, the environmental ambient sound level corresponding to that masking level is defined as the *90 percentile exceedance level (L_{90})*, indicating that it is exceeded 90% of the time. This statistical level (and its

corollary use to determine audibility of intrusive noise 10% of the time) has been adopted as a standard for characterization of ambient environmental sound level by most U.S. authorities (EPA 1971; State of Connecticut 1978; Thompson and Wood 1984). To identify the L_{90} spectra, the measured spectra must be statistically sorted to determine the sound level in each frequency band exceeded by 90% of the measured values (Rodman and Liebich 1990). Typical hourly L_{90} values of sound level throughout rural Ellis County, based on the medians of measured values, are listed in Table 3.18. Minima occur at the same hourly periods of the day as noted for L_{eq} in Section 3.7.2.3.

Assessment of impact and mitigation options requires determination of L_{90} environmental ambient spectra (unweighted L_{90} level by frequency band) for each DC-NSL to be evaluated. Table 3.19 lists, for each facility area having a potential for noise impact, which of the 10 measured surrogate ambient sound spectra discussed in Section 3.7.2.2 is appropriate for DC-NSL impact analysis in that area. Table 3.20 lists the levels by frequency band of the surrogate spectra.

3.7.2.5 Traffic Noise Levels

Traffic is expected to increase more (in terms of percentage increase) on three farm-to-market routes than on any other routes in Ellis County because of SSC-related activities. These routes are F.M. 66 between I-35E and the east edge of the west campus, F.M. 876 from I-35E to Five Points, and F.M. 1493 from F.M. 876 to the east edge of the west campus. A Federal Highway Administration model (STAMINA 2.0/BCR, modified in 1985 by the Minnesota Department of Transportation) (Barry and Reagan 1978; FHWA 1982) was used to compute baseline hourly average L_{eq} levels for NSLs selected as typical of those nearest to each highway (Table 3.21). Distances from the road centerline range from 60 to 200 ft, with most at 100 ft. In the computations, no shielding by terrain, vegetation, or structures was assumed. The receptor location was assumed to be 5 ft higher than the centerline of the highway. The computations were based on average daily traffic (ADT) data furnished by the SSCL (1990). The following assumptions were made:

- A one-hour peak traffic period exists in both the morning and the afternoon.
- One-eighth of the ADT for each route occurs during each of the peak periods.
- The car/truck mix is 5% medium trucks and 95% cars. Medium trucks are those with gross weight exceeding five tons, but not over 13 tons. Light trucks, including vans, pickup trucks, and utility vehicles, are included in the automobile category.
- No heavy trucks are included since the three routes serve primarily local traffic.

TABLE 3.19 Assignment of Surrogate Measured Preconstruction Environmental Ambient Sound Data to Various SSC Facility Locations[a]

SSC Facility Location	Location	Surrogate Measurement Location
E1	See Figure 2.2	MJ
F1	See Figure 2.2	MD
E2	See Figure 2.2	MW
F2	See Figure 2.2	MD
E3	See Figure 2.2	MM
F3	See Figure 2.2	MG
E4	See Figure 2.2	MH
F4	See Figure 2.2	MJ
E5	See Figure 2.2	MJ
E6	See Figure 2.2	MM
F6	See Figure 2.2	MR
E7	See Figure 2.2	MS
F7	See Figure 2.2	MW
E8	See Figure 2.2	MW
F8	See Figure 2.2	MW
E9	See Figure 2.2	MY
F9	See Figure 2.2	MY
E10	See Figure 2.2	MZ
OAA	SW of E1	MZ
OEA	NW of M8	MR
OEB	NW of M8	MR
OGA	W of M7	MR
OGC	W of M6	MR
OHA	W of LEB	MR
OOA	NW of IR4	MH
OPA	SW of IR4	MR
OPD	SE of IR4	MH
OXA	W of H6	MZ
OXC	NW of H7	MZ
OXD	W of WP4	MR
OXE	W of WCAA	MZ
OXF	SE of H3	MH
QAA	NE of ECA	MJ
QAB	E of IR8	MG
QAC	E of N access	MG
QAD	W of IR5	MH

[a]See Rodman and Liebich (1990) for details regarding correlation of surrogate measurement locations with SSC facility locations.

TABLE 3.20 Measured Preconstruction Environmental L_{90} Sound Level Spectra[a]

Surrogate Measurement Location	Residual Sound Level (L_{90}) for Specified Octave Band Center Frequency (Hz)									
	31	63	125	250	500	1K	2K	4K	8K	Overall
MD	41	40	32	27	20	14	11	8	6	24
MG	43	42	38	28	26	21	17	17	13	29
MH	45	42	32	24	21	17	13	11	7	24
MJ	46	44	36	26	19	15	11	9	7	25
MM	40	36	28	21	20	16	12	7	7	22
MR	38	36	28	21	18	12	5	4	2	20
MS	43	38	28	25	19	8	3	2	1	21
MW	48	41	34	28	20	16	6	4	3	24
MY	40	36	30	25	20	15	10	7	5	22
MZ	40	38	29	16	16	9	6	5	3	19

[a]Unweighted decibels (dB) referenced to 20 micropascals, except for overall values, which are A-weighted decibels (dBA).

TABLE 3.21 Summary of Preconstruction Noise Levels at Typical Nearby Residential Locations on Potentially Affected Roadways between I-35E and the Proposed West Campus Area[a]

Route	Range of Hourly Equivalent Noise Level (L_{eq})			
	Dallas-Bound		Homeward-Bound	
	Morning	Evening	Morning	Evening
F.M. 66	62-65	62-65	59-65	59-65
F.M. 876	56-60	55-59	55-59	56-60
F.M. 1493	57-58	56-57	56-57	57-58

[a]A-weighted decibels (dBA) referenced to 20 micropascals.

- During the peak hours, the traffic consists mostly of local residents commuting to and from the Dallas area. Morning traffic is primarily eastbound and northbound, while evening traffic is westbound and southbound.

3.7.3 Baseline Ground-Surface Vibration Levels

Baseline ground vibration levels have been documented for several locations, including locations near railroads and quarries in the study area (Hennon and Hennon 1989; Texas National Research Laboratory Commission 1987). At a point 60 ft underground and 6,600 ft from a quarry, the peak-to-peak (p-p) ground motion measured during quarry blasting was 0.00004 in. at a frequency of 1/2 cycle per second (Hz). Results of railroad vibration measurements at the ground surface are not available; however, at a depth of 25 ft, the ground motion is estimated to be 0.00004 in. (p-p). Criteria for ground motion effects are expressed in terms of velocity rather than displacement. When the criteria (FEIS, Vol. IV, Section 9.2.2.1.C.1) are converted from p-p displacement at a specified (measurement) frequency to peak particle velocity (PPV) (Shortly 1957), they are 0.64 in./s for onset of structural damage and between 0.006 and 0.06 in./s (depending upon frequency) for human perception. Thus, in terms of decibel units, the baseline ground-surface vibration is at least 44 dB below the level of human perception, and 84 dB below the level at which structural damage occurs.

3.8 ENVIRONMENTAL HAZARDS AND HAZARDOUS WASTES

3.8.1 Radiological Environmental Hazards

3.8.1.1 Natural Environmental Radiation

In the FEIS (Vol. I, Section 4.6.1), radon and its progeny were identified as the only potentially significant natural environmental radiation sources at the SSC site. The source terms were presented in the FEIS and are not repeated here. Radon concentrations in the tunnel air space and other excavated areas are not expected to pose a potential health hazard. However, since the distribution of radon-producing natural materials is random, the expected absence of radon will be verified through sampling during and following construction.

3.8.1.2 Man-Made Radiation

The man-made sources of radiation for the Texas region, including the SSC site area, are reported in the FEIS (Vol. I, Section 4, Table 4-14). (The man-made sources of radiation considered in this document are limited to those for which state and federal licenses are issued. The analysis does not consider minor sources outside state and federal regulatory control.) While the actual number of U.S. Nuclear Regulatory

Commission and state licenses (86 and 2,145, respectively) granted for storage and use of radioactive materials has probably changed slightly since the FEIS was issued, these numbers still represent most of the man-made radiation sources in the Dallas-Fort Worth region. No other sources of radioactivity, such as nuclear power plants, occur near the site.

3.8.2 Nonradiological Environmental Hazards

3.8.2.1 Insecticides

Insecticides may be needed to control fire ants and typical household pests such as cockroaches. Chemical insecticides labeled for use against fire ants include amidinohydrazone (Amdro, Combat, and Maxforce), fenoxycarb (Logic), avermectin-B1 (Affirm), acephate (Orthene), chlorpyrifos (Dursban), diazinon (Spectracide and AG500), isofenphos (Amaze and Oftanol), and pyrethrins (Accudose). Depending on the product and/or formulation, these insecticides are variously applied as baits, mound drenches, granules, dusts, injections, broadcasts, or liquid fumigants.

If high colony densities are causing a problem, baits are generally used. Baits are about 90% effective and can reduce population levels to a level that is tolerable and manageable by follow-up techniques (e.g., individual mound treatments) (Texas Department of Agriculture undated). Bait formulations typically consist of about 1% toxicant and are applied at a rate of 1.0-1.5 lb/acre. Control lasts up to one year if the bait is applied in the spring. Because the baits are sensitive to hydrolysis and the active ingredients are photosensitive, the toxicants do not persist in the environment. Of necessity, baits are slow-acting so that the poison can spread throughout the colony.

Aerial application would not be appropriate, as access sites are too small and the entire campus sites would not require treatment. Rather, only areas where people are present and the ants are causing a problem would need treatment. The "no control" option should be used in most areas.

If infestation is not severe, only individual mound treatment should be conducted. Although more labor intensive, this technique has the added advantage of not eliminating competing ant species that slow the spread of fire ants (Drees and Vinson 1988).

If applied correctly, boiling water is about 60% effective in controlling individual mounds. No effective biological agents have yet been found for fire ant control.

Regardless of the method used, the colony will not be eradicated if the queen survives. However, the number of workers may be temporarily decreased to tolerable levels. In the event that ants must be controlled, insecticides will probably need to be reapplied annually or semiannually.

Baits and chemicals used for fire ant control are commercially available to homeowners, and an applicator's license is not required to purchase the material.

However, commercial applicators must be licensed. Under 40 CFR 171.9, any federal employee using or supervising the use of restricted-use pesticides must be certified under the government agency plan for determining and attesting to their competency. Furthermore, federal employees must fulfill any additional requirements enumerated by the states under state plans in 40 CFR 171.7. In Texas, licensing and testing are administered by the District Offices of the state's Department of Agriculture.

A wide range of insecticides are used by licensed exterminators in the region for control of cockroaches and other household pests. Local exterminators indicate that typical insecticides used for cockroach control inside buildings and residences include Baygon, Dursban (chlorpyrifos), diazinon, DEMON (cypermethrin), boric acid, and pyrethrin. Most of the chemicals (active ingredients) are available in several formulations. The exact chemical and formulation used depends on the applicator and the nature of the area being treated. Similar insecticides are used to control cockroaches and other household pests throughout the United States.

The large number of insect pests attacking cotton and other agricultural crops leads to frequent applications of numerous insecticides from all classes, but principally organophosphates, synthetic pyrethroids, and carbamates. Applicators are licensed to ensure safe handling and use of insecticides and are required to adhere to label instructions. Texas Pesticide Regulations are contained in 4 Texas Administrative Code -- Chapter 7. Texas Pesticide Laws are given in Chapter 76.

3.8.2.2 Red Imported Fire Ants

The red imported fire ant is considered a major pest species throughout the Southeast. It has gained notoriety as an agricultural pest and for causing power outages, inflicting painful stings, and, more rarely, eliciting allergic responses. More importantly, it has gained notoriety because of the long-term "war" that has been waged to eradicate or control the fire ant since its introduction.

Traditionally, fire ant colonies are evenly distributed, with each colony defending a discrete territory and depending on a single queen for egg production. While fire ants build mounds in almost any type of soil, moundless colonies are occasionally established in dry, compacted, cracked soil; in the walls of buildings; in logs; or under sidewalks (Vinson and Sorensen 1986; Drees and Vinson 1988).

Recently, multiple queen colonies have been observed in many areas and are particularly abundant in Texas (Glancey et al. 1987). Multiple queen colonies are significant because they lead to a great increase in the density of colonies (200 to 400 mounds/acre as opposed to 40 to 60 mounds/acre) (Drees and Vinson 1988). Both single- and multiple-queen colonies are present in Ellis County. Estimated colony densities for the latter are around 300 mounds/acre (Mulder 1988). Though densities varied considerably, red imported fire ant colonies were observed at all sites visited during a walkover survey of the SSC area in spring 1990.

When their mound is disturbed, fire ants will attack and sting whatever is causing the disturbance. Alkaloids in the fire ant venom cause a burning sensation. Following

the sting, a vesicle appears at the site of venom entry. The vesicle develops into a persistent pustule. If the pustule is broken, there is a risk of infection.

Reports variably state that 1-10% of the population is allergic. There is large variation in the severity of the allergic response. More serious complications can occur in individuals who receive numerous stings or in people who are highly allergic to the protein in the venom. Systemic reactions can include nausea, vomiting, dizziness, perspiration, and (in severe cases) anaphylactic shock. Since introduction of the red imported fire ant to Texas in 1957, only 19 (14 of these documented) anaphylactic deaths have been reported. Such deaths can be considered a rare event considering that more than 30% of people living in infested areas are probably stung each year (Rhoades et al. 1989).

Fire ants also can cause economic impacts, especially agricultural (e.g., some mounds are rock hard and can damage farm machinery, and ants will feed on germinating seeds and young trees). Ants can also impair use of an area (e.g., playgrounds and backyards) in instances of high colony densities.

As is typical of many ant species, fire ants are attracted to electrical fields and are occasionally responsible for power outages, disruption of telephone signals, fouling of air conditioners, and interruption of traffic signals. Ants are more likely to enter a structure (such as a relay switch box) when a colony is established immediately underneath it. Nevertheless, it is possible to exclude the ants from electrical devices by tightly sealing electrical components or their surrounding containers. Also, chemical control of fire ants in the vicinity of electrical equipment can reduce ant levels to a point that they are not a problem (MacKay 1989). Routine surveillance and control of any species of ant in or near sensitive electrical equipment are highly recommended.

3.8.3 Hazardous Wastes

The status of potential hazardous waste sources and waste management facilities in the site vicinity is the same as discussed in the FEIS (Vol. I, Section 4.2.6).

3.9 SOCIOECONOMICS AND INFRASTRUCTURE

The regional economic, demographic, community resource, and fiscal conditions -- independent of the SSC -- presented in the DEIS (Vol. IV, Appendix 5, Section 5.7.11.1) were based on information current as of spring 1988. This supplemental analysis incorporates more recent estimates of those conditions (fall 1989) and specifically focuses on the part of the region that is most likely to notice SSC-related socioeconomic impacts. A more detailed account, from which all the information presented in this section has been summarized, is provided in a separate technical report (Robert D. Niehaus, Inc. 1990).

Eight counties constitute the socioeconomic region of influence (ROI) considered in this SEIS: Dallas, Ellis, Hill, Johnson, Kaufman, Navarro, Rockwall, and Tarrant. This region encompasses most communities within reasonable daily commuting distance of the

SSC (less than 90 min one way) and includes almost all of the Dallas-Fort Worth metropolis and suburbs.

Prior studies indicated that most socioeconomic effects would occur in Ellis County and in southern Dallas County (FEIS, Appendix 14, Section 14.1.3.7). That part of the region (Figure 3.16) is therefore the primary focus of this supplemental discussion of baseline conditions, particularly with regard to housing, community services, public finances, quality of life, and transportation.

3.9.1 Economic Activity

In the mid-1980s, the region's labor force grew rapidly as workers in-migrated from the northeastern United States and elsewhere in search of jobs. Crude oil prices reached their peak during this period. Revenues in the mining sector and lower interest rates spurred new commercial and residential development within the region. As a result, many of the in-migrating workers found jobs in construction industries. The sudden drop in the price of crude oil in early 1986 resulted in layoffs in the industry and triggered a major slowdown in construction, as well as in the rest of the economy. Between 1984 and 1987, the mining sector's share of regional jobs fell from 2.4% to 1.8%, and the construction sector's share fell from 6.6% to 5.7%. Speculative real estate loan ventures financed by numerous regional banks and savings and loans institutions during the mid-1980s failed, causing a disastrous setback in financial markets. The regional economy is still recovering from these events.

The region has grown steadily over the past two decades at a relatively fast pace compared with average rates of growth for the entire nation. Average annual growth rates in employment, earnings per job, and per capita personal income were all greater than those of the nation for the 1970-1987 period. Furthermore, the relative levels of earnings per job and per capita income have consistently been greater than the national average. In 1987, earnings per job in the region were 12% higher than the U.S. average, and the region's per capita income was 9.1% greater than the U.S. level.

3.9.2 Demographics and Housing

With an estimated total population exceeding 3.3 million in January 1989, the ROI contained nearly one-fifth of the entire population of Texas. Each of the eight ROI counties has grown in population since the 1980 census (Table 3.22). At an average annual rate of 5.9%, Rockwall County has grown the fastest during this time. Dallas County still contains more than half the ROI's population, however, with an estimated 1.56 million persons in 1989. Together with an estimated 1.16 million persons in Tarrant County (where Fort Worth is located), these two counties account for nearly 90% of the people in the ROI.

Ellis County's population has grown at an average annual rate of 2.7% during the 1980s, from less than 60,000 to more than 75,000, that is, slightly faster than the ROI as a whole. Although small, Ovilla and Red Oak, each with annual growth rates of 5.5%, and Midlothian, at 4%, are the fastest growing cities in Ellis County (Table 3.22). These

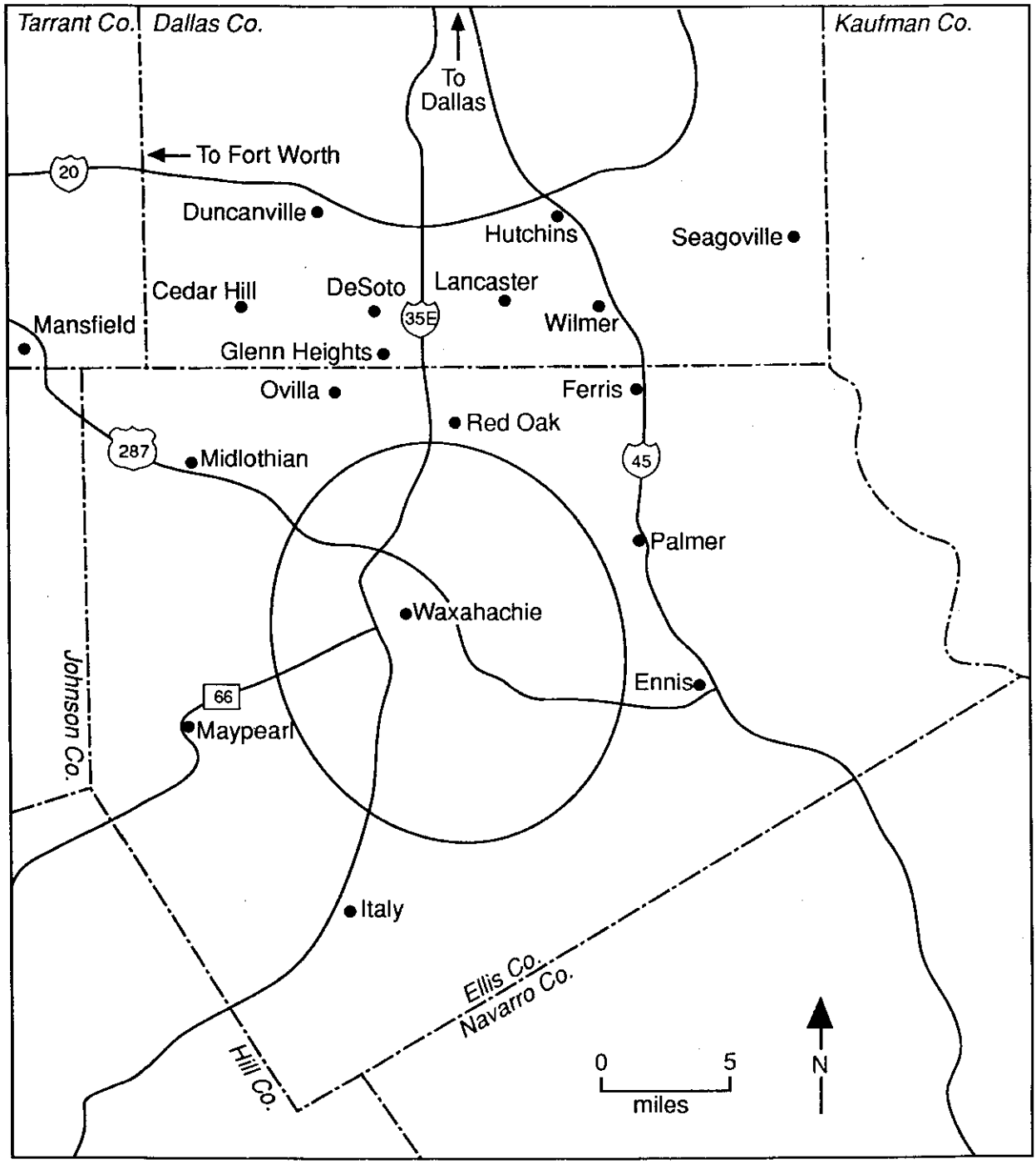


FIGURE 3.16 Counties and Municipalities in the Immediate Vicinity of the SSC Site

TABLE 3.22 Population Growth in ROI Counties and Selected Municipalities, 1980-1989

County/City	Population April 1, 1980	Population January 1, 1989	Average Annual Growth Rate (%)
Dallas County	1,556,390	1,838,250	1.92
Cedar Hill	6,849	18,000	11.68
DeSoto	15,538	30,050	7.83
Duncanville	27,781	36,500	3.17
Glenn Heights	1,033	4,100	17.06
Hutchins	2,837	2,800	-0.15
Lancaster	14,807	22,100	4.68
Seagoville	7,304	9,550	3.11
Wilmer	2,367	3,150	3.32
Ellis County	59,743	75,400	2.69
Ennis	12,110	14,200	1.84
Ferris	2,228	2,350	0.61
Italy	1,306	1,700	3.06
Midlothian	3,219	4,550	4.03
Ovilla	1,067	1,700	5.47
Palmer	1,187	1,450	2.31
Red Oak	1,882	3,000	5.47
Waxahachie	14,624	18,000	2.40
Tarrant County	860,880	1,157,700	3.44
Mansfield	8,102	14,450	6.84
Hill County	25,024	28,146	1.35
Johnson County	67,649	92,700	3.66
Kaufman County	39,015	53,050	3.57
Navarro County	35,323	42,250	2.06
Rockwall County	14,528	23,900	5.85
ROI total	2,658,552	3,311,396	2.54

Source: Robert D. Niehaus, Inc. 1990, Tables 2-2 and 2-3.

northernmost areas of the county are subject to suburban Dallas growth forces similar to those affecting several cities in southern Dallas County: Cedar Hill (11.7% annual growth since 1980), DeSoto (7.8%), Glenn Heights (17.1%), and Lancaster (4.7%), to name a few.

By contrast, Waxahachie's population has grown by only 2.4% annually since 1980, a percentage that is similar to other parts of the ROI that are more distant from Dallas. Ennis, the second largest city in Ellis County, for instance, has grown by only 1.8% per year during this period. At the ROI's southern extreme, farthest from Dallas, the populations of Hill and Navarro counties have grown at average annual rates of 1.4% and 2.1%, respectively.

Ellis County had about 17,400 total housing units in 1989. More than two-thirds of these were single-family structures. Overall growth in Ellis County housing was about 28% during the 1980s, up from about 13,600 units in 1980. Far more housing is available in communities in the southern portion of Dallas County, and these homes generally are newer. Housing in Glenn Heights, for instance, more than quadrupled from 1980 to 1989, from less than 400 units to more than 1,600 units. Housing in DeSoto doubled during that period, from about 5,000 total units to nearly 11,000 units. Cedar Hill's housing, about 2,250 units in 1980, increased to more than 6,600 units in 1989. Nearly all of the new housing units in these communities are single-family structures. Significant housing growth also has occurred in the southern Tarrant County community of Mansfield, from about 2,800 total units in 1980 to nearly 5,300 units in 1989.

3.9.3 Public Services

3.9.3.1 Public Education

The ROI is served by 80 school districts that range in enrollment size from fewer than 100 students in Malone Independent School District (ISD) in Hill County to more than 130,000 students in Dallas ISD. The student/teacher ratio for the ROI is 17.3, as compared with 16.7 for the state as a whole and 18.0 for the nation. Each of the school districts in the project area (Ellis and southern Dallas and Tarrant counties, Figure 3.17) reports either steady or increasing enrollments in recent years. All currently maintain excess capacity at their facilities to accommodate growth. The greatest excess capacities are found at the five larger school districts of southern Dallas and Tarrant counties and Waxahachie, Midlothian, and Ennis ISDs in Ellis County (Table 3.23). Student/teacher ratios for these school districts are between 11.1 (Avalon ISD) and 19.9 (Duncanville ISD).

3.9.3.2 Police and Fire Protection

Law enforcement in the ROI is dominated by the large police forces of primarily urban Dallas and Tarrant counties, with a level of service of 2.1 officers per 1,000 people. The project area is served by nine municipal police departments in Ellis County, five in Dallas County, and the sheriff's offices of each county. ROI fire protection is

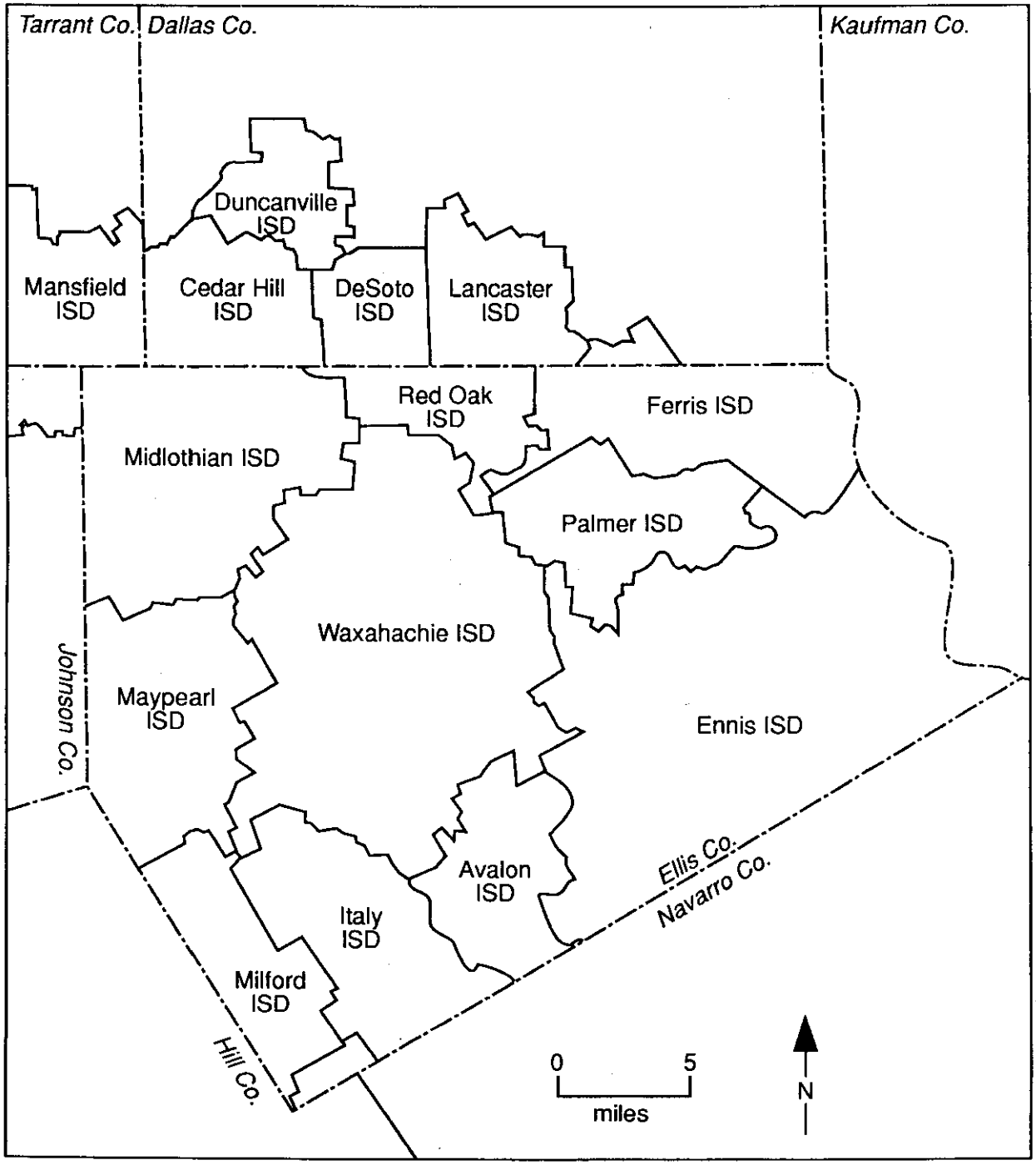


FIGURE 3.17 Independent School Districts in the SSC Site Vicinity

TABLE 3.23 Capacity and Enrollment by School District

School	Fall 88-89 Enrollment	Capacity	Excess Capacity	FTE[a] Teachers	Fall 88-89 S/T Ratio
Ellis County					
Avalon ISD	167	260	93	15	11.1
Ennis ISD	3,986	4,972	986	230	17.3
Ferris ISD	1,370	1,975	605	79	17.3
Italy ISD	572	600	28	39	14.7
Midlothian ISD	2,690	4,000	1,310	160	16.8
Milford ISD	214	275	61	17	12.6
Palmer ISD	672	750	78	41	16.4
Red Oak ISD	2,999	3,632	633	169	17.7
Waxahachie ISD	4,893	6,800	1,907	279	17.5
Maypearl ISD	491	629	138	31	15.8
Dallas County					
Cedar Hill ISD	3,640	4,600	960	224	16.3
DeSoto ISD	5,764	7,975	2,211	349	16.5
Duncanville ISD	9,860	11,400	1,540	496	19.9
Lancaster ISD	4,270	6,500	2,230	263	16.2
Tarrant County					
Mansfield ISD	6,390	8,637	2,247	393	16.3

[a]FTE = full-time equivalent.

Source: Robert D. Niehaus, Inc. 1990, Table 2-6.

provided at a level of service of 1.1 professional fire fighters per 1,000 population. This level of service is also augmented by rosters of volunteers: more than 70% of 280 fire fighters in Ellis County are volunteers. Both Ellis and Dallas counties provide fire protection at levels of service equal to those of the ROI and state as a whole.

3.9.3.3 Health Care

Most of the medical facilities and health care providers in the ROI (offering the full range of services and including more than 80 hospitals) are located in Dallas and Tarrant counties. The ROI contains a higher number of physicians, dentists, and nurses per capita than the state on average. The two acute care hospitals located in Ellis County (at Waxahachie and Ennis) have a combined capacity of 125 beds and provide emergency and outpatient services. Ellis County is served by 12 emergency medical care providers, including two air ambulance services, all of which meet the basic life support standard.

3.9.4 Public Finance

Table 3.24 presents revenue and expenditure levels, fund balances, assessed valuations, and indebtedness levels for the most recent fiscal year for Ellis County and potentially affected cities and school districts in the SSC ROI. The data reflect actual revenues and expenditures in the year noted for each jurisdiction's general fund, and in some instances (as applicable), a jurisdiction's special revenue funds. For each of the jurisdictions, these funds account for the majority of the money used in the provision of services to community residents. Data are given in current-year dollars unless otherwise noted.

3.9.4.1 Ellis County

Property taxes accounted for approximately 50% of the county's general and special revenue funds in FY 1988. Although public services provided by jurisdictions in the region are financed mainly through general funds, a large portion of Ellis County services are funded through special revenue funds, most notably farm-to-market road accounts and road and bridge funds. Property taxes and vehicle registration fees are the principal sources of revenue for these special funds. Proposed increases in motor vehicle registration fees would make it possible for existing undedicated monies in the road and bridge special revenue accounts to be used in support of land acquisition for SSC use. Road and bridge maintenance, public safety (police and fire protection services), and general administration functions are the principal expenditure functions of the county. Fund balances represented approximately 74% of expenditures in FY 1988.

3.9.4.2 Cities

Public services provided by cities within the ROI are supported principally through each city's general funds. Property taxes are typically the single largest revenue source of these funds. For example, in the most recent fiscal year, property taxes accounted for about 60% of general fund revenues in Glenn Heights and Cedar Hill. However, in Waxahachie and Midlothian, property taxes made up only about 25% and 10% of general fund revenues, respectively. In Midlothian, general fund property tax collections represented the third largest single revenue source; business franchise taxes and sales taxes were the primary revenue sources for the city. In Waxahachie, sales taxes, charges for services, license revenue, permits, and fine and fee revenues also play important roles in the city's revenue structure. Public safety, public works, and general administrative services are the major functions of the cities.

3.9.4.3 School Districts

Revenues of local school districts are composed principally of local-source revenue (property taxes plus other miscellaneous sources), state-source revenue, and federal program revenues. State sources account for the majority of general fund revenue in four districts: Waxahachie ISD, Ennis ISD, Red Oak ISD, and Maypearl ISD.

TABLE 3.24 Fiscal Data for Selected Local Jurisdictions

Jurisdiction	FY 1988 Revenues ($ mil)	FY 1988 Expenditures ($ mil)	FY 1988 Fund Balances ($ mil)	FY 1988 Fund Balances as Percent of Expenditures (%)	FY 1988 General Obligation Bond Indebtedness ($ mil)	CY 1988 Assessed Valuation ($ mil)	FY 1990 Property Tax Rate per $100 Assessed Valuation	
							Maintenance and Operation	Debt Service
Ellis County[b]	10.0	8.5	6.3	74.1	6.6	2,027	0.240	0.034
Waxahachie City[c]	6.3	5.5	0.7	12.7	13.8	660[d]	0.334	0.214
Midlothian City	2.6	2.9	1.8	62.1	0.2	404[d,e]	N/A[f]	0.079
Ennis City	4.5	4.4	0.7	15.9	4.8	423[e]	0.465	0.126
Maypearl City	0.05	0.07	0.02	33.3	0	9	0.192[g]	0
Red Oak City	0.7	0.7	0.2	35.3	1.3	N/A	N/A	N/A
DeSoto City	8.9	7.8	3.1	39.7	14.5	1,231	0.396	0.110
Lancaster City	7.2	6.9	1.3	18.8	9.5	753	0.321[g]	0.171[g]
Duncanville City	10.0	10.7	2.2	20.6	17.3	1,300	N/A	N/A
Cedar Hill City	3.5	3.9	0.3	8.7	7.2	900[d]	0.315	0.106
Glenn Heights City	1.0	1.1	-0.3	-30.0	2.8	116[d]	0.560	0.158
Waxahachie ISD	13.2[h]	13.6[h]	1.7[h]	12.5[h]	18.6[h]	737[d]	0.752	0.348
Midlothian ISD	8.3	8.7	0.1	1.4	10.9	566	0.810[g]	0.390[g]
Ennis ISD	11.8[h]	11.8[h]	1.5[h]	12.7[h]	10.9[h]	491	0.823	0.257
Maypearl ISD	1.5	1.6	0.05	2.8	1.5	39	0.730[g]	0.420[g]
Red Oak ISD	7.9	7.8	0.4	5.0	9.6	360	0.866	N/A
Palmer ISD	1.9[h]	1.9[h]	0.3[h]	15.8[h]	1.8[h]	67	0.545[g]	0.295[g]
DeSoto ISD	16.9	17.0	1.7	10.0	31.5	1,050	0.713[g]	0.348[g]
Lancaster ISD	12.4	11.5	1.2	10.4	30.5	740	0.780[g]	0.290[g]
Duncanville ISD	28.4[h]	28.7[h]	4.6[h]	16.0[h]	36.7[h]	2,200[d]	0.776	0.264
Cedar Hill ISD	11.6	11.3	0.6	5.3	28.7	902[d]	0.876	0.396

[a]Data are for general funds, unless otherwise noted.

[b]Includes special revenue funds.

[c]Includes data for Ellis County Water Control and Improvement District No. 1.

[d]CY 1989.

[e]Data reflect taxable valuations.

[f]N/A = Not applicable or data not available.

[g]FY 1988.

[h]FY 1989.

Source: Robert D. Niehaus, Inc. 1990, Table 2-9.

Local sources account for the majority of revenue in three districts: Cedar Hill ISD, Duncanville ISD, and Midlothian ISD. In the remaining districts, local and state source revenues account for about equal shares of general fund revenues.

3.9.4.4 Other Agencies

Other governmental agencies potentially affected by the project include the Texas National Research Laboratory Commission and the proposed Superconducting Super Collider Facility Research Authority. The Commission is the authorized agent of the State of Texas to acquire and transfer (to the U.S. Government) all land required for the SSC project. It also is authorized to issue bonds to provide additional funding for project needs. These bonds would be repaid through either legislative appropriation or a combination of legislative appropriation and revenue generated by funded activities. The proposed SSC Facility Research Authority would be composed of various local governmental units in the area. This authority would act as an intermediary agency with a charter to pass to the Texas National Research Laboratory Commission money given it by member jurisdictions for the purpose of defraying land acquisition costs.

3.9.5 Quality of Life

Life quality issues relative to the proposed SSC project are most relevant for people and groups in Ellis County, that is, those who would be affected directly by project placement, particularly those whose homes and livelihoods would be relocated. To facilitate qualitative description of the diverse nature of the project area, major societal groups reflecting the composition of the county were identified. Residents were grouped into four general categories: rural, nonfarm residents; farm operators; town residents; and urban/suburban residents.

3.9.5.1 Rural, Nonfarm Residents

Ellis County, outside of the small towns, is characterized largely by agriculture and open spaces, together with rural residences that dot the countryside. Many of the inhabitants of the SSC area are exurbanites who choose to live in Ellis County mainly for the rural atmosphere and way of life. Although maintaining economic ties to the metropolis, they prefer to live where they feel it is less crowded and polluted, more quiet and safe, naturally scenic, more open, and less traffic congested.

3.9.5.2 Farm Operators

Agriculture is an important way of life for many in the county, even though a number of farmers have sources of income other than farming or ranching. Many farm operators are the older, long-term residents of the county. Some live on land that has been in their families for generations. The preservationist sentiment is strong among this group who want "good crop and pasture land" to remain in agricultural production (DEIS comment #1467).

3.9.5.3 Town Residents

The majority of comments received on the EIS were from town residents who favor the SSC project because they believe it would have significant economic benefits for their area. On the other hand, although growth and development are valued, many want to ensure that such progress does not mean losing the unique character of their communities.

3.9.5.4 Urban/Suburban Residents

Urban/suburban residents include residents of the Dallas-Fort Worth metroplex and its southern suburbs. The suburbs in southern Dallas County have been growing at a rapid rate and are continuing to grow as Dallas expands. These communities, as suburban extensions of the metropolitan area, have a more concentrated urban life style than the smaller, autonomous cities of Ellis County.

3.9.6 Transportation Systems

The recent rapid growth of the Dallas-Fort Worth region has caused increasing problems with transportation; this growth has begun to overload the region's transportation system and outpace improvements designed to ease congestion. Planned improvements -- including increased passenger rail service, establishment of a regional high-occupancy vehicle system, addition of more than 2,000 freeway lane miles, and nearly 2,500 additional lane miles of arterial improvements -- would help reduce impending highway congestion.

Rural two-lane highways of the Texas farm-to-market system dominate the project area. These roads provide efficient mobility by crossing the rural environment with long stretches lacking traffic control interruptions. They connect rural communities with other rural areas, with larger towns, and with main traffic routes. Major routes linking the SSC project area with Dallas, Fort Worth, and the Dallas-Fort Worth International Airport (DFW) are Interstate 35E (I-35E), U.S. 67, U.S. 77, I-45, and U.S. 287. The proposed extension of S.H. 360, which would provide direct access between the project area and DFW, has been stalled by delays in rights-of-way acquisition.

Several improvements are planned by the Texas Department of Highways and Public Transportation to upgrade Ellis County roads; other improvements have been designated by the department specifically to improve transportation to and from construction and operation sites of the SSC. Gross weight limits on routes in the project area are reported to be 80,000 lb on interstates and U.S. highways; 58,420 lb on farm-to-market routes; and 40,000 lb on small, county roads. Bridge limits are generally 28,000 lb per tandem axle, although some bridges are posted for smaller loads.

No significant information regarding air, rail, water, or public transportation has been identified other than what was reported previously in the EIS.

3.9.7 Utilities

3.9.7.1 Electricity

Electrical power is supplied to Ellis and surrounding counties by the Texas Utilities Electric Co. (TU Electric), which has a service territory encompassing much of the northern half of Texas. Total sales for the TU Electric system were 80.7 billion kWh in 1988, an increase of 3.8% over 1987. At the time of the year's peak demand, the net capability of the system was 20.1 million kW, with a reserve margin of 15.2%. Six new generating units in the construction stage are expected to provide an additional 6.4 million kW to meet the projected growth in demand over the next 10 years. A new double circuit 345-kV transmission line planned by TU Electric would traverse the project area approximately south to north between the cities of Waxahachie and Ennis. The new line is scheduled to be in service by 1994. Portions of Ellis County are supplied by the Hill County and Navarro County Electric Cooperatives.

3.9.7.2 Natural Gas

The project area is served primarily by two natural gas companies -- Lone Star Gas Co. and Valero Natural Gas Co. Lone Star had sales of 325 billion ft^3 in 1988 and maintains an adequate level of natural gas reserves totaling 2.8 trillion ft^3. Valero Natural Gas Company had sales that reached 356 billion ft^3 in 1988, up 25% over the previous year. The company purchases gas from suppliers and currently has access to adequate reserves (3 trillion ft^3) to meet future demands. Lone Star owns high-pressure transmission lines that traverse the project area, including a 30-in. pipeline that extends southwest-northeast on the eastern side of the project area. Valero operates a 36-in. pipeline that traverses the project area from east to west.

3.9.7.3 Telecommunications

Southwestern Bell Telephone Co. is the primary provider of communication services in the project area and is the authorized service company for the western portion of the project area. Contel Co. owns lines crossing the eastern half of the project site, servicing towns to the east of Waxahachie. Southwestern Bell serves the towns of Waxahachie, Midlothian, Red Oak, and Ennis with digital switch service and is scheduled to provide similar service to Italy. Southwestern Bell has installed a fiber-optic connection from Dallas to San Antonio that generally follows the alignment of I-35E. Currently, Southwestern Bell is introducing a new technology in Dallas, known as integrated services digital network, which will be available in the project area in the future.

3.10 CULTURAL AND PALEONTOLOGICAL RESOURCES

The inventory and evaluation of archaeological sites and historic structures that would be affected by the proposed action are in the process of being completed, in

consultation with the Texas State Historic Preservation Office. An assessment of paleontological resources has been completed.

3.10.1 Regional Prehistory and History

The prehistory and history of Ellis County and surrounding region was summarized in the EIS. The prehistoric record may be divided into the following major periods: Paleoindian (10,000-5000 B.C.), Archaic (5000 B.C.-A.D. 800), Late Prehistoric (A.D. 800-1687), and Historic (A.D. 1687-present). The historic period may be further subdivided into Spanish Colonization (1687-1821), Antebellum (1821-1861), Civil War and Reconstruction (1861-1875), Late Victorian (including the *cotton boom* era) (1876-1910), and Post-Victorian (1910-present) (Raab 1982a, 1982b; Hardy, Heck, and Moore 1985a, 1985b).

3.10.2 Archaeological Sites

Archaeological surveys conducted in conjunction with several projects in Ellis County and surrounding areas provide information on the distribution of sites in the region. These surveys include Bardwell Lake (Shafer 1964), Joe Pool Lake (Skinner and Connors 1979; Raab 1982a; Peter and McGregor 1988), Richland Creek Reservoir (Raab 1982b), and approximately 30 small surveys within Ellis County (e.g., Waxahachie-Midlothian Airport) (Westbury 1986). The results of these surveys are summarized in the DEIS (Vol. IV, Appendix 15, p. 61).

A literature and file search for previously recorded sites in the proposed project area yielded a total of 17 archaeological sites (State of Texas 1988; DEIS, Vol. IV, Appendix 15, p. 62, Table 15-11). Fourteen of those sites were discovered during the Bardwell Lake survey and are located in the southern portion of the project area (Shafer 1964).

A survey of areas that would be affected by the SSC recently has been completed. The survey design, which was developed in consultation with the Texas Historical Commission, entailed a 100% pedestrian reconnaissance of fee simple lands that would be directly affected by the proposed project. With the exception of recent alluvial deposits along major streams, most surficial sediment in the project area was deposited before 12,000 years ago and is unlikely to contain archaeological remains in a primary geologic context. However, unplowed areas were subjected to shallow shovel testing (20-m intervals) to sample for artifacts that have been reworked into a secondary buried context by surficial disturbance processes (e.g., desiccation cracks). It was assumed that in plowed areas, a high proportion of artifacts buried by such processes will be reworked to the surface by the plowing action.

Currently, survey results are available for geotechnical bore and trench locations in the west campus area. A total of 30 acres has been examined at various locations selected for geotechnical characterization; no artifacts have been observed (EG&G 1989). Pedestrian surface surveys have been conducted on more than 75% of the 5,000-acre west campus area; access to the remaining portions of the area has been denied by

landowners. Nineteen archaeological sites (surficial artifact scatters) and historic farmsteads have been reported (Jurney et al. 1990). These sites are being evaluated for significance, in consultation with the Texas Historical Commission.

3.10.3 Historical Structures

Previous surveys of Ellis County and surrounding areas have documented the presence of numerous significant or potentially significant structures from the historic period (Raab 1982a, 1982b; Westbury 1986; Moir and Jurney 1987). Historic structure surveys in Waxahachie and Ennis recorded 1,988 and 1,286 structures, respectively (Hardy, Heck, and Moore 1985a, 1985b). Included were houses, farms, churches, bridges, municipal buildings, and other structures. Results of these surveys are discussed in the DEIS (Vol. IV, Appendix 15, pp. 62-64).

More than 400 historic structures in Ellis County, all in Waxahachie or Ennis, are currently listed on the National Register of Historic Places (Table 3.25). In Waxahachie alone there are 330 National Register structures, and 118 are located in Ennis. More than half of the Ennis National Register structures are incorporated into the Ennis Commercial Historic District. Most of those buildings are associated with the development of the railroad and cotton industries. More than two-thirds of the National Register structures in Waxahachie are residential.

Previously uninvestigated portions of Ellis County currently were surveyed to complete the inventory of historic structures that could be affected by the proposed action. The survey included areas that would be directly affected by the project and areas that could be indirectly affected (e.g., impacts generated by increased local residential and commercial construction). The survey design, which was developed in consultation with the Texas Historical Commission (Hardy, Heck, and Moore 1989), entailed review of historic maps, legal records, county histories, and other written sources, as well as a field reconnaissance of all public streets and roads. All structures built before 1942 were mapped, photographed, and described.

The new survey (Clark et al. 1990) recorded a total of 3,714 structures, of which 465 (12.5%) appear likely to meet eligibility criteria for the National Register. Nineteen eligible structures are located within the SSC ring and campus areas. Structures are determined eligible primarily on the basis of their contribution to regional history and/or their architectural quality. Formal significance determinations have been undertaken; eligibility for the National Register was determined in consultation with the Texas Historical Commission.

3.10.4 Native American Religious Sites

The Caddo and Wichita tribes and the Texas Indian Commission have been consulted regarding the presence of religious sites in areas that would be affected by the proposed action; no sites have been reported (State of Texas 1988).

TABLE 3.25 Inventory of National Register Properties in Ellis County[a]

Period/Location	Residential	Commercial	Institution	Non-specified	Total
1850-1884					
Waxahachie	8	0	0	1	9
Ennis	0	1	0	0	1
1885-1899					
Waxahachie	79	13	3	1	96
Ennis	9	4	0	0	13
1900-1919					
Waxahachie	95	34	7	2	138
Ennis	25	29	1	1	56
1920-1939					
Waxahachie	46	30	4	0	80
Ennis	3	14	0	0	17
1940 and later					
Waxahachie	0	0	1	0	1
Ennis	0	2	1	0	3
No date					
Waxahachie	0	2	0	4	6
Ennis	1	26	1	0	28
Totals					
Waxahachie	228	79	15	8	330
Ennis	38	76	3	1	118
Ellis County	266	155	18	9	448

[a]Listings currently are confined to Waxahachie and Ennis.

3.10.5 Paleontological Resources

Fossils have been recovered from two distinct geologic contexts in Ellis County: Cretaceous bedrock and Quaternary alluvium (Slaughter and Thurmond 1965). Cretaceous fossils include pelecypods and fishes; Quaternary fossils include molluscs and isolated fragments of amphibians and mammals (DEIS, Vol. IV, Appendix 15, pp. 85-86). During the fall of 1989, geotechnical test cores were examined for fossils; no rare or important fossil forms were observed (Garner and DuBar 1989).

3.11 VISUAL RESOURCES

3.11.1 Visual Character and Sensitivity

Landscape features collectively constitute the visual character of an area. Visual character is used as a reference point to assess whether a given project appears compatible with the existing features of the setting. The visual resources of the SSC site vicinity are the features of its landforms, vegetation, water surfaces, and cultural modifications (physical changes caused by human activities) that give the landscape its visually aesthetic qualities. Features in the site area are natural appearing but modified by human activities reflecting the various agricultural land uses of the area.

Visual sensitivity, defined as the relative degree of public interest in visual resources and concern about adverse changes in the quality of that resource, has been addressed in project impact assessments by other federal agencies. Visual sensitivity is a key element in the impact assessment presented in Section 4.10, relative to the importance or significance of an impact.

An overview of visual character and sensitivity for the Dallas-Fort Worth region and SSC site vicinity was provided in the DEIS (Vol. IV, Appendix 5C, pp. 141-142). The footprint rotation and changes in the height of certain facilities, particularly at the service areas, potentially affect sensitive views that are both greater in number and different from those described in the DEIS (Vol. IV, Appendix 5C, p. 153).

The approach to assessing sensitivity was presented in the DEIS (Vol. IV, Appendix 16, Section 16.2.3.2). The impact categories are as follows:

- *High Sensitivity.* Strong public reaction is likely in a given locale to proposed action perceived as an impact to visual quality.

- *Moderate Sensitivity.* The public will likely voice some concern to proposed action perceived as having a substantial impact to visual quality.

- *Low Sensitivity.* The public will express little or no concern to proposed action resulting in impact to visual quality.

3.11.2 Visual Setting of SSC Facility Locations

The following paragraphs describe SSC facility locations, residences, and areas of frequent public use that are considered to be subject to moderate or high sensitivity from a viewer perspective. Locations selected also have the greatest potential of experiencing significant visual impact from the SSC project. These same locations are analyzed in Section 4.10 with respect to visual impacts and possible mitigation options.

- *Service Area E2.* Seven residences are within 1,500-2,400 ft northeast of the northern boundary of E2. Three residences are 1,200-2,400 ft southeast of the nearest site boundary. A privately owned lake borders area E2 on the northwest and has an extensively used picnic area. Views from some of the residences would be considered as moderately sensitive, as would views from the lake surface and picnic area.

- *Service Area F2.* Approximately 30 residences are located to the north within 300-2,000 ft of the site. One residence is approximately 700 ft southeast of area F2. Access to most of the homes is via Springbranch and Daniels roads. These homes are part of a subdivision constituting a significant, well-defined rural residential area. Consequently, sensitivity is categorized as moderate.

- *Service Area F3.* A major subdivision, currently about 50% developed and comprising about 50 homes, is located south and southwest of the site. Fifteen more homes are located near the subdivision along Shawnee Road, south and southeast of area F3. The nearest homes in the subdivision are 1,200-1,400 ft from the proposed service shaft location. Sensitivity for views from the homes and roads accessing the homes is categorized as moderate.

- *Service Area E4.* Pritchett Road is immediately adjacent and roughly parallel to area E4. Approximately 20 homes along this road are within 1,200-2,200 ft of the proposed service shaft location. Important views from these residences are to the east and northeast. Sensitivity for views from the homes and accessing roads is categorized as moderate.

- *Service Area E7.* Five residences are located 3,700-3,800 ft northwest of the service area near the intersection of S.H. 34 and F.M. 877. Views from these and other nearby residences are categorized as moderately sensitive. Other views of concern are those from the northeast edge of the town of Bardwell and

Waxahachie Creek Park northwest of the service area at the end of F.M. 877. Views from the park entrance are considered highly sensitive.

- *Service Area E10.* Four residences are within 1,600-3,500 ft northeast of the service area. Five homes are approximately 3,500 ft to the north, as is the Bethel Church. Bethel Church Road, south of the church, would pass by the service area. Sensitivity for views from the residences and Bethel Church Road is considered moderate.

- *West Campus Area.* The most sensitive views in the west campus area are in the vicinity of service area E1. Eleven residences are 2,200-4,000 ft west of the service area. Views from these homes are considered moderately sensitive.

- *East Campus Area.* Six residences occur along F.M. 1722 southwest of service area E6, and six residences are located to the southeast. All are within 1,300-2,000 ft of the service area. Views from these homes and the roads serving them are considered moderately sensitive.

Detailed descriptions of the landscape associated with the proposed service areas are provided in a supporting technical document (Headley 1990).

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4 ENVIRONMENTAL CONSEQUENCES

4.1 EARTH RESOURCES

4.1.1 Technical Approach and Methodology

The technical approach and methodology to assess impacts to earth resources are described in the DEIS (Vol. IV, Appendix 6, Section 6.2). Additional assessments have been made for this SEIS only where warranted by changes in facility features, as presented in Chapter 2. Additional information obtained related to faulting at the site has not led to any changes since the FEIS.

4.1.2 Topography

Topographic changes to the site would include (1) landscaping of spoils and cooling pond excavations at service shafts; (2) temporary excavations and spoils landscaping for the booster tunnels (linear accelerator [Linac], low-energy booster [LEB], and medium-energy booster [MEB]) and interaction (experimental) halls; and (3) grading in the vicinity of campus structures. The discussions below, covering each of these topics in turn, are limited to assessments of topographic impacts. Impacts to water resources, visual aesthetics, and biota resulting from excavation, grading, and spoils landscaping are discussed in separate sections of this SEIS.

4.1.2.1 Service Shafts

As described in Chapter 2, service area E7 has been chosen as representative of the 18 E and F areas. Site-specific impacts are reported where appropriate in this and subsequent sections of Chapter 4.

Topsoil would be removed and stockpiled from the 7- to 10-acre area proposed for the cooling ponds and the 5- to 6-acre rectangular area in the northwestern quarter of the service area planned for buildings, parking lots, and landscaped areas immediately surrounding these facilities. Depending on the sequence of surface construction activities, one or more stockpiles may be created. Care would be taken to control sediment runoff from disturbed areas through the use of sediment-control basins. If excavation for the cooling pond occurs early in the construction process, the pond itself could serve to control runoff from disturbed areas. An estimated 102,000 yd^3 of loosely placed (i.e., not compacted) rock and earthen material would be excavated for the cooling pond. Excavation of the access shaft and tunnel segment at the E7 area would yield, respectively, totals of 10,000 and 124,000 yd^3 of loose rock and earthen material.

Four landscaped spoils placements, ranging in size from 3 to 5 acres each, would contain the spoils from excavation of the access shaft, tunnel segment, and cooling pond. A total volume of about 236,000 yd^3 of loose spoils would be handled in this manner. The finished topography would range from 460 to 470 ft msl in elevation and

would be contoured to blend with the existing topography. The average net increase in topographic elevation as a result of the landscaped placement would not exceed 10 ft.

Other service areas will have similar volumes of spoils materials from the access shaft and tunnel segments. However, no spoils removal is planned from E1, which will reduce the impacts at that location. The spoils from near E1 will be removed from another shaft in a less sensitive area near the high-energy booster (HEB). The spoils from E8 may be removed from the F-area shafts on either side of E8 to avoid placing spoils in a floodplain. Alternatively, spoils may be removed from the E8 shaft, with placement immediately outside the floodplain. The number and configuration of spoils placements will vary, depending on volume and site-specific topography and local drainage patterns.

4.1.2.2 Experimental Halls, Linac, LEB, and MEB

In the design as presented here, the structures for the Linac, LEB, MEB, and four to six experimental halls would all be built in temporary excavations that would then be covered with backfill. Excavated materials not used for backfilling would be placed and graded in the vicinity of the structures so as to create visually attractive landscaping and screening. The methodology used to design and implement the landscaping would be the same as was described for service shafts above.

Experimental halls 1-4 would be in areas of flat to gently rolling topography in the west campus; halls 5-8 would be in areas of rolling topography and broad, incised creek bottoms in the east campus. Table 4.1 lists the estimated uncompacted volumes of spoils material (excluding material used as backfill) produced during excavation of the interaction halls.

Spoils from the west campus halls would consist of 1,184,000 yd^3 of Austin chalk and 32,000 yd^3 of Eagle Ford shale. Excavation for east campus halls (IR5 and IR8) would yield 129,000 yd^3 of chalk and 1,635,000 yd^3 of Taylor marl spoils.

The Linac, LEB, and MEB would be located in areas of flat to gently rolling topography. Table 4.2 lists volumes of spoils for these structures, plus the HEB and the injector shafts. (Although the HEB would not be constructed by cut and cover, construction of the facility would produce spoils that would have to be placed in the vicinity of these other structures.)

The actual contouring and placement of the spoils would be compatible with existing natural landforms. Slopes would be of a gentle character, similar to those in the immediate area of spoils placement. Average depth of spoils may range from 2 to 3 ft to 6 to 8 ft and would raise the natural contour rather than introducing berms of an artificial, man-made character.

Of the 7,376 acres in the west complex (which would include the above structures and experimental halls 1-4, as well as the campus discussed below), approximately 550 acres would be affected by spoils placement, and 160 acres would be used for cooling pond development. Several floodplains are located in the proposed area for the east

TABLE 4.1 Estimated Volumes of Loose Spoils Material from Experimental Hall Excavations

Experimental Hall	Loose Spoils Material (yd^3)[a] Hall Excavation	Associated Tunnel	Total
West area			
IR1	461,000	62,000	461,000[b]
IR2 (future)	94,000	0	156,000[c]
IR3 (future)	95,000	0	157,000[c]
IR4	442,000	62,000	442,000[b]
Subtotal	1,092,000	124,000	1,216,000
East area			
IR5	848,000	61,000	909,000[b]
IR6 (future)	848,000	0	848,000[b]
IR7 (future)	794,000	0	794,000[b]
IR8	794,000	61,000	855,000[b]
Subtotal	3,284,000	122,000	3,406,000

[a]Excludes volumes used for backfill.

[b]Cut-and-cover excavation.

[c]Cavern excavation.

Source: SSCL 1989.

complex (which includes experimental halls 5-8); spoils-placement plans would be developed to avoid impacts on floodplains.

Because of the planned approach -- emplacement of relatively thin layers of spoils shaped to be similar to existing topographic forms -- the impact on topography from spoils landscaping near the experimental halls and injector structures is expected to be negligible. Placement of spoils above existing utilities will be avoided.

4.1.2.3 West Campus Area Grading

Grading for campus structures will need to accommodate a broad wash (with intermittent flow) that has incised the campus area to a depth of about 50 ft beneath the general level of the prairie. Surface grades are low enough that topographic changes at the structures can be kept to a minimum by careful layout. The development within the wash would maintain existing drainage patterns; however, there is a need for drainage improvement and water detention because of the potential increased volumes of runoff

associated with the development of the west complex and associated cooling ponds (SSCL 1990). The development of the cooling water pond and drainage system would follow the existing drainage pattern relative to existing contours. Portions of the water-retention ponds would have to be excavated to provide an adequate depth for improved water quality. The pond forms would have a very natural appearance to blend with the existing topography.

Because of the approach being used -- working with existing drainage patterns to create a landscape that would blend with natural topography -- the impact to topography from campus drainage is expected to be negligible.

TABLE 4.2 Loose Spoils Material from Injector and Collider Structure Excavations

Structure	Loose Spoils Material (yd^3)[a]
Injector	
Linac[b]	29,000
LEB[c]	35,000
MEB[c]	237,000
HEB[c]	424,000
Shafts	15,000
Subtotal	740,000
Collider	3,438,000

[a]Injector spoils from these excavations will include 347,000 yd^3 of Austin chalk, 358,000 yd^3 of Eagle Ford shale, and 15,000 yd^3 of Austin chalk from injector shafts.

[b]With associated transfer tunnels.

[c]With associated transfer tunnels and transfer hall.

Source: SSCL 1990.

4.1.3 Rock and Earthen Materials

Up to 11 million yd^3 of rock and earthen material may be excavated from the collider tunnel, access shafts, booster and injector tunnels, and experimental halls. Excluding material used to backfill cut-and-cover excavations, this would result in 8.8 million yd^3 of loose material that would be placed as landscaped spoils. The spoils material would include 3.6 million yd^3 of Austin chalk, 4.5 million yd^3 of Taylor marl, and 0.7 million yd^3 of Eagle Ford shale. Samples of the three rock types collected from outcrops were tested to assess their potential to produce deleterious leachate when placed as landscaped spoils. Detailed descriptions of the laboratory leachate studies are reported by Werner (1989). The results of the leachate tests are discussed in Section 4.2.3.4.

4.1.4 Economic Geological Resources

The consequences with respect to economic geologic resources are described in the DEIS (Vol. IV, Appendix 6, Section 6.3.7.3).

4.1.5 Cumulative Impacts

The planned approach to placement and distribution of soils and spoils over 1,400 acres will result in minimal disruption of the existing topography.

4.1.6 Mitigative Measures

The on-site placement of excavation spoils as landscaping materials is a measure intended to mitigate the potential impacts that might occur if the material were disposed of off-site, as was described in the EIS. Potential impacts of off-site disposal included increased traffic, increased fugitive dust, and increased traffic noise and exhaust, all of which would be greatly reduced or avoided by on-site placement.

The topographic impacts of on-site disposal are planned to be mitigated by contouring and landscaping the spoils placements to blend into the existing and surrounding topography.

The available data indicate no impacts because of deleterious leachate from spoils placements. However, since the rock materials vary in composition from place to place, further testing of leachability will be conducted during excavation of the Eagle Ford shale (SSCL 1990). Potentially, spoils of different rock types at each source could be blended to reduce leachability (e.g., chalk spoils could be blended with the other rock types to help buffer the acidity of rainwater, thereby decreasing its ability to leach the rocks). Liners or leachate-collection systems could be used where spoils blending is not a practical alternative.

4.2 WATER RESOURCES

4.2.1 Technical Approach and Methodology

The purpose of water resources assessment is to identify and evaluate potential impacts to surface water and groundwater resources from construction and operation of the SSC. The scope of the assessment includes the following: (1) identify potential impacts and assess their magnitudes; (2) identify and evaluate planned impact-mitigation measures; and (3) assess the significance of the residual impacts after the implementation of the planned mitigation measures.

Potential impacts are defined as project-induced changes to the existing environment and projected future trends without the SSC project. As an example, to assess impacts on water use, the SSC water requirements are compared with the current system capacity and the future trend in water supply and demand in the affected region.

4.2.1.1 Surface Water

The construction and operation of the SSC could affect surface runoff and streamflow, floodplains, wetlands, erosion and sedimentation, water quality, and water

use. Detailed descriptions of the methodology used to assess potential surface water impacts of the SSC project are presented in the FEIS (Vol. IV, Appendix 7). The same methodology is used in this SEIS unless noted otherwise in Section 4.2.2. The technical approach used to locate and identify wetlands for this SEIS also is similar to that used for the FEIS (Vol. IV, Appendix 11, Section 11.2.2.4).

4.2.1.2 Groundwater

The groundwater resources impact assessment within this SEIS focuses on issues or impact categories that require further evaluation because of changed project design, resource requirements, or availability of additional site-specific data. These impact categories or types are as follows:

- Water level and overdraft effects from direct and indirect project groundwater use.
- Reduction in recharge to local aquifers.
- Closure of existing wells near SSC facilities or tunnel alignment.
- Ground subsidence due to direct and indirect project groundwater withdrawal.

Standard good construction practices and further possible site-specific mitigation for each impact are then identified and discussed. Impacts may be characterized as short-term, long-term, or irreversible. Impact mitigations are construction or operation activities, procedures, or methods that would reduce the magnitude of project impacts.

Detailed descriptions of the methodology used to assess potential impacts on groundwater are presented in the FEIS (Vol. IV, Appendix 7). The same methodology is used in this SEIS.

4.2.2 Impacts on Surface Water Hydrology and Quality

4.2.2.1 Surface Runoff and Streamflow

Surface runoff and streamflow could be affected by vegetation clearing, grading, excavating, and heavy equipment movement associated with construction of the SSC. About 3,400 acres of land would be subject to such disturbance during construction (Table 4.3). The largest concentrated disturbed areas would be at the west campus (1,920 acres) and the east campus (300 acres). Most of the disturbed area in the west campus would be in the watershed of an unnamed tributary to Chambers Creek, which has a total drainage area of about 6 mi^2. The disturbed area would constitute about 50% of the watershed.

Most of the disturbed area in the east campus would be in the Grove Creek basin, which has a relatively large drainage area of 38 mi^2 at the tunnel crossing. The disturbed area would constitute about 1% of the watershed.

The remaining areas of disturbance would be at the 18 service areas. Areas of disturbance at these locations would range from 45 to 49 acres (Table 4.3). Disturbance due to road construction would be dispersed throughout the project area as shown in Figure 2.12. The potential impacts on surface runoff and flood magnitude would be much smaller at these locations.

Increases in runoff and streamflow will be mitigated by the following measures: (1) scheduling construction activities to reduce the size of disturbed areas at any time; (2) installing temporary drainage ditches to divert runoff from disturbed areas to detention basins; and (3) restoring disturbed areas to desired topography and establishing vegetation as soon as possible. The detention basins will be designed to reduce streamflow and flood magnitudes to preconstruction levels. Excavations for cooling ponds will be used as runoff and sediment control basins if design and construction schedules permit. If this option is not possible, sediment-control basins adequate to control runoff and sedimentation will be constructed at appropriate locations. With implementation of proper impact mitigation measures, the construction impact should be insignificant. Runoff-detention basins also will be used to mitigate increases in runoff and streamflow during the operational phase.

TABLE 4.3 Sizes of Disturbed Areas during Construction

Site	Disturbed Area (acres)
West campus	1,920[a]
East campus	300[a]
E1	45
E2	49
E3	45
E4	45
E5	48
E6	48
E7	48
E8	48
E9	47
E10	45
F1	45
F2	45
F3	45
F4	48
F6	45
F7	45
F8	45
F9	45
Off-site areas[b]	367
Total	3,418

[a]Includes buildings, utilities, and roads.

[b]Includes utilities and roads.

4.2.2.2 Floodplains

As discussed in Section 3.2.1.2, flooding has been common in the Chambers Creek and Red Oak Creek basins. Although no quantitative information is available, flash

flooding is also a potential danger. One indication of the potential for flash flooding is the occurrence of zero or low flows for long periods in relatively large drainage basins.

Given the technically optimum placement of surface facilities in relation to the tunnel footprint, service areas F2, F6, E8, and E10 would potentially affect the floodplain, and some surface facilities would be subject to flooding during the 100-year or larger flood. However, where practicable, the buildings and vertical access shafts to the tunnel would be located outside of the 100-year floodplain to mitigate most of the potential impacts. During the design stage, more detailed and complete flood studies will be performed for the above four service areas to minimize impacts on the floodplain and the potential danger of flash flooding.

Without relocation, part of service area F2 would be in the floodplain of Long Branch (a tributary to Waxahachie Creek) and one of its tributaries (Figure 4.1). Part of service area F6 would be in the floodplain of Mustang Creek and one small unnamed tributary (drainage area of less than 1 mi^2) at the upstream part of Bardwell Lake (Figure 4.2). Service area E8 would be located at the confluence of Big Onion and Little Onion creeks, which form Onion Creek at E8 (Figure 4.3). The total drainage area of the two creeks at the confluence is about 39 mi^2. The floodplain is about 2,400 ft wide. Service area E10 would encroach on the floodplain of Baker Branch, a tributary of Chambers Creek (Figure 4.4). Baker Branch at E10 has a drainage area of about 3.5 mi^2 and a 100-year floodplain 200 ft wide.

The SSCL has proposed to locate the shafts and buildings at service areas F2, F6, and E10 outside the 100-year floodplain delineated on the Federal Emergency Management Agency flood hazard maps (Figures 4.1 to 4.4). Cooling ponds at these service areas also will be located outside of the floodplain. Surface facilities at E8 will also be adjusted; however, the expanse of the floodplain around E8 necessitates further engineering study to define the option having the least environmental impact. The level of this effort is beyond the scope of the conceptual planning effort and will be conducted by the selected architect-engineer for the project. Five possible shaft locations for E8 are shown in Figure 4.3. The preferred location for placing the shaft site outside the floodplain is option 1.

The floodplain maps for the four service areas were approximated and, in the case of F2, do not completely cover the stream segments in the service area (Federal Emergency Management Agency 1987). As stated earlier, more detailed and complete flood studies will be performed for these service areas for facility siting and impact mitigation.

Approximate 100-year floodplains in the west and east campuses also have been identified by Federal Emergency Management Agency (1987). The locations for SSC surface facilities at the campuses are more flexible than for the service areas, and these facilities will be located away from the identified floodplains.

The most effective mitigation option for floodplain impact is to locate the facilities outside the identified floodplain. With the implementation of the proposed plan to locate most surface facilities to avoid floodplain encroachment, the only potentially unavoidable impact is at service area E8. Service area E8, in its optimal location, would be in the broad floodplain formed by the confluence of Big and Little Onion creeks

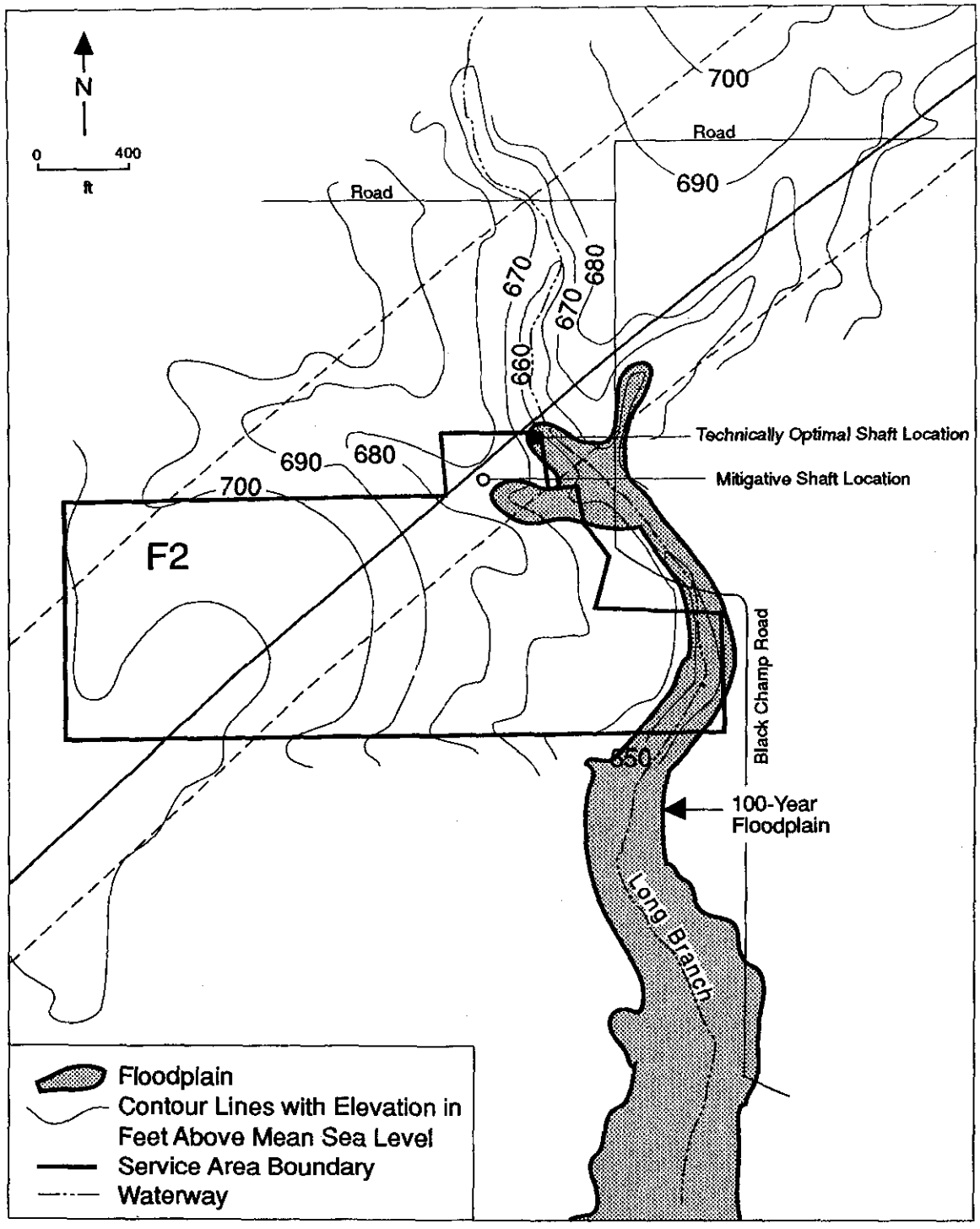

FIGURE 4.1 Location of Service Area F2 Relative to Floodplains

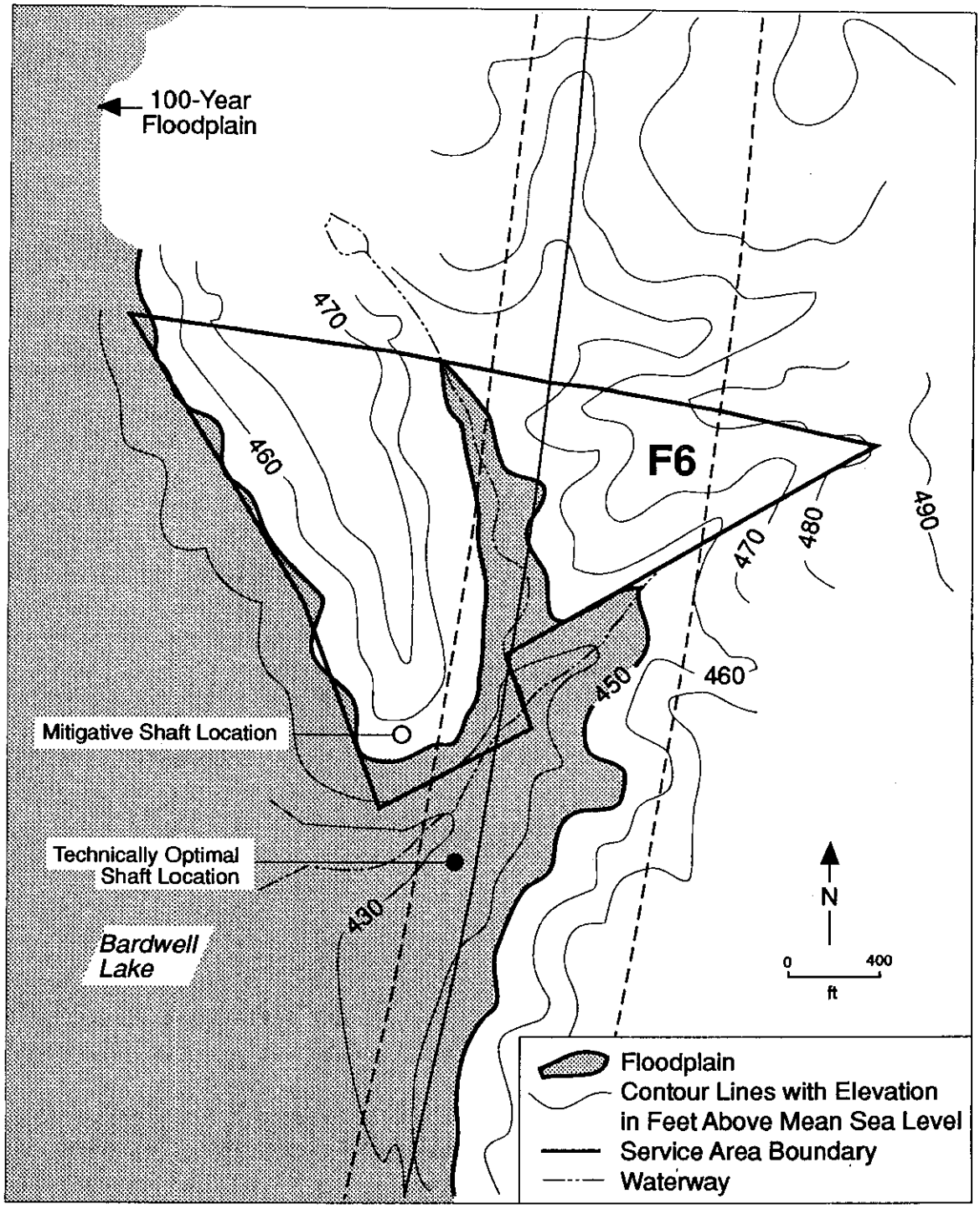

FIGURE 4.2 Location of Service Area F6 Relative to Floodplains

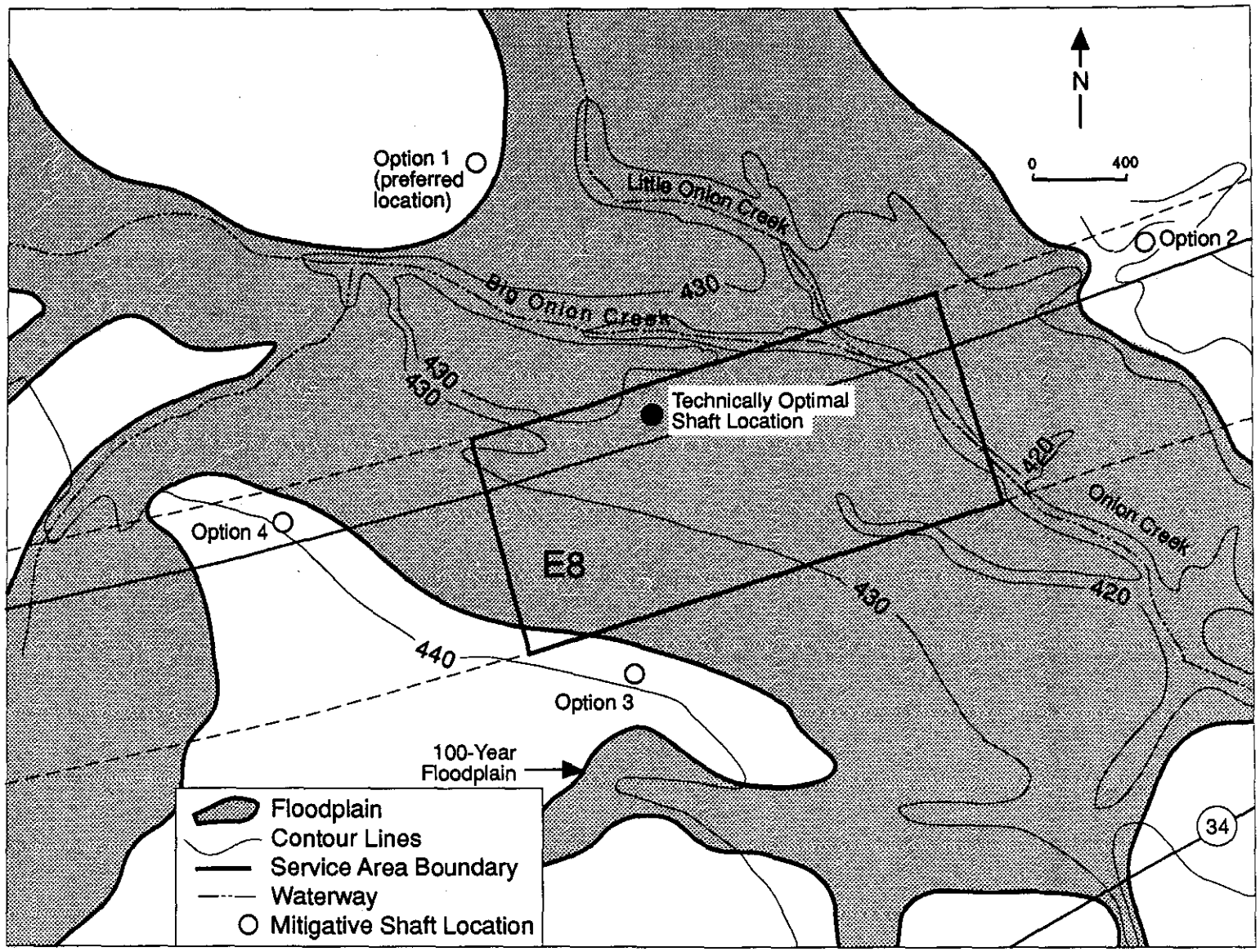

FIGURE 4.3 Location of Service Area E8 Relative to Floodplains

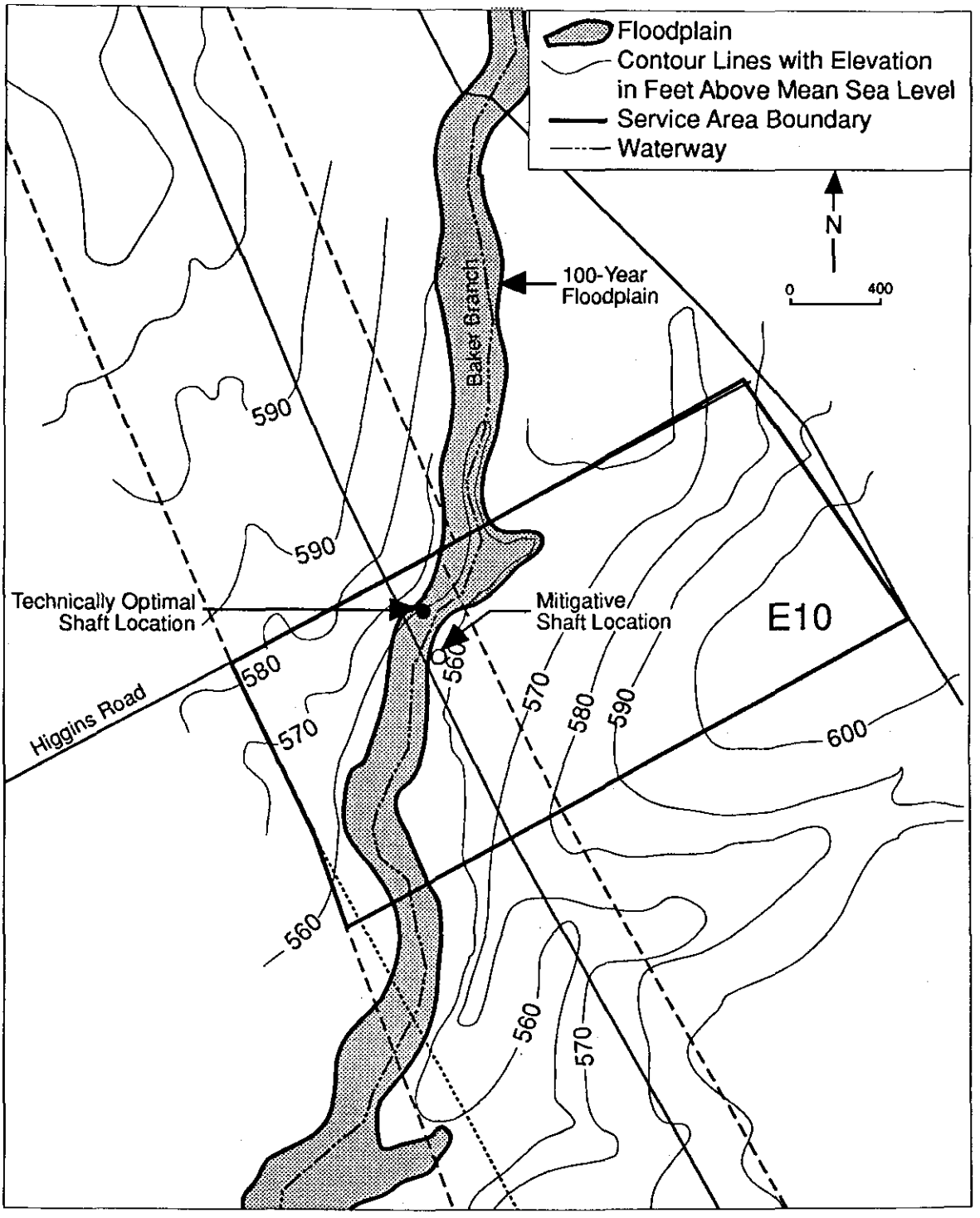

FIGURE 4.4 Location of Service Area E10 Relative to Floodplains

(Figure 4.3). Construction of a shaft and support facilities at this location would require filling a small portion of the floodplain to raise the facilities above flood levels. As discussed in Section 2.2.1, five alternative locations for this shaft and service area are being considered. Under all alternatives, impacts to the floodplain would be minimized by placing excavated tunnel spoils outside the floodplain. Initial discussion with the Fort Worth District of the U.S. Army Corps of Engineers indicates that, even if shaft E8 and support buildings are constructed within the floodplain, there will be minimal impact as far as upstream or downstream flood potential. Formal consultation with the Corps will precede selection of the preferred placement alternative and any required mitigative measures.

4.2.2.3 Wetlands

Realignment and acreage modifications of the surface facility sites have increased the number and acreage of wetlands contained within fee simple areas (i.e., 77 wetlands comprising 271 acres versus 12 wetlands comprising 40 acres for the alignment analyzed in the FEIS). The locations of these wetlands are shown in Figures 3.6a-m. However, this difference would not greatly alter the impacts to wetlands as discussed in the FEIS (Vol. IV, Appendix 11, Section 11.3.7.3). Of the 76 wetlands occurring on fee simple areas, only 12 will be impacted. A conservative assessment of the potential impacts to wetlands would be: (1) isolated wetlands (i.e., palustrine open water and emergent wetlands) -- 10 wetlands totaling 14 acres, and (2) forested wetlands -- 2 wetlands totaling 7 acres. However, as previously discussed, the estimate for the forested wetlands is very conservative. Mitigation through avoidance is likely for most of this wetland acreage. A primary consideration in the location of the surface facilities was to avoid wetlands. Specifically, construction in floodplains was to be avoided to the extent possible. Riparian habitats, which contain the highest quality wetlands in the area, occur within floodplain boundaries. Where surface facility site boundaries encompass riparian habitats, options will be explored to avoid disturbance of these areas. Thus, direct impacts to riverine and palustrine wetlands that occur within riparian habitats will be minimized. As with the original design, however, construction under the current plans would eliminate several palustrine open water and palustrine emergent wetlands (mostly livestock watering ponds or flood-retention basins).

Impacts to riparian habitats would result primarily from facility structure and cooling pond construction, shaft excavation, and spoils disposal. Minor sedimentation impacts from construction runoff from upland areas adjacent to such wetlands could also occur. These should mostly be minimized by the application of mitigative measures (Section 4.3.8). Also, most sites are flat or have only minor slopes, so runoff would not be a major concern. Riparian habitats occur within both campus sites and at F1, E8, and E10. Minor amounts of riparian habitats also occur just within the boundaries of F2 and F9.

Of the 12 acres of riparian habitat occurring at F1, no more than 3 acres would be impacted by facility construction. This result is based on F1 encompassing 54 acres, the riparian area comprising 12 acres, and construction disturbing 45 acres. Complete avoidance of this habitat is possible, as discussed later in this section.

Service area E8 contains 1 acre of riverine wetland and about 32 acres of riparian habitat. A maximum of 20 acres of this site will be disturbed by construction, as spoils will be removed and disposed of out of the floodplain. Most construction disturbance can be limited to agricultural land. Nevertheless, without some siting adjustment, at least 5 acres of riparian habitat would be affected. This result is based on E8 encompassing 48 acres, riparian habitat and riverine wetlands comprising 33 acres, and agricultural lands comprising the remaining 15 acres.

The four alternative sites being considered for E8 are referred to as E8a through E8d, as shown in Figures 3.6j and 3.6k. Option E8a is the only option that contains identified wetlands and riparian areas. (The latter areas are not identified as wetlands on the U.S. Fish and Wildlife national wetland inventory maps.) It contains 1 acre of isolated wetland (stock pond), 2 acres of riverine wetlands (Big Onion Creek), and 24 acres of riparian habitat along the south side of the creek.

No impacts to the forested and riverine wetlands associated with Bone Branch and Grove Creek in the east campus are anticipated. A riparian area associated with a tributary of South Prong Creek occurs in close proximity to a proposed shaft for the HEB. However, the shaft will be shifted 200-300 ft to the west to avoid impacts to this riparian habitat.

Several of the isolated wetlands (e.g., stock watering ponds) would be impacted by cooling pond construction or other surface disturbances. Of the nine wetlands that occur at the service area sites (Section 3.2.1.3), only the one in E5 and, possibly, one of the three in F6 (two acres total) would be expected to be incorporated into the cooling pond systems or filled with spoils. Thirty-three isolated wetlands occur at the east campus and 16 at the west campus. Given the locations of facilities and cooling ponds for the west campus (Figure 2.3), only four of these wetlands (4 acres) would likely be impacted. Similarly, given the locations for the east campus facilities (Figure 2.14), only four isolated wetlands (8 acres) would likely be impacted. One of these wetlands is approximately 5 acres in size, but only about 2 acres fall within the boundaries of the facility (northeast IR area). This wetland could probably be incorporated into the cooling pond for the facility.

The remaining 41 isolated wetlands (55 acres) will be left undisturbed. Generally, most of the isolated wetlands are moderately degraded from grazing and soil erosion and were not optimally designed as wildlife habitat. Thus, impacts to 10 of these wetlands (14 acres) would not constitute a critical loss of wildlife habitat. Those left undisturbed by SSC construction may experience a general increase in value as wildlife habitat, once impacts associated with agricultural practices end. These wetlands could also be enhanced as part of the wetland compensation program or as a means to improve the natural quality of the campus areas.

It is DOE policy (10 CFR 1022) to avoid impacts to wetlands to the maximum extent practicable, in compliance with Section 404 of the Clean Water Act and Executive Order 11990 (Protection of Wetlands). The U.S. Fish and Wildlife Service has made several recommendations both to limit potential impacts to riparian areas and to improve the quality of the wetlands that would be unaffected or created by construction (Short 1990a). The DOE will consider the U.S. Fish and Wildlife Service's suggestions in its

ultimate design of the following fee simple areas: (1) F1 -- use adjacent land for spoils disposal, rather than using riparian area; (2) E2 -- impound low area to flood trees and let them die naturally; (3) F2 -- avoid making the cooling pond system attractive to waterfowl (an existing transmission line could cause a number of potential bird strikes); (4) F6 -- similar to E2 and also try to retain as large a tree stand as possible; (5) E7 -- direct overflow from cooling pond into floodplain area; (6) E8 -- similar to F6; (7) E10 -- avoid impacting Baker Branch (or its tributary); and (8) IR1 access shaft location -- similar to F1.

Where wetland avoidance is not practicable, some form of wetland compensation will be required. Such compensation could involve wetland creation or enhancement, or both. Interagency cooperation with the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency (EPA), and the U.S. Fish and Wildlife Service has been initiated so that wildlife concerns will be considered an integral part of site development. To be included is any wetland compensation required for the isolated wetlands and riparian areas that may be impacted.

The thermal characteristics of the cooling ponds to be constructed at the service area and campus sites are described in Section 2.2.1.1. These cooling ponds will be of only minimal value to biota because of their excessive temperatures (Section 4.3.3). Therefore, the more than 260 acres of cooling ponds will not be considered toward fulfilling wetland compensation requirements.

Additional ponds can be constructed at a number of service area and campus sites to function as wetland habitat. Figure 4.5 shows a conceptual design for such ponds. The example shown adjoins the cooling pond, but is physically and thermally separated from it by a dam with a closable drain pipe. Similar wetland ponds could be constructed apart from the cooling ponds, especially at the campus sites.

Figure 4.5 shows an example of a two-tiered design; that is, it has two interconnected ponds. Major features of this design are as follows: (1) moderately large size (4-7 acres) as compared with most ponds in the area, which are smaller than one acres; (2) deep holes that would provide protection for fish during hot weather or periods of low water levels; (3) irregular shorelines; (4) rocky and vegetated shallows; and (5) means of drawing down most of the water in the smaller pond section to allow rushes and grasses to grow. The smaller pond section should remain flooded from October to April when migratory waterfowl are in the area, and then drawn down during the other months to allow the shallows to vegetate.

Creation of these wetlands would provide excellent habitat for aquatic biota and wildlife such as waterfowl (Sections 4.3.2 and 4.3.3). Both campus areas would be ideally suited for such ponds because of the expanse of open lands that would be available. Any of the following service area sites would lend itself to creation of such ponds: E3, E4, F4, E5, E6, E7, F7, F8, E9, and F9. The other service areas are less suitable because of their closeness to major roads, residential areas, or transmission lines; the presence of riparian areas or other habitats that should not be impacted; and their close proximity to other ponds. The last reason is included because initial efforts should concentrate on establishing wetlands in areas where they are not as abundant.

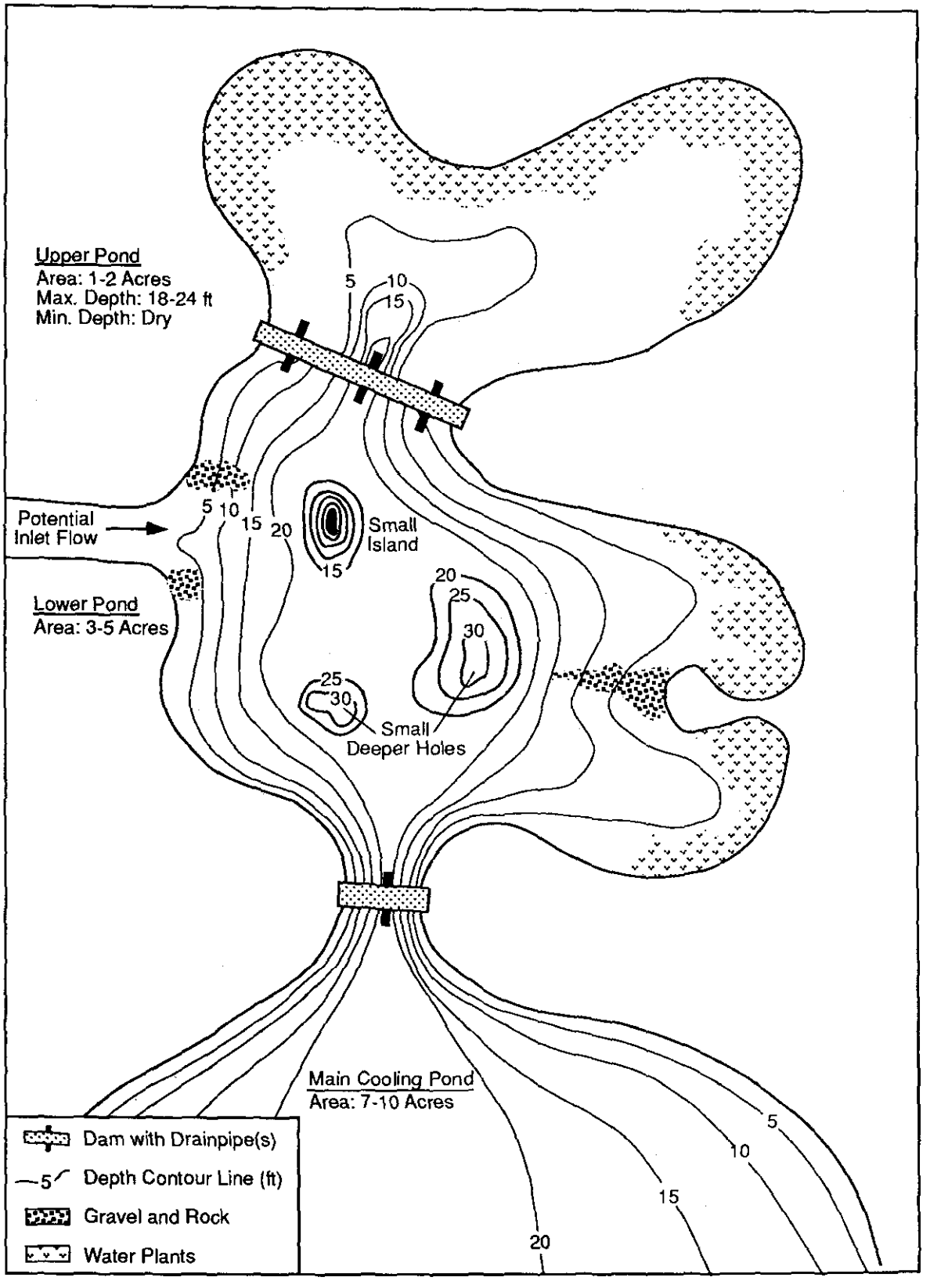

FIGURE 4.5 Conceptual Design of Wetland Mitigation Ponds

The U.S. Fish and Wildlife Service is committed to assist in development of a mitigation management plan that will include both the design and operative manipulation of wetlands (Short 1990a). In addition to the wetland ponds discussed above, small emergent wetlands could be created within low areas. Such wetlands currently exist at a number of sites, but are not identified on wetland inventory maps because of their small size (e.g., smaller than 100 ft^2). Although most are only seasonally or temporarily flooded, they provide beneficial habitat to a number of wildlife such as waterfowl and amphibians.

Disturbance to riparian wetlands along streams can be compensated for in several ways. Following construction, streamsides can be revegetated with the same species present before construction. Depending on preconstruction conditions, comparable wetland habitats could be achieved within as short a time as a few years. Palustrine forested wetlands would more likely take several decades to be fully replaced. Unaffected riparian wetlands that occur in fee simple lands could also be enhanced. Existing wetlands that are not optimally suitable for wildlife use (e.g., areas degraded by livestock or containing plant species that do not provide significant cover or food for wildlife) could be enhanced to increase their value to wildlife.

Planned SSC project development would meet the President's adopted goal of no net loss of wetlands. Sufficient wetlands will be developed and/or enhanced to meet or exceed 150% replacement of impacted wetlands.

4.2.2.4 Erosion and Sedimentation

Surface erosion and subsequent transport and deposit of sediment in stream channels and other locations could result from the same construction activities that would affect surface runoff and streamflow, as discussed in Section 4.2.2.1. Most of the land disturbance would be in the west campus area within the watershed of an unnamed tributary to Chambers Creek. Other disturbed areas around the tunnel footprint would be smaller or dispersed.

Erosion and sedimentation will be controlled by the following mitigative measures: (1) scheduling of construction activities to reduce the number and total acreage of disturbed areas at any one time; (2) maintaining natural vegetative buffer strips between disturbed areas and surface water bodies; (3) installing temporary drainage ditches to divert runoff to sedimentation basins; (4) using runoff-retarding devices, such as hay bales, to reduce flow velocity and, consequently, erosion; (5) protecting temporary stockpiles of spoil material to minimize erosion; and (6) restoring disturbed areas to desired topography and establishing vegetation as soon as possible. Sediment will be removed as necessary from the sedimentation basins so that the basins would be ready to retain eroded material from future runoff events.

Increased runoff caused by changes to land surface characteristics or by alteration of drainage through diversions could induce channel erosion. The potential for increased channel erosion will be minimized by using the detention basins and sediment traps described for surface erosion mitigation. The potential for channel erosion will also be mitigated by using various types of armoring material or by constructing grade-stabilizing structures in the channel. Armoring material includes concrete lining, rock

riprap, gabions, and felt material. Grade-stabilizing structures will be used, where appropriate, to reduce channel slopes to reduce the flow velocity to nonerosive magnitudes. The existing incised wash in the west campus area (Section 4.1.2.3) will be stabilized with armoring and grade-stabilizing structures to prevent additional erosion and eventually reduce the extent of erosion.

In the operational phase, SSC-related surface erosion should be insignificant because disturbed areas will be revegetated and landscaped after construction, according to the proposed plan. Channel erosion during the operational phase could be caused by long-term changes in runoff characteristics of the watersheds. Only the campus area would have a significant amount of impervious surface present. With implementation of the previously mentioned measures to mitigate increases in runoff, the impact of runoff, and hence the amount of channel erosion, should be negligible. Potential problem areas will be monitored, and corrective actions will be implemented, if necessary.

4.2.2.5 Water Quality

Development will result in the presence of construction equipment, surface disturbance, potential for spills of pollutants (e.g., lubricants and fuels), increased emissions, and placement of more impermeable surfaces to accumulate pollutants for easy washoff. These potential impacts are most likely to be of concern in areas of highest disturbance where pollutants could be transported to a nearby watercourse (e.g., service areas F1, F2, E2, E3, F3, F6, and E8, and portions of the campus areas). Runoff detention basins will be used to effectively trap pollutants.

Extensive dewatering is not likely to be necessary (Section 4.2.3.1); therefore, no impacts are expected from discharge of water from the tunnel to natural channels.

Some short-term impacts to surface water quality are expected from erosion of spoil stockpiles. This potential impact will be mitigated by use of sediment traps (e.g., detention ponds and silt fences) around temporary spoil stockpiles. Potential impacts of leachate from spoil material on water quality are discussed in Section 4.2.3.4. Potential impacts on water quality from nonpoint sources will be mitigated with the measures described above to control runoff increase and surface and channel erosion.

During the construction period, sanitary wastewater will be treated with package treatment systems that result in zero discharge. In the operational phase, sanitary wastewater from the west and east campuses will be treated at their separate on-site treatment plants. The treated effluent will be reused for irrigation or other industrial uses. The total sanitary flow is estimated to be 180,000 gal/d from the west campus and 54,000 gal/d from the east campus (SSCL 1990). Because the service areas will be occupied only for brief periods during normal operation, they will be equipped as necessary with transportable sanitary facilities.

Wastewater from the cooling systems and other industrial wastewater will be treated, if required, and then discharged to lined ponds for evaporation or holding tanks for collection and disposal off site (SSCL 1990).

With implementation of the planned mitigation measures described above, no significant impact on the water quality of major streams and lakes in the project area is expected.

4.2.3 Groundwater Hydrology and Quality

The following sections discuss each of the potential groundwater impact categories for the SSC site identified and defined above. The impact assessments consider both the SSC construction and operational periods.

4.2.3.1 Water Levels and Overdraft Impact

This discussion addresses potential water level and overdraft impacts associated with direct and indirect SSC project groundwater use during construction and operations. Potential impacts from groundwater control during construction (i.e., tunnel, shafts, and buildings) and operations (i.e., tunnel) also are addressed.

Construction and operation of the SSC at the proposed Texas site would result in increased water demands locally, during both construction and operations. Estimated on- and off-site (direct and indirect) water use is summarized in Table 4.4. Construction water requirements will be provided by the contractor. If the surface water pipeline or wells drilled for operational phase water supply are completed in time, they may be used for construction. Total water use for construction would be about 360 acre-ft over a nine-year period from 1990-1998.

Use of both surface water and groundwater is proposed to meet direct SSC operation water requirements. The current water supply plan would provide all water to the west and east campuses from the Trinity River Authority/Tarrant County Water Control and Improvement District No. 1 raw water pipelines (surface water), although the local water supply district is certified to serve various project site areas. Water from individual wells completed in the Woodbine or Twin Mountains aquifers, in combination with surface water, may be used for industrial, irrigation, and fire protection supply at the eight remote sector service areas (i.e., E2, E3, E4, E5, E6, E7, E8, and E9). The average water requirement will be about 150 gal/min at E6 and 75 gal/min at the other seven service areas (SSCL 1990). If no surface water supply is implemented, groundwater would provide about 27% (1,030 acre-ft/yr) of site water requirements during SSC operations (Section 4.2.4.1). In this case, the operational water needs of the project to be supplied from groundwater represent about 14% of 1986 groundwater use in Ellis County, but less than 3% of total groundwater use of approximately 39,300 acre-ft in Dallas, Ellis, and Tarrant counties (Table 3.11). Groundwater from shallow alluvial aquifiers in the SSC project area would be considered only for use as a supplemental resource. With use of surface supplies (preferred option) at the remote sector areas, demand for groundwater will be significantly reduced.

During construction and throughout operations, indirect water use would occur in communities and rural areas in the site vicinity because of in-migration of construction and operations workers and their dependents. This estimated water use, shown in Table 4.4, varies from 255 acre-ft in 1990 to almost 1,700 acre-ft in 1993 and totals

TABLE 4.4 Estimated On- and Off-Site Water Use during SSC Construction and Operation (acre-ft/yr)

Category	Water Use by Construction Year										Water Use, Operations Period
	1	2	3	4	5	6	7	8	9	Total	
On-Site											
Construction[a]	5	39	87	88	68	46	10	10	10	363	
Operations											
Cooling makeup	-	-	-	-	-	-	-	-	-	-	3,550
Irrigation	-	-	-	-	-	-	-	-	-	-	30
Domestic water	-	-	-	-	-	-	-	-	-	-	262
Total	-	-	-	-	-	-	-	-	-	-	3,842
Off-Site[b]											
Ellis County	55	190	350	395	375	420	390	350	335	2,860	385-430
Dallas County	120	390	740	780	700	735	625	530	515	5,135	600-675
Tarrant County	60	180	345	360	310	320	260	210	210	2,255	245-275
Other nearby counties[c]	20	65	120	125	115	120	105	90	90	850	100-115
Total	255	825	1,555	1,660	1,595	1,595	1,380	1,180	1,150	11,100	1,330-1,495

[a]Includes potable water for workers and water for concrete, compaction, dust control, landscaping, access roads, spoils area, and contractor areas.

[b]Estimated domestic water use is based on population projections multiplied by a factor of 160 gal/d per capita. This factor is based on estimates provided in Solley et al. (1983) for water delivered for domestic and public use in Texas. The estimates do not include water delivered for industrial and commercial use.

[c]Includes estimates for Hill, Johnson, Kaufman, Navarro, and Rockwall counties.

Source: Schwitters 1990 (operations water use); FEIS, Vol. IV, Appendix 7 (construction water use).

more than 11,000 acre-ft for the planned nine-year construction period. Indirect water use during SSC operations is anticipated to range from 1,330 to 1,495 acre-ft/yr. During construction and operations, less than 25% of the in-migrating population is expected to settle in Ellis County. Most of the increased water use would occur in communities and rural areas in Dallas, Tarrant, and Ellis counties, where the majority of the water supply is surface water. The impacts on groundwater levels are expected to be minor and widely distributed throughout Ellis and surrounding counties.

If no surface supply is feasible, SSC wells may be required at up to eight service areas (one well into the Woodbine or Twin Mountains aquifer at areas E2, E3, E4, E5, E6, E7, E8, and E9). If groundwater is used exclusively, the projected declines in potentiometric level to SSC wells pumping either all from the Woodbine aquifer or all from the Twin Mountains aquifer are shown in Table 4.5. Pumpage of wells was simulated simultaneously so that potentiometric decline interference in the confined aquifers would be considered. As shown in Table 4.5, a pumping rate scenario was simulated for the Woodbine and Twin Mountains aquifers. Aquifer transmissivity values of 9,000 and 5,000 gal/d-ft were selected for the Twin Mountains and Woodbine aquifers, respectively. These transmissivities represent middle range values for the reported data (Table 3.8). Drawdown at the pumping wells in the Woodbine aquifer after 30 years (in the year 2020) varied between 88 and 135 ft. At one mile from the pumping centers, the drawdown varied between 55 and 70 ft. Corresponding predictions for the Twin Mountains aquifer are pumping well drawdowns between 53 and 80 ft. At one mile from the pumping well centers, the drawdown is reduced to between 34 and 46 ft.

TABLE 4.5 Projected Drawdowns in the Twin Mountains and Woodbine Aquifers in the Year 2020[a]

Well No.	Pumping Rate (gal/min)	Drawdown (ft) Twin Mountains	Drawdown (ft) Woodbine
E2	70	53	88
E3	70	55	91
E4	70	57	93
E5	70	59	97
E6	150	80	135
E7	70	58	96
E8	70	56	92
E9	70	54	89

[a]Scenario assumptions: (1) storativity value of 0.001 in all calculations; (2) transmissivity of 9,000 gal/ft-d for Twin Mountains aquifer; (3) transmissivity of 5,000 gal/ft-d for Woodbine aquifer.

The above declines in potentiometric level could potentially affect nearby wells producing from the same aquifers. The pumping rate and duration assumptions for these projections are somewhat conservative, and the actual potentiometric level declines in the two units should be less than the projected values. In addition, these drawdown predictions correspond to complete reliance on groundwater. As stated in Section 2.2.3, the surface water
106 option will be implemented where impacts to groundwater are determined to be unacceptable. This strategy is expected to reduce the need for supplemental groundwater by 25-30%. No water level effects should be observed in the shallow alluvial

aquifer, even immediately adjacent to SSC wells, because the source aquifers for the SSC are at depth and isolated from the local alluvial aquifers by significant thicknesses of confining layers of low permeability.

TABLE 4.6 Recorded Water Wells in Vicinity of Proposed SSC Supply Wells

Well No.	Number of Wells within 1 mi	Closest Well (mi)[a]
E2	3	0.25
E3	1	1
E4	2	0.6
E7	2	0.6
E8	0	1
E9	1	1

[a]SSC well locations are not set; assumed location is at point of use.

Table 4.6 lists the number of existing recorded water wells in the vicinity of proposed SSC supply wells. Pumping of proposed SSC supply wells could cause measurable effects (i.e., water level declines) to other wells within one mile. A limited number of wells are indicated; however, the table reflects only wells recorded by the state. Recording requirements have changed over time, and a number of unrecorded wells likely may exist. In addition, the records do not define the aquifer units in which the wells are completed, and only wells completed in the same unit as the SSC wells should be affected. A comprehensive inventory of wells on fee simple and stratified fee estate land will be taken during the land acquisition phase. All wells within 150 ft of the tunnel are subject to closure. In addition, the Texas Bureau of Economic Geology is developing a hydrogeological data base that will describe the characteristics, baseline conditions, and resource potential of aquifers in Ellis County. When these records are available, a complete assessment of the effects of SSC groundwater pumping on existing wells can be developed. The results of the well inventory and the hydrogeologic data base also will be used in selecting the appropriate aquifer for the SSC wells.

Available information indicates that water level and overdraft impacts from operations water withdrawals would be measurable over the long term. The groundwater required annually for SSC operations represents about 14% of 1986 groundwater use in Ellis County. Trends within the Ellis County region indicate that surface water supplies are replacing groundwater for municipal use (Table 3.10). The Woodbine and Twin Mountains aquifers are confined aquifers with relatively low transmissivities. These aquifers also are currently overdrafted regionally, as evidenced by regional declines in water levels (Section 3.2.2.1). The only effective mitigation for the water level/overdraft impact is to reduce or preclude groundwater use. Specifically, one way to reduce groundwater use is to provide service areas with an alternative surface water supply. Groundwater pumping also can be distributed between the Woodbine and Twin Mountains aquifers to reduce the impact on either one. Prior to SSC operations, a decision will be made on mitigative measures to reduce groundwater impacts.

There would be negligible water level and overdraft impact from groundwater control required for construction of building foundations, shafts, and the tunnel. The relatively thin channel alluvium and terrace deposits are the only water-bearing and

moderately permeable deposits that may require some groundwater inflow control during shaft and building construction. Few SSC facilities will be constructed within or through alluvium or terrace deposits. There would be negligible water level and overdraft impact, even if dewatering were employed. These impacts could be mitigated by employing alternative groundwater control technology such as freezing or slurry walls.

Water level and overdraft impact associated with building foundation, shaft, or tunnel construction within the Taylor marl, Austin chalk, and Eagle Ford shale stratigraphic sequence is expected to be minor. Although a small number of wells develop low yields from shallow weathered zones or isolated fractures in these units, they are basically low-permeability confining or aquitard units. Groundwater inflows would be anticipated to be very low except where isolated fractures or fault zones are encountered by construction. Previous permeability testing of these units in the project vicinity (Mason, Johnson and Assoc. 1987; Southwestern Laboratories 1987) and ongoing site characterization studies (unpublished to date) have typically yielded hydraulic conductivity values for these units of 10^{-5} to 10^{-7} cm/s or less, even at formation contacts or in fractured zones. Although apparently atypical, where permeable fractures are encountered, inflows of a few to several tens or even hundreds of gallons per minute might be encountered. As they would be infrequent, inflows should be easy to control with normal pressure-grouting techniques. Neither initial nor long-term inflow would be of a magnitude to have any water level or overdraft impact to the local groundwater system.

4.2.3.2 Recharge Reduction

Impact to groundwater recharge from SSC project construction would be negligible. Principal recharge to the regional aquifers occurs by direct precipitation and infiltration in outcrop areas of the geologic units involved (Woodbine, Paluxy, Twin Mountains), which occur 20-70 mi northwest of the site. This recharge will not be affected by the project. While there may be a component of recharge to the regional aquifers that occurs by vertical leakage through the regional confining units in Ellis County (Taylor marl, Austin chalk, and Eagle Ford shale) (Rapp 1988), this component would be very dispersed, operating over a large area. The effect of SSC construction on any regional vertical leakage, while it cannot be quantified, should be minimal.

Recharge to alluvial aquifers may be affected to a small degree. A total of four E service areas will be built on shallow alluvial or terrace deposits. Each of these may have a total of approximately eight acres of impervious cover that may reduce or preclude recharge. An estimate of annual recharge for the alluvial aquifers in Ellis County is not available. Estimated recharge rates on outcrop areas of the deep or regional aquifers to the northwest of Ellis County have been calculated to be between 0.5 and 4.5 in./yr (Rapp 1988). If the high value is assumed to be more typical of the more permeable alluvial deposits and if 32 acres of affected areas is assumed, the alluvial aquifers may lose up to 12 acre-ft of recharge per year as a result of SSC construction. This loss of recharge may be compensated for by conversion of cultivated land to prairie or landscaped area, which may increase recharge.

The impact to recharge of alluvial aquifers would continue to be negligible through project operations because minimal further construction of impervious surfaces would occur.

4.2.3.3 Closure of Existing Wells

All existing wells within a 300-ft-wide zone (i.e., within 150 ft of the centerline of the tunnel) of the tunnel footprint and within other restricted zones will have to be sealed to protect the integrity of the tunnel. State records of existing water wells indicate there are 155 wells within 2.5 mi of the centerline of the tunnel. However, the existing information is not adequate to assess specific location or the precise number of wells that may occur within areas to be purchased. The magnitude of impact (number of well closures) cannot be assessed until the field inventory of existing water well locations in the immediate vicinity of the SSC footprint is completed. All existing wells on fee simple land not used by the SSC will be decommissioned after land acquisition. Existing wells on stratified fee land will not necessarily have to be abandoned unless they fall within the 300-ft-wide zone of the tunnel footprint or could interfere with SSC facility construction or operation.

For those wells affected, the impact to water users could be partially mitigated if replacement wells or hookups to alternative water supply sources of equal or better quality are provided. The state of Texas has indicated that it will provide this mitigation.

4.2.3.4 Groundwater Quality

The septic tanks and leach fields discussed in the EIS are no longer proposed. Treatment and disposal of wastewater are discussed in Section 4.2.2.5. The only potential groundwater quality impact issue that requires further treatment is leachate generation from disposal of spoils. To evaluate potential impact of the leachate, leaching tests of rock samples from Taylor marl, Austin chalk, and Eagle Ford shale were performed. Simulated acid rainwater (comparable to typical rainwater in the region) was prepared from ASTM-grade purified water and was introduced at a rate that kept the columns undersaturated. This simulated a vadose condition, with rainwater percolating through the spoils material.

Fluid was run through the columns for about one month to allow the leachate to achieve a degree of equilibrium. During this period, the leachate was collected at six intervals and analyzed for organic and inorganic compounds and various chemical properties.

Results of the leachate analyses were compared to (1) National Primary Drinking Water Standards (NPDWS), (2) National Secondary Drinking Water Standards (NSDWS), (3) Texas Department of Health drinking water standards, (4) recommended concentrations for stock water, and (5) Texas standards for Trinity River basin surface waters. The results of the analyses are summarized below for general water quality and trace

metal components. Concentrations that exceed standards are noted. Detailed descriptions of the leaching studies are reported in Werner (1989).

General Water Quality

- Total organic carbon (TOC) ranged from 10 to 45 mg/L. The TOC concentration was initially elevated in all samples, but then decreased over time and generally stabilized by the midpoint of the test period. Organic material is a natural component of sedimentary rock. There are no water quality standards for TOC.

- Nitrite was not detected in any of the samples.

- Nitrate ranged from not detected to 50 mg/L. The NPDWS is 45 mg/L.

- Sulfate ranged from 40 to 3,000 mg/L. The NSDWS is 250 mg/L, and the Trinity River Basin standard is 40 to 175 mg/L. Sulfate declined to within NSDWS over time in all but the marl leachate.

- In all samples, the pH was elevated above that of the introduced acidified water, ranging from 7.2 to 8.2. This pH range is similar to that in the local groundwater and is within the NPDWS.

- Total dissolved solids (TDS) ranged from 150 to 4,200 mg/L. The NSDWS is 500 mg/L, and the Trinity River Basin standard is 300 to 500 mg/L. TDS decreased over time in all leachate samples and was within NSDWS in the Austin chalk leachate by the final sampling period. The TDS in the marl leachate was initially higher than that in the other leachates and remained higher throughout the experiment. Elevated TDS in the marl leachate may be a result of the high clay content of the marl.

- Alkalinity ranged from 40 to 120 mg/L throughout the experiment and did not change significantly over time. These concentrations are lower than local groundwater concentrations.

- Hardness ranged from 140 to 2,100 mg/L. Hardness decreased over time to 100-300 mg/L in all leachates, except the marl, in which it remained between 1,400 to 1,800 mg/L during the test.

- Sulfide ranged from not detected to 0.5 mg/L and fluctuated randomly over time. No sulfide was detected after the first three sampling periods of the test.

- Fluoride ranged from 0.8 to 2.0 mg/L, fluctuating randomly throughout the test. These levels are below the NPDWS for water at 58.3°F or lower, but would exceed the limits for higher temperatures. They are slightly higher than or equal to fluoride levels in groundwater.

Metals

- The following metals were not detected or were detected in trace (below quantification limits) quantities only: antimony, arsenic, beryllium, cadmium, chromium, iron, lead, and thallium.

- Barium levels ranged from 0.02 to 0.19 mg/L, all values being below the NPDWS.

- Calcium, which was analyzed for only in the first sampling period, ranged from 470 to 570 mg/L. Free calcium ions would be expected from the leaching of calcium carbonate rocks.

- Copper ranged from not detected to 0.03 mg/L. These levels are below the NSDWS.

- Mercury was detected in three samples, which ranged from 0.0004 to 0.0005 mg/L. These levels are below the NPDWS.

- Nickel appeared randomly throughout the experiment, ranging from a trace to 0.16 mg/L.

- Potassium decreased over time in all samples, ranging from 4.7 to 31 mg/L. Potassium is a common element in illite clays.

- Selenium appeared in the first two samples of the Austin chalk leachate (0.25 and 0.034 mg/L) and the first marl sample (0.01 mg/L), and was not detected thereafter. These initial concentrations were greater than or equal to the NPDWS of 0.01 mg/L.

- Sodium decreased over time in all samples. Free sodium ions would be expected from the leaching of montmorillionite clays.

- Silver was detected in one Austin chalk sample (0.02 mg/L) at levels below the NPDWS.

- Zinc was detected in six samples (trace to 0.23 mg/L) at levels below the NPDWS.

The leach tests may be a somewhat conservative indicator of potential impacts. The median particle size used in the leach tests was smaller than the particles created by tunnel boring machines. The particles therefore provided more surface area for contact, which would allow for more dissolution and thus higher concentrations of contaminants in the experimental leachate. Additionally, in the field, water may channel quickly through the rock piles and therefore pick up few contaminants.

Possible water quality impacts on the cooling ponds, streams, and lakes include increased water hardness, TDS, and sulfate, and slightly elevated TOC and fluoride levels, especially with respect to marl leachate. The magnitude of the impact would depend on the size of the body of water affected and its existing water chemistry and biota, as well as current and projected water uses. Increased acidity is not a likely problem because the carbonate rocks would have a buffering effect. The potential for impact to shallow groundwater appears to be low because leachate quality is quite similar to documented local shallow groundwater quality.

Test results do not indicate a danger of contamination of surface waters or groundwaters from metal contamination. Of all the metals tested for, only selenium exceeded its NPDWS and then only in initial (nonstabilized) samples.

Additional leaching tests will be conducted during the construction phase, and the spoil disposal areas will be monitored for leachate quality. Appropriate impact mitigation measures will be implemented, if necessary, to comply with relevant federal and state regulations.

4.2.3.5 Ground Subsidence

No subsidence related to SSC direct or indirect construction or operations groundwater withdrawals is anticipated. The large declines in water levels observed since the 1930s in both the Woodbine and Twin Mountains aquifers have not resulted in ground subsidence. Because these aquifers are relatively old and well consolidated, they are not prone to compaction as potentiometric head declines or as the formation is dewatered. Land surface subsidence is more common, and generally more severe, in young, poorly consolidated aquifers and oil reservoirs (such as those of the Gulf Coastal Plain located about 140 mi south of Ellis County). In the vicinity of Houston, groundwater withdrawals (and to a lesser extent oil production) between 1906 and 1978 resulted in widespread land surface subsidence (0.2-9 ft) (Texas Water Commission 1989). That area is the area closest to Ellis County with documented ground subsidence.

4.2.4 Water Use

4.2.4.1 Surface Water Use

Construction and operation of the SSC is not likely to adversely affect surface water availability for current and future water users in Ellis County. Water use by the SSC project will not infringe upon existing and pending water rights.

As described in Section 2.2.3, water for the west and east campuses would be supplied from Trinity River Authority/Tarrant County Water Control and Improvement District No. 1 pipelines passing through the SSC site. Water for service areas E1 and E10 would be provided by the water systems servicing the west campus. The eight other E service areas would be supplied with groundwater and surface water if needed. The F service areas would require water supply if developed for refrigeration. The water requirements for the SSC operation would total about 3,840 acre-ft/yr (3.43 million gal/d) including 2,810 acre-ft/yr (2.62 million gal/d) from surface water and up to 1,030 acre-ft/yr (0.92 million gal/d) from groundwater (SSCL 1990). The District has committed to supply 1.58 million gal/d to the SSC project (Oliver 1988), but appears to be able to supply up to 22.6 million gal/d starting in the year 2030 and up to 24.7 million gal/d starting in 2040 to new customers in Ellis County, including the SSC project (Oliver 1990). A recent study partially sponsored by the Texas Water Development Board and Trinity River Authority indicates that, with the SSC project in place, Ellis County may require new surface water supplies up to 17.3 million gal/d by 2030 (high demand scenario, but not including supply for the SSC project) (Espey, Huston & Assoc. 1989). It appears that TCWCID alone will be able to meet new future demand on surface water supply in Ellis County. Several surface water sources that have been studied could provide additional supply if needed (Espey, Huston & Assoc. 1989).

Implementation of the SSC would affect the feasibility of the Red Oak Reservoir proposed by the Rockett Water Supply Company (Horizon Environmental Service 1988). The proposed reservoir would have a firm yield of 4 million gal/d. The dam would be located just north of service area E5 (Jerry W. Lands 1987; Horizon Environmental Service 1988). On March 21, 1990, at a meeting of the Texas Water Commission, the Rockett Water Supply Corp.'s reservoir application for a water use permit was contested and remanded to a hearing examiner. Since this meeting, the Rockett Water Supply Company has taken steps to withdraw its application. Thus, the previously identified impact will no longer occur.

4.2.4.2 Groundwater Use

Impacts on current and future groundwater users are addressed in Section 4.2.3.1.

4.2.5 Cumulative Impacts

No significant cumulative impacts related to surface water hydrology and quality or to wetlands in the project vicinity have been identified. The groundwater use impact of the project is assessed in Section 4.2.3.1. The potential exists for cumulative impact on groundwater users due to the SSC project in combination with other major projects in the area. On the basis of the results of the ongoing study by the Texas Bureau of Economic Geology, mitigative measures will be adopted, as appropriate, by the DOE.

4.2.6 Mitigative Measures

4.2.6.1 Surface Water

The planned impact mitigation measures discussed along with the impact assessment in Section 4.2.2 are summarized below.

- Scheduling construction activities so as to minimize the size of disturbed areas at any given time.
- Where possible, maintaining natural vegetative buffer strips between disturbed areas and surface water bodies.
- Scheduling clearing and construction activities, when practical, so as to avoid relatively erodible soils during wet seasons.
- Collecting runoff from disturbed areas in temporary diversion ditches and diverting such runoff to sedimentation basins; using runoff-retarding devices, such as hay bales, to reduce flow velocity and erosion.
- Restoring disturbed areas to the desired topography and establishing locally adapted vegetation as soon as possible.
- Conducting detailed floodplain studies at the design stage to determine floodway and flood fringe for stream reaches where project facilities might encroach on the floodplain and locating such facilities away from the floodway where possible.
- Using effective construction scheduling to minimize drainage or channel diversion (i.e., shorten the duration and extent of diversions by accomplishing construction in smaller steps).
- Use runoff-retention ponds to lessen the impacts of land disturbance.
- Use properly sized retention structures to control runoff and sediment during construction and operation.
- Where possible, locating surface facilities outside floodplains.
- Using berms to protect construction excavation areas from runoff and erosion.
- Removing sediment from sedimentation basins at the proper time so that the basins will be ready to retain eroded material from next runoff event.

- Reducing the potential for channel erosion by using various types of armoring material or by constructing grade-stabilizing structures in the channel.

4.2.6.2 Wetlands

Several measures to mitigate impacts to wetlands have been discussed in Section 4.2.2.3. Wetland mitigation required from any dredge and fill activities would be included in any required Section 404 permits. Loss of palustrine open water and emergent wetlands (e.g., livestock watering ponds) can be partly to fully compensated for by creation of ponds similar to those described in Section 4.2.2.3. The U.S. Fish and Wildlife Service and Texas Parks and Wildlife Department will be consulted during the design phase for such ponds. Their advice will be valuable in creating ponds that will provide wetland habitat for wildlife. These agencies also will be consulted for suggestions on reclaiming or enhancing riparian habitat throughout the fee simple lands. Mitigative measures aimed at ecological resources (Section 4.3.8) also would apply to wetlands.

4.2.6.3 Groundwater

The potential mitigative measures discussed in Section 4.2.3 for mitigating impacts on groundwater are summarized below:

- Reducing groundwater use by supplying service areas with an alternative surface water supply.

- Completing some wells in the Woodbine aquifer and others in the Twin Mountains aquifer to reduce the water level impact on either aquifer.

4.3 BIOTIC RESOURCES

4.3.1 Technical Approach and Methodology

The technical approach and methodology used in this SEIS to assess potential impacts to biotic resources are similar to those used for the FEIS (Vol. IV, Appendix 11). Biotic resource assessments for the SEIS focus on (1) issues raised or that remained unresolved in the FEIS (e.g., confirmation of the absence of listed species and blackland prairies and the issue of fire ants) and (2) effects of realignment or redesign of surface facility sites on potential impacts to biota.

General information describing preferred habitats of the fish and wildlife species that occur in Ellis County was used to determine potential long-term impacts of project development. By comparing habitats that may be lost by development to habitats that may be established by reclamation, qualitative conclusions could be made on how project

development might affect each species. Potential impacts were categorized as follows: (1) an increase in available habitat, (2) no major change in available habitat and no significant occurrence of habitat in the portions of fee simple areas that would not be impacted by construction, (3) a decrease in available habitat, and (4) potential for habitat protection in fee simple areas (e.g., occurrence of habitat in fee simple areas that would not be affected for the operational life of the SSC). A fifth category, combining categories 1 and 4 above, also was used. Category 2 was assigned for instances where one aspect of a species' requirement would be decreased (e.g., general habitat), but other aspects could be increased (e.g., nesting or feeding habitat).

4.3.2 Terrestrial Biotic Resources

Impacts to terrestrial habitats and biota from construction and operation of the SSC based on current design and siting plans would be similar to impacts discussed for the original design (FEIS, Vol. I, Chapter 5, Section 5.1.5). The fee simple areas are still predominantly located within agricultural lands. Annual plantings and harvests, coupled with monoculture (one-crop) fields during the growing season, severely limit wildlife use. While not as limiting, rangeland also suppresses wildlife diversity because of impacts from livestock and human activities. Among other things, livestock minimize habitat diversity by curtailing the development of woody plants and by degrading wetlands and streams. Livestock will be removed following fee simple acquisition, thus minimizing these impacts.

Surface construction and spoils disposal would affect biota at the campus sites, service areas, access roads, and other project-related sites (e.g., utility rights-of-way). Construction impacts to wildlife would include (1) loss and alteration of habitat and (2) disturbance of individuals due to noise and human activity. All vegetation would be eliminated within construction and spoils disposal areas. Until precise engineering plans are prepared, approximate disturbance is conservatively set at 45 acres for each service area, 1,920 acres for the west campus, 300 acres for the east campus, and 367 acres for off-site roads and utilities. Most of the disturbance would occur to cultivated cropland and rangeland. Efforts will be made to avoid, to the extent practicable, riparian areas, upland woods, and other areas that are not under recent agricultural or residential use. However, complete avoidance of such habitats will not be possible.

Most wildlife will be excluded from construction sites because of habitat destruction. The only exceptions are (1) omnivores, such as skunk, raccoon, opossum, and rodents, which might search construction areas at night for edible debris left by construction workers, and (2) birds such as sparrows and starlings that are less sensitive to human annoyance. Additional displacement of wildlife from undisturbed areas adjacent to construction sites due to noise and the presence of workers and machinery can also be expected. Suitable alternative habitats, and escape pathways to those habitats, exist for displaced individuals. Removal of livestock from unaffected portions of the fee simple areas would lessen competition and interference with wildlife relocating away from areas of impact. However, animals sufficiently sensitive to noise and human presence might completely leave the area of construction activities. These animals would face stronger competitive pressures, potentially resulting in the temporary

loss of a number of individuals. Increased traffic and local disturbances could lead to increased numbers of road-killed individuals of some species. The U.S. Fish and Wildlife Service and the Texas Parks and Wildlife Department have offered to provide consultation to the SSCL prior to construction in order to avoid or minimize impacts (and optimize habitat restoration). In some cases, consultation would be a requirement. For instance, consultation with the U.S. Fish and Wildlife Service would be required to comply with the Migratory Bird Treaty Act (i.e., the U.S. Fish and Wildlife Service would advise DOE of precautions to take to protect migrating birds).

It is unlikely that construction activities would be a threat to the continued survival of any wildlife species. Most construction activities would occur on agricultural lands. Wooded habitats (especially riparian areas) and wetlands are the most highly valued wildlife habitats in the fee simple areas that could be impacted. Destruction of these habitats would be avoided to the maximum extent practicable. The U.S. Fish and Wildlife Service and Texas Parks and Wildlife Department surveyed many of the fee simple areas, and the federal agency also examined aerial photographs of all fee simple areas. A number of the areas were concluded to be of no concern relative to construction impacts to ecological resources, including: E2, F2, E3, F3, E4, F4, E5, E6, E7, F7, F8, E9, and F9. Construction impact concerns expressed for the other sites mainly pertained to protecting wooded habitat (especially riparian areas) to the maximum extent practicable (Short 1990a) (Section 4.2.2.3).

Following construction, the lands within fee simple areas would be variously developed. Buildings, equipment (e.g., tanks for cryogenic cooling), cooling ponds, and roadways would occupy portions of all surface facility sites. These areas would be essentially unavailable to wildlife for the life of the project. (See Sections 4.2.2.3 and 4.3.3 for specifics on the cooling ponds.) About 3-5 acres of each service area site would be occupied by buildings and equipment, while cooling ponds would occupy 7-10 acres. This acreage would include a freeboard area to accommodate the increased volume of water that may result from severe weather. Overall, a maximum total of 270 acres for all 18 service areas would not be suitable as wildlife habitat. There also would be about 21 acres occupied by roads required for several of these sites (E2, E5, E6, E7, E8, E9, and F4). The west campus would incur the largest preemption of habitat -- some 1,210 acres being occupied by built-up areas and roads (850 acres), experimental halls (80 acres), and the injector complex (280 acres). At the east campus, 200 acres would be occupied by built-up areas and roads (100 acres) and experimental halls (100 acres). In addition, a number of cooling ponds would be developed at the campus sites: Linac -- 7 acres, LEB -- 7 acres, MEB -- 15 acres, HEB -- 25 acres, and IH -- 7 acres at each of the four initially developed sites, for a total of 82 acres. In addition, several cooling ponds (of as yet undetermined sizes) would be associated with the office and campus buildings, and several storm drainage ponds would be constructed at the campus sites. Out of the 10,283 total acres of fee simple property, 1,783 acres (of the 3,030 acres disturbed by construction) would be precluded from wildlife use. Off-site areas (i.e., roads and utility rights-of-way) would occupy an additional 140 acres (out of the 367 acres disturbed by construction).

Although a seemingly large amount of acreage would be unavailable for wildlife, it should be mentioned that more than 260 residential tracts of land, including the

community of Boz, are included among the fee simple lands. For example, the subdivisions that make up the community of Boz occupy more than 140 acres (Smith 1990) and provide only minimal wildlife habitat.

Some portions of the campus sites, particularly those around the main buildings, would be landscaped with lawns and scattered trees. Lawn or parklike habitats are of limited use to wildlife species. Nevertheless, species adapted to suburban areas would readily inhabit or utilize these areas.

Most of the fee simple areas would be passively or actively revegetated and managed to develop them into prairie, rangeland, wetland, or wooded habitats. The last of these would be concentrated principally within riparian areas associated with streams that pass through several of the sites. However, tree plantings would be made around the cooling ponds and wetlands, and along portions of some roadways. Trees may also be planted to reduce visual impacts by screening buildings, tank farms, and other built-up surface features. Where conditions warrant, attempts would be made to establish native blackland prairie habitat by seeding with prairie species obtained from local seed sources. Until true prairie habitats are established, most of the open areas would resemble rangeland or old-field habitats that are common to the area.

The rolling topography (resulting from spoils placement) and other features (e.g., scattered trees and shrubs) that would be established at the surface facility sites should benefit wildlife. Among other attributes, such features would diversify habitats and provide visual and thermal cover.

Appendix B (Tables B.2 through B.5) lists the amphibian, reptile, bird, and mammal species that could occur in the project area. This appendix includes an indication of potential long-term project impact to each species. A total of 1,923 acres of habitat (1,783 acres within fee simple areas and 140 acres of off-site property) would be unavailable to wildlife for the life of the project (i.e., areas occupied by buildings, roads, and other features). However, because of habitat enhancement over the remaining 8,505 acres of fee simple land that is now largely disturbed by agricultural practices, few wildlife species would be adversely impacted, except during construction, as previously discussed.

Most of the 24 species of amphibians in the site vicinity (Appendix B, Table B.2) could potentially benefit from the project. This assessment is based on the fact that habitat conditions that could be established on fee simple sites could be similar to general habitat types utilized by the species. Ample habitat currently exists for most of the species in the general project area. However, for species whose habitat is currently limited in the area (e.g., eastern newt, crawfish, and frog), intervention by man would undoubtedly be required to either (1) stock individuals at a site and/or (2) conduct habitat manipulations aimed specifically at enhancing habitat for the species. The latter would be especially important for species with more specific habitat requirements. For example, without habitat manipulation, an amphibian species that is primarily found in wet meadows would be less likely to benefit from project development than would a species that can colonize any type of wetland habitat.

Of the 62 reptile species occurring in the project area (Appendix B, Table B.3), none would be expected to experience a long-term negative impact. Eight species would not be expected to experience a major change in available habitat. These species include those that inhabit large streams or rivers, cliffs, or other specialized habitats not found in fee simple areas and that would not be practical to develop as part of site reclamation. Two of the species (corn and rat snakes) would not experience a change in habitat because they can be found in almost all habitats. Habitat impact for two other species (American alligator and Mississippi map turtle) could range from no major change to an increase in available habitat. The impact would depend on ultimate development of the sites and the potential of the species to colonize the sites. Protection of existing habitat may also occur for these two species. Habitat protection may also occur for 10 other species. There is also the potential for creation or enhancement of habitats for 9 of these species. However, in the case of the poisonous or nuisance species, safety considerations would not favor active habitat enhancement. Habitat enhancement would result for the 40 other reptile species. It should be mentioned that habitat enhancement for these species (or any other vertebrate species, for that matter) does not guarantee that the number of individuals will increase in the area. For example, ample habitat currently exists for the western diamondback rattlesnake and the western massasauga. However, neither species has ever been officially reported from Ellis County. Therefore, establishing additional preferred habitat on SSC fee simple areas does not necessarily mean that the species will either be present or more prevalent.

More than 80% (193 of 232) of the bird species that inhabit the project area (permanently or seasonally) or that migrate through or sporadically occupy it (as transients or visitors) could experience long-term benefits from the SSC (Appendix B, Table B.4). Design parameters for the wetland ponds (that can be finalized through consultations with the U.S. Fish and Wildlife Service and Texas Parks and Wildlife Department) would allow water level manipulation that can provide seasonally important water for migratory waterfowl (Section 4.2.2.3). However, 35 of these species may only have existing habitat protected, rather than also realizing an increase in available habitat. Two species may not realize any protection or benefit. Of the remaining 39 bird species, habitat protection would occur for 11 species, and 28 species would probably not be impacted by the project. Many waterfowl and shorebird species would especially benefit from the wetland ponds. During the late fall and winter months, the warm waters of the cooling ponds could be mixed with the wetland ponds, making the latter especially attractive to these birds.

Bird species that would not incur any beneficial or adverse impact from the SSC are either species that are primarily associated with large reservoirs or that inhabit upland forest habitat. However, some species that do prefer large reservoirs, such as several gull and tern species, could be expected to occasionally utilize the wetland ponds. This would be most likely at a site such as F6 that is located relatively close to a reservoir. (F2 is also located close to a large reservoir. However, as discussed in Section 4.2.2.3, habitat conducive to waterfowl should not be developed at this site because of the transmission line that crosses through the site.) Limited habitat is presently available for forest-inhabiting bird species (especially, inhabitants of coniferous or mixed woods). Reclamation is not expected to greatly expand upland forest habitat, but rather would more likely attempt to replace wooded habitat that is impacted

by construction. Any tree planting that would be done would contribute primarily to forested edge, woodlot, or riparian habitat. This type of habitat would benefit a number of bird species (Appendix B, Table B.4).

Among the 41 mammal species, 37 may incur a long-term increase in available habitat, although 4 of these species may only benefit through habitat protection and 2 may receive either habitat protection or no habitat protection or enhancement (Appendix B, Table B.5). Two other species would only receive habitat protection, while two species would not be affected by the project.

Few impacts unrelated to habitat development would occur to terrestrial biota during the operational lifetime of the SSC. One potential impact not addressed in the EIS is bird collisions with windows. Collisions are likely at any structure located in any type of habitat, particularly if the building has clear, transparent, or tinted reflective panes. Annual mortality from window collisions in the United States is estimated at 98 million to 975 million birds (Klem 1990). The attractive influence of trees and ponds that would be located close to SSC buildings may influence the frequency of bird collisions by increasing bird density near windows (Klem 1989). The number of collisions could be reduced by design options such as: (1) minimizing the extent of glass on the buildings, especially tinted glass and clear panes that allow viewing through a structure; (2) complete or partial covering of windows; and/or (3) angling windows at the base to reflect ground rather than sky or aboveground habitat (Klem 1989, 1990).

The net result of the project development would be that habitat for a number of wildlife species would be protected or, more importantly, enhanced. Species that would initially colonize the reclaimed sites would consist primarily of species that are mobile or easily dispersed and that are tolerant of a wide range of environmental conditions. Once conditions moderate (e.g., vegetation is more stabilized, prey species become established), the less tolerant and less easily dispersed species would also start to colonize the sites. Size of the sites and distances to colonizer sources would also influence the rate and diversity of colonizing wildlife (Recher 1989). For instance, species with large territories or home ranges may not colonize a service area site if conditions around the site are not suitable for the species (e.g., service area site surrounded by cultivated cropland). Thus, efforts to establish natural habitats should be varied at each site. For example, prairie restoration efforts would be more advisable at sites located in agricultural areas, whereas wooded habitat would be better established at sites where there is some existing expanse of forests or woodlots adjacent to the site.

Species associated with prairies, old fields, suburbanlike habitats, shrubs, woodlots, and ponds would all benefit from the project. Species associated with riparian habitat and streams would receive some degree of habitat protection; while species associated with large reservoirs, large tracts of upland forest, or other habitats not found in the fee simple areas would be minimally affected by the project. Overall, vegetation and wetland management can provide a variety of habitats for food, shelter, and reproductive cover in an area dominated by agriculture (Short 1990b). This would account for the net benefit or protection that most vertebrate species would derive from development of the SSC.

4.3.3 Aquatic Resources

Aquatic resources associated with the streams and ponds in the area would be affected in varying degrees by construction. Several small ponds (e.g., livestock ponds, small flood retention basins) may be eliminated, and construction runoff could temporarily increase sediment loads to a number of streams. Practically all 60 ponds that occur within fee simple areas are man-made (e.g., excavated stock ponds or ponds created by impounding small streams). Section 4.2.2.3 discusses the potential for a few of these ponds to be either eliminated (e.g., filled with spoils) or modified (e.g., incorporated into the cooling pond system at the site). However, most of them (50 out of 60) may be left intact, especially those located along the outer portions of the campus boundaries or at other areas that will receive minimal development. Most of the biota inhabiting the impacted ponds would be destroyed. Individuals of semiaquatic species (e.g., amphibians) may escape impact if an overland escape route to a nearby water body is present. Other animals, such as waterfowl and mammals, that use the ponds can be expected to make use of other ponds that are numerous in the area. Figure 3.6b, which shows the wetlands in the area of the east campus, provides a good example of the abundance of such water bodies. Most of the ponds are not of high quality because of the effects of agriculture, including livestock grazing. Nevertheless, the ponds are of value to waterfowl and a number of other wildlife species. They also can support warm-water fish populations, although in many cases fish in these ponds are stunted because of overcrowding and minimal food resources.

Aquatic biota of streams could be impacted as a result of (1) habitat destruction or modification resulting from in-stream construction activities or (2) increases in turbidity and sedimentation. The severity of impacts would depend upon several factors, including season of construction, stream size, construction area and procedures, and habitat quality. Most streams located within the fee simple sites are smaller headwater streams, and many have intermittent or ephemeral flows. Such streams usually are not biologically diverse.

Additionally, detrimental effects to such streams can be more readily minimized. Construction could be timed to coincide with low- or no-flow periods in the streams. Spoils excavated from the streams or stream banks could be removed to designated spoils-disposal areas to prevent subsequent siltation. Also, banks could be stabilized with riprap or vegetation to minimize undercutting and erosion. The length of time that an area would remain affected following construction would depend primarily upon the time required for introduced silts to be removed from the natural substrates. Because only a limited area would be disturbed by construction and adequate mitigative measures would be implemented, stream recovery should be fairly rapid. Stream recovery times (i.e., the time to return to near the original biological and physical conditions that existed before construction) are often estimated to occur within a year and as fast as six weeks to a few days (Dehoney and Mancini 1984; Vinikour et al. 1988).

In addition to their potential to be directly affected by construction activities, local streams and ponds could be affected by runoff from construction areas. Effects of construction runoff can be minimized by a number of mitigative measures (Section 4.2.6.1). For the most part, the adverse impacts of construction runoff would be minor, temporary, and reversible. If deposited into aquatic systems, dust from

construction activities could have effects similar to those from construction runoff. Thus, measures will be taken to control dust from construction traffic on roadways, some of which pass near water bodies (Section 4.5.5).

Overall, construction impacts to aquatic resources would not be considered significant because: (1) critical habitats (e.g., spawning and rearing areas) for important species (e.g., recreational, commercial, or listed species) would not be impacted; and/or (2) increased sedimentation, habitat removal or modification, or potential spills (e.g., fuel) would be localized and short-term (e.g., would not be expected to extend the period of a reproduction season).

Operation of the SSC is expected to cause few impacts to stream biota in the area. Elimination of agricultural use from fee simple areas will reduce sediment inputs to some streams. However, the ephemeral or seasonal nature of flow of most stream reaches near the surface facility sites tends to limit aquatic diversity.

Development of wetland ponds (Section 4.2.2.3) will have the potential to increase the acreage and quality of standing water bodies in the area. Other than the larger area reservoirs, most standing water bodies are livestock watering ponds, small flood retention basins, or quarry ponds of varying quality. Of the 42 fish species that occur in the project area (Appendix B, Table B.1), 15 could benefit from the increase in available habitat. These 15 species are generally common to the area and are adapted to a wide variety of habitats, including ponds. The species include various sunfish, bass, and catfish that are routinely stocked in ponded waters throughout the state.

Anticipated thermal characteristics of the cooling ponds are discussed in Section 2.2.1.1. Most warm-water fish (and invertebrates) tend to avoid temperatures above 90°F and generally are adversely affected at higher temperatures (e.g., physiological stress, reproductive impairment, and death) (Carlander 1969; 1977; Wurtz and Renn 1965; Jensen et al. 1969 and references cited therein). Therefore, the cooling ponds will only provide minimal aquatic habitat. Exceptions may occur where site conditions allow a two-tiered cooling pond to be constructed (Figure 2.9). One tier would receive both groundwater input and the heated water from the cooling system outflow. The water throughout most of this tier would be fairly hot (≥ 100°F), making this tier of essentially no value of aquatic biota. The second tier, which would provide the inflow water to the cooling system, would have more temperate conditions (≥ 85°F). If temperatures in most of this tier could be maintained below 90°F, a moderate quality habitat could be provided. Design requirements (e.g., liner, riprapped shoreline, and steep slopes) would still place limitations on its usefulness to biota.

Additional constraints to biotic development in the cooling ponds would result from maintenance activities required to maintain proper functioning of the ponds. Maintenance activities would include removing undesirable materials, cleansing the bed and intakes, adding makeup water, and servicing the pump systems. If needed, algae control would probably be accomplished with triazine (2-chlor-4, 6-bis (ethylamine)-5-triazine). This chemical is used effectively at Fermilab as an algal growth inhibitor and is not considered harmful to nontargeted biota. It is also biodegradable. A five-acre pond at Fermilab requires an annual application of 480 lb of triazine. The amount of triazine needed for the cooling ponds will depend on the volume

of water and the degree of algal development at the time of treatment. Higher year-round temperatures for the SSC cooling ponds will probably necessitate an increase in the quantity of algicide.

The ponds that could be created for wetland habitat (Section 4.2.2.3) would have thermal characteristics typical of other standing-water bodies in the area. These ponds would be within the temperature limits tolerated by aquatic species common to the area. Additionally, maintenance required for the cooling ponds would probably not be necessary for the wetland ponds.

Fish development would depend on stocking except in cases where the wetland ponds are connected to streams. Ponds larger than 1 acre are suitable for multispecies management (Texas Chapter American Fisheries Society 1986). Species routinely stocked include channel catfish, largemouth bass, bluegills, redear sunfish, golden shiners, and fathead minnows. Species that should not be stocked are crappie, hybrid sunfish, carp, bullhead, and green sunfish) (Texas Chapter American Fisheries Society 1986). These species can degrade the quality of a wetland (pond) by consuming aquatic plants or stirring up bottom sediments. It could be expected that carp, bullhead, or green sunfish may be inadvertently introduced. Also, they may gain access to some ponds that have connections to other water bodies.

Habitat protection for eight fish species may occur. These would include species whose habitats include headwater streams or slow sections of streams. Such habitat types occur primarily in the campus areas, although a few of the service area sites also contain stream segments within their borders. The 19 fish species that inhabit reservoirs, large rivers, or fast-flowing streams would not be affected by project development.

In addition to fish, a number of reptile and amphibian species would benefit from the wetland ponds or the other areas where wetlands are created or enhanced. These species are listed in Appendix B, Tables B.2 and B.3. The extent and rate at which these species would colonize the ponds depends on the proximity of existing aquatic habitats. Wetland ponds surrounded by agricultural lands, especially cultivated cropland, would be least likely or slowest to develop diverse aquatic communities without intervention by man. Conversely, ponds developed near streams, existing stock and water retention ponds, or reservoirs could be expected to develop a diverse aquatic community within a short period (e.g., a few years).

4.3.4 Commercially, Recreationally, and Culturally Important Species

In the FEIS (Vol. I, Section 5.1.5.4.G), it was concluded that recreational hunting and fishing would continue to be under pressure due to ongoing urban and suburban growth of the area. Changes made in site development plans since publication of the EIS do not alter that conclusion in regards to hunting. Minor increases in the population size of white-tailed deer could be expected. Invasion of brush and woody species, as well as desertions of small farms and fewer people living in rural areas, all contribute to a population (or range) increase for deer (Gore and Reagan 1989). Similar increases in small game populations (e.g., mourning dove, rabbit, and squirrel) could be expected.

However, most localized areas where increases in individual animals might occur would probably be made off limits to hunting in order to protect SSC equipment and personnel. Therefore, while project development might benefit wildlife species, it probably would not significantly contribute to recreational hunting opportunities in the area.

The wetland ponds that would be constructed to provide wetland mitigation would have the potential to provide adequate habitat for warm-water fish (Section 4.3.3). However, it has not been decided if fishing would be allowed in the ponds, or even if the ponds would be stocked. If a decision is made to develop fish communities in the ponds, appropriate agencies or organizations in the state (e.g., Texas Chapter of the American Fisheries Society and Fish Farmers of Texas, Inc.) will be contacted to assist in development of stocking and maintenance plans for the ponds.

Passive recreational opportunities, such as bird watching and nature walks, would be greatly increased by project development. The wetland ponds would be attractive to waterfowl and a number of other wildlife species. Establishment of nature trails along streams within the campus sites would afford excellent opportunities to observe nature by both the SSC staff and the public. Reestablishment of prairie habitat over portions of the site would also increase opportunities to appreciate and view nature that are currently not afforded by cropland and rangeland that extends over most of the area.

The potential impacts associated with the red imported fire ant are discussed in Section 4.7.2.5.

4.3.5 Sensitive and Unique Terrestrial and Aquatic Communities

The importance of riparian areas to wildlife in the area remains unchanged since publication of the EIS. Realignment and design alterations of the service areas and campus sites have resulted in changes in the riparian areas that may be affected.

While design changes would move project facilities out of Chambers Creek, realignment and enlargement of the service areas would result in several of these sites being located near other riparian habitats (Section 4.2.2.3). Construction in riparian habitats will be avoided to the fullest extent practicable. What impacts to riparian habitats that may occur can be considered reversible. Reclamation and revegetation efforts will be aimed at both restoring affected areas and establishing new riparian habitat, where feasible.

Aerial photographs (and videotape) were examined and walkover and drive-by surveys of the campus sites and service areas were conducted to determine the potential presence of remnant native blackland prairie grassland habitat. No blackland prairie sites were evident, due largely to the extensive disturbance from agricultural activities at most sites. Many of the plants observed on the fee simple sites also occur at the existing prairie in Ennis. Therefore, with active management, prairie habitat could be established at several locations.

Landscaping plans at both campus sites and the service areas would be aimed primarily at establishing native vegetation. Except at areas that would receive special

treatment or landscaping (such as riparian areas, wetland ponds, areas immediately around major campus buildings, and the main entrance to the west campus) open, unused areas would be established as rangeland or prairie habitat. This would provide an opportunity for prairie restoration throughout the SSC site. Before any landscaping is undertaken, the advice and cooperation of the Soil Conservation Service and other concerned agencies and citizen groups will be sought to discuss procedures to establish and maintain blackland prairies. Soils types, drainage patterns, and other conditions would have to be considered in determining optimal sites to actively pursue establishment of prairie habitat.

4.3.6 Federal Government and State Protected Species

Realignment and acreage changes to various surface facility sites do not alter the conclusion reached in the EIS -- that no deleterious impacts to listed species would occur from construction of the SSC. Surface facilities would still be located predominantly on agricultural lands that do not provide optimal habitat for the listed species.

On the basis of walkover surveys, aerial photographs (and videotapes), and drive-bys of the sites, no breeding habitat for the black-capped vireo occurs at any of the proposed surface facility sites. The U.S. Fish and Wildlife Service has concluded that the black-capped vireo will not likely be impacted by the SSC (Short 1990b). The black-capped vireo tends to return to the same territory or one nearby each year. It would, therefore, be reasonable to assume that if the vireo occurred in the immediate area, there would have been recent records of the species. It is also unlikely that the project would provide any benefits to the species (e.g., establishment of potential breeding habitat). Considerable efforts would be required to establish and maintain the specialized habitat required by the black-capped vireo. Furthermore, habitats currently existing and those to be largely developed as a result of the SSC are conducive to brown-headed cowbirds. This species parasitizes more than 80% of all known vireo nests (Texas Natural Heritage Program 1988).

Ample habitat (dry areas, open lands with loose soil and grasses, mesquite) exists in the area for the Texas horned lizard, but minimal habitat (wooded areas in wet bottomlands) exists for the timber rattlesnake. Most construction activities would be located away from bottomlands to avoid impact to floodplains. Therefore, impacts to the timber rattlesnake are doubtful based both on the snake's rarity and the minimal amount of habitat that might be affected. Habitat suitable to the Texas horned lizard is more likely to be affected. While Texas horned lizards might be impacted during construction, an increased amount of habitat conducive to the lizard could result from project development. The Texas Parks and Wildlife Department has offered to provide consultation to the SSCL pertaining to establishment, enhancement, and preservation of wildlife habitat.

A survey conducted by the Texas Parks and Wildlife Department (Wahl 1988) determined that no habitat was present at the SSC site for the golden-cheeked warbler, which nests in relatively undisturbed stands of scattered juniper. Changes in the siting of

SSC surface facilities have not altered this conclusion. Areas containing such habitat do not occur at any of the sites that would be developed.

Survey commitments were also made for several migrant Category 2 species: Swainson's hawk, western snowy plover, mountain plover, long-billed curlew, and migrant loggerhead shrike (FEIS, Vol. IV, Appendix 11, Section 11.3.7.2.G). Habitats at currently planned surface facility sites do not differ significantly from habitats located at the originally proposed surface facility sites discussed in the EIS. These Category 2 bird species do not breed in the area of the project. Preferred habitats for the plovers (sand flats and alkali ponds for the western snowy plover and cactus deserts and high plains for the mountain plover) do not exist in the immediate project area. Ample habitat for the other species (consisting of varying types of open habitat [see Appendix B, Table B.4]) does occur in the project area. It is expected that any individuals of these species that may be present at a site when construction starts would readily relocate to surrounding areas or continue on its migration.

4.3.7 Cumulative Impacts

Construction of the SSC would result in the loss of about 1,925 acres of potential wildlife habitat because of buildings, cooling ponds, roads, and other surface facilities during the lifetime of the project. Habitat in the area is currently being lost or modified because of urban/suburban growth that is greatly expanding in the counties centered around the metropolitan Dallas area. The remaining 8,500 acres of fee simple land that is now largely agricultural land would be largely developed into prairie, rangeland, wooded, and wetland (pond) habitats. This can be viewed as a beneficial impact to the area, with good- to high-quality habitat being provided in place of marginal wildlife habitat. Proper design of SSC lands not occupied by surface structures could restore habitat that has been lost to residential, industrial, and agricultural developments.

4.3.8 Mitigative Measures

General commitments for mitigative measures made in the EIS are still applicable. Some modification of these measures would be required based on differences in site locations and acreage and on variation in habitats to be affected or created as a result of project realignment or design changes. Generally, mitigative measures undertaken to protect or minimize impacts to terrestrial systems would similarly mitigate impacts to aquatic resources. A number of mitigative measures would be incorporated into many of the permits that would be required (e.g., Section 404 permits for work in streams). In conjunction with this, agencies such as the EPA are committed to work with other key federal agencies in the Section 404 permit program in order to develop a joint mitigation policy. The contractor would have to comply with all federal, state, and local environmental laws, orders, and regulations, which function as a general form of mitigation. Furthermore, a number of regulations intended to reduce environmental impacts must be followed for such activities as use of pesticides and construction of transmission lines and roads.

The following additional mitigative measures will be implemented, as appropriate, to minimize impacts to ecological resources:

- Make minor adjustments to land boundaries as a possible environmental mitigative measure.

- Instruct the construction foreman and supervisory staff on how to recognize and protect ecologically sensitive features. The foreman or a supervisory staff member should be present to supervise all construction on, or adjacent to, wetlands, streams, riparian areas, and other habitats of significance to wildlife. In lieu of this, the services of a qualified ecologist should be secured, who should be present to advise the foreman at construction sites.

- Select staging area locations so as to avoid impacts to trees and other nonagricultural vegetation to the maximum extent practicable.

- Immediately move dredged material to designate spoils-deposit areas and avoid intentionally placing dredged materials in stream channels.

- Stabilize banks to prevent sloughing of bank material.

- Conduct in-stream activities during low- or no-flow conditions.

- Utilize sediment retention ponds, intercept ditches, and other control devices, where appropriate, to prevent discharge of construction-site runoff directly into streams or wetlands.

- Use culverts or other crossing devices to span ditches or small streams where land damage could result from erosion. Design any stream crossings required to avoid restrictive stream flow.

- Grade spoils-disposal piles to gentle slopes that blend with surrounding terrain and reduce erosion.

- Segregate and store topsoil for subsequent use in revegetating disturbed areas.

- Remove excess construction materials from construction sites and rights-of-way. Clean up affected sites as soon as each phase of work is completed. Upon completion of construction, repair damaged areas by restoring original contours (where feasible), filling ruts, reseeding, and mulching, as required. Leave sites in a condition that will facilitate natural revegetation, provide for proper drainage, and prevent erosion.

- Make every effort to minimize damage to vegetation during construction of electrical transmission lines and utility pipelines. Restrict movement of vehicles and machinery along these rights-of-way to one established path, utilizing existing access where feasible. Keep all structure sites associated with these facilities (e.g., electrical substations) to as small an area as possible.

- Use existing access where possible in preference to constructing new access, especially at stream and wetland crossings.

- At construction sites, fence off wooded stands that would not be affected by construction activities to prevent accidental damage from machinery.

- To the extent practicable, locate structures (e.g., transmission towers) far enough from streams and wetlands so that erosion and destruction of natural vegetation do not occur along their banks.

4.4 LAND RESOURCES

Three types of land resources concerns emerged as a result of the DEIS public comment process: land acquisition and relocation, land use matters, and agriculturally important soils. The FEIS addresses these issues to the extent possible given a lack of site-specific data on SSC facility location and design. In the FEIS, a commitment is made to address these issues in greater detail in the SEIS. These issues are addressed here as part of the larger analytical context provided in the DEIS.

4.4.1 Technical Approach and Methodology

A supporting technical document (Higman 1990) provides a description of research objectives and methods and a discussion of the overall analytical approach taken and the steps involved in its execution. Highlights are presented below.

The Texas National Research Laboratory Commission Land Acquisition Plan is described fully in Higman (1990). The formulation of the plan, in and of itself, represents a systematic approach to development of an accurate land information system that recognizes and overcomes the difficulties inherent in working with a cumbersome and often imprecise rural conveyancing record system (Slonaker 1989). The Land Acquisition Plan therefore constitutes part of the proposed action as well as a mitigation measure. It meets DOE land acquisition requirements as specified in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 and DOE relocation rules (Uniform Relocation Assistance and Real Property Acquisition for Federal and Federally Assisted Programs) (Chapter 5).

In this discussion, land acquisition data are taken from the most recent (May 8, 1990) Texas National Research Laboratory Commission land acquisition ownership audit

report. These data are expected to change slightly throughout the course of land acquisition as a result of new information being acquired through land surveys.

In Higman (1990), the section entitled "Affected Environment" includes discussions based on three spatially distinct levels of analysis: regional (Texas Blacklands), county (Ellis County), and site-specific (on- and off-site [adjacent] areas). Characterization of the affected environment at the first two levels of analysis is based on secondary data gathered primarily from publicly available sources. Portions of the regional-level discussions are originally written from materials orally provided at the Baylor University Regional Studies Program Symposium entitled "The Texas Blacklands: The Land, Its History, and Culture" held in April 1990. Site-specific land use descriptions are largely based on personal observations made during a field verification program conducted between December 1989 and April 1990.

Environmental impacts were evaluated at all three levels of analysis, with emphasis on each level's corresponding selective focus on land resources issues. County-level environmental impact evaluations included discussions of the impacts associated with converting farmland that is prime or unique, or of statewide or locally importance, to nonagriculturally productive uses. Data are provided as part of the requirement of the U.S. Department of Agriculture, Soil Conservation Service (SCS), to complete SCS Form AD-1006 as part of a NEPA mandate to consult and coordinate actions with both federal and state agencies.

4.4.2 Land Ownership Pattern Impacts

Ellis County land ownership patterns will change as a result of SSC development. Federal land ownership has been limited to various water storage and flood control projects, such as Lake Bardwell and Joe Pool Lake (U.S. Army Corps of Engineers) and the SCS system of dams. The SSC project will add another federal agency to the roster. The indirect impacts associated with this land transfer as manifested in the realm of public finance are discussed in Section 4.8.6 and in a supporting technical document (Higman 1990).

4.4.3 Land Use Pattern Impacts

Ellis County land use patterns will change as a result of SSC development. The fee simple estate acquisition areas will be developed in an uncharacteristic way. That is, an institutional/industrial land use, along with off-site (adjacent) land uses, will be superimposed on a backdrop of agricultural, rural residential, or mixed land use.

4.4.4 Agricultural Land Use Impacts

Ellis County agricultural land uses will change as a result of SSC development. The completed SCS Form AD-1006 (Farmland Conversion Impact Rating) is provided as Appendix 1 in Higman (1990). In the form, the DOE provided the SCS with the following acreage figures for evaluation: 10,283 acres to be converted directly for the west

campus area, east campus area, 16 service/access areas, and nine monitoring station sites; and 367 acres to be converted indirectly for infrastructure needs. This total of 10,655 acres of farmland conversion represents a 2.3% reduction in farmable land taken out of agricultural production in Ellis County. Of this total, 4,632 acres represents prime or unique farmland.

Ellis County currently has 272,497 acres of farmland classified by SCS as prime and unique, with another 106,110 acres classified as farmland of statewide importance. The SCS has calculated that the SSC project will cause: (1) a 1.7% reduction in Ellis County prime and unique farmland available for cultivation; and (2) a 1.5% reduction in Ellis County statewide and locally important farmland available for cultivation. The relative value of this farmland to be converted by the project has been assessed by the SCS and given the score of 54 points on a 100-point maximum scale. Calculations of farmland impacts in both the FEIS and the DSEIS assumed that most of the SSC fee simple parcels would be leased for cultivation. Although the leasing of farmable acreage is still an option, the current impact analysis assumes no leasing for cultivation.

127 The SSC fee simple acquisition areas have also been assessed according to 12 locational and economics-related evaluation criteria by the Ellis County Food and Agriculture Council, as represented by the following three U.S. Department of Agriculture agencies: SCS, Agricultural Stabilization and Conservation Service (ASCS), and Farmers Home Administration (FHA); and one state agency: the Texas Agricultural Extension Service. In the process, each of the four agencies consulted with its respective citizen advisory groups for input. The score assigned is 94 points on a 160-point maximum scale.

When these two scores are combined, a total rating of 148 points is produced (out of a combined maximum total of 260 points). The combined total score is less than the threshold score of 160 points, at which the SCS determines that project areas are worthy of farmland protection measures, as specified by the local SCS District Conservationist. As a result, the SCS has recommended that: "a minimal level of consideration for protection and no additional sites be evaluated," per federal guidelines [7 CFR 658.4(c)(2)].

Given the widespread local practice of crop rotation and limited agricultural agency resources, no annually mapped data are available for Ellis County that specify exactly what kinds of crops are grown in certain locations and that could have assisted with assessments of project-related impacts. However, the acreages involved suggest that the SSC project will not cause perceptible reductions in any of the major crops grown in Ellis County. By the same token, the SSC project should not affect ongoing agricultural trends manifest in Ellis County.

4.4.5 Land Use Planning Impacts

2 The west campus and 15 out of the 18 service areas, with the exception of a portion of E4, are located in unincorporated Ellis County. As a consequence, almost all of the project's on- and off-site (adjacent) land uses will be under the jurisdiction of the Ellis County Commissioners Court. The expansion of the Ellis County Commissioners

Court's land use planning control to include up to 10 mi around the SSC project is seen as an important mitigation measure designed to shape future growth and development. The Texas National Research Laboratory Commission is providing the services of a local planning consultant to aid the Ellis County Commissioners Court and Ellis County Planning Commission in the development of a comprehensive land use plan and associated land use controls.

The results of this study, along with the mechanisms legislated to implement it, should be in place before the start of major west campus construction. Thus, there should be a minimum of potentially conflicting development, such as was presented in a scenario in the EIS. These zoning ordinances will likely build on the urban planning experience of other Texas Blackland cities such as Dallas, Waco, and Austin. In addition, cooperative efforts are likely between the Ellis County Commissioners Court and other municipal planning departments (e.g., that of the city of Red Oak whose whose extraterritorial jurisdiction includes the proposed F3 site) to work toward integrating respective land use plans into a cohesive regulatory framework so that growth and development can occur in an integrated manner.

4.4.6 Facility-Specific Land Use Impacts

Table 4.7 recapitulates the land requirements data provided in Section 3.4.6. Similar data are provided from the EIS so that the original and revised project footprints can be compared. For the project as a whole, the change in footprint location has resulted in (1) a decrease in the total acreage required, (2) an increase in the number of parcels and landowners affected, and (3) a decrease in the number of required relocations. On the whole, the change in footprint has been beneficial in that various land resources impacts have been reduced.

4.4.6.1 West Campus

Land acquisition activities conducted for the west campus will directly and indirectly affect the same range of land uses, including rural residential, both with and without associated businesses; agricultural production; dairy production; livestock production; and water supply services. Direct land use impacts will result as properties are being acquired; socioeconomic impacts will emerge indirectly as relocations occur. Indirect land use impacts will result to off-site (adjacent) land uses and will be manifested in various ways, such as changes in transportation, traffic, and circulation patterns; background noise levels; and scenic and visual character. This issue is expected to be of more import on the western boundary, because of the almost continuous rural residential land use pattern, and in the vicinity of Bethel to the south, because of the location of rural residences in an area of historical and cultural importance.

West campus area land acquisition activities will need to recognize the existence of four USDA-ASCS Conservation Reserve Program 10-year contracts in effect for a total of approximately 964 acres, or 13% of the proposed west campus area. The reasons why these areas were set aside (i.e., to take highly erodible land out of production and establish a protective vegetative cover) need to be understood and factored into the

TABLE 4.7 SSC Project Original and Revised Footprint Land Acquisition Changes, by Major Project Facility Area

Estate Type	Original[a]	Revised[b]	Change
Fee Simple			
West campus			
Acreage required	5,890	7,376	+1,486
Number of parcels	213	328	+ 115
Number of landowners[c]	N/A[d]	242	N/A
Number of relocations	152	180	+ 28
Number of relocatees[d]	410.4	486	+ 75.6
East campus			
Acreage required	2,137	1,861	- 276
Number of parcels	69	92	- 23
Number of landowners[c]	N/A	52	N/A
Number of relocations	62	12	- 50
Number of relocatees[e]	167.4	32.4	- 135
Access/service areas			
Acreage required	614	1,046	+ 432
Number of parcels	36	37	+ 1
Number of landowners[c]	N/A	14	N/A
Number of relocations	10	1	- 9
Number of relocatees[e]	27	2.7	- 24.3
Stratified Fee			
Acreage required	7,929	6,270	-1,659
Number of parcels	298	804	+ 506
Number of landowners[c]	N/A	399	N/A
Number of relocations	0	0	0
Number of relocatees[e]	0	0	0
Total			
Acreage required	16,570	16,553	- 17
Number of parcels	616	1,261	+ 645
Number of landowners[c]	420	707	+ 287
Number of relocations	224	195	- 31
Number of relocatees[e]	604.8	521.1	- 83.7

[a]Data obtained from Texas Proposal.

[b]Baseline Acquisition Audit, May 8 (Texas National Research Laboratory Commission 1990).

[c]Information reported as total only in Texas Proposal.

[d]N/A = not available.

[e]Assumes an estimated 2.7 persons per household (North Central Texas Council of Governments 1989).

design process, both as a building avoidance measure and as a potential landscaping design opportunity, if plant materials are well established. In addition, the monetary value of these contracts should be factored into purchase price negotiations, as well as into any special coordination activities needed between the Texas National Research Laboratory Commission and the ASCS.

4.4.6.2 East Campus

Land acquisition activities conducted for the east campus area will directly and indirectly impact the same range of land uses, including rural residential, agricultural production, livestock production, and several utility crossings. Direct land use impacts will result as properties are acquired; socioeconomic impacts will emerge indirectly as relocations occur. Indirect land use impacts to off-site (adjacent) areas will be manifest in various ways such as changes in transportation, traffic, and circulation patterns; in background noise levels; and in scenic and visual character. Given the proximity of Palmer, the impacts should be more of an issue on the northeastern boundary.

4.4.6.3 Service Areas

Land acquisition activities conducted for the noncampus area service sites will directly and indirectly impact the same range of land uses, including rural residential, agricultural production, and livestock production (rangeland). Direct land use impacts will emerge as properties are acquired; socioeconomic impacts associated with the relocation process will occur only at F3. Indirect land use impacts to off-site (adjacent) areas will be manifest in various ways, such as in transportation, traffic, and circulation patterns; in background noise levels; and in scenic and visual character. This is particularly the case for the following four E sites: E2, E4, E5, and E10. If F sites are developed as E-site equivalents, the F2, F3, and F4 sites will also result in impacts.

4.4.6.4 Stratified Fee Areas

The collider ring tunnel will be buried to an average depth of 150 ft. Existing surface uses and activities will be allowed to continue so long as they do not penetrate the stratified fee estate purchased. Surface land use limitations could be placed on current or planned facilities (e.g., water wells), which would constitute a direct land use impact.

4.4.7 Cumulative Impacts

Siting the SSC in Ellis County places it in one of the most important natural regions in Texas. The Texas Blacklands -- vibrant and growing -- continues to be a vital part of the Texas economy.

The west and east campuses are situated in roughly the northern half of the county, which is being progressively urbanized as development moves south from Dallas.

Therefore, the project is in keeping with other types of major Dallas-Fort Worth Metroplex developments. Seen in this context, the SSC project would not appear to be a foreign element as it would be if it had been located farther to the south in the decidedly rural portion of the county. As construction occurs, it will likely be difficult to distinguish project-related indirect impacts from the impacts from other major economic developments occurring in the region. Given the wealth of housing opportunities available between Dallas and Waxahachie, the development pull will be strongest from this direction. This factor should be considered in creating a comprehensive land use plan that could be designed to encourage urban growth to the north, while leaving the southern area protected from encroaching development. As a result, valuable agricultural land could be preserved for continued productive use.

4.4.8 Mitigative Measures

Many of the land resources issues discussed above have been anticipated by either the Texas National Research Laboratory Commission or the SSCL. On-site direct land use impacts and indirect socioeconomic impacts will be mitigated under the terms and conditions of the Commission's SSC Land Acquisition Plan. Off-site (adjacent) land use impacts will be mitigated under the terms and conditions of a comprehensive land use plan and associated implementing ordinances being prepared by the Ellis County Commissioners Court. Land resources concerns related to final engineering design and the creation of a landscape plan have already been anticipated by the SSCL. Sections 4.6.5, 4.8.11, and 4.10.2, respectively, or the supporting technical documents, discuss off-site (adjacent) indirect impact mitigation measures relating to noise; socioeconomics and infrastructure; and visual resources.

4.4.9 Environmental Consequences of the No-Action Alternative

If the SSC were not built, regional growth and development would likely continue along the same course and with the same speed that is currently evident. Current trends include (1) more parcelization of land in urban and rural areas in response to increasing urbanization pressures; (2) continued development in areas progressively less suited for construction (e.g., in floodplains and terraces or on soils with a high shrink-swell potential); and (3) continued leapfrog development in the absence of a strong areawide local planning tradition.

For Ellis County, there will likely be (1) continued suburbanization in the north as developments radiate south from Dallas along the I-35 and I-45 transportation corridors and (2) continued changes in agricultural production trends to include fewer full-time farm operators, larger-acreage operating units, and larger increases in per-acre production. Although some speculative development has occurred in anticipation of the SSC project, particularly in Waxahachie, it has been relatively small scale, given that the SSCL is now located in Dallas County. Also, by the end of 1990, the SSC project will have acquired an initial amount of land. If the no-action alternative were selected, this property would be disposed of, in consultation with the state of Texas and in accordance with applicable laws and regulations.

4.5 AIR RESOURCES

This assessment of potential air quality impacts from construction and operation of the proposed SSC is intended to supplement the assessment provided in the EIS. It addresses specific issues and commitments made during EIS preparation and incorporates previously unavailable site-specific data. Five air regulatory issues form the basis for the reassessment presented here: (1) complying with public health and welfare standards for thoracic particles (PM_{10}), (2) establishing federally enforceable mitigation measures, (3) determining the need for performing an SSC clean air area industrial growth impact assessment (prevention of significant deterioration [PSD] increment consumption analysis) for total suspended particulate matter and nitrogen oxides, (4) applying the latest EPA-approved version of the Industrial Source Complex (ISC) model, and (5) complying with any applicable nonattainment provisions. In addition to the assessment conducted in response to these issues, an analysis was done to demonstrate compliance with new EPA standards for radionuclide releases from DOE facilities.

The following subsections specifically address issues one and four above with a description of the methodology used in data analysis, the estimated potential air quality impacts, and the proposed mitigation measures to address the public health and welfare standards for PM_{10} during SSC construction. Issues two, three, and five are addressed in Section 5.5. The National Emissions Standards for Hazardous Air Pollutants (NESHAPS) compliance demonstration made with AIRDOS-PC, for radionuclides, is discussed in Sections 4.5.3.

4.5.1 General Technical Approach and Methodology

Partly because of the availability of detailed site-specific data, a technical approach more refined than that used in the EIS is now possible for estimating potential SSC air quality impacts. The approach involves conducting an environmentally conservative and yet reasonable worst-case (RWC) analysis.

Thoracic particle (PM_{10}) emissions under RWC assumptions were determined by examining the concurrency, proximity, and duration of scheduled construction activities that would result in the highest PM_{10} emission rate. Primarily because of the availability of site-specific data, four other major improvements to or departures from the earlier assessment methodology were possible. In addition, for the RWC approach, it was assumed that activities were spread over the latest available construction schedule. This approach differed from the worst-case approach used in the EIS, in which peak emissions from each task were assumed to occur concurrently. Also, better information is now available on the most likely physical characteristics, numbers, and scheduled activities of most construction equipment. Better information is also available on total spoils volume and on the spoils disposal method; that is, spoils will be used in a land enhancement effort at each access and service area. The SEIS analysis focuses only on construction-generated PM_{10} emissions. Finally, control strategies developed during the SEIS analysis were studied to ensure that they were technologically and economically feasible and federally enforceable. Details of the emission inventory development methodology under the RWC approach are given in Appendix C.

4.5.2 Emission Inventory Development

The RWC construction-generated PM_{10} emissions were determined by examining all major SSC construction activities scheduled to occur over the approximately nine-year construction period (SSCL 1989; Morris 1989). The RWC days (required for the short-term impact analysis) were systematically determined by finding both contiguous and concurrently scheduled construction work.

The collider ring was divided into four major areas consisting of 10 segments labeled clockwise as west campus (WC), upper arc (A-D), east campus (EC), and lower arc (E-H) (Figure 2.2). Activities were defined as contiguous if they occurred in any of three adjacent segments. Because of the inherent uncertainties in any conceptual construction schedule, activities occurring in the same month were assumed to have a high probability of occurring on the same day, unless they were obviously consecutive subtasks. On the basis of these assumptions, the months with the highest level of construction activity were determined to be associated with periods of construction in the west campus and at service and access areas E10, F1, and F9. During this period, 10 major PM_{10} emission-generating construction activities were expected to occur in these areas. These activities are discussed in more detail in Appendix C.

To permit application of predictive emission factor equations for construction activities, the 10 major construction activities were subdivided into subtasks. For example, construction of office building No. 2 in the west campus was subdivided into seven subtasks: (1) haul topsoil in truck, (2) grade topsoil on pile, (3) haul excavated spoils in truck, (4) haul foundation concrete, (5) haul slab base material, (6) grade slab base material with bulldozer, and (7) haul slab concrete.

The emissions inventories were prepared after identification of the periods and corresponding construction activities expected to contain the RWC day for the short-term analysis and RWC year for the long-term analysis. In developing the initial emissions inventory, a baseline level of emissions control anticipated to be the most cost effective and easily achievable was assumed. Past experience with fugitive dust sources from major facility construction led to the conclusion that failing to implement dust controls would cause National Ambient Air Quality Standards (NAAQS) violations at many receptors on the SSC boundaries.

Emission rates for each source activity occurring during the RWC periods were calculated using the following equation:

$$ER = EF \times SE \times (1 - CEF)$$

where:

ER = controlled emission rate (mass/time),

EF = uncontrolled emission factor (mass/unit of source extent),

SE = source extent (units of source extent/time), and

CEF = control efficiency fraction.

The controlled emission inventories for the periods expected to contain the RWC day and year were completed first. The day and year with the highest cumulative emission rate from all sources were then selected as the RWC emission inventories, which served as input to the appropriate dispersion models.

The fugitive dust emissions generated by SSC construction were grouped into two broad types: (1) anthropogenic emissions from construction activity and (2) nonanthropogenic emissions from wind erosion of particulate matter (PM) at ground surface. Wind erosion emissions occur only when the wind velocity exceeds a threshold value, whereas anthropogenic emissions can occur whenever the surface is disturbed by human activity. Wind erosion can occur day or night, whereas anthropogenic emissions occur only during working hours. Wind erosion will occur for as long as it takes to clear the exposed surfaces of dust that can be suspended. At this point, no further erosion will occur until the surface is again disturbed by equipment. Emission sources other than wind erosion are unique in that the generation mechanism continually replenishes the surface dust layer. Because of these differences, special treatment was required for determining the RWC air quality impact from these emissions (Section 4.5.3).

Details on short-term and long-term emission inventory preparation methods, including how the variables in the emission rate equation were quantified, as well as a complete list of sources modeled, are presented in Appendix C, Section C.2. The results of the short-term and long-term PM_{10} emission inventories are contained in Appendix C, Section C.5.

Because of modifications in the SSC conceptual design (e.g., need to assess a fixed test beam target), estimates of the air activation product (AAP) source term needed revision. The source-term now consists of routine releases from five points around the collider ring, three of which are in the west campus and two of which are in the east campus. West campus releases come from the test beam area and the northwest and southwest experimental halls (IR1 and IR4). East campus releases would come from the northeast and southeast experimental halls (IR8 and IR5). Further information on source-term characterization is presented in Section 4.7.1.2. Appendix C, Section C.3, contains a complete description of the source strength assumptions and a list of AAP activities (in terms of curies of activity per year) for each radionuclide and release point.

4.5.3 Air Quality Impact Assessment

The air quality modeling analysis for this study is intended to assess construction impact on ambient PM_{10} concentration levels. The latest versions of EPA's Industrial Source Complex Long-Term (ISCLT) model (version 90008) and Industrial Source Complex Short-Term (ISCST) model (version 88348) were used to predict maximum annual and 24-hour average PM_{10} concentrations, respectively. The regulatory default options were selected in the modeling runs.

The SSC would be constructed over a period of about nine years. Analysis of the construction schedule and planned activities (Appendix C, Section C.2) indicates that RWC scenario fugitive dust emissions will occur in four SSC construction areas: the west campus area and the E10, F1, and F9 service and access areas. Source emission identification and quantification are described in Appendix C, Section C.2, and Section 4.5.3. In the models, construction-related fugitive dust emissions were treated as volume sources, whereas wind erosion emissions from aggregated soil storage piles were treated as area sources. For impact analysis, receptors were placed with 100-m spacing on the site boundary of the west campus and the service and access areas.

For short-term (daily) air quality predictions, five individual years of processed hourly meteorological data were used as input to the EPA's ISCST model. For long-term (annual) air quality predictions, meteorological joint-frequency distributions of wind speed, wind direction, and atmospheric stability for five individual years were used as input to the same model. In addition, hourly meteorological data for each year were used to determine the average ambient air temperature for each atmospheric stability class and the average mixing height for each atmospheric stability and wind speed class.

The model-predicted PM_{10} concentrations, combined with the estimated background concentrations, were used to assess the compliance status of fugitive dust emissions from construction activities with the PM_{10} NAAQS. The predicted maximum total annual mean PM_{10} concentrations from all receptors were compared with the PM_{10} NAAQS of 50 $\mu g/m^3$ for annual averages for each modeled year. The predicted *highest sixth highest** total PM_{10} concentrations from all receptors, with the background concentration value added, were compared with the PM_{10} NAAQS of 150 $\mu g/m^3$ for 24-hour averages for each modeled year. Use of the highest sixth highest concentration values predicted by the ISCST model to demonstrate compliance with the PM_{10} 24-hour standards is consistent with the EPA guidance for determining PM_{10} design concentrations for control strategy development (EPA 1987, 1990).

Use of the ISCST to model short-term air quality impacts from wind erosion was complicated by the fact that there could be up to 17 hours of wind-erosion threshold wind speeds (Category 6, >8.75 m/s) in a given day. However, wind erosion cannot be supported for all those hours because, once the limited amount of surface dust available becomes airborne, erosion can no longer occur. Wind tunnel testing has shown that the erodible material on a surface with a limited dust reservoir can easily be blown away in less than an hour. However, within a given year, the time at which the first hour of threshold wind speed occurs changes from day to day. The ISCST model cannot automatically account for these day-to-day changes or for the fact that sometimes high wind speeds produce wind erosion and sometimes they do not. To handle these complexities, short-term impacts from wind erosion and nonwind-erosion sources were run separately for each of the five years of meteorological data. The long-term impacts from wind erosion and nonwind-erosion sources could be more easily accommodated with

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*The *highest sixth highest* concentration is the calculated concentration remaining after discarding the top five ranked concentrations at each of the modeled receptor points for all five years of 24-hour concentration estimates. It is used as the design concentration for setting PM_{10} NAAQS regulatory limits (EPA 1987, 1990).

the ISCLT model. The model was structured to allow wind erosion only when wind speeds were above the threshold; thus, both source types could be modeled together.

In addition to the 15 ISC model runs (5 ISCLT and 10 ISCST) discussed above, certain modeling efforts had to be rerun to accommodate more stringent control strategies. Both ISCST and ISCLT models were run with five years (1982-1986) of Dallas-Fort Worth/Stephenville meteorological data. The results were examined to determine the first year in which construction activities would produce an impact that, in combination with the background concentration, would exceed the NAAQS. That year then served as a guide to strengthen the emission controls on the particular sources creating the problem. That particular year was then rerun to ensure that the NAAQS would be met with the new controls in place.

The sequence of modeling runs required to develop the control strategy started when the first short-term run using 1982 meteorological data indicated severe violations of standards, even though a moderate control strategy was employed. After this effort, a more stringent control strategy involving additional emission reduction at several sources was employed, thus allowing the standard to be met for 1982-1985 meteorological data.

Table 4.8 summarizes the predicted maximum (highest sixth highest) PM_{10} concentrations associated with mitigated construction activities, which are described in Section 4.5.5. The general location of these concentrations, the meteorological day or year of occurrence, and the total concentrations (SSC source plus background) are also provided. The largest impacts are projected to occur from construction activities in service and access areas. The highest model-predicted concentration (107.9 $\mu g/m^3$) occurred on the northern boundary of service area E10. This impact is caused primarily by wind erosion (during wind speeds exceeding 12 m/s) from storage piles. The E10 topsoil storage pile contributed more than 90% of the estimated impact. The model predicted a maximum concentration of 103.0 $\mu g/m^3$ on the southern boundary of service area E10 during nonwind-erosion conditions. Spoils hauling contributed more than 90% of the estimated impact.

Initial mitigation levels for four construction activities were identified as being too conservative and not very cost effective for achieving the PM_{10} regulatory limits. These activities were the construction of the northwest experimental hall (IR1) and the southwest experimental hall (IR4), and construction traffic on F.M. 66 and F.M. 1493. Table 4.8 shows the air quality impacts associated with both the conservative and the more cost effective mitigation levels. The initial maximum predicted impact from construction activities in the west campus was 90.4 $\mu g/m^3$. This impact was caused primarily by construction traffic on the eastern leg of F.M. 66. Less frequent vacuum sweeping (resulting in a control efficiency change from 75% to 71%) can be used to achieve NAAQS compliance. Similarly, less frequent vacuum sweeping (resulting in a control efficiency change from 50% to 25%) on F.M. 1493 can also be used to achieve the same goal.

The initial maximum predicted impact associated with construction of an SSC facility in the west campus was 81.4 $\mu g/m^3$. This impact was caused primarily by spoils hauling associated with construction of IR4 during nonwind-erosion conditions. Less

TABLE 4.8 Summary of Predicted Daily Maximum (highest sixth highest) PM_{10} Concentrations Associated with SSC Construction Activities[a]

Meteorological Data Year	Location of Receptor Site	Location Direction[b,c]	Julian Day[d]	Maximum SSC Concentration ($\mu g/m^3$)[e]	Background Concentration ($\mu g/m^3$)	Total PM_{10} Concentration ($\mu g/m^3$)
1984	E10	North	329 (WE)	107.9	41.2	149.1
1982	E10	South	295 (NWE)	103.0	41.2	144.2
1982	West campus	East-N	20 (NWE)	90.4 (103.8)	41.2	131.6 (145.0)
1982	West campus	South	295 (NWE)	81.4 (103.8)	41.2	122.6 (145.0)
1985	West campus	South	178 (WE)	74.5	41.2	115.7
1983	West campus	East-S	16 (NWE)	66.3 (103.8)	41.2	107.5 (145.0)
1986	West campus	West-C	349 (NWE)	72.8[f] (103.8)	41.2	114.0 (145.0)

[a]The NAAQS for PM_{10} is 150 $\mu g/m^3$ (24-hour).

[b]Receptors are placed on the site boundary, and their directions are determined from the center of each source site area.

[c]East-N = northern portion of east boundary; East-S = southern portion of the east boundary; and West-C = central portion of the west boundary.

[d]WE = wind-erosion day; NWE = nonwind-erosion day.

[e]Values in parentheses are projected impacts with more cost effective controls.

[f]Highest predicted concentration with greatest influence from IR1 topsoil hauling and handling.

frequent application of petroleum resins on unpaved haul roads (resulting in a control efficiency change from 90% to 86.4%) will still guarantee compliance. Similarly, control using petroleum resins can be reduced from 90% to 68.5% for topsoil hauling associated with construction of IR1. During worst-case wind erosion conditions (Julian day 359, 1983 meteorology), dust from the IR4 spoils pile contributed 59% of the predicted maximum PM_{10} concentration of 74.5 $\mu g/m^3$. Because a less conservative control efficiency for storage piles (based on relative impacts) with watering is not very cost beneficial or easily implemented (when not applied uniformly to all storage piles), all storage piles are controlled at the same level.

The predicted maximum annual impact plus background was 40.1 $\mu g/m^3$ and occurred on the northern side of access area F1. This concentration complies with the annual PM_{10} standard of 50 $\mu g/m^3$.

It can be concluded that the proposed strategy to mitigate fugitive construction dust emissions, as described in Section 4.5.3 and Appendix C, would ensure compliance with the PM_{10} health and welfare standards in Ellis County.

In addition to the summary results of the air quality impact analysis provided above for PM_{10}, a radiation exposure/risk assessment was made to demonstrate compliance with NESHAPS regulations. The public radiation exposure associated with routine releases of air activation products in the west and east campuses during SSC operation was calculated, with the AIRDOS-PC model being used to estimate dose. The computed dose (effective dose equivalent) to the maximally exposed hypothetical individual was 0.077 mrem/yr. This dose would be experienced at the east boundary of the east campus, approximately 335 m east of IR5. The calculated dose is less than 1% of the NESHAPS standard (10 mrem/yr) for DOE facilities (40 CFR Part 61, Subpart H). Further information on the modeling analysis results is presented in Appendix C, Section C.5. Section 4.7.1.3 presents the results of a more detailed assessment of individual and cumulative population risks estimated with the Clean Air Act Assessment Package (CAP-88).

4.5.4 Cumulative Impacts

Cumulative air quality impacts from SSC construction and project-related industrial and population growth are analyzed in this section. Potential impacts on soil, vegetation, and visibility from emissions of air pollutants also are discussed. Because no acceptable analytical techniques have been established to quantify such impacts, these issues are addressed qualitatively.

4.5.4.1 Construction Impact

Construction and construction-related impacts on air quality would be temporary and would consist mainly of pollutants emitted from construction equipment required for site preparation, tunneling, and facility construction, and from commuter traffic. General construction vehicles (both gasoline- and diesel-powered) and other diesel-powered engines would be used. These engines emit minor amounts of sulfur dioxide,

carbon monoxide, nitrogen dioxide, and PM. The pollutants are expected to cause small, localized, temporary increases in existing air pollutant levels that drop off rapidly with distance from the source (FEIS, Vol. IV, Appendix 8).

The amount of fugitive dust will vary from day to day and from year to year, depending on the intensity of tunneling activity and weather. The cumulative impacts on the west campus will be reduced by the location of the Magnet Support Facility Complex (MSFC) in the northern part of the campus, well separated from the IR regions. Spoils hauling associated with construction of the IR regions is expected to have a much greater impact.

Fugitive dust emissions would be noticeable during most of the scheduled construction activity, but would have their greatest impact during a relatively short portion of the scheduled construction. Dust would be generated by ground excavation, cut-and-fill operations, and other activities. The air quality modeling analyses of construction impact on ambient PM_{10} concentrations were presented above. The results of those modeling analyses support implementation of various mitigative measures to minimize fugitive dust emissions and to ensure compliance with both the long-term and short-term PM_{10} NAAQS during the construction periods.

4.5.4.2 Growth Impact

Operation of the SSC would result in relatively small industrial growth in the area. Much of the long-term growth would have a positive economic impact on nearby cities and communities.

Operation of the facility would require a maximum work force of approximately 3,900 people (Section 4.8.3). Most of the employees would reside in Ellis, Dallas, and Tarrant counties. Some of the technical staff would be recruited from throughout the country. From time to time, other scientists will visit the site for a short time to participate in various research activities. The air quality impact caused by population growth can be found in the EIS and would be in the form of additional automobile and home furnace emissions that would be dispersed over a large area and would therefore have negligible impact. No significant commercial growth in the immediate vicinity of the site is expected to be associated with construction or operation of the proposed facility, other than general commercial growth associated with the projected increased residential population (Section 4.8).

4.5.4.3 Impact on Soil and Vegetation

The operation of the SSC would result in insignificant annual sulfur dioxide and PM emissions and less than 250 tons/yr of nitrogen oxide emissions. The contribution of sulfur dioxide and nitrogen oxide emissions from the facility to long-range transport and formation of acid precipitation, if any, would be insignificant compared with the sulfur dioxide and nitrogen oxide emitted from large coal-fired power plants with tall stacks. The impacts on soils and vegetation would therefore be negligible.

4.5.4.4 Impact on Visibility

Visibility is measured with respect to the greatest distance at which a black object can be distinguished against the horizon sky. Visibility impairment is defined by visual range reduction and/or atmospheric discoloration caused by absorption and scattering of light caused by the presence of gaseous molecules and suspended solid or liquid particles in the atmosphere. Visual range reduction is caused primarily by atmospheric particles that scatter and absorb light; gases play a relatively minor role. Nitrogen dioxide may be responsible for a portion of the brownish coloration sometimes observed in polluted air. Because SSC operation would result in insignificant sulfur dioxide and PM_{10} emissions and less than 250 tons/yr of nitrogen oxide emissions, the facility is not considered a major stationary source. The impact of the proposed facility on visibility would therefore be negligible.

4.5.4.5 Global-Scale Impacts

The global sources, emissions, and concentrations of radiatively important trace gases projected to play a major role in contributing to future global warming and stratospheric ozone depletion are discussed in Section 3.6.3. Average annual emission estimates of CO_2, CH_4, and chlorofluorocarbons in the continental United States and in the state of Texas are given in Table 4.9, along with a rough estimate of the SSC's potential contribution to these emissions. (National, state, and SSC estimates of N_2O, CH_3CCl_3, and CCl_4 emissions are not available.)

The estimated CO_2 emission totals are based on contributions from four major source categories: (1) electric utilities, (2) industrial combustion, (3) transportation, and (4) residential/commercial. Transportation sources represent 24% and 22% of the total national-level and state-level CO_2 emissions, respectively. The chlorofluorocarbon emission estimates cover more than 12 chlorofluorocarbons, including four of the most significant radiatively important trace gases (with respect to their greenhouse-gas and

TABLE 4.9 Estimates of Average Annual Emissions of Three Greenhouse Gases ($\times 10^3$ tons/yr)

Source	Carbon Dioxide	Methane	Chloro-fluorocarbons
National	5,517,223	33,000	440
Texas	517,239	3,100	29
SSC	38	N/A[a]	N/A

[a]N/A = not available.

Source: Piccot et al. 1990.

ozone-depleting potential) identified in Section 3.6.3. The radiatively important trace gases that are most significant represent approximately 95% of the total chlorofluorocarbon emissions listed above. The global average emissions and emission growth rates of the most significant radiatively important trace gases are given in Table 3.18. The CO_2 emission estimates for the SSC are based on the projected major peak-period natural gas requirements for heating structures and for producing hot water during SSC operations (Table 2.6). By assuming natural gas consumption rates at peak levels throughout the year, the projected SSC CO_2 emissions from natural gas consumption should be considered very conservative. Although the contribution of CO_2 emissions from SSC-related traffic volumes is not given above, a conservative estimate is approximately 11 tons/yr (assuming emissions from SSC transportation sources represent the same percentage as these sources represent at the state level). The combined contribution (natural gas consumption plus transportation) to total projected CO_2 emissions from the SSC represents 0.0095% and 0.0009% of the totals in Texas and the continental United States, respectively. Although no data are available to provide meaningful estimates of SSC contributions from other radiatively important trace gases, their contributions to the national and state totals are expected to be negligible.

Climate change and stratospheric ozone depletion are significant global environmental issues that will require international cooperation. Under the auspices of the United Nations Environmental Programme and the World Meteorological Organization, an Intergovernmental Panel on Climate Change has been established. Members of this panel include representatives from the DOE as well as several other federal agencies. The panel has initiated an intense effort to better understand the causes, impacts, and policy and technology implications of global climate change. The current administration strongly endorses the efforts of the panel and expects its work will lead to formal negotiations on an international framework to deal with the legal, technical, economic, financial, and educational issues associated with implementing an international response to this very important global issue (DOE 1990a). International cooperation to address stratospheric ozone depletion has led to a multilateral agreement, the 1987 Montreal Protocol (EPA 1988), to find replacements for the most significant ozone-depleting chlorofluorocarbons and to cut their use by 50% by 1998. The Protocol also limits Halon production beginning in 1992. The DOE has made a strong commitment to these efforts and to an overall effort to make the SSC as environmentally benign as possible.

4.5.5 Mitigative Measures

The determination of the control efficiencies needed, as well as the control strategies that can achieve those efficiencies, is discussed in detail in Appendix C, Section C.4. On the basis of the analysis and the assumptions made, the following four basic techniques allowed control of fugitive dust emissions such that the required standards could be met during construction: (1) petroleum resin application on most unpaved roads and haul routes; (2) watering of unimproved, unpaved haul routes; (3) vacuum sweeping of all paved roads within fee simple areas (i.e., F.M. 66, F.M. 1446, and F.M. 1493 in the west campus area); and (4) watering of the active areas of topsoil and spoils storage piles when wind gusts exceed about 25 mph. A wide range of control efficiencies can be achieved with these control strategies, depending on such variables as

application frequency, application intensity, and dilution ratio. Appendix C, Section C.4, presents values for these variables that will ensure that the required efficiencies are achieved.

The control efficiencies necessary to meet NAAQS were determined by modeling dispersion for those activities currently scheduled as occurring during the RWC periods of December 1991 (for the short-term analysis) and January 1992 to December 1992 (for the long-term analysis). For example, during December 1991, such activity might be scheduled to occur at the west campus and at E10. The controls indicated for E10, based on the short-term analysis, also might be required at the other 17 access and service areas on the ring. Likewise, controls indicated for the west campus might be necessary for similar activities at the east campus.

Table 4.10 presents a general summary of the control efficiency and strategy required for general classes of sources at specific sites. Control strategies for the specific sources modeled were determined quantitatively and are shown in Appendix C. However, the strategies for sources taking place outside the RWC periods were determined qualitatively through comparisons with similar sources. The specified control efficiencies for the strategies shown in Table 4.10 are amenable to monitoring through use of the surrogate variables of application frequency, application intensity, and dilution ratio. As discussed in Section 5.5.1, the necessity for federal enforceability of the fugitive dust control measures necessary to comply with PM_{10} health and welfare standards will be established through consultation with the Texas Air Control Board.

4.6 NOISE AND VIBRATION (BLASTING) IMPACTS

Implementing the commitments made in response to public comments received on the DEIS required more precise determination of noise impacts to residents near construction sites and operating facilities, as well as identification of specific mitigation options at specific SSC site areas. Achieving the objectives set forth in the commitments required:

- Identifying important SSC-related noise sources. Noise emissions from activities such as earth moving, tunneling, foundation construction, and facility operation were used in the impact analysis.

- Locating the nearest noise receptors from the emission source. Data on distance and direction from the source, intervening terrain, and wind and ground cover were used to evaluate propagation of sound.

- Obtaining existing (i.e., ambient) low-level environmental noise. Existing noise conditions were obtained in a field study of representative locations in the fall and winter of 1989-1990 to establish baseline conditions.

- Evaluating viable mitigation options.

TABLE 4.10 Summary of Mitigative Measures for PM_{10} Dust during SSC Construction[a]

Site	Source Description	Control Strategy	Control Efficiency (%)
West campus and east campus	Storage pile wind erosion[b]	Watering	50
	Paved roads	Vacuuming	25-50[a]
	Most unpaved roads and haul routes	Chemical dust suppression	68.5-90[c]
	HEB topsoil removal haul routes	Watering	60
	Other topsoil removal haul routes[d]	None	0
E and F areas	Storage pile wind erosion[b]	Watering	50
	Most unpaved roads and haul routes[e]	Chemical dust suppression	90,93
	Topsoil removal haul routes	Watering	60

[a]If construction activities are kept at least 50 m away from any SSC fee simple site boundary, the specified controls should provide the mitigation necessary to comply with all PM_{10} health and welfare standards. Necessary construction supply traffic on roads that cross site boundaries should, for practical purposes, be exempt from such a restriction.

[b]From spoils and topsoil.

[c]The specific sources that require the lower or the higher values are identified in Appendix C.

[d]Includes construction activity associated with the MSFC (all spoils at E1 will come out at an alternate shaft location on the west side of the HEB).

[e]Topsoil hauling requires 93% control, whereas all other hauling truck traffic requires 90% control.

The analysis conducted is more site-specific than the analysis provided for the EIS. For that effort, no baseline noise measurements were available for noise propagation modeling. Also, rotation of the collider ring required reexamination of the locations of nearest residences and noise sources.

4.6.1 Technical Approach and Methodology

An environmental sound propagation computerized model (Environmental Noise Model 1.0, Tonin 1985; RTA 1989) was used to predict the noise level from SSC construction activities and normal operations. The model uses information on meteorological variables, ground cover, and topographic conditions and the effects of barriers in arriving at projections of audible sound levels. The model is highly sophisticated, incorporating sound propagation models developed by the Edison Electric Institute (Thompson and Wood 1984) and the European Oil Companies Organization for Environmental and Health Protection (Manning 1981).

STAMINA, a Federal Highway Administration computer program (Barry and Reagan 1978; FHWA 1982), was used to compute hourly energy-average sound levels (L_{eq}) at each of three sensitive noise locations along a local road expected to experience heavy SSC construction traffic. STAMINA calculates the traffic-generated contribution to the noise level at the designated listener locations. The calculations take into consideration the traffic mix (i.e., autos, medium trucks, and heavy trucks) as well as speed and direction of flow. Numeric descriptions of natural or artificial sound barriers can be entered and are accounted for in the calculations.

Construction of SSC surface facilities will require diverse activities spread over a number of years. Changes in the nature of construction activities at any given location will produce corresponding changes in sound level on adjoining property. Rather than describe all of the construction activities and the corresponding mitigation approaches that DOE could consider, several of the most challenging construction noise mitigation situations were selected. A service area, a campus area, and a highway construction area were selected to project anticipated noise levels from the SSC and to illustrate the manner in which mitigation options are analyzed. The objective was to show that, if methods were available for successful mitigation of challenge cases, all other cases could be mitigated successfully. Details of these analyses, as well as details of those for other site locations where construction noise impact mitigation will be needed, are provided in a supporting technical document (Rodman and Liebich 1990).

Operational noise impact analysis considers intrusive noise levels relative to the preconstruction ambient noise levels. Because the preconstruction (baseline) ambient noise environment throughout the SSC site averages 39 decibels (dB) L_{dn} (Section 3.7.2.3), which is more than an order of magnitude below the 55 dB L_{dn} reference level (Section 4.6.2), effective criteria for assessing intrusive noise impact*

*The level of intrusiveness ("intrusion level") is a measure of the extent to which a newly introduced sound "intrudes" on the existing (baseline) environment. The model takes into consideration the baseline level and the threshold of hearing.

must take into account the baseline environmental sound level, as well as nonacoustic factors (Section 3.7.1). Criteria for evaluating annoyance with noise are based on results from three models: the Stevens Composite Noise Rating (CNR) model, the Fidell Probabilistic Noise Audibility (PNA) model, and the Fidell Individual Annoyance Prediction (IAP) model. CNR, an empirical model, provides a multistep classification of annoyance, expressed in terms of probable action in response to a newly introduced noise (Table 4.11). The model evaluates readily observable factors of experience, attitude toward the noise source, and relative noise levels. PNA and IAP together provide a five-level annoyance classification (Table 4.12). The PNA compares the spectrum of the newly introduced noise with an audibility spectrum that the model generates as a composite of the masking effect of the baseline ambient spectrum and the threshold of hearing to calculate the intrusion level. IAP, like CNR, includes evaluation of nonacoustic aspects of resident attitudes. Technical information and references can be found in a supporting technical document (Rodman and Liebich 1990).

TABLE 4.11 Composite Noise Rating (CNR) Scale of Community Complaint Reaction to Intrusive Noise

CNR Category	Description of Complaint Activity
A	No complaints among community members or to noise source operators
B/C	A few spontaneous complaints, usually among residents but not to noise source operators
D	Sporadic individual complaints to noise source operators or to authorities, irregular in number, time, and area of origin
E	Widespread individual complaints regularly received; single threat of legal action; initiation of group organization to register complaints with authorities
F/G	Several threats of legal action; organized, strong group appeals to authorities to stop noise
H+	Vigorous group and community action highly organized and supported communitywide; police authority, legal action, or other public authority is employed to oppose noise-source operation

Sources: Stevens et al. 1953; Rosenblith et al. 1953; Stevens et al. 1955; Parrack 1957; Miller et al. 1978; Thompson and Wood 1984.

4.6.2 Source Terms and Assumptions

The following noise level criteria were used as standards against which noise generated by SSC construction and operation was evaluated. Although these criteria represent government agency recommendations and thus are not legally enforceable, they were used as a basis of comparison for SSC-generated noise levels.

Because affected residents are aware of the temporary nature of construction activity in general, the acceptable average noise level is higher than it would be for a continuously operating, newly constructed facility. The EPA recommends a day-night average sound level (L_{dn}) limit of 55 dBA outside residences and farm homes (EPA 1974). This level corresponds to a constant hourly energy-average sound level (L_{eq}) of 49 dBA during a 24-hour period or a combination of 55 dBA hourly L_{eq} during the daytime construction period (8 a.m. to 5:30 p.m.) and 47 dBA hourly L_{eq} during the nighttime (5:30 p.m. to 8:00 a.m.). The U.S. Department of Housing and Urban Development recommends limits that are essentially 10 dBA higher for urban residential locations (Galloway and Schultz 1979). Because more than half of the SSC residential sites that will be nearest to SSC construction activities are rural rather than urban, hourly L_{eq} construction noise limit criteria of 55 dBA for daytime hours and 47 dBA for nighttime hours were selected for analysis of mitigation requirements and options.

TABLE 4.12 Individual Annoyance Prediction (IAP) Scale Related to Intrusion Level ($L_{I//50-1}$) for SSC Site Design Critical/Noise Sensitive Locations (DC-NSLs)[a]

Intrusion Level $L_{I//50-1}$ (dB)	Verbal Description of Annoyance
<1	Not at all annoyed
1 through 10	Slightly annoyed
11 through 19	Moderately annoyed
20 through 25	Very annoyed
>25	Extremely annoyed

[a]Decision Criterion Index = -16.

Sources: Vér and Anderson 1977; Fidell and Teffeteller 1981; Fidell et al. 1987, 1988.

4.6.3 Construction Noise Impacts

Noise impacts from four groups of construction activities are described below. Included are impacts from surface construction activities in service and access and campus areas, and from construction traffic and blasting.

4.6.3.1 Service Area Construction Noise Impacts

Consideration was given to earthworking noise levels, along with their durations and their distances from nearest residences at various service areas, in order to select a challenge case (worst-case example) of a requirement for noise mitigation, to identify

appropriate mitigation options, and to illustrate the relative effectiveness of each. This approach resulted in selection of the surface construction activity associated with tunneling operations at service area E4 as the challenge case.

Sources of Tunneling Surface-Operations Noise at E4

Surface operations involve tunnel ventilation equipment, the hoist used to bring spoils to the surface, and conveyor equipment. The ventilation equipment was assumed to operate 24 hours a day over the six-month period of tunnel construction at E4. The hoist and conveyor operate 15 hours per day on weekdays. These sources were also included as sources in the second activity, which is placement of spoils on the site and delivery of materials for the tunnel lining. The latter activity occurs five days per week between 8 a.m. and 5:30 p.m.

Ventilation fans provide fresh air to the tunnel at all times. The fan that forces the air into the tunnel is located near the shaft entrance. Normally, a propeller-type fan, driven by an electric motor, is used for this purpose. The hoisting equipment and spoils conveyor are also located near the shaft entrance. The combined L_{eq} noise level produced by these sources at the residence nearest the shaft entrance will probably be 47 dBA.

When spoil is brought to the surface by the hoist, it is transferred into the chute of a conveyor system, which deposits it on a temporary storage pile. The noise level of rock dropping into the chute and onto the storage pile is expected to be well above the baseline ambient level. Because of its nature, the noise impact may be significant and mitigative measures would therefore be implemented, where appropriate.

Tunneling Surface-Operations Noise Impacts (Unmitigated) near E4

The nighttime baseline ambient L_{90} sound level in the E4 area goes as low as 24 dBA. The 47 dBA nighttime noise level that is expected to occur at the nearest residence because of the fan and hoist is 23 dBA above this ambient level; however, at that level, the daily L_{dn} level would not exceed the 55 dBA recommended construction noise limit (EPA 1974).

During daytime hours, a wheeled loader transfers the spoils to haulers that carry the rock to the on-site spoils pile. A bulldozer will contour the pile. Daily delivery of materials and removal of spoils require concrete mixers as well as other trucks.

Spoils placement and surface operations associated with tunnel lining will likely produce an hourly L_{eq} noise level of 74 dBA at the residence nearest the service shaft entrance. Trucks arriving at and leaving the site are expected to produce temporary noise levels as high as 67 dBA at residences on the west side of Prichett Road opposite the E4 site access road.

Construction Noise Mitigation

Reduction of the daytime spoils-placement noise levels to acceptable values at nearby residences may require use of both noise-suppressed equipment and, if measured sound levels are as high as estimated, construction at some service areas of a noise barrier along the boundary between the equipment movement paths and nearby residences. A barrier wall would not reduce the impact to all properties but would reduce the overall impact to residences adjoining the sites. Partial and full engineering mitigations are outlined in the following paragraphs.

Two levels of mitigation have been identified for consideration with respect to mitigating construction noise impacts at service area E4. Similar measures could be used, with suitable adjustment, at any of the service or campus areas requiring mitigation.*

The first mitigation level involves initial specification of an airfoil-bladed centrifugal fan for tunnel ventilation. This type of fan would reduce the hourly L_{eq} noise level of the continuously operating equipment to 32 dBA from the 45 dBA estimated for a propeller-type fan.

Noise-suppressed models of most construction equipment are available; however, if normal, commercially available noise-suppressed equipment were used, the noise level at the most severely affected residence would be reduced by only 3 dBA. The problem stems more from bulldozers (for which reduction of track noise is difficult), haul trucks, and concrete mixers. An alternative to the standard tracked bulldozer is the wheeled bulldozer. This substitution would reduce the radiated noise level of the bulldozer by 9 dBA. To realize any benefit from this reduction, however, the typical noise level of the bulldozer and truck engine exhausts would have to be reduced by at least 8 dBA. This reduction could be accomplished by requiring all trucks and the bulldozer to meet engine exhaust noise emission limits achievable with the most effective commercially available mufflers. The resulting equipment-generated daytime hourly L_{eq} noise level could then be reduced by 5 dBA to 65 dBA at the residence nearest the site boundary.

The second mitigation level, which is to be considered only if field measurements confirm preliminary estimates, involves constructing a temporary noise barrier in addition to using noise-suppressed equipment. If a noise barrier wall, or temporary construction sheds, were to be constructed along the entire west boundary of the site, along approximately two-thirds of the north boundary, and along one-third of the south boundary, the daytime noise level could be reduced an additional 11-15 dBA at the residences studied, as well as at other residences in the immediate area. (The site could be accessed through an opening consisting of two offset walls at the southeast corner of the site.)

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*Estimates of the noise-impact mitigation achieved from relocating the spoils piles and cooling ponds within the E4 site show no significant benefit during spoils placement. However, relocation of the larger cooling pond could significantly reduce the impact to the residence nearest the site boundary during lake excavation.

With a 20-ft-high noise barrier in place and with use of noise-suppressed equipment, the equipment-generated daytime hourly L_{eq} noise level at the nearest residence is estimated to be 52 dBA, and 44 dBA or less at the residences on the west side of Prichett Road. The barrier modeled would not extend the full length of the north site boundary; therefore, the daytime noise level at a residence slightly farther away than the residence at the northwest corner is estimated to be 53 dBA. Residences on the west side of Prichett Road could experience daytime noise levels of 50-60 dBA when delivery trucks leave or enter the site.

During weekday hours, intermittent noise from handling spoils at the hoist and conveyor is expected to be masked by mobile equipment noise. During evening hours, when most construction noise is not present, some form of mitigation could be necessary at E2, F2, and E4. A supplemental barrier wall near the conveyor system could be considered. Two possibilities are a temporary concrete-block structure surrounding the conveyor hopper or early construction of the north and west walls of the refrigeration building. The latter possibility might entail erection of at least one bay of structural steel adjacent to the walls before the start of the tunneling operation. Noise from spoils falling onto the temporary spoils pile from the conveyor is expected to be controlled adequately by the perimeter wall.

In summary, full mitigation, including use of noise-suppressed equipment, a 20-ft-high partial perimeter barrier wall, and a 30-ft-high partial enclosure of the conveyor hopper (or shielding by early construction of refrigeration building walls), should limit the estimated daytime hourly L_{eq} noise levels to 53 dBA or lower at all nearby residences (approximately 40 individuals). Table 4.13 summarizes construction noise levels for the residence nearest the boundary of E4 with various levels of mitigation. Introduction of additional mitigative measures at construction sites will be considered if monitoring results show sound levels to be excessive.

4.6.3.2 Campus Area Construction Noise Impacts

Noise Sources

A campus area construction noise impact case to exemplify the approach to be used for assessment and mitigation was selected with the same considerations as for the service area example. A design-critical, noise-sensitive location (DC-NSL) was selected in the Bethel Chapel community near the southwest campus interaction region IR4. Noise impact at that location is expected to be greater during the six months of construction than during any other phase of work.

The noise sources are power shovels, bulldozers equipped with ripper blades, loaders, scrapers, and large haul trucks. Of these, the scrapers and trucks, when operating on top of the spoils pile, will create the greatest noise impacts. The Bethel Chapel community will be partially shielded from noise emissions from other equipment by the spoils pile and the depth of excavation. This shielding will provide approximately 10 dBA of noise reduction for those other sources all of the time and for scrapers and trucks about half of the time.

TABLE 4.13 Weekday Energy Average Sound Levels (dBA) at the E4 Residence Nearest the Site Boundary during Service Area Construction, Tunnel Construction, and Placement of Spoils[a]

Mitigation Level	Daytime L_{eq}[b]	Evening L_{eq}	Nighttime L_{eq}	L_{dn}
No mitigation	70	52	45	70
Noise-suppressed equipment, no wall	65	46.9	32	61
Noise-suppressed equipment, wall and partial hopper enclosure	52	46.5	27	49
Baseline ambient	30	27	27	34

[a]As modeled, weekdays are the five days specified by SSCL (1990) as normal workdays. For the construction period modeled for E4, the workday is assumed to be from 8 a.m. to 5:30 p.m. Hoisting of tunnel spoils will continue until 10 p.m. It is assumed that there will be no activity, other than operation of the tunnel ventilation fan, between 10 p.m. and 7 a.m. on weekdays and on weekends. It is also assumed that the tunnel ventilation fan will operate continuously.

[b]Daytime is defined as 7 a.m. to 6 p.m.; evening is 6 p.m. to 10 p.m.; and nighttime is 10 p.m. to 7 a.m.

Typical construction equipment, in an ordinary state of maintenance, is predicted to produce maximum daytime noise levels at the DC-NSL of 46 dBA. The value of the hourly L_{eq} for the hour containing that maximum level is somewhat lower. If the 46-dBA level persisted all of the time, the L_{eq} would be 46 dBA or higher. However, because the equipment operates intermittently at only partial load, the L_{eq} will be about 3 dBA lower than the maximum level (i.e., 43 dBA), which is within the recommended criterion (i.e., 55 dBA) (EPA 1974).

Although the criterion level will not be exceeded, the expected levels will exceed the baseline environmental ambient level by approximately 25 dBA. This noise level could be very annoying to residents at times. Therefore, any mitigation available at modest cost should be considered. The primary source of noise from construction machinery is the diesel engine exhaust system.

Construction Noise Mitigation

High-grade, low-pressure-drop mufflers for construction equipment are commercially available. On average, these mufflers provide approximately 10 dBA of noise reduction. This mitigation option could reduce the maximum hourly L_{eq} level to 33 dBA, a level that could significantly reduce the likelihood of more than moderate annoyance. Therefore, DOE will consider the feasibility of specifying such muffling systems for all construction equipment if its field monitoring program shows measured noise levels exceed acceptable levels.

4.6.3.3 Construction Traffic Noise Impacts

Noise Sources

Three NSLs, designated as TA, TB, and TC, adjacent to F.M. 66 were selected for analysis of construction traffic noise impacts. Residence TA is located just west of Prong Creek on the north side of F.M. 66 about 75 ft from the edge of the westbound traffic lane. Figure 4.6 illustrates the location of NSLs TB and TC relative to the

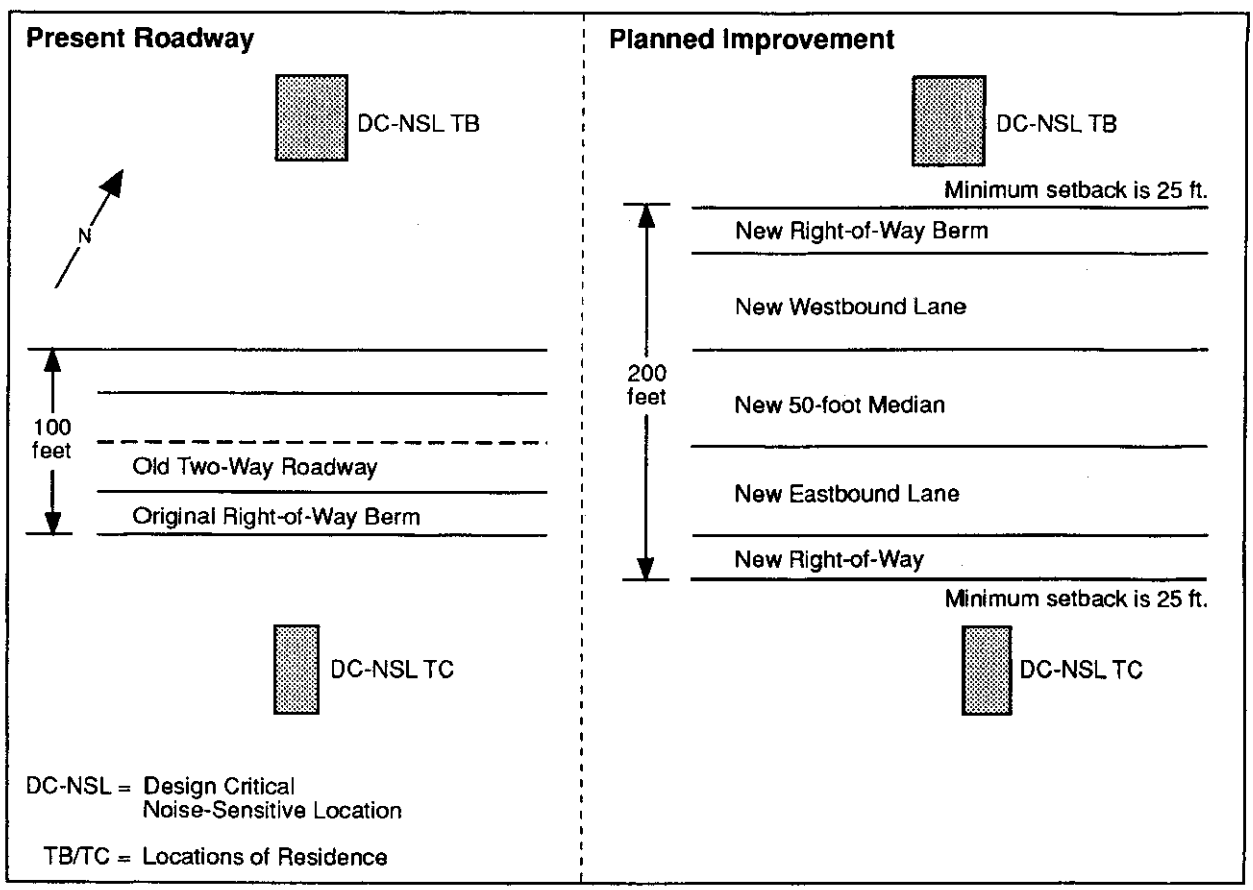

FIGURE 4.6 Assumed Layout for Widening F.M. 66 between I-35E and the Campus Area

existing 100-ft right-of-way (SSCL 1989) as well as the assumed layout of the roadway after the planned widening has been completed. Note that NSL-TB is now 100 ft from the right-of-way and that NSL-TC is 50 ft from the right-of-way, with a total separation of 250 ft. These NSLs cannot avoid being within 25 ft of the 200-ft right-of-way* assumed for the upgraded highway.

The Federal Highway Administration computer program STAMINA 2.0/BCR (Barry and Reagan 1978; FHWA 1982) was used to compute hourly L_{eq} levels at each of the three NSLs. The road segment modeled starts 890 ft west of location TA and extends to 2,300 ft east of TB. The east end of the segment is 1.8 mi east of the intersection of F.M. 66 and the I-35E frontage road.

The traffic modeled included construction-related vehicles and local traffic during the peak traffic hour expected in 1992 (SSCL 1989). The results indicate that the greatest impact to residences on F.M. 66 will occur between 4:30 p.m. and 5:30 p.m. Peaks in both local traffic and construction-related traffic are projected to occur during this hour. Traffic density values take into consideration the proposed SSCL policy of requiring construction-related traffic to use F.M. 1493 and F.M. 1446 when arriving or leaving the SSC west campus (SSCL 1989).

The computed hourly L_{eq} values for this time period were 65 dBA for location TA, 67 dBA for TB, and 68 dBA for TC. Comparing these values with those from the 1988 average daily traffic (ADT) count shows a predicted increase of 8 dBA.

The morning peak traffic volume, between 7:30 a.m. and 8:30 a.m., is not expected to be measurably different from the afternoon peak volume, although the maximum noise impact would shift from the residences on the north side of F.M. 66 to those on the south side. The construction-related traffic at peak hours is expected to flow in a direction opposite to that of local commuter traffic.

Traffic Noise Mitigation

Most of the 8-dBA sound level reduction needed to preserve baseline noise level conditions at the impacted residences could be achieved by designing a 10- to 12-ft cut in the area where the right-of-way passes between the houses. Because the area in question is near the brow of a 50-ft change in elevation, such a cut should not be difficult to achieve. The noise impact during construction of the roadway would be slightly greater but would last only two or three days.

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*Each two-lane half of the divided roadway is assumed to be 50 ft wide, including a breakdown lane for each direction. The median strip between the roadways is also assumed to be 50 ft wide. A berm and bar ditch account for 25 ft of right-of-way on each side of the roadway pair.

4.6.3.4 Vibration (Blasting) Impacts

Some blasting may be required during construction. A detailed assessment of blasting impacts is contained in the FEIS (Vol. IV, Appendix 9, Section 9.2). Blasting should not be necessary for construction of the underground tunnels; however, some blasting may be required for construction of shafts, starter tunnels, and experimental halls.

Exact locations of shafts and starter tunnels will be determined during detailed design; the locations chosen could be modified later in consultation with the contractor selected to do the work. Therefore, it is impossible at this time to analyze potential impacts of blasting to specific residences. However, it is possible to set design and construction criteria that could be written into contracts so that adverse impacts from blasting are minimized or eliminated. The criteria could be those specified in the FEIS (Vol. IV, Appendix 9). These criteria and the rationale for each are summarized as follows:

- *Ground Vibrations from Blasting.* A peak particle velocity (PPV) of 2.0 in./s is generally accepted as safe for poor plaster. Therefore, the criterion set for SSC-related activities is that blasting charge-weight-per-delay values will be adjusted to keep PPVs below this level at any existing occupied structure not related to construction in the vicinity of blasting sites.

- *Air Blast Overpressures.* It is generally accepted that overpressures of 0.1-0.5 lb/in.^{2} will not cause windowpane damage, although such overpressures may cause public annoyance. Other research has shown that overpressures somewhat above 0.01 lb/in.^{2} would not cause damage to farm or wild animals. Therefore, an upper limit of 0.01 lb/in.^{2} has been chosen as the criterion for overpressure.

It was concluded in the FEIS that a 35-lb charge-weight-per-delay would result in peak overpressures of 0.003-0.01 lb/in.^{2} at a distance of 360 ft from the detonation point. If blasting is required in the vicinity of occupied structures, design criteria and construction contracts will be such that peak overpressures will be taken into account.

In addition to the above, the FEIS also states (Vol. IV, Appendix 9, Section 9.2) that "Prior to the start of blasting in any given area, surveys of potential vibration and noise receptors will be taken to establish preconstruction conditions. Monitoring vibrations and noise will be done during all blasting phases of excavation. During and after completion of blasting, surveys of the same receptors will be conducted to assess damage and determine if repairs are necessary."

4.6.4 Operation Noise Impacts

Field surveys and study of aerial photos have resulted in the identification of more than 20 locations throughout the SSC site area where DC-NSLs will be close enough to SSC operating facilities to require detailed study of noise impacts and mitigation

requirements. Consequently, the same approach is followed in this section as in Section 4.6.3. In other words, cases were selected that represented the most severe mitigation requirements. A service area, a west campus location, and a location typical of those closest to the highway that will experience the greatest increase in SSC-related traffic (i.e., F.M. 66) were selected. Analyses of the remaining DC-NSLs are contained in a supporting technical document (Rodman and Liebich 1990).

Noise impacts from three groups of operation activities are described below. Included are impacts from tunnel ventilation fans and cryogenic screw compressors to be located in service and campus areas, and from commuter and operations traffic.

4.6.4.1 Service Area Operational Impacts

The F2 service area was selected for analysis and discussion in this section because, of all 18 service areas, it will have the most significant noise impacts to nearby residents. The analysis considers impacts with and without additional mitigation.

The principal contributors to noise impacts to nearby NSLs are the tunnel ventilation systems and proposed future cryogenic screw compressors and their drive motors and gas pulsations in the helium lines. The "assumed initial design" calls for these machines to be enclosed in standard industrial buildings with metal panel walls. Sound-control baffles would be fitted to the ventilation openings in the walls, and airfoil-bladed centrifugal blowers would be specified for the tunnel ventilation fan and the roof-mounted, air-cooled condenser for the control room air-conditioning system.

The measured baseline L_{90} spectrum for a measurement location appropriate for the F2 area (Table 3.19), corresponding to an overall A-weighted level of 23 dBA, was used to calculate the audibility spectrum for the area. This masking spectrum was compared with the results of modeling the impacts of the conventional operating plant. The noise level from the plant would be 36 dBA. The corresponding intrusion level would be 23 dB at the nearest residence. The CNR category would be D; consequently, the nearest resident could be "very annoyed" and "sporadic complaints" could be expected. The plant noise and the baseline ambient spectra are compared in Figure 4.7.

Mitigation Analysis

The "impact analysis" described above shows that the "assumed initial design" would probably fail to reduce noise to levels acceptable to nearby residents. Additional mitigation measures, in contrast, should reduce noise to levels that would not elicit complaints from nearby residents. The following discussion describes detailed mitigative measures.

Control of noise impact involves one or more of three elements: the source, the listener, and the sound propagation path between them. Mitigation measures to be considered by DOE are limited to the source and path.

Ways in which noise-source sound power could be reduced are limited to specifying low-noise equipment when it is available. Some benefit could be realized, for

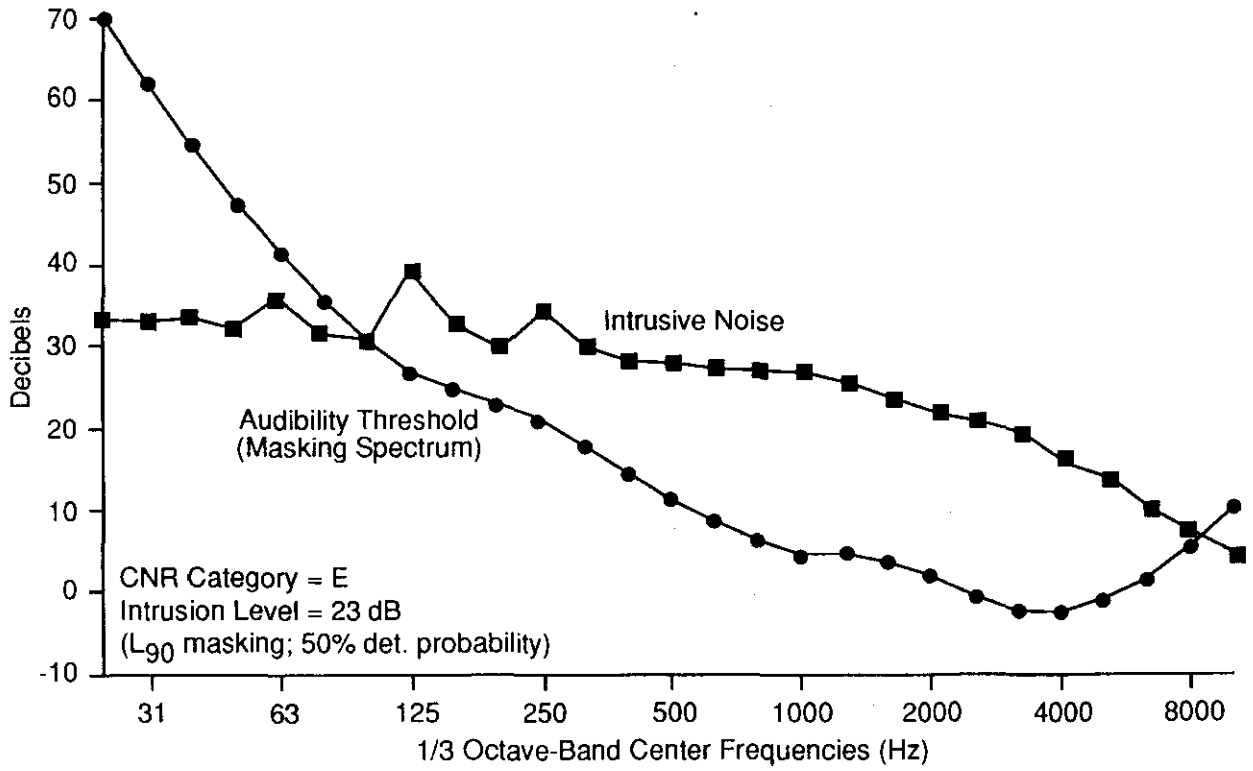

FIGURE 4.7 Conventional-Design F2 Operating-Plant Noise Emission to the DC-NSL, Compared with the Audibility Threshold

example, by specifying liquid-cooled electric motors to drive the compressors. The effectiveness of this approach is limited by the inherently high noise level of the compressors.

One approach to controlling the noise propagation path, and one that applies to some of the service areas, is increasing the length of the sound propagation path. In the case of F2, where this alternative is not available, the most effective way to control the noise propagation path is to enclose the noise sources in a structure having a high sound transmission loss. The individual noise sources could be enclosed or the building could be designed for noise control. For the initial design, DOE chose the latter approach, specifying that all ventilator openings in the buildings be fitted with sound-control baffles if field measurements show they are necessary.

The most prominent noise source in the spectrum of a preliminary design that was found to be unsatisfactory was a conventionally selected propeller-type tunnel ventilation fan. A similar, though smaller, fan is used to circulate cooling air over the coils of the air-cooled condenser. These two fans alone could produce a sound level that is 42 dBA greater than the baseline L_{90} sound level.

Attaining appropriate sound levels from the tunnel ventilation fan and the air-cooled condenser has been shown to be partially achievable by initially specifying airfoil-bladed centrifugal blowers. The additional noise reduction needed to achieve the desired

noise level involves using inlet-duct noise baffles for the tunnel ventilation fan and the air-cooled condenser.

With the above-described supplemental mitigative features included in or added to the initial design (Figure 4.8), the noise emission from the plant is calculated to be 19 dBA. This level corresponds to an intrusion level of 5 dB at the nearest residence and a CNR category of B. Consequently, the nearest residents would not be expected to be annoyed beyond a few complaints expressed among themselves.

Other Service Areas

Of the 18 service areas, areas E2 and F2 are considered to pose the greatest problems for control of operational noise. Mitigation of noise impact at a few of the other service areas would require the same types of noise control but to a lesser degree. Factors that will be taken into consideration in the noise control engineering design for all of the service areas, as well as other areas of SSC facilities, are the baseline sound level, the level required to meet the objective of preventing undue noise impact, and the extent to which distance affects the noise reaching the nearest residence or other NSL.

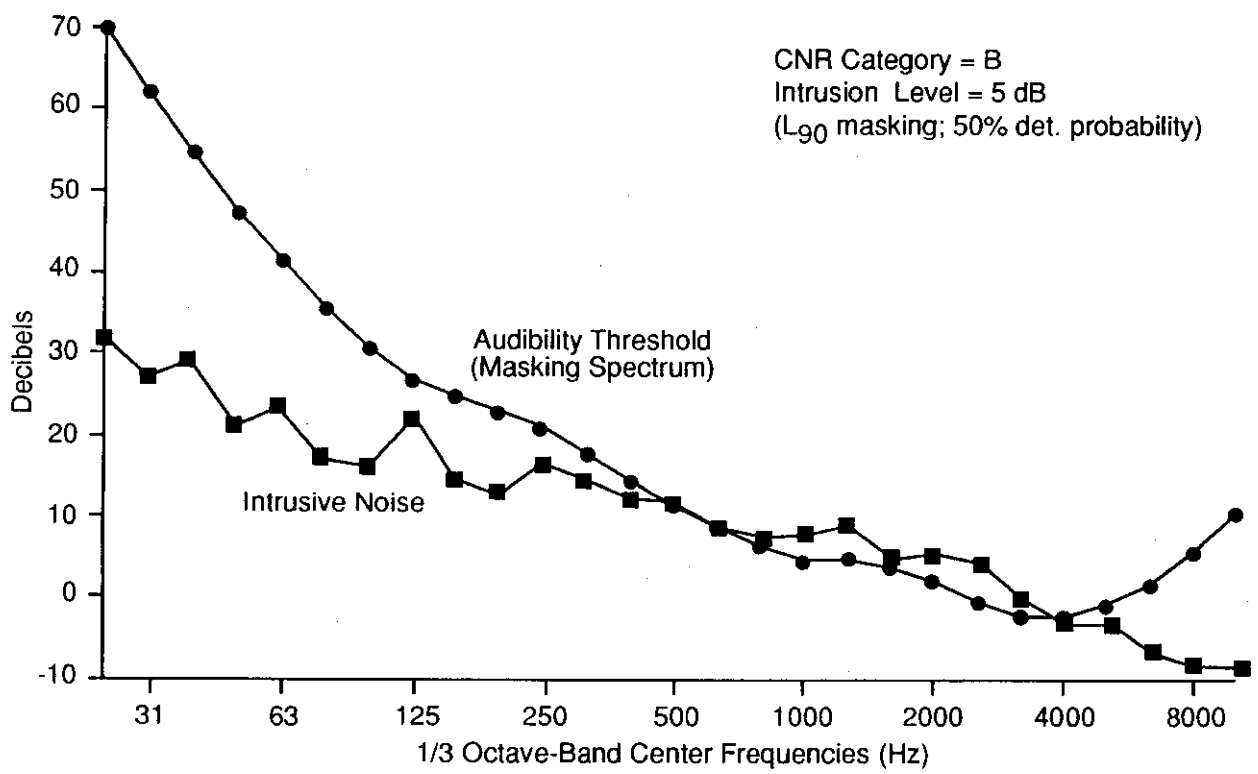

FIGURE 4.8 Additional Mitigation Measures for F2 Operating-Plant Noise Emission to the DC-NSL, Compared with the Audibility Threshold

4.6.4.2 Campus Area Operational Noise Impacts

Two facilities on the west campus were evaluated for operating noise impacts: the IR4 facility at the south end and the Magnet Support Facility Complex (MSFC) and the E1/H8 complex at the north end.

IR4 Operation

A residence located in the Bethel Chapel community was selected as a DC-NSL for analysis of campus operational noise impact because of its proximity to IR4 in the southwest portion of the campus. The most significant sources of noise for this locality are refrigeration and ventilation equipment for the experimental hall.

Initial modeling results were based on conventional installation of standard commercial equipment (Figure 4.9). The 26-dB intrusion level and CNR category of F indicate that residents at that location are likely to be extremely annoyed. The primary contributors to the noise emitted by conventionally designed IR4 facilities are the fans that supply makeup air to the ventilation system. Consequently, to avoid the cost of replacing these fans later, and if the architect-engineer agrees with these preliminary estimates, a suggested mitigation would entail modifying the fan system design in two fundamental ways: (1) instead of standard propeller-type fans, specify airfoil-bladed

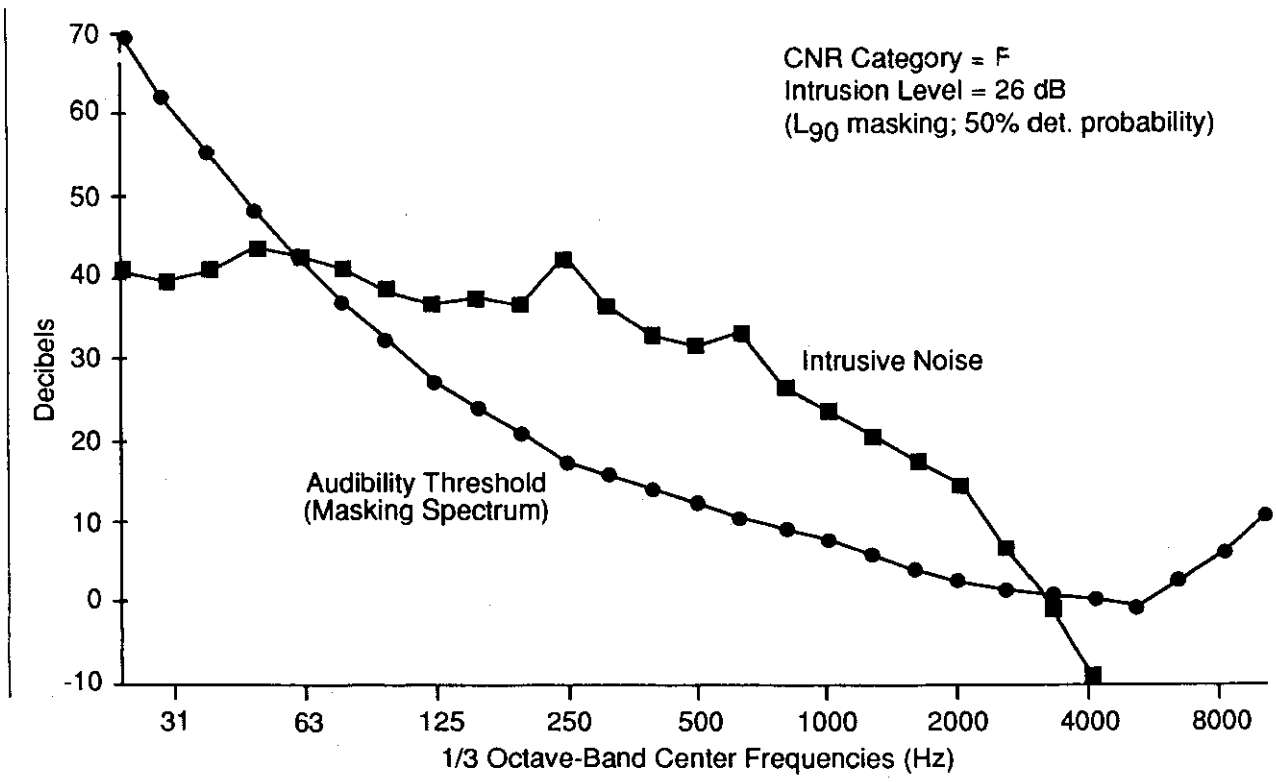

FIGURE 4.9 Conventional-Design IR4 Operating-Plant Noise Emission to the DC-NSL, Compared with the Audibility Threshold

centrifugal blowers with vaned inlets, and (2) if the results of field measurements show levels are still excessive, equip fan inlets with appropriate inlet silencers. Figure 4.10 shows the result of implementing the mitigation measures described above. The intrusive noise emission level is estimated to be below audibility in all frequency bands; therefore, no annoyance or complaints should occur.

MSFC E1/H8 Operation

The MSFC is a relatively small noise source relative to total operations sources at the north end of the west campus. The nearest residence, located north of F.M. 66 in the Emerald Estates subdivision, is estimated to receive less than 24 dBA from the combined contributions of E1, H8, and MSFC operations. The MSFC is responsible for fewer than 2 dBA of this contribution.* Annoyance from this slight increase is expected to be in the range of "none" to "slight" without the use of sound-control baffles on the compressor building. If mitigation monitoring shows excessive sound levels at any residence, addition of such baffles could eliminate the impact.

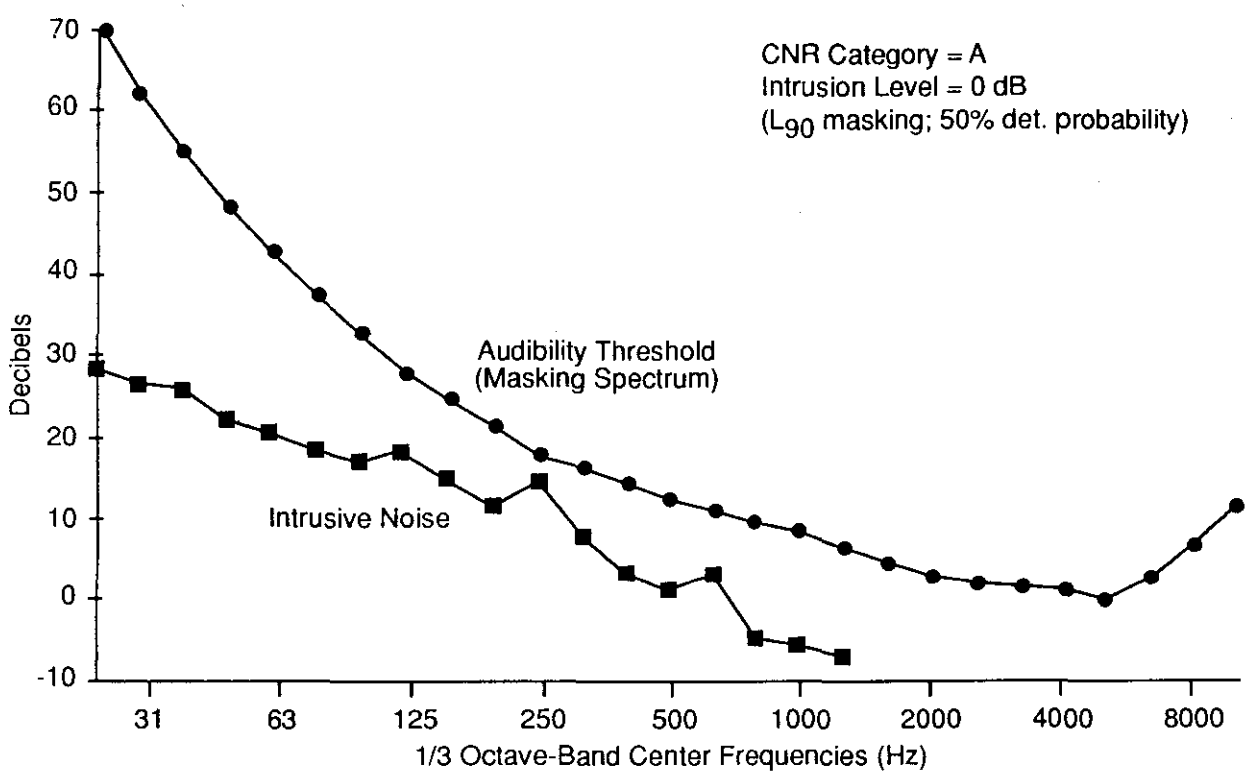

FIGURE 4.10 Supplemental Mitigation Measures for IR4 Operating-Plant Noise Emission to the DC-NSL, Compared with the Audibility Threshold

*According to information received from SSCL, the additional compressors at E1 increased the horsepower at that location to 1.5 times that at other E sites, which corresponds to a sound power increase of approximately 2 dBA.

4.6.4.3 Operational SSC-Related Traffic Noise Impacts

The same residential locations near F.M. 66 (TA, TB, and TC in Figure 4.6) analyzed for construction-related traffic noise impacts (Section 4.6.3.3) were selected for analysis of operational SSC-related impacts. The same computer program (STAMINA 2.0/BCR) was used. This approach allows comparison of the relative magnitude of traffic noise impacts at these three NSLs, for both the construction and operational phases of the project, relative to preconstruction noise levels.

Table 4.14 shows the results of modeling traffic noise caused by operational SSC-related traffic, plus 1988 baseline traffic (Table 3.21). The first part of the table represents the morning and afternoon hours when the anticipated truck traffic is greatest. The second part of the table shows the morning and afternoon hours when total traffic volume is greatest. The peak traffic volume does not coincide with the peak truck traffic volume because of the assumption that most of the trucks leave the Dallas-Fort Worth area sometime after 8:30 a.m. and return sometime before 4:30 p.m. Automobile traffic consists mostly of people commuting to work earlier in the morning and later in the afternoon than the peak of truck traffic.

The results indicate that noise impacts of SSC-related traffic will increase hourly L_{eq} noise levels at residences near F.M. 66 (from preconstruction levels) by 5-8 dBA in the morning and 3-7 dBA in the late afternoon. The same mitigation comments apply to the operational SSC-related traffic noise impacts as to the construction-related traffic noise impacts (Section 4.6.3.3). These increases are less than those caused at construction locations near I-35E.

4.6.5 Mitigative Measures

Both construction and operation noise are treated in sufficient detail to show that the potential impacts of each representative case can be mitigated through the use of practical, state-of-the-art control technology. By showing this for the more significant cases, it is also demonstrated that potential noise impacts from other campus facilities can also be mitigated.

TABLE 4.14 Predicted Operational SSC-Related (plus local) Traffic Noise near F.M. 66 (hourly L_{eq} in dBA)

	Truck Traffic		Peak Traffic	
Location	Morning (9:30-10:30)	Afternoon (2:30-3:30)	Morning (7:30-8:30)	Afternoon (4:30-5:30)
TA	67	66	66	64
TB	70	68	68	66
TC	67	68	65	67

The noise mitigation action plan for the SSC would include analyses for the construction of each facility and establish mitigation requirements based on comparisons of predicted noise emissions with applicable criteria. To assure the cost effectiveness of the noise impact mitigation measures at each construction site, noise control measures would be tailored to the requirements at each site. During construction, noise monitoring should be conducted routinely at critical locations to confirm that the noise control measures continue to be effective and to detect situations caused by failure of any contractor or subcontractor to adhere to the noise control policy. Changes in facility design and construction schedules would be evaluated for mitigation of potential noise impacts related to the changes.

Tables 4.15 and 4.16 summarize the construction and operation noise impact mitigation measures recommended (note asterisks) on the basis of the analysis described in Sections 4.6.3 and 4.6.4.

TABLE 4.15 Summary of Noise Impact Mitigation Methods for SSC Construction Noise[a]

Location	Noise-Suppressed Construction Equipment[b]	Noise-Barrier Perimeter Walls[c]
E2	*	*
E4	*	*
F2	*	*
IR4	*	
MSFC	*	

[a]Based on estimated noise levels obtained by modeling scenarios described in the text. Other locations should be analyzed on a case-by-case basis. Mitigation methods described for these representative cases should be adapted to provide the degree of mitigation indicated by field monitoring during construction.

[b]High-grade exhaust mufflers at all construction sites shown by analysis, and confirmed by monitoring, to exceed appropriate levels.

[c]Height and length to be determined on a case-by-case basis for sites at which analysis, confirmed by field monitoring, indicates additional mitigation is needed.

4.7 HUMAN HEALTH EFFECTS

4.7.1 Radiation Effects

The changes to the SSC project since the EIS was published (i.e., modifications to facility locations, increased energy of the HEB, and other changes) are described in Section 2.1.1. In this section, the health and safety aspects of SSC operations following those modifications are discussed. The information presented in the EIS has been reviewed within the context of the project changes. If the information does not change, it is not repeated here. The emphasis in this section is on the changes to projected health effects given in the EIS as a result of the changes to the project.

Section 4.7.1.1 describes the technical approach and methodology used to obtain the radiological impact estimates given in Section 4.7.1.3. Source terms (environmental release rates of radionuclides) and calculational assumptions are given in Section 4.7.1.2.

TABLE 4.16 Summary of Noise Impact Mitigation Methods for SSC Operational Noise[a]

Location	Baffles on Building Vents[b]	Design-Load HVAC[c] Chillers[d]	Centrifugal HVAC Fans[e]	Baffles on HVAC Fans[f]
E2	*	*		
E4	*	*		
F2	*	*	*	*
IR4		*	*	*
MSFC	g			

[a]Based on estimated noise levels obtained by modeling scenarios described in the text. Other locations should be analyzed on a case-by-case basis. Mitigation methods described for these representative cases should be adapted to provide the degree of mitigation indicated by field monitoring during operation.

[b]Sound transmission loss of vent baffles equals or exceeds sound transmission loss of wall.

[c]HVAC = heating, ventilating, and air-conditioning.

[d]Initial design for use of several small chillers rather than one large one, with load management controls, so that each chiller operates at full load.

[e]Tunnel-ventilating fan and air-cooled condensers.

[f]Use for all tunnel vent fans; use on air-cooled condensers only if monitoring shows a need for reduction of noise from this source.

[g]Use only if monitoring shows a need for reduction of noise from this source.

4.7.1.1 Technical Approach and Methodology

The Clean Air Act Assessment Package - 1988 (CAP-88) (Beres 1989) was used to estimate the radiological impacts from normal operations of the SSC on the maximally exposed off-site individual and the general population. CAP-88 uses the AIRDOS-EPA code (Moore et al. 1979) to calculate environmental concentrations resulting from radionuclide emissions into air. The results of the AIRDOS-EPA analyses are estimates of air and ground surface radionuclide concentrations; intake rates via inhalation of air; and ingestion of radioactivity via meat, milk, and fresh vegetables. The code is described in detail in Moore et al. (1979) and summarized in EPA (1989).

DARTAB is the code incorporated into the CAP-88 package to estimate the health effects resulting from airborne emissions of radionuclides (Begovich et al. 1981). DARTAB takes as input the environmental concentrations of radionuclides as calculated by AIRDOS-EPA and provides tabulations of predicted impacts of radioactive airborne effluents. DARTAB is described in Begovich et al. (1981) and RSIC (1987). RSIC (1987, 1990) provides a description of the input and output as well as auxiliary programs for the Clean Air Act Code (CAAC), CAP-88's predecessor, and for CAP-88.

The radiological impacts are also assessed for transportation of the low-level radioactive wastes (LLW) from SSC to the disposal sites. Such impacts include incident-free operations and accident conditions. For the FEIS, the RADTRAN III Code (Madsen et al. 1986) was used to calculate radiological risks from transport of LLW, given the assumption that the LLW disposal site was DOE's Hanford site. In this SEIS, the impacts are also assessed for the alternative LLW disposal site in Texas. For this assessment, the RADTRAN III Code is once again used for the calculation. For comparison, the transportation risks for the Hanford site were recalculated, but updated data and parameters were used.

All radiological impacts are assessed collectively for the affected general population and individually for the hypothetical maximally exposed person, during transportation of radioactive materials involving either on-site or off-site activities. The radiological impacts are expressed as the 50-year committed effective dose equivalent ($CEDE_{50}$) for the exposed individuals and for the exposed population as a whole.

4.7.1.2 Source Terms and Assumptions for Impact Projections

The radiological hazards (i.e., radon and radon progeny source terms) given for the SSC site in the EIS were reviewed and determined to be accurate. However, because of the rather random distribution of radon-producing natural material, the expected absence of appreciable amounts of radon (well below the accepted working level) will be verified through an in-situ air sampling program during and following construction. The *working level* concept is used because of the complex decay schemes and behaviors of radon and its daughters. As a matter of practicality, the working level for occupationally exposed persons, as defined in 10 CFR 20, is taken as 100 pCi/L of Rn-222 at equilibrium. DOE Order 5480.11 lists a concentration guide for radon gas in air under control conditions of 80 pCi/L. As indicated in the DEIS (Appendix 10, Table 10.1.3-12), the SSC site is expected to have tunnel airspace radon concentrations of 6.2 pCi/L, with ventilation during periods of tunnel occupancy. Thus, radon is not expected to be a problem in the tunnels or excavated areas.

Because of changes in the conceptual design of the SSC since the EIS was published (Section 2.1.1), the estimate of the annual amount of radionuclides released into the atmosphere (source terms) by the SSC has been recalculated. There are basically six points where radionuclides are released. These release points and their coordinates are listed in Table 4.17. Initially, only the test beam 200-GeV target will be operating. Later, the 2-TeV target will become operational. The estimated annual radionuclide releases from each of the points are given in Table 4.18. Two of the release

points (IR5 and IR8) are located in the east campus. The rest are in the west campus. Table 4.18 also lists the half-lives of the radionuclides released to the atmosphere.

CAP-88 was used to calculate doses and health effects for a hypothetical maximally exposed off-site individual and for the off-site population within 25 mi of the site boundary. The maximum individual is assumed to reside on the site boundary all his life and consume only the food grown locally. The off-site population is the projected population for the year 2010, which is within the operational period for the SSC (Williams 1990). The population is spatially distributed by direction and distance around the east and west campuses. Food production and consumption parameters for the population are based on Ellis County averages and are assumed to be uniform throughout the assessment region (Williams 1990). The meteorological data used are based on measurements taken at the Dallas-Fort Worth International Airport over five years (1982 through 1986) (Section 4.5.4).

TABLE 4.17 Release Point Coordinates

Release Point	Texas Coordinates
Test beam, 200-GeV target	N 236,851 E 2,175,202
Test beam, 2-TeV target	N 237,832 E 2,174,959
Beam scraper exhaust	N 251,508 E 2,171,621
IR5	N 266,346 E 2,250,661
IR8	N 273,856 E 2,247,633
IR1	N 239,013 E 2,175,513
IR4	N 231,376 E 2,178,674

The source terms and assumptions published in the EIS for muon penetration at the SSC site were reviewed and found to be adequate. A discussion of the "as low as reasonably achievable" (ALARA) concept and transportation of LLW is included to provide a realistic picture of radiation exposure to workers and the public.

Muon penetration into the earth during SSC operations, including beam-loss muons, will result in no additional radiation dose to the public or to the surface environment. Land through which the muons travel and to which they could potentially deliver annual exposures in excess of 10 mrem to individual members of the public will be purchased and maintained with appropriate restrictions on public access. Because muons do not interact strongly with matter, there will be no measurable residual radioactivity and, thus, no potential for groundwater contamination. Stations will be established along muon vectors to continuously monitor muon penetration. Detectors will be placed at the depth of the muons and their cables routed to stations at the surface (Jackson 1987).

Other monitoring stations will be located on the east and west campuses and at E and F sites. These stations will detect any airborne radioactivity or penetrating radiation (primarily gamma rays) produced by SSC operations. An extensive water sampling program will be implemented to verify that the groundwaters and surface waters are safe from radioactivity. Land acquisition requirements include purchase of

TABLE 4.18 Estimated Annual Radionuclide Releases during Normal SSC Operations (Ci/yr)

Radio-nuclide	Half-Life (min)	Test Beam (200 GeV)	Test Beam (2 TeV)	IR5 and IR8	IR1 and IR4	Beam Scraper
H-3	6.47×10^{6}	0	0	5.2×10^{-4}	5.2×10^{-4}	7.2×10^{-4}
Be-7	7.67×10^{4}	0	0	1.0×10^{-1}	1.0×10^{-1}	1.4×10^{-1}
C-11	2.04×10^{1}	0	4.8×10^{1}	2.2×10^{1}	4.8×10^{0}	2.2×10^{1}
N-13	9.99×10^{0}	0	4.8×10^{-1}	5.6×10^{0}	2.6×10^{-1}	4.0×10^{0}
O-15	2.03×10^{0}	0	0	1.0×10^{-2}	0	4.6×10^{-4}
Cl-39	5.55×10^{1}	0	0	1.1×10^{-1}	6.6×10^{-2}	1.4×10^{-1}
Ar-41	1.10×10^{2}	7.5×10^{0}	0	1.8×10^{1}	3.8×10^{0}	1.8×10^{1}
Totals		7.5×10^{0}	4.9×10^{1}	4.5×10^{1}	9.0×10^{0}	4.4×10^{1}

all land where there is a potential to exceed an annual exposure of 10 mrem to an individual member of the public from SSC operations.

The ALARA concept is in use at DOE facilities and encompasses the objective that radiation exposures should be kept as low as reasonably achievable. Through a written radiation control program, potential sources and control methods will be identified. The program will be established and maintained in accordance with relevant DOE orders, including 5480.1B (Environmental Protection, Safety, and Health Protection Program for DOE Operations) and 5480.4 (Environmental Protection, Safety, and Health Program for DOE Contractor Employees at Government-Owned and Contractor-Operated Facilities). In addition, routine monitoring of employees with radiation detection badges and portable survey instruments will ensure that target goals are maintained. Cumulative individual radiation doses will be administratively monitored to maintain ALARA goals.

4.7.1.3 Routine Operational Impacts

CAP-88 was used to calculate the doses for the maximally exposed off-site individual and the general population and the genetic effects for the population for the west campus and separately for the east campus. For the maximum off-site individual dose calculations for the west campus, two cases were considered: an initial case, in which the release points were taken as the 200-GeV test beam target, the radio frequency shaft, and IR4 and IR1, and a future case, in which the 200-GeV test beam target is replaced by the 2-TeV test beam target. The environmental release rates of radionuclides from these points are given in Section 4.7.1.2.

Figures 4.11 and 4.12 show the CAP-88 predictions of the locations of the maximum off-site individuals for the west and east campuses, respectively, along with the radionuclide release points. For the future case in the west campus, there are two locations having the same dose within two significant figures. For the maximum off-site individual locations shown in the figures, Table 4.19 lists the estimated one-year intake and 50-year CEDE, and the health effects in terms of incremental lifetime fatal cancer risk. The lifetime fatal cancer risk values listed in the table were calculated from the CEDE values by using the risk conversion factor of 400 cancer deaths per 1,000,000 person-rem exposure, as recommended by EPA (1989). The annual CEDE received by an individual in Texas because of the natural background radiation is estimated to be
169 100 mrem. Table 4.19 lists these values as well as the expected lifetime fatal cancer risk of this individual due to natural background radiation (using the same EPA risk estimator of 400 cancer deaths per 1,000,000 person-rem exposure).

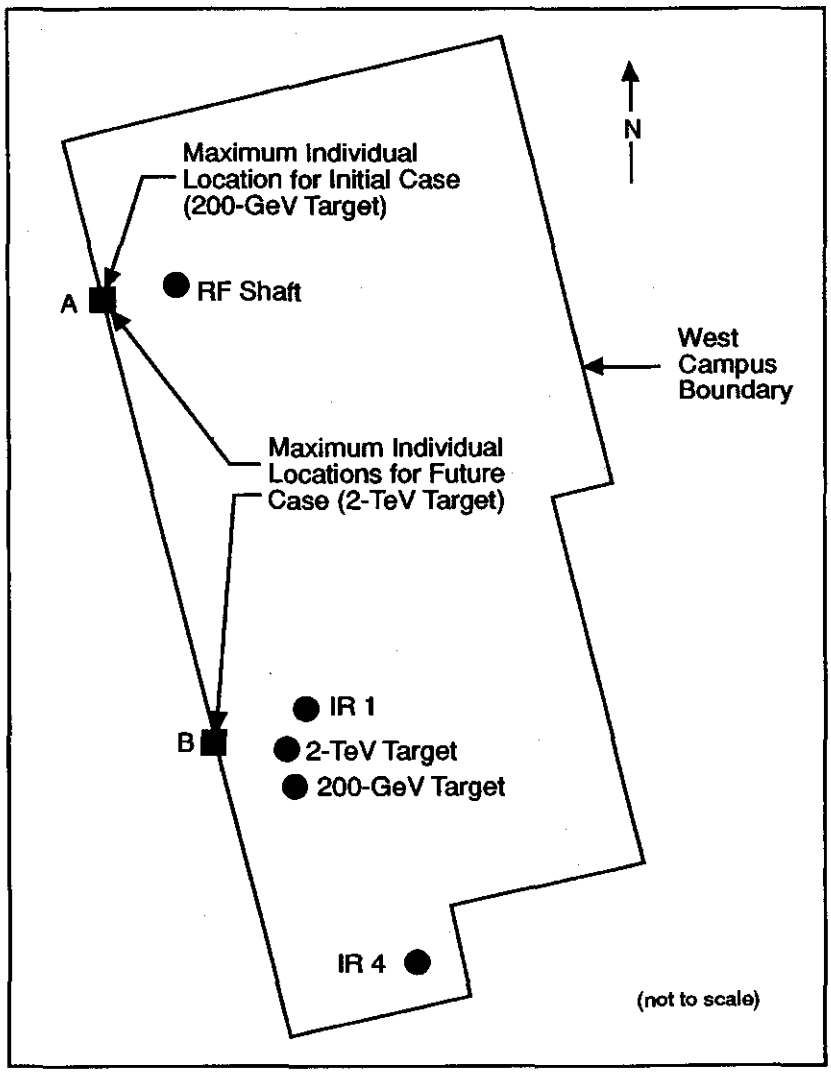

FIGURE 4.11 SSC West Campus Maximum Off-Site Individual Locations and Radionuclide Release Points

Table 4.19 shows that the maximum off-site individual CEDE due to SSC operations is about 3,700 times less than the natural background dose. Also, the incremental lifetime fatal cancer risk due to SSC operations is about 1×10^4 times less than the natural-background-radiation-induced incremental lifetime fatal cancer risk. The estimated maximum off-site individual doses are also much less (by about a factor of 3,700) than the DOE limit
169 of 100 mrem/yr (DOE 1990b).

The off-site population doses and genetic effects as calculated by the CAP-88 package are listed in Table 4.20. The health effects numbers in terms of cancer deaths listed in Table 4.20 were calculated from the collective CEDE values. The risk conversion factor of 400 cancer deaths per 1,000,000 person-rem exposure was used, as recommended by EPA (1989). The genetic effect risk conversion factors used in CAP-88 are the same as those recommended in EPA (1989), that is, 2.6×10^{-4} per person-rad for low LET radiation and 6.9×10^{-4} per person-rad for high LET radiation. Therefore, the values calculated by CAP-88 are reported in Table 4.20.

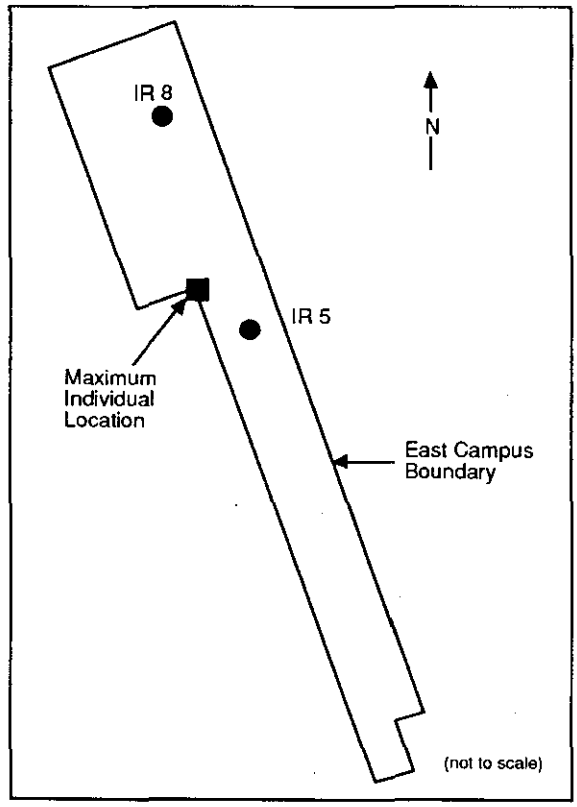

FIGURE 4.12 SSC East Campus Maximum Off-Site Individual Location and Radionuclide Release Points

The fifth in a series of committee reports on the biological effects of ionizing radiation (BEIR V, National Research Council 1990), which was released in mid-December 1989, updates the findings of the BEIR III committee report on the risks of exposure to ionizing radiation. An evaluation of this report and its implications for DOE operations and standards is underway; similar evaluations are being performed by national and international radiation protection organizations. If these findings were to be adopted, the risks calculated on the basis of the BEIR V report would be higher by three to four times than those calculated using the BEIR III risk factors and about a factor of two higher than the EPA values used for this assessment. However, these higher risks have been largely recognized in the EPA health-risk estimators. Thus, if such risk factors were adopted by federal agencies, including DOE, it is unlikely that significant changes in the risk estimates presented in this SEIS would be required.

For the off-site population calculations, releases from all the points in the west campus are assumed to be released from the center of the campus. Similarly, the releases from the east campus area are assumed to be from the center of the campus. A separate population grid is developed for each campus, with the center of the campus

TABLE 4.19 Maximum Off-Site Individual Doses and Health Effects due to Normal SSC Operations and Natural Background Radiation[a]

Source	Committed Effective Dose Equivalent (mrem/yr)	Lifetime Fatal Cancer Risk
West campus, initial case[b]	2.6×10^{-2}	1×10^{-8}
West campus, future case[c]	2.7×10^{-2}	1×10^{-8}
East campus	1.9×10^{-2}	8×10^{-9}
Natural background	1.0×10^{2}	4×10^{-5}

[a]See Figures 4.11 and 4.12 for locations of maximally exposed off-site individuals.

[b]With 200-GeV test beam target.

[c]With 2-TeV test beam target.

being at the center of the assessment grid. The assessment grid goes out to 40 km (25 mi). The centers of the two campuses are separated by a distance of about 21 km (13 mi). Therefore, the two assessment grids overlap, and some of the population will be exposed to radiation from both campuses. However, because of the short half-lives of the radionuclides released to the atmosphere (Table 4.18), the collective dose to the population around the west campus from the releases in the east campus, and vice versa, are small (8.5×10^{-4} and 2.5×10^{-3} person-rem/yr, respectively) compared with the doses listed in Table 4.20.

Also listed in Table 4.20 are the natural background doses and health effects in terms of cancer deaths per year. Values for genetic effects due to natural background radiation are not given in Table 4.20 because, even though there are conversion factors recommended by EPA to estimate these effects (EPA 1989), those factors apply to doses to reproductive organs. Because numbers for reproductive organ doses due to natural background radiation were not available, the genetic effects due to it could not be calculated. As can be seen, the doses and the incremental health effects due to the operation of the SSC are much smaller than the doses and incremental health effects due to natural background radiation.

Occupational and area radiation monitoring will be performed on a routine basis to ensure that exposures are maintained as low as reasonably achievable. The written

TABLE 4.20 Off-Site Population Doses and Health Effects due to Normal SSC Operations and Natural Background Radiation[a]

Source	Collective Committed Effective Dose Equivalent (person-rem/yr)	Health Effects	
		Annual Cancer Deaths	Annual Genetic Effects
West campus, initial case[b]	1.8×10^{-2}	7×10^{-6}	2×10^{-6}
West campus, future case[c]	1.7×10^{-2}	7×10^{-6}	2×10^{-6}
East campus	1.4×10^{-2}	6×10^{-6}	2×10^{-6}
Natural background			
West campus	2.8×10^{4}	1×10	nc[d]
East campus	3.1×10^{4}	1×10	nc[d]

[a]Total population exposed: west campus = 284,000 and east campus = 306,500.

[b]With 200-GeV test beam target.

[c]With 2-TeV test beam target. If both test beams were used for the future case during the same year, the resultant dose would be less than 1.8×10^{-2} person-rem. (The total number of protons in test beams is limited because 200-GeV protons are accelerated to produce 2-TeV test beams.)

[d]nc = not calculated.

radiological control program will address acceptable levels, methods and frequency for monitoring personnel and areas, and emergency action plans.

The changes in the design of the SSC, as detailed in SSCL (1990), require that the estimate of the average yearly amount of LLW produced at the SSC be reexamined. The original estimate, which was based on other accelerator laboratories (such as Fermilab), was that the volume of LLW would be 8,000 ft^3 less if sorting and compaction were employed and that its curie content would be 10 Ci. The major changes in the current design that will affect the amount of waste produced are the modifications in the MEB and HEB and the west beam facilities (Coulson 1989).

Fermilab's experience is that little radioactive waste is produced in the Tevatron accelerator area of the laboratory. This is because the superconducting magnets in this accelerator are limited in the amount of energy they can absorb before they become inoperative, independent of beam energy and intensity. Thus, changes in the HEB will have little effect on the radioactive waste produced at the SSC (Coulson 1989).

The MEB, on the other hand, is a conventional magnet accelerator, and modifications to its design will affect the amount of waste produced. Under the design changes, the MEB has been doubled in both length and energy, while the beam intensity has increased a factor of 10 compared with the original design. Because the activation of the tunnel must be held constant, despite the design changes, to allow safe access to the machine during maintenance periods, the increase in beam energy and intensity will have no effect on the amount of radioactive waste produced per linear foot of the accelerator tunnel. Therefore, the only factor significantly affecting the amount of radioactive waste generated will be the doubling of the energy of the MEB accelerator. This doubling will cause a twofold increase in the volume of waste from failed components and the total curie content of the waste associated with operation of the MEB (Coulson 1989).

In the test beam area, the beam lines also will be composed of superconducting magnets; thus, no additional waste is expected from the beam transport areas. As for the target and backstop areas, these facilities are being designed to minimize the number of failures and changes to the system. The changes in energy and intensity will not change this plan. Thus, the increase in beam energy and intensity at the test beam areas will not significantly affect the total radioactive waste produced.

It was determined that only the MEB will significantly alter the amount of radioactive waste produced at the SSC because of the changes in the accelerator design. Fermilab's experience is that approximately one-half of the radioactive waste produced is from accelerator operation and the other half is generated in target facilities. Of the accelerator-produced waste, most is from the conventional magnet booster rings (approximately 75%). Taking into account the relative lengths of the MEB and LEB, roughly 80% of this waste can be attributed to the MEB. Thus, the MEB will produce approximately 30% ($0.8 \times 0.75 \times 0.5$) of the total radioactive waste produced at the SSC. Doubling the volume of waste produced by the MEB will increase the SSC's average yearly produced volume to approximately 11,000 ft^3. Likewise, increasing the curie content of the waste produced by the MEB by two will increase the average yearly curie content of the radioactive waste to 13 Ci.

In the EIS, the LLW generated by the SSC was assumed to be disposed of at a DOE waste disposal site located at the Hanford Reservation. Shipment of LLW to the Hanford Reservation remains the preferred option. The impact analysis provided in the EIS for LLW shipments to Hanford remains valid. The Texas Low Level Waste Disposal Authority has confirmed its willingness and ability to accept the LLW produced by the SSC since the EIS was published. Texas LLW would be disposed of at a proposed LLW disposal site located approximately one hour from El Paso, Texas, in Hudspeth County. To use this disposal option, DOE would need to grant the SSC an exemption from current DOE Order 5820.2A requirements.

The following discussion addresses the impacts of LLW disposal at the Hudspeth County, Texas, site. The LLW would be shipped from the SSC to the Texas disposal site in 55-gal steel drums (7.5 ft^3) or boxes (56 ft^3) approved by the U.S. Department of Transportation. For the purposes of this analysis, it was assumed that the drums or boxes will be equivalent to Type A containers. A typical shipment of drums would consist of 80 drums and contain 0.4 Ci of Na-22 and 0.4 Ci of Mn-54. A typical shipment of boxes

would consist of 18 boxes and contain 0.6 Ci of Na-22 and 0.6 Ci of Mn-54. Approximately 15 shipments (9,000 ft^3) of drums and 2 shipments (2,000 ft^3) of boxes are expected each year. It was assumed that the shipments would be exclusive use and would be transported by trucks.

The shortest Interstate highway route from the origin to destination is used to transport radioactive materials (49 CFR 177). The route thus selected consists of the following highway segments from the SSC to the Texas LLW disposal site: F.M. 66 to I-35, I-35 to I-20, I-20 to I-10, I-10 to Fort Hancock, and Fort Hancock to the disposal site. The total distance of this route is approximately 994 km, with all but 24 km on the Interstate system. Approximately 20 km of the route is through urban areas; 129 km is through suburban areas; and 845 km is through rural areas.

Radiological dose during normal, incident-free transport results from exposure to the external radiation field surrounding the drums or boxes. The dose is a function of the number of people exposed, their proximity to the containers, the length of time of exposure, and the radiation field surrounding the containers.

Radiological impacts were determined for two groups during normal operations: (1) crewmen and (2) members of the public. The crewmen were assumed to be the drivers of the shipment vehicle. The members of the public were assumed to be persons within 800 m of the road, persons sharing the transport link, and persons at stops.

The computer code RADTRAN III (Madsen et al. 1986) was used to determine the radiological risk from incident-free transportation. The magnitude of this risk depends mainly on the transport index (TI) of the shipment, which is defined as the external dose rate (mrem/h) at 1 m from the package surface, and the surrounding population densities (DOE 1988). For the purposes of this analysis, the TI was assumed to be equal to 0.05 for drums and 0.4 for boxes. Three population density zones (rural, suburban, and urban) were used. These zones correspond to mean population densities of 6,719 and 3,861 persons/km^2, respectively. Data specific to the analysis are contained in Table 4.21.

Radiological risk for incident-free shipments is expressed in terms of the collective dose to crewmen (occupational) and members of the public over the routes of shipment. The annual occupational risks for the shipments are contained in Table 4.22. The annual risks to members of the public for the shipments are contained in Table 4.23. The incident-free annual occupational dose, 5.4×10^{-2} person-rem, and the incident-free annual dose to members of the public, 1.3×10^{-1} person-rem, translate to the estimated 2×10^{-5} and 5×10^{-5} cancer cases per year and the 1×10^{-5} and 3×10^{-5} genetic effects per year, respectively. Health effects conversion factors recommended by the EPA (1989) were used in calculating these values.

The incident-free annual doses from transport of LLW have been assessed in the FEIS for the destination site at Hanford. (In the FEIS [Vol I], Table 5.1.6-3 gives estimates of 0.22 person-rem for members of the public and 1.15 person-rem for crew members.) The revised calculation of doses for transport of LLW from the SSC site to Hanford, given assumptions consistent with those of Table 4.17, are 0.17 person-rem for crew members and 0.39 person-rem for members of the public. These revised estimates

TABLE 4.21 Incident-Free Transportation Parameters

Parameter	Value
Transport mode	Exclusive-use truck
Velocity in population zones (km/h)	
Rural	88.5
Suburban	40.3
Urban	24.2
Number of crewmen	2
Distance from crew to source (m)	10
Stop time per kilometer (h/km)	0.0031
Persons exposed while stopped	50
Average exposure distance while stopped (m)	20
Number of people per vehicle on transport link	2
Distance in population zones (km)	
Rural	845
Suburban	129
Urban	20
Population densities (persons/km^2)	
Rural	6
Suburban	719
Urban	3,861
Number of shipments	
Drums	15
Boxes	2
Number of containers per shipment	
Drums	80
Boxes	18
Transport index	
Drum	0.05
Box	0.4
Activity in single container (Ci)	
Drum, Na-22	0.005
Drum, Mn-54	0.005
Box, Na-22	0.035
Box, Mn-54	0.035
Radioactive half-life (days)	
Na-22	942
Mn-54	300

Source: DOE 1986, 1988.

TABLE 4.22 Occupational Radiological Dose from Incident-Free Transport of LLW from the SSC to the Texas Disposal Site

Population Zone	Unit Dose Factor (person-rem/km)	Distance/ Shipment (km)	Number of Shipments	Collective Dose (person-rem)
Drums[a]				
Rural	2.05×10^{-6}	845	15	2.60×10^{-2}
Suburban	4.50×10^{-6}	129	15	8.71×10^{-3}
Urban	7.52×10^{-6}	20	15	2.26×10^{-3}
Total				3.70×10^{-2}
Bins[b]				
Rural	7.23×10^{-6}	845	2	1.22×10^{-2}
Suburban	1.59×10^{-5}	129	2	4.10×10^{-3}
Urban	2.65×10^{-5}	20	2	1.06×10^{-3}
Total				1.74×10^{-2}
Grand total				5.44×10^{-2}

[a]80 packages per shipment.

[b]18 packages per shipment.

translate into increased annual cancer cases of 7×10^{-5} and 1×10^{-4} and annual genetic effects of 4×10^{-5} and 1×10^{-4}, respectively. These values are about a factor of three higher than those estimated for transport of LLW to the Texas site. The differences are mainly attributable to the difference between the shipment distances (i.e., 845 km from the SSC site to the Texas site versus 3,270 km from the SSC site to the Hanford site).

4.7.2 Nonradioactive Environmental Hazards

4.7.2.1 Technical Approach and Methodology

The technical approach and methodology used to assess health impacts from nonradioactive hazardous and toxic materials are not fully addressed in the EIS because of the conceptual nature of the SSC design. Selection of the Texas site has not resolved this. As discussed below, information from other DOE accelerator facilities can serve as sources of the needed information.

TABLE 4.23 Radiological Dose to Members of the Public from Incident-Free Transport of LLW from the SSC to the Texas Disposal Site

Population Zone	Unit Dose Factor (person-rem/km)	Distance/ Shipment (km)	Number of Shipments	Collective Dose (person-rem)
Drums[a]				
Rural	4.28×10^{-6}	845	15	5.42×10^{-2}
Suburban	1.54×10^{-5}	129	15	2.98×10^{-2}
Urban	7.94×10^{-6}	20	15	2.38×10^{-3}
Total				8.64×10^{-2}
Bins[b]				
Rural	1.51×10^{-5}	845	2	2.55×10^{-2}
Suburban	5.45×10^{-5}	129	2	1.41×10^{-2}
Urban	2.80×10^{-5}	20	2	1.12×10^{-3}
Total				4.07×10^{-2}
Grand total				1.27×10^{-1}

[a]80 packages per shipment.

[b]18 packages per shipment.

4.7.2.2 Source Terms and Assumptions for Impact Projections

The source term and assumptions for projecting impacts from nonradioactive hazards are still within the conceptual phase of the project. A list of materials utilized at Fermilab is a good representation of the type of chemicals that would be encountered at the SSC (Table 4.24). This list represents chemicals used primarily during operations. As required at DOE facilities, all safety and health requirements of various federal agencies -- including DOE, Occupational Safety and Health Administration, National Institute of Occupational Safety and Health, and EPA -- will be implemented, as applicable, in the SSC Health and Safety Plan. Safety analysis reports will be prepared for each phase of the construction and operation of the SSC. These requirements will be followed to protect the health and safety of employees and the public. Herbicides and pesticides will be applied by certified pesticide applicators.

4.7.2.3 Nonhazardous and Hazardous Construction Wastes

Construction of the SSC will generate some nonhazardous wastes (Tener 1989). Construction debris will consist of concrete block, brick, concrete rubble, scrap lumber, drywall material, insulation, and other building materials, all of which are considered nonhazardous. Construction debris will be placed in 30-yd^3 shipping containers. Approximately 128,660 yd^3 will be generated during construction. These materials will

TABLE 4.24 Allowable Levels for Representative Chemicals Likely to Be Used at the SSC

Chemical	TLV[a]		TLV-STEL[b]	
	ppm	mg/m^3	ppm	mg/m^3
Acetone	750	1,780	1,000	2,375
Methanol	200	260	250	310
Beryllium	-	2[c]	-	-
FREON TF	1,000	7,600	1,250	9,500
1,1,1-Trichloroethane	350	1,900	450	2,450
Xylene	100	435	150	655
Toluene	100	375	150	560
Methyl ethyl ketone[d]	2,000	590	300	885
Methylene chloride	50	175	-	-
N-Hexane	50	180	-	-
Hexanes	500	1,800	-	-
Chlorpyrifos	-	0.2	-	0.6
Roundup	NE[e]	-	-	-
Lead	-	015 Pb	-	0.45
Copper	-	1	-	2
Silver				
Soluble	-	0.01	-	-
Dust	-	0.1	-	-
Mineral spirits	500	2,000	-	-
2,4-D	-	10	-	20
HCN[d]	10	11	-	-
Gasoline	300	900	500	1,500
Naphtha	400	1,600	-	-
Benzene[d]	10	30	-	-
Trichloroethylene[d]	50	270	200	1,080
Nitric acid	2	5	4	10
Sulfuric acid	-	1	-	3
Citric acid	NE	-	-	-
Ammonium hydroxide	25	18	35	27
Ethylene glycol	50	125	-	-
Isopropanol	400	980	500	1,225
Ethanol	1,000	1,900	-	-
Sodium chromate	-	0.05	-	-
Copper sulfate	-	1	-	-
Orthene	NE	-	-	-
Dipel	NE	-	-	-
Malathion	-	12.5	-	-
Metribuzin	-	5	-	-
Sodium hydroxide	-	2	-	-
Hydrochloric acid	5	7	-	-
Aquazine	NE	-	-	-
Dalapon	1	6	-	-
AMDRO	NE	-	-	-

TABLE 4.24 (Cont'd)

Chemical	TLV[a] ppm	TLV[a] mg/m^3	TLV-STEL[b] ppm	TLV-STEL[b] mg/m^3
Terbufos	NE	-	-	-
Atrazine	-	5	-	-
Alachlor	NE	-	-	-
Metolachlor	NE	-	-	-
Chlorine	0.5	1.5	1	3
Glycerin	-	5	-	-
Oryzalin	NE	-	-	-
Logic	NE	-	-	-
Bromine	0.1	-	-	0.3

[a]TLV (threshold limit value) is the time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

[b]TLV-STEL (short-term exposure limit) is the concentration to which workers can be exposed continuously for a short period of time without suffering from (1) irritation, (2) chronic or irreversible tissue damage, or (3) narcosis of sufficient degree to increase the likelihood of accidental injury, or materially reducing work efficiency.

[c]In μg/m^3.

[d]A less hazardous chemical will be substituted.

[e]NE = no occupational exposure limit has been established.

be disposed of in a licensed local landfill characterized as a *Type 5* landfill by the Texas Department of Health (Tener 1989).

The SSC construction schedule indicates that the greatest waste quantities will be produced during the period 1991-1995. The exact volume of specific waste materials (by category) generated during a specific period cannot be precisely predicted. The SSC will arrange to have a licensed contractor collect and transport construction wastes to a licensed disposal facility. The disposal of construction debris will not result in adverse environmental impacts if proper transportation and disposal procedures are followed. Items in the *containers* waste category will be compacted and placed in shipping

containers before transport to the disposal facility. The quantities listed above do not include packing materials and crates, which typically can be disposed of at a licensed landfill without preparation or placement in disposal vessels. The majority of liquid wastes generated during construction of the IR halls, tunnel, and injector will consist of petroleum-contaminated soil.

All hazardous wastes generated during construction will be stored, transported, and disposed of in accordance with all legal requirements. As with operational hazardous wastes, construction hazardous wastes will be transported to licensed treatment/disposal facilities by a licensed transporter. Copies of all shipping and disposal manifests will be returned to the SSC, and records will be maintained.

The EIS predicted that the SSC would generate approximately 10,000 gal of hazardous waste annually during operation. Fermilab produced approximately 5,700 gal of hazardous waste in 1988. Since the SSC is projected to have employment about 15% higher than Fermilab and would be considerably larger than Fermilab in area, the value of 10,000 gal is a reasonable estimate of the hazardous waste to be produced at the SSC. The waste produced at Fermilab consisted of 60% solvent waste, 25% photographic developer solution waste, and 15% corrosive waste. The SSC waste is expected to have a similar composition.

On the basis of Fermilab data, the 10,000 gal of waste would have a density of about 8.9 lb/gal. The SSC would therefore be producing about 3,402 kg/mo (45 tons/yr) of waste. This amount would be negligible compared with the 38 million tons of hazardous waste produced annually in Texas.

The disposal of hazardous wastes produced during construction will not result in adverse environmental impacts if proper transport and disposal procedures are followed.

4.7.2.4 Hazardous Construction Wastes

Liquid wastes generated during construction will consist predominantly of ignitable paint wastes, spent solvents, strong acid/alkaline wastes, soil contaminated by petroleum products, spills of petroleum products, and various epoxy resins and adhesives generated by cleaning and degreasing activities. These wastes are all classified as hazardous by the EPA.

A second category of wastes expected to be generated during construction consists of various containers that originally contained hazardous materials. This waste category includes packaging containers that must be disposed of in a licensed landfill conforming to regulations of the appropriate governing authority. The containers to be disposed of will be items such as paint cans, epoxy containers, solvent cans, and cans for various finishing compounds. These are considered hazardous wastes by the EPA (40 CFR Part 261.7, revised July 1, 1989).

Estimated quantities of hazardous wastes generated during SSC construction are as follows: containers -- 143 yd^3 (compacted volume) and liquids -- 18,250 gal.

4.7.2.5 Routine Occupational Impacts

Chemicals

Pursuant to the required Facility Health and Safety Plan, potential exposures to hazardous and/or toxic materials will be monitored to ensure compliance with federal standards. One requirement included in these standards is a Hazard Communication Program that will inform employees about health effects, monitoring methods, and access to available monitoring results. This program also tracks the hazardous and toxic materials from arrival through final disposal or usage. Employee exposure to hazardous/toxic materials will be kept to a minimum, with the federal guidelines functioning as an upper limit.

Impacts from Fire Ants

Fire ants can be controlled through application of approved insecticides, or, in the case of electrical equipment, through adequate sealing of cabinets or junction boxes (Section 3.8.2.2). Personnel exposure can be reduced through the use of commercial insect repellents when encounters are likely. Regardless of the precautions or steps taken to eradicate fire ants, it can be expected that some of the SSC staff and their families will have occasional encounters with fire ants. Some of these encounters may require medical attention.

The red imported fire ant is already well established in the area. Thus, construction of access roads and revegetation of fee simple areas would not be expected to increase fire ant habitat. Construction activities are routinely carried out in fire ant infested areas without serious consequences (Vinson 1989). The ants are undoubtedly a nuisance, but typically active pest control is not done at construction sites. Not trying to control the ants is an acceptable alternative, especially in areas that do not directly interfere with human activities (Drees and Vinson 1988). Well established single-queen colonies can prevent invasion of an area by multiple queen colonies. Eliminating single queen colonies under these circumstances is not recommended. This factor should be considered when deciding on the use of broadcast application of baits, in that single-queen colonies are more easily eliminated with insecticides than are multiple-queen colonies (Glancey et al. 1987). Thus, broadcast application of baits or other types of insecticides should only be used (1) in areas where potential ant contact with people will be frequent and, more importantly, (2) only if red imported fire ants are causing a problem.

Cooling ponds associated with the SSC will produce moist areas that are attractive to newly mated females. These areas will most likely be colonized rapidly and should be monitored and/or treated, if necessary.

While a large portion of the population in areas infested with red imported fire ants may be stung, only a small percentage are at risk in a life-threatening sense (Apperson and Adams 1983). Nevertheless, documented fatalities emphasize the need for SSC health care workers to recognize symptoms of systematic allergic reactions and to

be able to provide emergency treatment for acute reactions. Immunotherapy for long-term management would be advisable for the rare individual who is known to be highly allergic (Rhoades et al. 1989).

It is unlikely that the ants will cause any significant problems regarding operation of the SSC. Ant nests are normally limited to a depth of about 10 ft. Consequently, the ants will not be of concern to the collider ring and other belowground structures (Vinson 1989). Few studies have been conducted on economic damage caused by the red imported fire ant; most studies that have been conducted center on agricultural damage. Fire ants can damage roads by removing soil beneath the roads, resulting in subsequent road collapse (e.g., depressions or potholes). The potential for this can be minimized by treating roadsides with approved insecticides (Banks et al. 1990). In spite of the attraction of fire ants to electrical equipment, proper precautions can be taken to keep ants out of relay boxes, air conditioning units, and other such equipment. Little damage would be anticipated.

The fire ants will still be present, regardless of treatment, but densities can be maintained at tolerable levels.

4.7.3 Solid and Industrial Wastes from SSC Operation

4.7.3.1 Technical Approach and Methodology

The types and volumes of solid and industrial wastes generated during SSC operations have been estimated for a normal operating year and for the lifetime of the project. Disposal impacts have been assessed on the basis of available space at local disposal sites (i.e., existing landfills). The waste types generated at Fermilab during normal operations were used as representative, with increased volumes based on the greater employment expected at the SSC at full operations.

4.7.3.2 Source Terms and Assumptions for Projecting Impacts

Solid wastes are expected to be generated during cleaning of cooling intake and discharge structures at the service areas, during dredging of cooling ponds, and during treatment of sanitary waste at the east and west campus areas, as well as to be derived from various paper products and other debris produced at the campus areas.

In the EIS, it was estimated that 30,000 yd^3/yr of such wastes would be generated at the SSC. Using several methods of estimating solid waste generation described by Wilson (1977), estimates ranging from 15,000 to 60,000 yd^3/yr were made. The EIS estimate falls in the middle of that range. Using 25 data points, Wilson also lists an average of 1.603 tons of industrial waste generated per employee per year in miscellaneous manufacturing operations. Assuming a similar generation of waste at the SSC and 120 yd^3/ton, the 3,000 employees at the SSC would produce about 48,000 yd^3 of solid waste each year. This estimate also represents a median value.

Solid waste would be deposited in local landfills. Assuming 10 yd^3 of solid waste per ton, the SSC would generate 3,000 tons of waste each year. The impacts on the life of several local landfills from adding the solid waste from the SSC are estimated in Section 4.7.3.3.

Sludge would be generated during treatment of wastewater from the SSC. It is estimated that 150,000 gal of raw sewage would be produced each day, or approximately 55 million gal/yr. Typically, 1 million gal of wastewater produced about 4,000 gal of raw waste sludge (Viessman and Hammer 1985), so the treatment facility at the SSC would produce about 220,000 gal of sludge each year. The sludge will be characterized to ensure that hazardous materials are kept below regulatory limits.

The quantity of solid waste generated by dredging the cooling pond and cleaning the intake and discharge structures cannot be determined at this time. These wastes, along with industrial wastes generated in the campus areas, will be properly disposed of in local landfills.

4.7.3.3 Impacts to Existing Waste Disposal Facilities

The Avalon Solid Waste Disposal Unit (SWDU) uses 3.33 acres/yr. Avalon plans to add 186 acres. With 206 acres remaining, Avalon would have a 62-year life at current usage rates of 50,500 tons/yr, or 15,150 tons/acre. The 3,000 tons/yr produced by the SSC would occupy an additional 0.2 acre/yr in the Avalon SWDU.

The Waxahachie SWDU currently deposits 3,500 tons/yr and is expected to close in 14 years (2003). If all SSC solid waste were disposed of there, an additional 1.2 acres/yr would be required.

The Duncanville SWDU currently deposits 41,500 tons/yr on 4.33 acres. The waste generated at the SSC would require an additional 0.45 acre/yr. The Duncanville SWDU has 65 acres remaining and capacity expected for an additional 15 years.

The various federal and state laws and regulations governing waste disposal are discussed in Chapter 5. Regulations regarding solid waste management in Texas are described in the Texas Administrative Code, Chapter 325 -- Municipal Solid Waste Management.

When possible, a volume reduction plan would be implemented to reduce the impact on landfill capacity.

4.7.4 Impacts from Accidents Involving Radioactive and Nonradioactive Materials

The accident impacts and risks assessed in the EIS (Vol. I, Section 5.1.6.3) remain valid. The only additional evaluations and assessments included in this SEIS are in areas where the source terms or other conditions have changed from those used in the EIS.

4.7.4.1 Radioactive Materials

A risk analysis was used to conduct a probabilistic evaluation of the radiological risks of transportation accidents. The accident module of the RADTRAN III computer code (Madsen et al. 1986) was used for the risk analysis.

Accident risk may be generically defined as the consequences of an accident multiplied by the probability of that accident. In practice, any number of different accident sequences exist, each of which has an associated probability. These various types of accident sequences can be grouped according to their severities; in RADTRAN, each of these groupings is considered an accident severity category. Severity is a function of the magnitudes of the impact, puncture, and thermal forces to which a package may be subjected during an accident. Because all accidents may be described in terms of these basic physical forces, severity is scenario-independent. That is, any sequence of events that results in an accident in which a package is subjected to forces within a certain range is assigned to the accident severity category associated with that range of values. Each value must be multiplied by the baseline accident rate. Each population density zone has a distinct baseline accident rate and distribution of accident severities because of differences in average velocity, traffic density, and other factors in rural, suburban, and urban areas.

Radiological consequences were calculated by assigning release fractions to each category for each chemically and physically distinct type of radionuclide. The release fraction is defined as that fraction of the radionuclide group in the package that could be released in a given severity of accident. Release fractions vary by package type. Most solid materials are relatively nondispersible and would be difficult to release in particulate form. Therefore, RADTRAN allows the user to assign values for aerosolized and respirable aerosol fractions of the released radioactive material for each accident severity category. Distinct aerosol and respirable aerosol fractions are assigned by material dispersibility category; these categories describe the physical form of the material (e.g., gas, liquid, solid in powder form, monolithic, or nondispersible solid).

RADTRAN contains a meteorological model that allows the user to define the behavior of a plume of particulates, if one were produced by the type of accident considered. Material released in aerosol form is assumed to travel away from the immediate vicinity of an accident in a particulate plume.

To calculate health effects, five exposure pathways are considered:

- Inhalation of respirable aerosols in the passing plume.
- Cloudshine, which is defined as exposure to penetrating radiation (e.g., gamma radiation) from the passing plume.
- Groundshine, which is defined as exposure to penetrating radiation from radioactive material that is deposited on the ground from the plume.

- Resuspension, which is defined as inhalation dose from respirable aerosols that are deposited on the ground by the passing plume and subsequently resuspended.

- Ingestion, which is defined as exposure from ingestion of agricultural products from areas contaminated by particulates from the plume (rural zones only).

Cloudshine and inhalation of respirable aerosols occur only while persons are exposed to the plume. Since persons outdoors would be most directly affected, RADTRAN allows the user to account for pedestrian densities in urban areas. Groundshine, resuspension, and ingestion doses would be incurred at later times, and their magnitudes would depend, in part, on how rapidly a contaminated area is evacuated and whether the area is cleaned up or restricted from use. RADTRAN allows the user to estimate evacuation times, and it includes contamination thresholds for determining whether interdiction or cleanup will occur.

To calculate total transport risk, the risk per kilometer per shipment is multiplied by the number of kilometers a shipment travels in the appropriate population density zone and by the number of shipments of that type. These products are then summed.

The radiological risk associated with truck accidents involving SSC waste is expressed as the risk per shipment and as the risk for shipments that occur over one year. The risks are the product of several probabilities, which include accident rates, severity categories, release fractions, aerosolized fractions, and respirable fractions, along with the resulting consequences. Table 4.25 contains data pertaining to these probabilities, where the accident severity probabilities are the conditional probabilities estimated for each severity category (from category 1 to category 8).

The risks for single shipments and the risks for shipments made over the life of the program are contained in Table 4.26. The risks are expressed as collective dose, with units of person-rem. The estimated radiological dose for transportation accidents, 4.24×10^{-3} person-rem, translates to 2×10^{-6} health effects and 1×10^{-6} genetic effects per year.

The accident doses from transport of LLW from the SSC site to Hanford were evaluated for the FEIS (Vol. I, Table 12.4.1-3). The table shows an annual accident dose of 6.69×10^{-4} person-rem. Revised accident doses were calculated on the basis of assumptions consistent with those listed in Table 4.21. The revised annual accident dose for transport of LLW to Hanford is 1.32×10^{-2} person-rem, which translate into 5×10^{-6} health effects and 3×10^{-6} genetic effects. These values are about three times higher than those estimated for shipment to the Texas site. As in the incident-free situations, such differences are mainly attributable to differences in distance between the routes from the SSC site to the two LLW sites.

TABLE 4.25 Accident Parameters for Transport of Radioactive Wastes from the SSC[a,b]

Parameter	Value		
	Rural	Suburban	Urban
Accident rates (no./km)	1.4×10^{-7}	2.7×10^{-6}	1.6×10^{-5}
Accident severity probabilities			
Category 1	0.46	0.44	0.58
Category 2	0.30	0.26	0.38
Category 3	0.18	0.22	0.028
Category 4	0.040	0.051	0.0064
Category 5	0.012	0.0066	7.4×10^{-4}
Category 6	0.0065	0.0017	1.5×10^{-4}
Category 7	5.7×10^{-4}	6.7×10^{-5}	1.1×10^{-5}
Category 8	1.1×10^{-4}	5.9×10^{-6}	9.9×10^{-7}

[a]Transport by exclusive-use truck is assumed.

[b]Other, population-density-independent parameters are as follows:

- Package release factors -- 0.0 for Category 1 accidents; 0.01 for Category 2, 0.1 for Category 3, and 1.0 for Categories 4-8.
- Fraction aerosolized -- 0.1 for all categories of accidents.
- Fraction respirable -- 0.05 for all categories of accidents.

Sources: DOE 1986; U.S. Nuclear Regulatory Commission 1977.

4.7.4.2 Hazardous Solid Wastes

The SSC, as generator, has ultimate cradle-to-grave responsibility for the disposal of wastes in accordance with regulations. This is in accordance with (1) 40 CFR 260-270 (Resource Conservation and Recovery Act [RCRA]); (2) Section 7 of the Comprehensive Environmental Response, Compensation, and Recovery Act (CERCLA) (Hazardous Waste Management [EPA requirements]); (3) DOE Order 1540.1 (Materials Transportation and Traffic Management); and (4) 49 CFR 171-179 (Hazardous Materials Regulations [DOT requirements]). DOE Order 5400.3 requires compliance with RCRA. The SSC will maintain a record of accidents or releases of hazardous materials that includes the location, the material involved, and the amount released.

TABLE 4.26 Radiological Doses from Transportation Accidents during Shipment of LLW from the SSC to the Texas Disposal Site

Population Zone	Unit Dose Factor (person-rem/km)	Distance/ Shipment (km)	Number of Shipments	Collective Dose (person-rem)
Drums[a]				
Rural	5.23×10^{-9}	845	15	6.63×10^{-5}
Suburban	1.19×10^{-6}	129	15	2.30×10^{-3}
Urban	3.84×10^{-6}	20	15	1.15×10^{-3}
Total				3.52×10^{-3}
Bins[b]				
Rural	8.15×10^{-9}	845	2	1.38×10^{-5}
Suburban	1.84×10^{-6}	129	2	4.75×10^{-4}
Urban	5.90×10^{-6}	20	2	2.36×10^{-4}
Total				7.25×10^{-4}
Grand total				4.24×10^{-3}

[a]80 packages per shipment.

[b]18 packages per shipment.

Solid waste shipments will be handled by a contractor who will assume responsibility for the material once it is transferred to the contractor's vehicles. As the generator, the SSC retains ultimate responsibility for proper disposal of wastes. The contractor will be required to keep current Material Safety Data Sheets on file with the SSC for each material to be used at the SSC facility.

4.7.5 Cumulative Impacts

4.7.5.1 Radiological Hazards

Radiation effects are assumed to be cumulative in nature and may result in future risk of latent cancers and genetic effects.

Guidance for protection against radiation has been published by DOE under DOE orders for occupational personnel (DOE 5480.11) and for the general public (DOE 5400.5). In addition to meeting the current regulation of 5 rem/yr for occupational exposure and 0.1 rem/yr for exposure to the general public, DOE also strongly advocates the ALARA practice, which is clearly specified in the DOE orders. The ALARA program, which will be instituted at the SSC, will provide an additional safety factor to protect both the employees and the general public.

4.7.5.2 Hazardous Materials

Hazardous and toxic materials that can have a cumulative effect for employee exposure have recommended guidelines for exposure from such organizations as the Occupational Safety and Health Administration, National Institute for Occupational Safety and Health, or the American Conference of Governmental Industrial Hygienists. Chemical exposures will be maintained as low as possible to protect the health of the employee. Engineering controls will be the primary method for reducing employee exposure. If compliance cannot be achieved with engineering controls, then personal protective equipment will be utilized to prevent exposure of employees above the acceptable levels.

4.7.6 Mitigative Measures

4.7.6.1 Radiological Hazards

Radiological controls will be established and maintained to protect employees from harmful exposures. Such protection will be accomplished through implementation of a radiation control program well in advance of the start of SSC operations. Protective measures will include personal monitoring, area monitoring, and project analysis to determine the impact of new projects on the generation of radioactive materials and increased occupational exposure. Design interlocks and employee access control to areas where the potential for radiation exists will be built into the system to reduce the chance for human error. Areas that could receive radiation during operations or in an emergency will be off-limits to all personnel when that potential exists.

4.7.6.2 Hazardous Materials

Exposures to hazardous and toxic materials will be reduced through contractor training, hazard communication, engineering controls, and personal protective equipment. Employee monitoring programs, in coordination with the hazard communication program, will inform the employees of the potential and the actual levels of exposure that have been measured. In emergency situations, the site emergency plan will be activated, and trained spill responders will mitigate the situation.

4.7.6.3 Solid Waste

A state-licensed collection and disposal contractor will provide pickup and disposal of solid waste (refuse) in an approved solid waste disposal area. This contractor will be required to provide a copy of its license and information on the location of the landfill or disposal site. Hazardous wastes will be shipped to permitted hazardous waste storage/treatment facilities by licensed hazardous waste transporters. The hazardous waste contractors will be required to provide documentation of permits and licenses for transportation, storage, or treatment. The final disposal location will be identified before the contracts are awarded. Any change will require evaluation by the SSC before

any material can be placed in a new location. A copy of the completed hazardous waste shipping papers will be returned to the SSC after each shipment, in accordance with EPA regulations. Once the hazardous waste leaves the SSC, the responsibility for accidents or release of the material in transit rests with the waste contractor. The SSC would be notified of any accident or release of material and may evaluate the continuation of the contract.

4.7.6.4 Red Imported Fire Ants

The mitigative measures that will be considered to minimize impacts from red imported fire ants are:

- Consider active control only for areas where there is a likelihood of continuous and frequent contact between ants and humans (e.g., landscaped lawns near major campus facilities).
- Instruct SSC and contractor employees in avoidance techniques and on symptoms of anaphylactic shock.
- Suggest that persons known to be, or who fear that they are, hypersensitive to fire ants consult an allergist.
- Inspect vehicles, nursery stock, and soil brought to a construction site for fire ants, particularly if the site is not heavily infested.
- Periodically remove scrap lumber, equipment, and debris from construction sites as these items can serve as potential nest sites.
- Place susceptible electrical relays, junctions, and circuitry away from moist enclosed spaces that are conducive to ant nests.

4.8 SOCIOECONOMICS AND INFRASTRUCTURE

The information in this section is condensed from a supporting technical document (Robert D. Niehaus, Inc. 1990).

4.8.1 Technical Approach and Methodology

- *Economic Activity.* The methodology for projecting SSC-related direct and secondary economic effects is essentially unchanged from that used in the DEIS (Vol. IV, Appendix 14, Section 14.1.2.3.B.1). Updated information on project spending, earnings, and employment was derived from cost estimates current as of May 25, 1990. In-migrant work-force impacts for the eight-county region of influence (ROI) were derived as the mid-range of a

high and a low scenario, which are also discussed in the DEIS (Vol. IV, Appendix 14, Section 14.1.2.3.B.1).

- *Demographics and Housing.* Total population impacts include in-migrant workers and their families. The average household size of these workers (at the time they in-migrate) and the likely age and sex breakdowns were based on the observed composition of state-to-state migrants in the United States between 1980 and 1985. A cohort-component method was used to estimate children born to the in-migrants and to estimate deaths projected among this impact population. Where the impact population would reside within the region was projected for SSC direct workers by using a procedure based on entropy maximization that simultaneously considers the relative attractiveness of each local area and the travel time from each area to the main campus of the SSC. Housing unit requirements of the in-migrant population were estimated on the basis of documented housing tendencies associated with construction and operation of large-scale facilities.

- *Public Services.* Potential impacts to local public services from increased demand by SSC-induced in-migrants were determined for the region's key public services: public education, law enforcement, fire protection, and health care services. Impacts were determined for the ROI, the eight constituent ROI counties, 15 selected independent school districts (ISDs), and selected communities in the project area.

- *Public Finance.* Increases in local government revenues and expenditures due to SSC development were estimated for Ellis County and 20 jurisdictions within Ellis and southern Dallas counties. The focus of the analyses was on the jurisdictions' general funds and, as applicable, special revenue funds. These funds generally account for the majority of each jurisdiction's operation and maintenance revenues and expenditures.

- *Quality of Life.* Consistent with the approach used in the EIS, the quality-of-life analysis focused on key societal groups, especially the residents who would be relocated as a result of land acquisition. The analysis identified potential quality-of-life impacts from development of the SSC and described differential effects on groups experiencing these impacts. Explicit consideration was given to the perceived values of affected groups, so that project-induced changes could be considered from the point of view of residents.

- *Transportation Systems.* The transportation network of Ellis and southern Dallas and Tarrant counties was examined for potential impacts to levels of service arising from SSC development. SSC-related traffic volumes and peak-hour level-of-service ratings were

projected for road segments (excluding intersections and highway access ramps). The level-of-service ratings were based on Highway Capacity Manual recommendations.

- *Utilities.* Utility providers in Ellis County and communities anticipated to receive substantial in-migration were examined to assess existing service systems, including service areas, infrastructure, and planned expansions. The analysis for each utility system was based on communications with utility representatives, the most recent industry reports providing data on system capacity and performance, and the EIS.

- *Cumulative Growth.* Major projects planned in the region during the 1990s were described to place the SSC within the context of concurrent regional development. The SSC's share of cumulative employment and population was compared with growth projected by the North Central Texas Council of Governments between 1989 and construction year 4, and between 1989 and the first full year of operation. The magnitude of cumulative growth was quantified where possible by incorporating information regarding SSC-related effects and the SSC share of cumulative population growth. A qualitative assessment of the potential effects of cumulative growth on the public and private sectors was made where quantification was not possible.

4.8.2 Source Terms and Assumptions for Impact Projections

After the site selection process was concluded and the Ellis County site chosen by the DOE, the SSCL revised the estimates of labor, labor cost, and materials and services cost to incorporate new engineering and design details. These revised estimates (summarized in Robert D. Niehaus [1990]) were used as the basis for estimating direct and secondary changes to the region's economy and related socioeconomic and infrastructure effects.

Increases in total project cost estimates since the time of the 1988 EIS analysis have not resulted in proportional increases in local socioeconomic impacts. Overall, the 1990 estimates are approximately one-third higher than the estimates used previously for the analysis in the DEIS. Much of the increase in the overall cost estimate is attributable to more realistic cost information regarding technical system components. Only a very small portion (less than 2%) of the technical system of nonlabor costs, however, is estimated to be spent in the region. Thus, the category of spending that has experienced the greatest increase in estimated cost causes only a small increase in the regional spending input to the socioeconomic model. Regional quantities and costs of labor and materials/services are very similar to earlier estimates. The current estimate of the number of jobs in the region is slightly greater than the 1988 estimate, but estimated earnings in the region by direct project workers have declined. This decline in estimated earnings is due to additional, more detailed information regarding the proportion of labor costs that would be made in the form of payments for employee

benefits. Uncertainty regarding actual SSC project spending within the region and associated economic, demographic, and other related socioeconomic impacts has led the DOE and the state of Texas to develop a plan setting forth procedures to monitor socioeconomic impacts and to establish mechanisms for implementing mitigation measures.

4.8.3 Economic Activity

The regional economy is expected to experience beneficial increases in employment, income, and sales, beginning in the early construction years, as a result of SSC construction and operation in Ellis County (Table 4.27). By construction year 4, as many as 9,400 additional jobs would be created, including opportunities for direct employment at the SSC site and for secondary jobs supplying goods and services required by the project and satisfying the additional consumer demand created by direct project workers. As major construction efforts are completed, the number of workers required for the project would decline through construction year 7 and then rebound the following year because of the influx of workers required to complete several components of the project. SSC-related employment would reach its lowest level in year 10, providing approximately 4,200 direct and secondary jobs. During full operation, employment would stabilize and provide about 5,700 direct and secondary jobs in the region. Regional earnings also would escalate as a result of these job increases; sales demand would increase as a result of project-related expenditures for goods and services and additional consumer purchases made by SSC workers.

Of the eight counties in the ROI, Ellis County would receive the largest economic benefits relative to the size of the existing county economy. By construction year 4, more than 1,250 of the region's additional 9,400 jobs created by the SSC would be filled by existing Ellis County residents or by in-migrating workers who would choose to reside in the county. In construction year 8, during the second peak construction period, 1,500 of the 7,000 direct and secondary jobs in the region would be filled by workers living in Ellis County. During full operation, nearly 1,400 of the region's 5,700 jobs would be filled by workers living in Ellis County. Earnings levels and sales demand within the county would increase as a result of SSC construction and operation.

4.8.4 Demographics and Housing

Estimates of overall regional population impacts prepared for this supplemental analysis are approximately the same as those prepared earlier for the DEIS (Vol. IV, Appendix 14, Table 14.1.3.7-4). Current estimates indicate a peak year impact of 8,988 persons and a long-term impact of 7,491 people (Table 4.28). Unlike in the EIS, however, detailed analysis was performed for this SEIS concerning the local distribution of population impacts. The results are similar to those of the previous analysis, except for the city of Waxahachie. It is now projected that a smaller portion of the SSC-related population would reside in that city (926 in the long term, compared with the 1,865 projected previously). Most of the population impacts are still expected to occur in Dallas County; Ellis County ranks second; and Tarrant County ranks third. Impacts to the rest of the counties in the region would be substantially smaller.

TABLE 4.27 SSC-Related Changes in Regional Economic Activity[a]

Economic Attribute	Construction Year 1	2	3	4	5	6	7	8	9	Preoperation Year 10	11	12	Full Operation
SSC-Related Jobs (number)	3,069	6,348	8,713	9,390	8,011	6,991	6,327	7,093	5,132	4,215	5,047	5,533	5,706
Direct Jobs[b]	1,550	2,746	3,740	3,893	3,513	3,296	3,126	3,733	2,641	2,427	2,893	3,158	3,248
Construction	824	1,675	2,279	2,262	1,867	1,417	971	653	416	0	0	0	0
Crafts	199	680	925	903	631	422	241	119	54	0	0	0	0
Technical	246	483	721	731	707	583	525	394	261	0	0	0	0
Management, clerical	379	511	633	627	529	411	206	140	101	0	0	0	0
Operation and preoperation	726	1,071	1,461	1,632	1,646	1,879	2,155	3,081	2,225	2,427	2,893	3,158	3,248
Professional	268	388	517	525	511	562	648	981	656	732	909	1,010	1,044
Technical	78	112	150	152	148	163	188	284	190	212	263	292	302
Clerical and other	360	521	694	705	686	754	869	1,316	880	983	1,220	1,356	1,401
Visiting scientists	20	50	100	250	300	400	450	500	500	500	500	500	500
Secondary Jobs[c]	1,519	3,602	4,973	5,497	4,499	3,695	3,201	3,360	2,491	1,788	2,154	2,375	2,458
Manufacturing	214	615	815	847	628	468	343	307	207	150	178	196	202
Transportation, utilities	117	266	358	438	404	383	397	456	363	282	342	380	395
Trade	433	980	1,392	1,538	1,248	1,008	870	921	679	471	565	621	642
Services	569	1,327	1,836	2,042	1,693	1,392	1,197	1,255	930	655	793	874	904
Other	185	415	572	631	526	443	394	421	311	230	276	304	314
Location of Secondary Jobs													
Dallas County	817	1,964	2,709	2,994	2,438	1,996	1,729	1,813	1,346	967	1,165	1,285	1,330
Ellis County	101	174	246	273	255	224	195	211	150	107	129	140	144
Hill County	12	30	41	46	37	30	26	28	21	15	18	20	20
Johnson County	49	110	153	169	142	118	102	108	79	57	68	75	78
Kaufman County	22	54	74	82	66	54	46	48	36	26	31	35	36
Navarro County	18	44	60	67	54	44	38	40	30	21	26	28	29
Rockwall County	10	25	34	37	30	24	21	22	16	12	14	16	16
Tarrant County	490	1,202	1,656	1,829	1,477	1,204	1,043	1,091	813	584	703	777	804
Earnings (millions 1990$)[d]	81.4	172.3	238.7	261.7	222.1	188.9	168.3	180.9	131.9	98.8	118.1	130.0	134.8
Direct	41.9	77.0	107.0	115.8	103.4	91.9	84.2	92.8	66.3	51.9	61.6	67.6	70.2
Secondary	39.5	95.3	131.7	145.8	118.7	97.0	84.0	88.1	65.6	46.9	56.6	62.4	64.6
Sales Demand (millions 1990$)	122.5	303.1	421.4	469.9	385.3	319.1	278.7	294.0	220.7	161.8	197.2	219.3	228.8
Direct	63.4	154.3	214.5	239.8	197.9	165.4	146.3	155.7	117.2	86.9	105.9	117.7	122.8
Project purchases[e]	31.8	96.3	133.9	152.5	120.0	96.3	82.9	85.9	67.2	47.8	59.5	66.8	70.0
Consumer demand[f]	31.6	57.9	80.6	87.2	77.9	69.2	63.4	69.9	49.9	39.1	46.4	50.9	52.9
Secondary	59.1	148.8	207.0	230.1	187.5	153.7	132.4	138.3	103.5	74.9	91.3	101.6	106.0

[a]Some totals may not be exact because of rounding.

[b]All direct jobs are located in Ellis County.

[c]Includes indirect and induced employment effects.

[d]Earnings from direct and secondary jobs.

[e]Purchases from regional sources used for construction and operation of the SSC.

[f]Demand by direct SSC workers.

Source: Robert D. Niehaus 1990, Table 3-4.

TABLE 4.28 SSC-Related In-Migrating Population and Housing Requirements: Counties and Selected Cities[a,b]

Element	Construction Year 1	2	3	4	5	6	7	8	9	Preoperation Year 10	11	12	Full Operation
Population													
Dallas County	1,361	2,776	3,832	4,246	3,740	3,441	3,258	3,722	2,861	2,534	2,943	3,217	3,344
Cedar Hill	131	230	318	352	332	330	328	392	302	289	332	360	373
DeSoto	241	423	585	648	612	609	605	723	557	534	613	665	689
Duncanville	75	138	191	211	195	190	186	219	169	158	182	198	206
Glenn Heights	33	58	80	88	83	83	82	99	76	73	84	91	94
Lancaster	147	260	359	398	375	372	369	441	340	325	374	405	420
Ellis County	786	1,376	1,903	2,108	1,993	1,989	1,975	2,366	1,822	1,749	2,008	2,178	2,256
Ennis	28	52	71	79	73	71	69	82	63	59	68	74	77
Maypearl	17	30	42	46	44	44	44	53	40	39	45	49	50
Midlothian	42	74	102	113	106	106	105	126	97	93	107	116	120
Red Oak	45	78	107	119	113	113	112	134	103	99	114	124	128
Waxahachie	321	559	773	856	812	812	808	969	746	718	824	893	926
Hill County	20	41	57	63	56	51	48	55	42	37	44	48	49
Johnson County	156	292	403	446	410	395	385	454	349	325	375	408	423
Kaufman County	18	44	60	67	55	46	41	44	34	26	31	34	36
Navarro County	22	47	65	72	61	54	50	56	43	36	42	47	49
Rockwall County	10	22	31	34	29	25	22	24	19	15	18	20	20
Tarrant County	584	1,276	1,761	1,951	1,667	1,476	1,363	1,516	1,164	981	1,148	1,261	1,314
Total ROI	2,957	5,874	8,112	8,988	8,011	7,477	7,144	8,237	6,334	5,704	6,609	7,211	7,491
Housing Units													
Dallas County	375	767	1,058	1,168	1,019	929	871	996	747	650	758	822	844
Cedar Hill	36	64	88	97	90	89	88	105	79	74	86	92	94
DeSoto	66	117	162	178	167	164	162	194	145	137	158	170	174
Duncanville	21	38	53	58	53	51	50	59	44	41	47	51	52
Glenn Heights	9	16	22	24	23	22	22	26	20	19	22	23	24
Lancaster	41	72	99	109	102	101	99	118	89	83	96	104	106
Ellis County	217	380	525	580	543	537	528	633	476	448	517	556	570
Ennis	8	14	20	22	20	19	19	22	16	15	18	19	19
Maypearl	5	8	12	13	12	12	12	14	11	10	12	12	13
Midlothian	12	20	28	31	29	29	28	34	25	24	28	30	30
Red Oak	12	21	30	33	31	30	30	36	27	25	29	32	32
Waxahachie	89	154	213	236	221	219	216	259	195	184	212	228	234
Hill County	6	11	16	17	15	14	13	15	11	10	11	12	12
Johnson County	43	81	111	123	112	107	103	121	91	83	97	104	107
Kaufman County	5	12	17	18	15	12	11	12	9	7	8	9	9
Navarro County	6	13	18	20	17	15	13	15	11	9	11	12	12
Rockwall County	3	6	9	9	8	7	6	6	5	4	5	5	5
Tarrant County	161	353	486	537	454	398	365	406	304	251	296	322	332
Total ROI	815	1,623	2,240	2,473	2,183	2,018	1,911	2,204	1,654	1,462	1,703	1,843	1,891

[a]Totals for Dallas and Ellis counties include impacts in county locations not listed separately.

[b]Some totals may not be exact because of rounding.

Source: Adapted from Robert D. Niehaus 1990, Tables 3-5, 3-6, and 3-7.

Coincident with the estimated decrease in Waxahachie impacts, other portions of Ellis County are now expected to experience greater population impacts (1,330 persons in the long term outside the city of Waxahachie, compared with an estimated 451 in the FEIS). The majority of these people are expected to reside in and around the cities of Midlothian and Red Oak. In Dallas County, population impacts would be concentrated in the southern districts bordering Ellis County. In the long term, the city of DeSoto would experience relatively large impacts (an estimated 689 persons). Other cities in Dallas County in which many of the long-term SSC-related population likely would reside include Lancaster (420 persons), Cedar Hill (373), and Duncanville (206).

Almost half of the total SSC-related regional housing requirements would occur in Dallas County (Table 4.28). Peak requirements there would be 1,168 units in construction year 4; long-term requirements would be 844 units. The peak impact amounts to about 0.1% of total housing units in the county in 1989. Additional housing demand generated by SSC-related population in the city of DeSoto is expected to reach 194 units at the peak and 174 units in the long term. These impacts would be about 1.7% of existing city housing in 1989. Both Cedar Hill and Lancaster also would experience housing impacts in excess of 100 units; these impacts would represent about 1.5% of each city's 1989 housing stock. Vacancy rates for single-family homes in these cities were about 6% in 1989, and rates for multifamily units exceeded 10% (North Central Texas Council of Governments 1989b). The combination of ongoing development and currently available vacant units should absorb the anticipated increase in housing demand.

Whereas housing requirements would be numerically smaller in Ellis County, they would represent larger impacts relative to existing housing stocks. Peak requirements would be 633 units in the county, 259 units of which would be in the city of Waxahachie. These impacts would represent 3.6% of the 1989 county housing stock and 3.8% of the city housing stock. Long-term housing impacts in Ellis County and its constituent cities would be almost the same as these peak impacts: 570 units in the county and 234 in Waxahachie. The 36 units required during the peak year in the city of Red Oak (32 units in the long term) would represent about 3% of that city's housing in 1989. Vacancy rates for single-family homes were about 4% in Waxahachie and about 6% in Red Oak in 1989; for multifamily units, these rates were about 10% in both cities (North Central Texas Council of Governments 1989b). No significant housing impacts are expected.

4.8.5 Public Services

4.8.5.1 Public Education

Most SSC-related enrollment increases would occur in Dallas, Ellis, and Tarrant counties (Table 4.29). Increases in Dallas and Tarrant counties would be distributed mainly among the larger school districts that have the facilities to accommodate such increases. Although smaller in existing facility sizes and enrollments, the Ellis County school districts anticipated to receive SSC-related enrollment increases currently have sufficient classroom space at all grade levels to accommodate the projected enrollment growth. Additional teachers would be needed in many of the school districts, as indicated in Table 4.29.

TABLE 4.29 SSC-Related Changes in Public Education Enrollments and Staffing[a]

County/ School District	Construction Year 1	2	3	4	5	6	7	8	9	Preoperation Year 10	11	12	Full Operation
Enrollments													
Dallas County	230	469	647	717	632	581	550	629	483	428	497	543	565
Cedar Hill ISD	26	46	64	71	67	67	66	79	61	58	67	73	75
DeSoto ISD	46	81	112	124	117	117	116	139	107	102	118	128	132
Duncanville ISD	20	37	52	57	53	51	50	59	46	43	49	54	56
Lancaster ISD	28	50	69	77	72	72	71	85	66	63	72	78	81
Ellis County	188	329	456	505	477	473	473	567	436	419	481	521	540
Avalon ISD	0	0	0	0	0	0	0	0	0	0	0	0	0
Ennis ISD	8	15	20	22	20	20	19	23	18	17	19	21	22
Ferris ISD	4	8	11	12	11	11	11	12	10	9	10	11	12
Italy ISD	4	7	10	11	10	10	10	12	9	9	10	11	12
Midlothian ISD	25	43	60	67	63	63	62	75	57	55	63	69	71
Milford ISD	0	1	1	1	4	1	1	1	1	1	1	1	1
Palmer ISD	3	5	7	7	7	7	7	8	6	6	7	7	7
Red Oak ISD	45	78	107	119	113	113	112	134	103	99	114	124	128
Waxahachie ISD	87	152	210	233	221	221	220	263	203	195	224	243	252
Maypearl ISD	12	21	30	33	31	31	31	37	29	28	32	34	36
Tarrant County	99	216	298	330	282	249	231	257	198	166	194	214	222
Mansfield ISD	30	53	73	81	76	75	75	89	69	65	75	82	84
Hill County	4	7	10	11	10	9	9	10	8	7	8	8	9
Johnson County	33	62	86	95	87	84	82	96	74	69	80	87	90
Kaufman County	5	11	15	17	14	11	10	11	8	6	8	8	9
Navarro County	4	8	12	13	11	10	9	10	8	6	8	8	9
Rockwall County	2	5	7	8	6	6	5	6	4	3	4	4	5

TABLE 4.29 (Cont'd)

County/ School District	Construction Year 1	2	3	4	5	6	7	8	9	Preoperation Year 10	11	12	Full Operation
Teachers													
Dallas County	14	28	38	42	37	34	33	37	29	25	29	32	33
Cedar Hill ISD	2	3	4	4	4	4	4	5	4	4	4	4	5
De Soto ISD	3	5	7	8	7	7	7	8	6	6	7	8	8
Duncanville ISD	1	2	3	3	3	3	3	3	2	2	2	3	3
Lancaster ISD	2	3	4	5	4	4	4	5	4	4	4	5	5
Ellis County	11	19	27	30	28	28	28	33	26	24	28	30	32
Avalon ISD	0	0	0	0	0	0	0	0	0	0	0	0	0
Ennis ISD	0	1	1	1	1	1	1	1	1	1	1	1	1
Ferris ISD	0	0	1	1	1	1	1	1	1	1	1	1	1
Italy ISD	0	0	1	1	1	1	1	1	1	1	1	1	1
Midlothian ISD	1	3	4	4	4	4	4	4	3	3	4	4	4
Milford ISD	0	0	0	0	0	0	0	0	0	0	0	0	0
Palmer ISD	0	0	0	0	0	0	0		0	0	0	0	0
Red Oak ISD	3	4	6	7	6	6	6	8	6	6	6	7	7
Waxahachie ISD	5	9	12	13	13	13	13	15	12	11	13	14	14
Maypearl ISD	1	1	2	2	2	2	2	2	2	2	2	2	2
Tarrant County	5	12	16	18	15	14	13	14	11	9	11	12	12
Mansfield ISD	2	3	5	5	5	5	5	5	4	4	5	5	5
Hill County	0	0	1	1	1	1	1	1	1	0	1	1	1
Johnson County	2	3	5	5	5	5	5	5	4	4	4	5	5
Kaufman County	0	1	1	1	1	1	1	1	1	0	0	1	1
Navarro County	0	1	1	1	1	1	1	1	0	0	0	1	1
Rockwall County	0	0	0	0	0	0	0	0	0	0	0	0	0

[a]Totals for Dallas, Ellis, and Tarrant counties included changes in county locations not listed separately.

Source: Robert D. Niehaus 1990, Table 3-9.

4.8.5.2 Police and Fire Protection

Potential impacts to police and fire protection would occur mostly in Dallas, Tarrant, and Ellis counties. In Dallas and Tarrant counties, the existing extensive network of law enforcement and fire protection would be sufficient to serve SSC-induced population increases, which are relatively small compared with existing county populations. In Ellis County, an additional three police officers and two fire fighters would be needed for both the peak year of construction and during operations to serve the cities of Waxahachie, Red Oak, and Midlothian. Additional vehicles and station space also may be required. Although fire stations are planned for the campus areas, all SSC construction areas could have to call on existing local fire protection services.

4.8.5.3 Health Care

To maintain the currently high service levels in Dallas County, 11 new physicians, 3 dentists, 30 registered nurses (RNs), and 9 licensed vocational nurses (LVNs) would be required at the peak of construction. In Ellis County, a maximum addition of 2 physicians, 1 dentist, 10 RNs, and 6 LVNs would be needed. Demand will increase gradually by less than 2% per year. A gradual increase of this magnitude could be accommodated by Ellis County's existing service delivery system and the recently improved network of emergency medical services.

4.8.6 Public Finance

Potential impacts to local government finances would be limited principally to those jurisdictions within whose boundaries land is proposed for conveyance to the federal government. For some jurisdictions increases in local tax and nontax revenues from direct and indirect project-related development would be sufficient to meet SSC-induced expenditure increases. These jurisdictions include the cities of Glenn Heights, Maypearl, and Red Oak.

Some jurisdictions would experience minor temporary revenue shortfalls (ranging up to about $50,000 annually in the worst case) over the first three years of project construction. Such temporary shortfalls would represent less than 0.5% of each jurisdiction's budget and would be offset by projected surpluses in the later years of the project. These jurisdictions include the school districts of Ennis, Red Oak, Midlothian, DeSoto, Cedar Hill, Lancaster, Duncanville, and Maypearl, as well as the cities of DeSoto, Cedar Hill, Duncanville, Ennis, Lancaster, Midlothian, and Waxahachie (Table 4.30).

Significant reductions in the tax bases and subsequent long-term general fund revenue shortfalls are projected for Ellis County, and for Waxahachie and Palmer ISDs (Table 4.30). These jurisdictions could expect lower property tax collections in their debt service funds as well.

TABLE 4.30 SSC-Related Fiscal Impacts: Net Revenues Minus Expenditures by Selected Jurisdictions (values in 1990 dollars)

Jurisdiction	Construction Year									Preoperation Year			Full Operation
	1	2	3	4	5	6	7	8	9	10	11	12	
Ellis County	(79,397)	(56,104)	(43,927)	(16,284)	6,758	(1,845)	(1,270)	(27,020)	37,414	132	(21,832)	(12,616)	(4,448)
Waxahachie City	(20,950)	(9,489)	(2,692)	11,457	19,054	12,606	13,224	3,466	24,308	9,457	1,217	5,835	8,991
Midlothian City	(1,617)	2,703	6,267	9,579	10,515	8,895	8,890	7,945	9,479	6,858	5,631	7,490	8,305
Ennis City	(1,338)	3,095	6,676	9,581	10,776	9,104	8,755	7,537	9,780	6,648	5,774	7,050	7,711
Maypearl City	2,801	4,957	7,398	8,610	8,271	7,709	7,674	9,242	6,683	6,240	7,419	8,416	8,527
Red Oak City	3,497	14,518	22,932	30,117	30,137	27,408	27,803	30,083	27,847	22,828	23,680	27,312	29,282
DeSoto City	(29,573)	(14,084)	(5,826)	12,336	24,078	16,478	16,212	1,698	34,413	13,404	761	6,387	11,001
Glenn Heights City	3,868	12,746	19,729	25,150	25,123	23,070	23,077	22,842	27,045	19,130	18,798	22,132	24,142
Cedar Hill City	(7,405)	5,246	14,069	24,848	29,512	25,154	24,778	20,999	31,593	21,160	17,084	21,510	24,484
Lancaster City	(12,259)	(4,620)	301	9,313	14,247	10,076	9,776	3,462	16,698	7,475	1,429	4,458	6,981
Duncanville City	(5,125)	4,282	11,387	19,210	21,389	17,253	15,366	11,414	18,120	10,803	7,097	9,512	11,529
Waxahachie ISD	(139,589)	(103,363)	(82,899)	(44,526)	(14,535)	(25,803)	(25,103)	(56,121)	26,227	(24,518)	(52,315)	(38,375)	(26,829)
Midlothian ISD	(28,103)	(2,007)	12,377	35,837	53,002	45,686	46,776	30,771	74,177	43,436	31,054	39,143	47,936
Ennis ISD	(8,201)	(6,151)	(3,557)	(588)	2,589	833	1,544	(2,177)	4,888	1,209	(1,091)	(756)	290
Maypearl ISD	(9,075)	(5,493)	(3,585)	399	2,765	1,649	1,649	(427)	5,689	1,571	(371)	1,169	1,593
Red Oak ISD	(51,464)	(28,578)	(16,315)	7,159	27,196	20,002	20,943	(969)	54,596	21,193	2,274	10,844	19,068
Palmer ISD	(7,730)	(6,191)	(5,199)	(4,105)	(4,105)	(4,105)	(4,105)	(4,156)	(3,507)	(4,601)	(4,620)	(4,105)	(4,105)
DeSoto ISD	(45,701)	(15,338)	3,424	35,398	59,345	49,433	50,426	26,160	90,520	50,175	27,199	39,920	50,106
Cedar Hill ISD	(33,241)	(8,839)	6,588	32,235	50,803	43,115	44,393	25,851	73,850	43,089	25,817	35,444	44,419
Lancaster ISD	(23,660)	(4,590)	8,945	27,740	42,725	36,000	36,845	23,670	58,555	35,535	23,895	30,930	36,465
Duncanville ISD	(24,240)	(14,184)	(6,303)	10,632	23,145	19,437	17,583	5,142	34,695	18,402	6,531	9,669	14,910

Notes: Values in parantheses are negative.

Source: Robert D. Niehaus 1990.

4.8.7 Quality of Life

The residents who would be most affected by the project are the estimated 500 persons (192 households) who live on property (more than 10,000 acres) that would be required in fee simple for the SSC. Owners will be required to sell their properties and move. Those who lease land will have to find other land to lease, and renters will have to relocate. For more than two years, many people in the project area have been in a state of uncertainty about their future, not knowing if or when they may be relocated and worrying about whether they would receive adequate compensation. Although most people adjust well to relocation, the impact could be adverse for older persons, farmers, and long-term residents who are deeply attached to their homesteads. Previous studies suggest that some of the effects of relocation may include disruption of social ties and established social patterns; expenditures of time, energy, and money devoted to finding new housing; changes in housing conditions and costs; changes in location causing changes in accessibility to jobs, services, and activities; and changes in the economic situation of relocated persons. Although these types of problems are unavoidable for some people, the state of Texas has established two relocation service centers (Section 4.8.11) to assist in counseling related to relocation benefits.

Residents living adjacent to SSC sites, including those whose property would be required in stratified fee for the SSC, could constitute the group second most affected by the project. They could be inconvenienced by the noise of ongoing construction and increased vehicular traffic (including heavy trucks), as discussed in other sections of this SEIS. They would see the infrastructure features of the project where once they viewed a rural landscape. All these effects could have a cumulative impact that would influence the quality of life of nearby residents, particularly during the construction phase.

Exurbanites who have moved to the country to escape "big-city living" could experience dissatisfaction with the population growth and increased traffic resulting from development of the SSC. Farmers would be affected by the loss of prime farmland to the SSC and by subsequent accelerated changes in the agricultural way of life in the county. Off-farm employment opportunities generated by the SSC affect rural residents positively.

Town, city, and suburban residents, especially business owners, would benefit from the economic growth generated by the project. The majority of residents, judging by their comments on the DEIS, feel that economic development and the SSC are important to the county. However, many residents desire more local control over how the project and its attendant growth are managed in the county, a role they share with state and federal agencies. Such adjustments probably would not be so necessary for the SSC newcomers, who should find the region hospitable and responsive to their economic and social needs.

4.8.8 Transportation Systems

Traffic volume and peak hour level of service projections for SSC peak construction and full operation on key roadways in the SSC project area are presented in Table 4.31. Short- and long-term impacts during the SSC construction period would

TABLE 4.31 SSC-Related Changes to Road Traffic

Road Segment	Capacity (pcph)[a]	Existing Volume[b] (pcph)	Existing LOS[c]	Peak Construction Year Volume[b] (pcph)	Peak Construction Year LOS[c]	Full Operation Volume[b] (pcph)	Full Operation LOS[c]
I-35E: I-20 to F.M. 1382	8,000	6,450	D	7,700	E	7,850	E
I-35E: F.M. 1382 to U.S. 77	8,000	3,300	B	4,750	C	4,550	C
I-35E: U.S. 77 to U.S. 287	8,000	2,100	A	3,950	B	3,750	B
I-35E: U.S. 287 to F.M. 66	8,000	1,950	A	5,400	C	4,550	C
I-35E: F.M. 66 to S.R. 34	8,000	1,650	A	1,750	A	1,950	A
I-45: I-20 to F.M. 878	8,000	3,050	B	3,200	B	3,600	B
I-45: F.M. 878 to U.S. 287	8,000	2,350	A	2,500	A	2,800	A
S.R. 342: Lancaster to U.S. 77	2,800	450	B	900	C	1,100	C
U.S. 67: I-20 to F.M. 1382	8,000	3,700	B	4,050	B	4,550	C
U.S. 67: F.M. 1382 to U.S. 287	8,000	1,750	A	2,200	A	2,450	A
U.S. 67: U.S. 287 to Ellis County line	8,000	1,200	A	1,250	A	1,400	A
U.S. 287: Ellis County line to U.S. 67[d]	8,000	950	A	1,800	A	1,500	A
U.S. 287: U.S. 67 to F.M. 528 (west)[d]	8,000	1,100	A	2,450	A	2,300	A
179 U.S. 287: F.M. 528 (west) to F.M. 528 (east)	8,000	1,050	A	1,100	A	1,200	A
U.S. 287: F.M. 528 (east) to west of I-45	8,000	1,100	A	1,250	A	1,350	A
F.M. 66: I-35E to Maypearl[e]	2,800	250	A	4,150	F	3,200	B
F.M. 663: U.S. 287 to F.M. 875	2,800	350	B	350	B	400	B
179 F.M. 878: U.S. 287 to I-45	2,800	300	B	300	B	350	B
F.M. 879: F.M. 878 to I-45	2,800	100	A	100	A	100	A

TABLE 4.31 (Cont'd)

Road Segment	Capacity (pcph)[a]	Existing Volume[b] (pcph)	Existing LOS[c]	Peak Construction Year Volume[b] (pcph)	Peak Construction Year LOS[c]	Full Operation Volume[b] (pcph)	Full Operation LOS[c]
F.M. 875: U.S. 287 to F.M. 157	2,800	50	A	50	A	50	A
F.M. 157: F.M. 875 to Maypearl	2,800	100	A	300	A	350	B
F.M. 308: I-35E to Maypearl	2,800	50	A	150	A	150	A
S.R. 34: I-35E to F.M. 55	2,800	200	A	200	A	250	A
S.R. 34: F.M. 55 to F.M. 984	2,800	150	A	150	A	200	A
S.R. 34: F.M. 984 to Ennis	2,800	450	B	450	B	500	B
F.M. 55: S.R. 34 to I-35E	2,800	100	A	100	A	100	A
F.M. 877: S.R. 34 to Waxahachie	2,800	50	A	50	A	50	A

[a]pcph = passenger cars per hour.

[b]Volumes rounded to nearest 50.

[c]Level of service based on nonrounded volumes.

179 [d]U.S. 287 widened by peak construction year to four lanes between the Ellis County line and Sardis (F.M. 528 west) before 1993.

[e]F.M. 66 widened by full operation to four lanes.

Note: Table may be modified based on further study and finalization of a master plan of roadway improvements for the SSC area.

Source: Robert D. Niehaus 1990, Table 3-32.

occur throughout the project area. During the peak year of construction, I-35E (between I-20 and F.M. 66), S.R. 342 (between Lancaster and U.S. 77), and F.M. 66 (between I-35E and Maypearl) would experience peak-hour level-of-service degradation resulting from to SSC-generated commuter traffic. Particularly affected would be F.M. 66. It is slated for widening from two to four lanes, but, according to current schedules, it would still be under reconstruction in 1993. The following road segments would experience peak-hour level-of-service degradation during the operations phase: I-35E (between F.M. 1382 and F.M. 66), S.R. 342 (between Lancaster and U.S. 77), F.M. 66 (between I-35E and Maypearl), and F.M. 157 (between F.M. 875 and Maypearl). The remaining key roads are expected to experience negligible impacts from commuter traffic during SSC construction and operation.

Truck traffic would increase during the construction phase, peaking in the fourth year with 2,010 average daily truck trips on Ellis County roads attributable to the SSC. SSC-related truck traffic is anticipated to occur primarily on F.M. 1493, F.M. 66, and F.M. 1446, between the start of construction and the fifth year, and on F.M. 878 and F.M. 879, between the fifth and tenth years. Improvements to numerous small roads and bridges (as identified by the SSCL) that would facilitate construction and equipment delivery to all portions of the SSC ring should enable all traffic routes used during the construction period to accommodate materials and equipment loads. Roads will be upgraded appropriately to meet the requirements specified in the ISP. The design mitigation strategy for spoils disposal that calls for using spoils as landscaping and berm materials at service and access areas would eliminate both the need for spoils hauling and the associated traffic impacts.

The magnitude of indirect traffic impacts is assumed to be directly proportional to the forecasted magnitude of population increases ascribed to SSC development and would be minimal. There are no anticipated changes to the results of the air, rail, water, and public transportation analyses as presented in the EIS.

4.8.9 Utilities

4.8.9.1 Electricity

The TU Electric system would serve the project by adding several proposed improvements (Section 2.2.6). Construction power requirements could be accommodated with negligible impact, as discussed in the FEIS (Vol. IV, Appendix 14, Section 14.2.2.3.G.1). Beginning in the year before full operation, SSC program-related electrical demand is projected to peak at approximately 200 MW. SSC electrical requirements (representing 0.8% of total system capacity) would be manageable in the planned TU Electric system of approximately 25,000 MW. The impact of project-induced population and commercial and industrial growth would be felt mostly in the addition of individual customers to the existing service network. Percentage increases in population levels, and therefore in service demands, would be highest in Ellis County, where service demands could increase by as much as 3.2%. The existing network of power lines in Ellis County is adequate to accommodate this increased demand.

4.8.9.2 Natural Gas

Natural gas is likely to be supplied to the project by the Lone Star Gas Co. and Valero Natural Gas Co. Both companies have sufficient infrastructure in the project area to meet project demand.

4.8.9.3 Telecommunications

Southwestern Bell Telephone Company would likely provide telecommunications service to the project. A new underground main service cable would be constructed in the right-of-way along F.M. 66 from the telephone company connection point in Waxahachie to the west campus. Distribution trunk lines, potentially of fiber optic cable, would be run underground between buildings and to the collider tunnel. Lines would be run in the collider tunnel to perimeter locations. Construction of the SSC may require relocation of several communications lines, which would have a short-term impact on system continuity. The increase in the number of customers requiring service in Ellis County as a result of the project could be accommodated within the upgraded network.

4.8.10 Cumulative Impacts

Major developments that are planned for the next decade would require almost $10 billion in construction expenditures, with more than $5 billion attributed to state highway construction projects from 1988 through 1995 and $2.8 billion for a light rail rapid transit system in the Dallas area. Several highway projects and the new $3.3 million Waxahachie-Midlothian Airport are slated for development in Ellis County. The cumulative growth resulting from these major projects, as well as from all other development, was estimated from employment and population forecasts by the North Central Texas Council of Governments (1989c). The SSC share of cumulative growth effects would be relatively large in Ellis County (Table 4.32).

4.8.10.1 Public Sector

As indicated in the DEIS (Vol. IV, Appendix 14, Section 14.1.3.8.G), the cumulative effects of the SSC and additional projects planned in Ellis County and southern Dallas and Tarrant counties tend to be complementary, because many of these developments involve expansion of the public infrastructure. Some of the planned improvements include upgraded local roads and highways, new and expanded airport facilities, schools, water and wastewater treatment plants, and local health care and jail facilities. The public sector should be capable of meeting the demand of both SSC and cumulative growth, except that some school districts eventually would need to increase capacity. Table 4.33 shows that, by the fourth year of construction, the Italy ISD would experience cumulative growth that would exceed the current excess capacity of the district by 53 students. The expected SSC-related enrollment in that district in that year would be 11 students, which indicates that the district would have a shortage of classroom space with or without the SSC. By the first year of full operation, the Italy

TABLE 4.32 SSC Share of Cumulative Employment and Population Changes[a]

	Employment Change from 1989 to Peak Construction Year			Employment Change from 1989 to Full Operation		
County	SSC	Cumulative	Percent	SSC	Cumulative	Percent
Dallas	2,994	103,567	2.9	1,330	317,101	0.4
Ellis	4,166	6,360	65.5	3,392	10,411	32.6
Hill	46	N/A[b]	N/A	20	N/A	N/A
Johnson	169	2,381	7.1	78	7,565	1.0
Kaufman	82	1,518	5.4	36	4,857	0.7
Navarro	67	N/A	N/A	29	N/A	N/A
Rockwall	37	1,233	3.0	16	3,856	0.4
Tarrant	1,829	57,723	3.2	804	200,792	0.4

	Population Change from 1989 to Peak Construction Year			Population Change from 1989 to Full Operation		
County	SSC	Cumulative	Percent	SSC	Cumulative	Percent
Dallas	4,246	82,992	5.1	3,344	230,651	1.4
Ellis	2,108	7,770	27.1	2,256	20,656	10.9
Hill	63	N/A	N/A	49	N/A	N/A
Johnson	446	6,972	6.4	423	20,219	2.1
Kaufman	67	4,331	1.5	36	14,064	0.3
Navarro	72	N/A	N/A	49	N/A	N/A
Rockwall	34	2,953	1.2	20	9,648	0.2
Tarrant	1,951	90,422	2.2	1,314	265,347	0.5

[a]Estimates of cumulative growth for peak construction and full operation include SSC-related growth.

[b]N/A = cumulative growth projection not available from North Central Texas Council of Governments.

Source: Robert D. Niehaus 1990, Table 3-35.

TABLE 4.33 SSC Share of Cumulative Public School Enrollment Changes and Resulting Excess School District Capacity[a]

School District	Enrollment Change from 1989 to Peak Construction Year			Enrollment Change from 1989 to Full Operation			Excess Capacity with Cumulative Growth		
	SSC	Cumulative[a]	Percent	SSC	Cumulative[a]	Percent	1989	Peak Construction Year	Full Operation
Ellis County									
Avalon	0	21	1.5	0	71	0.3	93	72	22
Ennis	22	291	7.6	22	795	2.7	986	695	191
Ferris	12	54	21.6	12	147	8.0	605	551	458
Italy	11	81	13.5	12	253	4.6	28	-53	-225
Maypearl	33	72	45.4	36	178	20.0	138	66	-40
Midlothian	67	282	23.6	71	850	8.4	1,310	1,028	460
Milford	1	28	4.5	1	92	1.3	61	33	-31
Palmer	7	28	25.9	7	74	10.1	78	50	4
Red Oak	119	367	32.4	128	967	13.3	633	266	-334
Waxahachie	233	629	37.0	252	1,514	16.6	1,907	1,278	393
Dallas County									
Cedar Hill	71	733	9.7	75	2,325	3.2	960	227	-1,365
DeSoto	124	1,223	10.2	132	3,418	3.9	2,211	988	-1,207
Duncanville	57	485	11.8	56	1,535	3.6	1,540	1,055	5
Lancaster	77	432	17.8	81	1,561	5.2	2,230	1,798	669
Tarrant county									
Mansfield	81	337	24.1	84	980	8.6	2,247	1,910	1,267

[a]Estimates of cumulative growth for peak construction and full operation include projected SSC-related enrollments.

Source: Robert D. Niehaus 1990, Table 3-36.

ISD, as well as the Maypearl, Milford, Red Oak, Cedar Hill, and DeSoto ISDs, would all be affected by cumulative growth. Projections for that year show that a shortage of classroom space would exist with or without the SSC in each of these ISDs, although the SSC-related enrollment increase would contribute to the problem.

4.8.10.2 Private Sector

Although the volume of residential construction has been reduced significantly in the region because of the economic decline in the mid-1980s and severe losses have been incurred by many regional development entities, the private sector should be able to respond to the additional demand for housing created by the SSC and cumulative growth in both the short term and long term. The potential change in quality of life related to cumulative growth would depend on the type and location of other developments in Ellis County and the region. This change may be inevitable in some respects; however, its unavoidability does not necessarily lessen its impact. Utility providers are expected to be able to supply adequate power and other services in response to cumulative development in the region.

4.8.11 Mitigative Measures

Construction and operation of the SSC could result in impacts that require mitigation. The socioeconomic impact analysis identifies possible impacts from construction and operation of the SSC, according to a set of model assumptions. For example, impacts to local jurisdictions depend on assumptions about the number of new residents the SSC project will bring into the community and on the community's ability to plan for and provide those services. Although a range of impact projections can be made in this way, actual impacts cannot be predicted. Thus, commitments for specific types of impact assistance cannot be made at this time.

The proposed mitigative measures are listed after each potential impact:

- *Potential lack of fire protection capabilities during the initial construction phase:*

  - Construct the SSC fire stations at the earliest possible time so that they can be functioning during all of the construction period.

- *Revenue shortfalls in host jurisdictions:*

  - To be effective, socioeconomic impact assistance will need to be based on a monitoring program that will keep track of a set of key indicators. Such a monitoring plan is being prepared by the DOE and the state of Texas (through the Texas National Research Laboratory Commission), in consultation with affected communities. This plan will set forth procedures for monitoring SSC-related impacts (e.g., worker settlement patterns, increases

in emergency service use, and revenue shortfalls); thresholds for determining when an adverse impact occurs; and the types of mitigation and assistance available for each category of impact. The plan will also describe the process for affected parties to agree on appropriate levels of assistance.

- *Displacement of residents from land acquired in fee simple:*

  - The state of Texas has established two relocation services centers through which potentially affected persons will receive relocation counseling related to benefits under the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970.

- *Quality-of-life impacts on residents adjacent to project sites:*

  - Develop and fund a monitoring program that ensures that the project is constructed and operated according to sound environmental and safety policies.

- *Concern about local control over project impacts:*

  - Texas National Research Laboratory Commission enabling legislation has been modified to include at least one resident of Ellis County on the Commission. Ellis County has been granted planning and zoning authority by the Texas legislature on and in the vicinity of the SSCL.

- *Traffic increases on selected routes resulting in degradation of service levels:*

  - Improve the affected road and highway segments sufficiently to prevent level-of-service degradation (in particular, the widening of F.M. 66 from I-35E to Maypearl should be completed on an accelerated schedule to accommodate SSC-related traffic during the construction phase); and

  - Schedule construction activities and encourage use of alternate routes to minimize peak-hour congestion on potentially affected road segments.

Other socioeconomic effects are not anticipated to require mitigative measures. Public service and utility delivery systems should be able to accommodate projected growth in demand. Increased economic activity in the ROI is considered a beneficial effect of the project.

4.8.12 No-Action Alternative

Current staff positions at the SSCL and the Texas National Research Laboratory Commission would no longer be available if the no-action alternative were selected. In effect, these reductions would represent negative economic impacts to the region.

As of January 1990, the SSCL had a staff of about 450 persons, and the Texas National Research Laboratory Commission employed about 50 persons. The SSCL staff is expected to continue increasing in size during 1990, approximately doubling to 900 by the end of FY 1990. The DOE staff is currently 30 employees. Under the no-action alternative, these positions would cease to exist.

Associated earnings and project spending in the region also would no longer occur if the no-action alternative were selected; therefore, expected secondary economic effects likewise would be eliminated. About half of the secondary effects projected for 1990 (Section 4.8.3) are related to operations, and construction-related regional employment and project spending have not yet commenced. It is likely, therefore, that about half of the secondary employment, earnings, and sales demand reported for 1990 (Table 4.27) will already be evident by the end of FY 1990 and would be eliminated under this alternative. This secondary effect of the no-action alternative would therefore amount to the loss of about 400 jobs, nearly $20 million in earnings, and about $30 million in sales demand. Land acquisition is underway; under the no-action alternative, local residents would be unnecessarily disrupted.

As of June 1990, the state of Texas had sold $250 million in general obligation bonds whose proceeds were to be used for state-sponsored programs that would support SSC-related activities (e.g., land acquisition and local government planning activities in Ellis County). Under the no-action alternative, the state of Texas would remain obligated to continue the principal and interest payments to the respective bondholders.

4.9 CULTURAL AND PALEONTOLOGICAL RESOURCES

4.9.1 Assumptions for Projecting Impacts

This assessment of impacts to cultural and paleontological resources is based on projected ground disturbance (surface and subsurface) and projected indirect effects (population growth and economic impacts) of the proposed action. The assumptions regarding location and extent of ground disturbance are based on the current engineering design of the SSC as described in Section 1.2. Secondary growth effects are based on the projections given in Section 4.8.

4.9.2 Cultural Resources

4.9.2.1 Archaeological Sites

Significant archaeological sites (i.e., those eligible for inclusion in the National Register of Historic Places) could be adversely affected by the proposed action. Nineteen historic farmsteads and surficial artifact scatters that have been identified in the west campus area could be damaged or destroyed during the construction of aboveground facilities for the proposed SSC (Jurney et al. 1990). The significance of these sites is being evaluated, in consultation with the Texas Historical Commission.

4.9.2.2 Historic Structures

The project could have both direct and indirect adverse effects on significant historic structures. Recent surveys of lands that would be directly affected have documented 10 potentially significant structures in the designated west campus area (Clark et al. 1990) (Table 4.34). These structures (and any associated remains, such as related features or artifacts) could be damaged or destroyed during the construction of the proposed campus facilities. Assessment of specific impacts and mitigative measures must await formal National Register eligibility determination (in consultation with the Texas Historical Commission) and availability of additional information on construction plans.

Twelve eligible structures are located within the campus areas or other construction zones (Table 4.34). The DOE may require one or more of these structures to be removed during construction of the proposed facilities. The Dunaway house, built in 1855, is a Texas Historic Landmark, and a plan is being developed to preserve that house in place.

A total of 7 other eligible historic structures are reported within the ring (Clark et al. 1990). One or more of these structures could be exposed to construction- or operation-phase impacts, such as vibration, noise, and visual elements that are out of character with the historic setting of the site (36 CFR 800).

Historic structures also could be indirectly affected by the proposed action as a consequence of increased residential and commercial construction. Projected SSC-related housing impacts for Ellis County include an estimated peak demand in 1995 of 606 housing units, 40% of which are expected to be in Waxahachie (Table 4.28). Given the current occupancy rates for Waxahachie (e.g., 95.9% for single-family homes) and smaller communities in Ellis County, residential construction is likely to increase. The projected increases in employment, income, and consumer demand (which, as indicated in Section 4.8.3, are expected to be concentrated chiefly in Ellis County) appear likely to generate additional commercial construction.

Historic structures could be significantly modified or destroyed, or exposed to uncharacteristic visual elements, as a result of this increased construction. It is not

TABLE 4.34 Potentially Eligible Historic Structures in Campus or Service Areas

Survey Identification	Location	Description	Date[a]
	East Campus		
978	Prachyl Road	House	1900
	E10 Area		
4581	Higgins Road	House	1880
	West Campus		
4618	Old Maypearl Road	House	1895
4630	Old Maypearl Road	House	1885
4631	Old Maypearl Road	House	1895
4647	Boz Road	House	1885
4655	Bethel Road	House	1885
4658	Curry Road	Dunaway house	1855
4661	Sims and Curry roads	House	1890
4662	Sims and Curry roads	House	1915
4663	Sims and Curry roads	House	1920
4664	Sims and Curry roads	House	1895

[a]Construction date for item 4658 is known; other construction dates are estimated.

possible at this point to identify specific structures that are likely to be affected indirectly by growth in housing and business, although the relative distribution of housing and economic impacts on various communities in Ellis County can be estimated (Tables 4.27 and 4.28).

4.9.3 Paleontological Resources

The proposed action probably would have no adverse effect on rare or important paleontological resources (Garner and DuBar 1989) (Section 3.10.5).

4.9.4 Mitigative Measures

A variety of mitigative measures are available for reducing impacts to historic properties and archaeological sites. Direct adverse effects (damage or destruction) to significant historic structures and archaeological sites will be avoided by design

modification, if possible. Where avoidance is not feasible, protection (e.g., movement of historic structures to alternative locations) will be undertaken. When this alternative is not feasible, mitigative data recovery will be performed. Such recovery will entail collection and/or excavation of archaeological remains and detailed documentation of historic structures.

All mitigative measures will be undertaken within the context of a comprehensive cultural resources management plan. This plan will be incorporated into the programmatic agreement among the DOE, the Texas National Research Laboratory Commission, the Texas Historical Commission, and the Advisory Council on Historic Preservation. The agreement has been issued for comment to affected local governments and local historic preservation groups. The programmatic agreement ensures that the following stipulations have been or will be carried out by the DOE. Formal signing of the agreement will likely take place in the near future.

4.9.4.1 Archaeological Resources

An archaeological survey has been performed on all SSC project area lands that will be subject to surface disturbance as a direct result of the SSC project. A pedestrian survey using a 20-m traverse interval was conducted to assist in designing the archaeological survey. Shovel testing was used whenever sites were encountered to determine site boundaries and depth of cultural deposits. The survey was designed and conducted in consultation with the Texas Historical Commission and in a manner consistent with the Secretary of the Interior's *Standards and Guidelines for Identification*. The survey also took into account the National Park Service 1978 publication *The Archaeological Survey: Methods and Uses*.

Sites were located on maps of appropriate scale, and the archaeological site data forms were completed. All survey results were submitted to the Texas Historical Commission for review and comment. A determination of eligibility for inclusion on the National Register of Historic Places was made on the basis of the criteria in 36 CFR 60.4. For sites that the DOE and the Texas State Historic Preservation Office agree do not meet National Register criteria, the proposed project will proceed. Sites eligible for listing will be preserved, if possible, under the terms of the cultural resources management plan. If preservation is not possible, an archaeological data recovery program will be implemented in consultation with the Texas Historical Commission.

4.9.4.2 Historic Structures

The architectural survey has been completed, with development of historic *contexts*, where necessary, to assess the National Register eligibility of historic architectural properties identified in Ellis County. The survey, conducted in consultation with the Texas Historical Commission, followed the applicable portions of the Secretary of the Interior's *Guidelines for Archaeology and Historic Preservation*. All information obtained from the survey was provided to the Texas Historical Commission. If the DOE and the Texas State Historic Preservation Office agree that particular structures on SSC

project land are ineligible for listing under National Register criteria (36 CFR 60.4), then the proposed action will proceed. Structures eligible for listing will be left in place, if possible, and maintained under the terms of the cultural resources management plan. If preservation is impossible, relocation or demolition will take place, following preparation of sufficient documentation (e.g., photographs and floor plans) to ensure a permanent and adequate historical record. The appropriate level of documentation will be based on consultation with the Texas Historical Commission.

Other direct effects (noise, vibration, and visual impacts) to significant historic structures located near project facilities will be avoided by resiting or redesigning of the project facilities. When avoidance is not feasible, some form of mitigative protection (e.g., screening with trees and shrubs) will be undertaken.

Indirect effects on significant historic structures in Ellis County as a consequence of increased residential and commercial construction will be minimized by local planning bodies (when no federal and state protection exists). The countywide inventory of historic structures conducted for the proposed action (Section 3.10.3) constitutes a mitigative data recovery measure for these adverse effects, which cannot be predicted in terms of individual structures.

4.9.4.3 Worker Education Program

The DOE will also develop, in consultation with the Texas Historical Commission, an appropriate worker education program. Project workers will be informed about relevant laws and regulations related to unauthorized collection or disturbance of archaeological sites and historical properties. The program will also instruct workers to report immediately to the DOE the discovery of any such materials or properties. Appropriate controls will be instituted to protect highly visible historic structures and archaeological materials from vandalism.

4.10 VISUAL RESOURCES

4.10.1 Technical Approach and Methodology

The technical approach and methodology used in this SEIS to assess potential impacts on visual resources are similar to those of the EIS. A complete discussion of the approach is presented in the DEIS (Vol. IV, Appendix 16) and in a supporting technical document (Headley 1990). The visual resource assessments for the SEIS have been updated from the assessments presented in the EIS to reflect new site-specific information and to address possible impacts from the new locations of project facilities resulting from the counterclockwise ring rotation and from the current conceptual design of surface facilities and their sites. Precise locations of facilities will not be determined until detailed, final designs are prepared. Therefore, the visual impact analysis presented here is based on current assumptions on probable locations of surface facilities at the campus and service areas. Mitigative architectural modifications have not been addressed because of the uncertainties in design at this time. Landscaping has been addressed in general terms as it applies to screening facilities from sensitive views.

4.10.1.1 Impact Definitions

An adverse visual impact results when, within public view, the following occurs: (1) an action perceptibly changes the physical environment so that it no longer appears to be characteristic of the region or (2) aesthetic features of the landscape become less visible (e.g., partially or totally blocked from view) or are removed. Changes that seem uncharacteristic are those that appear out of place, discordant, or distracting. The intensity of the visual impact depends upon how noticeable the adverse change may be.

The four levels of visual impact intensity that may occur are termed visual modification (VM) classes and are defined as follows:

- *VM Class 1 — Not Noticeable.* Changes in the landscape are within the field of view but generally would be overlooked by all but the most concerned and interested viewers; detection would be very low because of distance, screening, and low contrast with context.

- *VM Class 2 — Noticeable, Visually Subordinate.* Changes in the landscape would not be overlooked and would be noticed without being pointed out; changes would attract some attention but would not compete for viewer attention with other features in the field of view. Such changes often are perceived as being in the background.

- *VM Class 3 — Distracting, Visually Codominant.* Changes in the landscape compete for attention with other features in view (attention is drawn to the change about as frequently as to other features in the landscape).

- *VM Class 4 — Visually Dominant, Demands Attention.* Changes in the landscape are the focus of attention and tend to become the subject of view; such changes often cause a memorable and lasting impression of the affected landscape.

Visual impacts can be further defined on the basis of duration and geographical extent of influence as follows:

- *Significant Visual Impacts.* Impacts resulting in a perceptible reduction of visual quality, lasting for more than one year, that are visible from moderately to highly sensitive viewing positions. A perceptible reduction of visual quality occurs when the impact intensity is VM class 2, 3, or 4 within a highly sensitive view or when the impact intensity is VM class 3 or 4 in a moderately sensitive view.

- *Negligible Visual Impacts.* Impacts resulting in no perceptible reduction in visual quality as seen from moderately to highly sensitive viewing position; those lasting for less than one year; or views from positions low in sensitivity.

- *Short-Term Impacts.* Impacts lasting for five years or less.

- *Long-Term Impacts.* Impacts lasting more than five years.

- *Local Scope.* Impacts that affect views from travel routes and areas primarily of local importance, such as city parks, residential areas, or locally popular recreation sites.

- *Regional Scope.* Impacts that affect views of importance to the (1) county or state, such as state parks, recreation areas, or county parks; or (2) larger region, such as public lands managed by the Bureau of Land Management.

- *National Scope.* Impacts where affected views are important at the national level, such as those from nationally designated parks, scenic trails, and wilderness areas.

4.10.1.2 Assessment Methodology

Visual impact analyses and conclusions of impact severity were based on application of the methodology discussed below at viewing positions categorized as moderately to highly sensitive from which SSC project facilities would be most visible. The moderately sensitive and highly sensitive views are described in Section 3.11.2. The following steps were used to assess visual impacts of the SSC project facilities:

- *Identifying the Most Critical Viewing Positions and Project Visibility.* Field investigations were used for preliminary identification of moderate to highly sensitive viewing positions. Computer visibility analyses were used for final verification of viewing positions. Computer-drawn perspectives of site facilities were overlain on photographs of the sites taken from the critical viewing positions. Use of the overlays allowed a determination of topographic and vegetative screening.

- *Selecting Representative Views for Detailed Analysis.* The range of affected views was considered and one or more that best represented the viewing conditions, project exposure, and public use were selected. The most critical views were selected to compensate for uncertainty about final siting and facility design.

- *Assessing the VM Class for Impacts on the Representative Views.* The conceptual designs presented in SSCL (1990) served as the basis for assessing the intensity of visual impacts. Computer perspective drawings scaled to photographs of the affected sites were evaluated for levels of visibility and visual dominance. Photographs of the range of views available from the vicinity also were evaluated to determined the role a selected view plays in the local visual experience. Consideration was given to whether the view was from a stationary point or from a vehicle. Primary viewing positions were assessed, as were viewing distance and factors either drawing attention toward or away from the site.

The following analyses focus on the long-term visual impacts of the SSC project. Project facilities at the west and east campus areas would be too far from the public to be visible, with the exception of service area E1. This area would be visible from a subdivision to the west. Visual impact analyses focused on the 18 service areas and a 4.5-mi extension to the 345-kV transmission line to the west campus. Construction activities at each service area are expected to be completed in one year or less. Visual impacts from construction were not considered in the SEIS because they would be short term and therefore insignificant.

The analyses focused on impacts of the facilities at the service areas, impacts from operations and impacts of the 345-kV transmission line. Facilities and other features of concern include the large buildings for the compressor and cryogenics equipment, the tank farm, electric yards, shaft building, parking lot, access road, and cooling ponds. It was assumed that the service area complex would have an industrial/institutional character that would be incongruous with the rural setting. Also, it was assumed that there would be night lighting and high security fencing around the facilities complex and cooling ponds.

Twelve of the 18 service areas would be within moderately to highly sensitive viewing positions, but only seven would result in potentially significant impacts to viewers. The analyses for these seven service areas and the electric line are presented in the following section. Detailed analyses of all service areas are presented elsewhere (Headley 1990).

4.10.2 Impact Assessment and Mitigation Measures

The following discussion first addresses visual impacts that reflect the current plan for siting SSC facilities. Mitigative measures that will be considered as part of the final design are then presented to determine the level of impact likely to occur after mitigation is implemented. The resulting impact and its significance level is discussed for facilities requiring use of visual mitigative measures.

4.10.2.1 Service Area E2

The E2 site is on a hill southeast of a lake. Most of the trees at the site would be removed to create the cooling pond and buildings. Spoils would be disposed of in berms south and east of the site and would not screen the facilities from critical views from the north. Removal of trees and berm placement would cause nearly all features of the site to be visible from the north. Critical views identified at the lake on the northwest side of the site are from the road accessing the lake, a picnic area along the shoreline, and the lake's surface.

Two representative critical viewing positions were considered. The first position is located next to the access road at the northern end of the dam, approximately 2,100 ft from the service area shaft. The view from this location represents those from the road and the lake, since the line of sight passes over the lake and next to the road. The second position is from a point within the picnic area, approximately 400 ft from the shaft location. Site E2 would dominate views from the road accessing the lake, the lake's surface, and the picnic area. A portion of the facilities would project substantially above the forested horizon. The slopes and crest of the hills are wooded, presenting a gently undulating, nearly flat skyline. The large, 18- to 52.5-ft-high structures at the service area would present an abrupt incongruity in this skyline. Also, no other discrete features in view draw attention away from the proposed facilities. The influence of the facilities, as seen from the road accessing the picnic area, would be magnified by the road's orientation toward E2, thus inviting prolonged attention from people driving into the area. From a boat, viewers would not see any distracting foreground features.

The facilities of the service area would dominate the scene and are classified as VM class 4. Existing visual conditions are VM class 1; consequently, there would be an adverse visual impact of major intensity. Sensitivity for the affected views is moderate; the adverse change is of such a magnitude that the affected public may consider the change to be an obvious reduction in visual quality and a significant impact.

Seven residences adjacent to the northeast side of the service area would not experience visual impacts because of intervening vegetative screening and topographic features.

The following mitigation measures will be considered in the final design planning for the service area:

- Possible movement of the location of the facilities to the southeast.
- Retain as many as possible of the 20- to 25-ft-tall trees along the north and northwest site boundary; this would result in only half of the cryogenics building's being visible and would conceal the tank farm and the compressor and control/electrical buildings.
- Plant additional trees for increased screening.

With successful screening, the visual impact of the facilities would be lessened to the point of appearing to codominate with other features in view (i.e., VM class 3).

Given that the affected views are moderately sensitive, such a residual impact (i.e., impacts after implementing mitigation measures) would not be significant.

4.10.2.2 Service Area F2

Approximately 30 residences are located in a subdivision between 300 and 2,000 ft north of service area F2. Potentially affected views from these residences are categorized as moderately sensitive. The representative critical viewing position is about 720 ft due north of the shaft location at the east end of Daniels Road at its intersection with an unnamed road running south. One home between the viewing position and the service area would be removed, as would a stand of trees presently screening the site. Spoils disposal berms are planned to be located on the south side of the service area and thus would not screen the facilities as viewed from the north. With a lack of vegetative and topographic screening, most site features would be visible. Factors contributing to the high noticeability of the SSC facilities include (1) the horizon is well defined by woodlands and the land is rolling to flat, (2) the line of sight is along a road in the subdivision and SSC facilities would appear at the road's end, (3) the size and scale of the facilities would conspicuously dwarf the residences.

SSC facilities would be highly noticeable to the point of dominating views generally toward the south from many points within the subdivision (VM class 4). Facilities would be highly incongruous with the rural residential subdivision and would appear to be in the neighborhood rather than distant, background features. A change from VM class 2 to VM class 4 would be a noticeable reduction in the quality of the affected views, categorized as moderately sensitive. Visual impacts would be significant and long-term, lasting for the life of the project. The impacts would only affect nearby residents and thus would be local in scope.

If F2 facilities are ultimately sited as planned, tree planting to eventually block views of some site features is the only viable mitigation measure. The use of evergreen trees would provide year-round screening. They would have to be 18 ft tall to block views of the tank farm and fences and approximately 30 ft tall to screen all but the cryogenics building. The top 30 ft of the cryogenics building would still be visible above 30-ft trees planted as a visual screen. Depending on the tree species planted, growth rate, and the number of trees planted, the time required for substantial screening would be many years.

4.10.2.3 Service Area F3

Approximately 15 residences are located south and southeast of the F3 area along Shawnee Road. Views from some of the residences and along Shawnee Road are moderate. Views from the Red Oak Valley Golf Course, located 500-2,400 ft from the service area site, are categorized as highly sensitive.

Two viewing positions were chosen to represent critical views. The first is on Shawnee Road, about 1,050 ft southeast of the shaft location. This position was chosen to represent views from residences and from the road. Six homes near the viewing

position would face the site; therefore, residents would have prolonged, stationary views of the site facilities. A second viewing position was selected at a point approximately 1,050 ft northeast of the shaft location on S.H. 342. This position represents the most critical views from the golf course.

From the Shawnee Road viewing position, the service area site appears mostly wooded, with an open field in the foreground. Trees within the site boundary would be cleared to accommodate facilities and spoil disposal. Some trees outside the site boundary would remain. The affected wooded area represents the essential aesthetic character of the site; removal of the trees would constitute an adverse change in the area's visual quality. The loss of a dominant feature is categorized as VM class 4. Spoils berms would afford no screening relative to the Shawnee Road viewing position. Service area facilities would be seen as one large industrial complex from the highway and nearby residences. No features exist in the site vicinity of sufficient contrast to draw attention from views of the site at this viewing position.

The change of visual impact intensity from VM class 1 to VM class 4 with the construction of the F3 service area would result in potentially significant impact. Views from the golf course are highly sensitive, and the public is likely to consider the SSC facilities a noticeable reduction in visual quality. Since local residents and golfers living outside the local area would be affected, the impact would be both local and regional in scope. The following mitigation measures will be considered in final design planning:

- Grade and dispose of spoils so as to protect stands of trees immediately south and southeast of the site.
- Place spoil berms in the western third of site; this would entirely screen views from Shawnee Road and residences along the road.
- Protect groves of trees with fencing during construction.
- Reorient the facility complex to protect trees in the northeast portion of the service area; this would completely screen lower height buildings, tank farm, fence, lighting, and parking lot.

The retention of woodland would not offset visual impacts. The upper portion of the cryogenics building would be visible to nearby residents. Full screening of the service area from users of the golf course is not possible within a reasonable time frame.

4.10.2.4 Service Area E4

Critical views of the E4 site are from approximately 20 residences along Pritchett Road, located 1,000-2,000 ft west and southwest, and the road immediate to the homes. This viewing position is categorized as moderate. These homes face east; thus, the site is in full view. The critical viewing position selected is at the northwest corner of Pritchett Road, approximately 1,335 ft from the proposed shaft location.

No screening of the site would occur. The site is within a flat, featureless, cultivated field and pasture, and no woodlands are in the line of sight. Spoils disposal berms are planned to be located north of the facilities and peripheral in the affected views, or behind the facilities complex for views from the southwest.

Project facilities at the service area would tend to attract viewer attention since they would be the only features in the affected field and would be in the foreground. The trees that line the northeast edge of the site are nearly 2,000 ft away and form a low, ragged skyline beyond the proposed facilities. The site buildings would rise conspicuously above the horizon.

The E4 facilities would be the focus of attention in the affected views. This is due to the incongruity of the project with the rural/agricultural setting, its degree of visibility, large size, and proximity. Visual intensity would change from VM class 1 to VM class 4, indicating an adverse visual impact of major intensity. Sensitivity for the affected views is moderate. The SSC-induced change would be considered by local residents as an obvious reduction in visual quality. The impact would be significant and local in scope. The following mitigation measures will be considered in final design planning:

- Place spoils disposal berms on the southwest side of the site; this would require locating the cooling ponds to the north and east of the facilities complex.

- Plant trees of 17-40 ft in height on the southern boundary of the service area to screen the tallest buildings.

- Contact off-site landowner of property immediately to the south of the service area relative to shrub or tree plantings; full visual screening can be achieved with plantings of 5- to 7-ft-tall trees or shrubs 30 ft from the viewing positions affected.

4.10.2.5 Service Area E6

Critical views of site E6 occur from F.M. 1722 to the southwest and from Turner Road to the southeast. Eleven residences are located along these roads within 1,300-2,000 ft of the shaft. Views of the SSC facilities from these critical viewing positions would be unobstructed and are categorized as moderately sensitive. No intervening vegetation screening occurs in the critical views.

Spoils disposal berms would minimally screen SSC structures for views from the south but would provide no screening for views from the southwest.

The representative view chosen is from a point on Turner Road about 380 ft from its intersection with F.M. 1722 and 1,600 ft from the shaft location. The spoils berm would be mostly peripheral to the view and would afford only partial screening for the facilities. No vegetation screening exists. Although SSC facilities would not be sited in a focally sensitive position, they would be the only features in the affected view, would

be in the foreground, and would become the focus of attention. Site buildings would rise conspicuously above an almost featureless horizon. The impact on the moderately sensitive views affected would be significant, long-term, and local in scope.

The following mitigation measures will be considered in final design planning:

- Landscaping could achieve full screening of SSC facilities; trees or shrubs would have to be planted no closer than 750 ft from structures and would have to reach 25 ft in height to achieve full screening.

- Plantings of trees 5-7 ft tall, located 30 ft from sensitive viewing positions could achieve full screening, but permission would be required from adjacent landowners.

The degree of success of mitigating impacts at this site would depend largely on the success of working with local landowners in establishing vegetation screening. If all the mitigation measures mentioned above are implemented, residual impacts would be insignificant in the long term.

4.10.2.6 Service Area E10

Critical views of the E10 site would occur from Bethel Church Road, in the vicinity of four homes located 1,600-3,500 ft northeast of the service area shaft. The historic Bethel Church and cemetery are also served by this road. Sensitivity is moderate because of the rural residential area affected. Insofar as views from the road provide the setting for the approach to the historic property, they are categorized as highly sensitive.

The 30- to 45-ft-tall trees along the north side of the stream forming the north boundary of the service area would not be removed during construction. The top 15-28 ft of the cryogenics building would be visible from the driveway entrance of the nearest residence. Unobstructed views of the service area would occur along 700-800 ft of Bethel Church Road near the site entrance. Current conceptual plans require removal of trees for construction of the cooling ponds.

The critical viewing position selected as representative is about 300 ft northwest of the site entrance and 1,850 ft from the shaft location. The viewing position is approximately 34 ft in elevation above the facilities complex pad. Several factors would draw a motorist's attention away from the site structures. When traveling north, some buildings draw attention toward the northwest, while the site is to the southwest. Views of the site from along the road when traveling in either direction are extremely lateral.

Other factors would draw attention to the SSC facilities. Cooling ponds in the foreground would appear large in comparison with small livestock watering ponds in the area. Also, the riprapped shoreline, fountains, and fencing around the cooling ponds would provide an appearance different from the character of the rural setting. The planned 20% slope of the berms along the cooling ponds is not typical of the areas where

5% slopes prevail. Collectively, the cooling pond features and site buildings beyond would attract viewer attention.

Given the attention drawn toward site facilities and their industrial character, the site would dominate the field of view (i.e., VM class 4). The existing visual condition is VM class 1, and sensitivity is both moderate and high. The SSC project would probably result in significant impact and be local in scope.

The following mitigation measures will be considered in final design planning:

- Landscaping along the southwest margin of Bethel Church Road adjacent to the service area could fully screen the site structures; plantings 5 ft tall would achieve the desired screening, depending upon distance from site facilities, proximity to the road, and elevation above the site facilities.

- Planting trees in irregular patterns rather than a linear pattern would better blend with the existing landscape.

If these mitigation measures are implemented, visual impacts will be reduced to a level of insignificance in the short term.

4.10.2.7 Service Area E7

The visual impacts of the proposed E7 service area are predicted to be negligible and insignificant. The SSC facilities would go unnoticed unless pointed out. A detailed discussion of the analyses is provided elsewhere (Headley 1990).

4.10.2.8 Service Area E1

The E1 site is located in the northern portion of the west campus area. The visual impacts of the proposed service area are predicted to be negligible and insignificant. Although E1 is within moderately to highly sensitive views, presence of the SSC facilities would not cause a perceptible lessening of visual quality. The SSC facilities would be noticeable, but subordinate, features of the affected views (i.e., VM Class 2). A detailed discussion of the analysis is provided elsewhere (Headley 1990).

4.10.3 Cumulative Impacts

Cumulative visual impacts are the additive effects of two or more activities or features within a single view or a set of closely related views (e.g., several views from a single position or closely spaced views along a travel route). No non-SSC activities have been identified that are expected to noticeably affect visual and scenic resources in or near the affected areas discussed. No cumulative impacts are predicted due to aggregation of SSC-related activities. Because of the distance between the service areas, views of any of these sites are not interrelated to views of any other site.

However, night lighting of the campus areas can be expected to be of a cumulative intensity sufficient to be noticeable for several miles. The effect would be urban in character and may cause an adverse response from the rural residents affected. No mitigation is possible to offset impacts from night lighting of the campus areas.

4.11 UNAVOIDABLE ADVERSE IMPACTS

Summarized below are the unavoidable adverse impacts, which are those that realistically cannot be mitigated. Chapter 4 contains detailed discussions of impacts, including those that can be mitigated.

- *Loss of Water Wells inside the SSC Footprint.* State records indicate that there are 155 water wells within 2.5 mi of the centerline of the tunnel. The exact number will be determined as a part of the land acquisition process. All existing wells within 150 ft of the tunnel centerline will be closed.

- *Local Groundwater Overdraft.* Initially, local aquifers are expected to experience some overdraft as a result of SSC groundwater use.

- *Loss of Wildlife Habitat.* During the lifetime of the SSC project, approximately 1,925 acres of potential wildlife habitat will be lost as a result of buildings, cooling ponds, roads, and other facilities.

- *Impacts to Isolated Wetlands.* Ten wetlands totaling 14 acres will be impacted because of the proposed action.

- *Impacts to Forested Wetlands.* Two wetlands totaling 7 acres will be impacted because of the proposed action.

- *Relocations.* One hundred ninety-three relocations are expected as a result of the land acquisition process.

- *Air Quality Impacts.* Short-term noticeable fugitive dust emissions are expected during SSC construction.

- *Prime and State Important Farmland Withdrawals.* As a result of the proposed action, the number of acres of farmland expected to be permanently withdrawn will be reported in the FSEIS.

- *Increased Ambient Noise Levels.* Around some service areas, noise levels may be above acceptable levels during SSC construction.

4.12 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The section in the FEIS on irreversible and irretrievable commitment of resources details the natural and depletable resources required for the SSC design. Included are natural and depletable resources (e.g., sand, gravel, and aggregate) and materials derived from natural and depletable resources (e.g., cement, gypsum, glass, steel, natural gas, electric power, land, and water). Although small changes in the land and electric power requirements of the SSC (Chapters 1 and 2) have occurred since the conceptual design, they have not affected the overall commitment of natural resources.

4.13 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

The proposed action would constrain uses of specified resources during the construction and operation of the SSC. These considerations have not changed between the conceptual design (as contained in the FEIS) and the site-specific design.

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5 FEDERAL PERMITS, LICENSES, AND OTHER ENTITLEMENTS

5.1 INTRODUCTION

This chapter identifies federal permits, licenses, and other entitlements that may be required in implementing the SSC project in Texas.

Various federal environmental statutes impose environmental protection and compliance requirements on the DOE, including requirements for the DOE to comply with certain state and local regulatory programs. It is DOE policy to conduct its operations in an environmentally safe and sound manner in compliance with applicable environmental statutes, regulations, and standards.

DOE Order 5480.4 sets forth the legally mandated environmental protection, safety, and health standards applicable to the DOE and DOE contractors during facility design, construction, operation, modification, and decommissioning. It also lists all standards applicable as a matter of DOE policy and some standards and guidelines that are not mandatory but are considered good practice. This chapter reviews the statutes, regulations, and guidelines applicable to the SSC project.

The National Environmental Policy Act of 1969 (NEPA) (42 USC 4321 et seq.) establishes broad national environmental policy. In December 1988, pursuant to NEPA, as amended, the DOE published an FEIS covering proposed construction of the SSC and its effects on the quality of the human environment. On January 25, 1989, a ROD was published in the Federal Register (54 FR 3651), designating Ellis County, Texas, as the location of the SSC. The ROD also stated that the DOE would prepare an SEIS prior to construction of the SSC. This SEIS has been prepared in accordance with DOE regulations (10 CFR 1021, which adopt the Council on Environmental Quality's regulations on implementing NEPA [40 CFR 1500-1508]) (52 FR 47662, December 15, 1987, as amended).

5.2 WATER QUALITY — CLEAN WATER ACT (33 USC 1251 et seq.)

5.2.1 Federal Regulation of Pollutant Discharge

The federal Clean Water Act (CWA) provides that it is illegal to discharge pollutants from a point source into navigable waters except in compliance with a National Pollutant Discharge Elimination System (NPDES) permit for the discharge of any pollutant, or combination of pollutants, into navigable waters. Through administrative and judicial interpretation, the navigable waters of the United States encompass any body of water the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce, including but not limited to interstate and intrastate lakes, rivers, streams, wetlands, prairie potholes, mudflats, intermittent streams, and wet meadows. The NPDES program does not apply to the introduction of sewage, industrial waste, or other pollutants into a publicly owned treatment works by indirect discharges [40 CFR 122.3(c)], or into privately owned treatment works [40 CFR

122.3(g)], provided the Administrator has not required the privately owned treatment works users to obtain separate permits [40 CFR 122.44(m)]. This program is administered by the Water Management Division of the EPA pursuant to regulations found at 40 CFR 122 et seq.

Deterioration of surface water quality at the SSC site area could result from surface and channel erosion, pollutant washoff, spoil disposal, and wastewater or storm water discharges. Development of the area could create the potential for spills of pollutants. There could be short-term impacts to surface water quality from erosion of spoil placed as berms, although the potential for impacts from leachate appears to be low (Section 4.2.2.5). Sewage, or domestic wastewater, will be discharged into on-site sewage treatment plants located at the east and west campuses. The treatment plant effluent will be used for irrigation or industrial purposes, and the sludge will be removed to off-site disposal facilities. There will also be a temporary evaporative field for sewage treatment at the magnet support facility until the west campus sewage treatment plant is completed. This field will be equipped with a liner and will be designed for zero discharge. This sludge also will be removed to off-site disposal facilities. Because all permanent and temporary sewage treatment facilities will be designed for zero discharge, there will be no pollutant discharge to navigable waters of the United States; therefore, an NPDES permit would not be required for the sewage treatment facilities. However, the facilities would require design approval, inspection, and reporting under the Texas Health and Safety Code, Chapter 26, with regulations found at 31 TAC 317.

Ion-exchange resins used for the portable mixed-bed demineralizers for polishing the low-conductivity water will be removed by a licensed vendor to an off-site regeneration facility. Wastewater from industrial cooling water will be discharged into lined ponds for evaporation (Section 4.2.2.5). If there will be any discharge of pollutants into the navigable waters of the United States from normal operation of the SSC (i.e., cooling pond runoff or discharges), the federal CWA would apply and an application for an NPDES permit would have to be made under 40 CFR 122.21 at least 180 days before the discharge is to commence.

Sections 401 and 405 of the Water Quality Act of 1987 added Section 402(p) to the CWA, which requires the EPA to establish regulations for issuing permits for storm water discharges associated with industrial activity. Proposed regulations for storm water discharges associated with industrial activity were published on December 7, 1988 (53 FR 49416). The language of the Water Quality Act of 1987 requiring an NPDES permit for storm water discharge was codified into EPA regulations at 40 CFR 122.26 (54 FR 246, effective January 4, 1989). Pursuant to revised 40 CFR 122.26(a)(1)(ii), any storm water discharge associated with industrial activity requires the obtaining of an NPDES permit. However, regulations implementing a separate storm water permit application process have not yet been adopted. It is anticipated that one year from their adoption in October 1990, the proposed regulations (published on December 7, 1988) will become effective. Pursuant to 40 CFR 122.21, an NPDES permit must be applied for if any storm water discharges are anticipated during SSC construction or operation.

5.2.2 Federal Regulation of Discharge of Dredged or Fill Material during Construction

Discharges of dredged or fill materials into waters of the United States, as defined in 33 CFR 328.3, would require a permit under Section 404 of the CWA (33 USC 1344). This program is administered by the U.S. Army Corps of Engineers. Permit applications are reviewed by the district engineer or the division engineer, if a federal agency has such an agreement.

On February 8, 1990, representatives of the SSC met with the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service to discuss (1) whether construction in a floodplain or wetlands area, or over various streams, would require permitting; (2) whether construction could be controlled to prevent regulated discharges of dredged or fill materials; and (3) if permitting were necessary, what mitigative measures should be incorporated. These issues are not yet resolved.

5.2.3 State Water Quality Permits

Texas has not received EPA approval of its NPDES program under the federal CWA. The Texas Water Quality Act, Texas Water Code Annotated, Section 26.121, requires a state permit for any discharges into or adjacent to waters in the state. The discharge of dredged or fill materials into waters in the state during construction would require a state permit [31 TAC 279.4(b)]. Pursuant to 33 CFR 320.4(j)(1), the U.S. Army Corps of Engineers may not issue a federal Section 404 permit if a state permit application is denied or if the discharge will violate any state water quality standards. Therefore, to secure a federal Section 404 permit, an application for the discharge of dredged or fill material into waters in the state must be made to the Texas Water Commission, Water Permit Bureau, pursuant to 31 TAC 279.1 et seq.

5.3 EXECUTIVE ORDER 11988 — FLOODPLAIN MANAGEMENT, AND EXECUTIVE ORDER 11990 — PROTECTION OF WETLANDS

Executive Order 11988 requires each federal agency to issue or amend existing regulations and procedures to ensure that the potential effects of any action it may take in a floodplain are evaluated. Executive Order 11990 requires all federal agencies to issue or amend existing procedures to ensure consideration of wetlands protection in decision making.

Under the DOE regulations implementing these executive orders (10 CFR 1022), the DOE is to take action to avoid, to the extent possible, adverse impacts associated with the destruction of wetlands and the occupancy and modification of floodplains and wetlands.

The DOE has proposed to relocate all shafts and buildings outside floodplain areas to mitigate significant floodplain impacts (Section 4.2.2.2). However, some portion of the SSC facilities will be located in a floodplain/wetland area (i.e., E8).

5.4 SAFE DRINKING WATER ACT (42 USC 300f et seq.)

Raw water will be obtained from Tarrant County Water Control and Improvement District No. 1 and pumped into a storage tank at the west campus before being treated at a 500,000-gal/d water treatment plant (Section 2.2.3). Water at the east campus will be pumped into a 400,000-gal storage tank from raw water pipelines located near the site. Water will be obtained from either a 72- or 90-in. raw water pipeline for industrial irrigation and fire protection supply at the east campus. The service areas will have no domestic water supply. Water for industrial use at the remote service areas will be obtained from aquifer wells drilled at each site and will be stored in ponds for use for cooling, fire protection, and irrigation (Section 4.2.3.1).

The Safe Drinking Water Act applies primarily to public water systems. Pursuant to Section 300g-2 of the Act, Texas has primary enforcement responsibility for public water systems in the state (Texas Revised Civil Statutes Annotated, Article 4477-1).

Pursuant to 25 TAC 337.201(j), public water system means a system for the provision to the public of piped water for human consumption. If the system has "at least fifteen service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year . . . an individual shall be deemed to be served by a water system if he . . . works in a place to which drinking water is supplied . . . ." Therefore, to supply water through its own treatment facilities, the SSC would be required to obtain review and approval from the Texas Department of Health pursuant to 25 TAC 337.202(f). The review is conducted by the Plan Review Branch of the Texas Department of Health, Division of Water Hygiene. Approval would be contained in a letter from the Plan Review Branch Chief or Senior Engineer.

5.5 CLEAN AIR ACT (42 USC 7401 et seq.)

Texas has responsibility under the terms of the federal Clean Air Act (CAA) to implement national primary and secondary ambient air quality standards within the state. However, Texas has not received EPA approval for enforcement of the Prevention of Significant Deterioration Program (42 USC Part C), New Source Performance Standards (42 USC 4311), or National Emission Standards for Hazardous Air Pollutants (42 USC 7412). The Texas Air Control Board implements the Texas Clean Air Act (Texas Health and Safety Code, Title V, Subtitle C, Chapter 382 and Texas Revised Civil Statutes Annotated, Article 4477-5) pursuant to regulations set forth at 31 TAC 101 et seq.

5.5.1 Attainment and Maintenance of National Ambient Air Quality Standards (NAAQS)

A commitment was made in the EIS to use more site specific emissions inventory data in performing additional air quality analyses of construction-generated fugitive dust impacts. Detailed site-specific data were collected to develop a refined PM_{10} construction emissions inventory. Any mitigative measures (emission limitations) required to achieve compliance must be federally enforceable. The DOE has consulted

with the EPA Region VI office to establish a mechanism to ensure federal enforceability of any necessary fugitive dust mitigative measures (EPA 1989). Before ground-breaking commences, the SSCL will consult with the Texas Air Control Board about obtaining a state permit with federally enforceable conditions for PM_{10} emissions.

The Texas Clean Air Act is embodied in both Title V, Subtitle C, Chapter 382 of the new Texas Health and Safety Code and in any sections of Texas Revised Civil Statutes Annotated, Article 4477-5, which were amended by the 71st Texas legislature. Texas regulations concerning air pollution are set forth at 31 TAC 101 et seq.

Pursuant to Section 382.057 of the Texas Health and Safety Code [or Section 3.27(a) of Texas Revised Civil Statutes Annotated, Article 4477-5], the Texas Air Control Board may, by rule, exempt the requirements of permitting and registration of certain types of facilities if it is found on investigation that such facilities will not make a significant contribution of air contaminants to the atmosphere. Clean Air Act are found in the Standard Exemption List, which is filed with the Texas Secretary of State's Office. Unlike the federal standards, a listed facility is exempt, pursuant to 31 TAC 116.6, if actual emissions do not exceed 250 tons/yr of carbon monoxide or nitrogen oxides, or 25 tons/yr of any other air contaminant except carbon dioxide, water, nitrogen, methane, ethane, hydrogen, and oxygen. The SSC is designated a public works project; therefore, the concrete batch plant operations, exempt under exemptions 71 and 93, would not need public notice and opportunity for public hearing.

5.5.2 Prevention of Significant Deterioration

The Texas state implementation plan has not yet obtained approval for delegation of authority under the federal CAA; therefore, pursuant to 40 CFR 52.2303(b), the regulations for preventing significant deterioration of air quality found at 40 CFR 52.21(b) through (w) are incorporated and made a part of the Texas state plan.

Under Part C of the federal CAA, emission limitations are set forth to prevent the deterioration of air quality. Prevention of significant deterioration (PSD) permitting applies to new major stationary sources of air pollutants in attainment or unclassified areas, such as Ellis County. A major stationary source is one that emits a minimum of 250 tons/yr of air pollutants subject to regulation under the Act [40 CFR 52.21(b)(1)(i)(b)]. The PSD regulations also set forth specific industry classifications, which are limited to 100 tons/yr of pollutants [40 CFR 52.21(b)(1)(i)(a)].

Sections 52.21(b)(1)(iii), (b)(4), and (b)(18) of the federal PSD regulations exempt SSC fugitive dust emissions from full PSD construction permit review. Except for nitrogen oxides, all other associated SSC pollutant sources have potential emissions well below what would trigger [Section 52.21(1)(b)] a full PSD review (FEIS, Vol. IV, Appendix 8). However, under the regulations at 40 CFR 52.21(b)(4), nitrogen oxide emissions from SSC heaters and backup diesel generators must be calculated on the basis of the "potential to emit" or the maximum capacity of a stationary source to emit the pollutant under its physical and operational design. Such a calculation was made, and the nitrogen oxide emissions from the diesel generators were found to exceed the PSD limitation of 250 tons/yr. The diesel generators will be operated only one hour every two

weeks for testing purposes; however, such a condition of operation is not federally enforceable unless the restriction is made part of a state or PSD permit. Therefore, before construction commences, the SSCL will consult with the Texas Air Control Board to obtain a state construction permit that includes the restricted operating conditions. The operating restrictions will thereby be federally enforceable, and the SSC would remain exempt from PSD review for all pollutants (EPA 1989).

The PSD regulations also provide for tracking PSD increment consumption. Minor sources, such as the SSC, that are exempt from full PSD review may be required to determine the level of new source increment it uses in a previously established "baseline" area. Discretion in determining how to track increment consumption is provided to EPA regional offices. It is EPA Region VI's policy not to require an increment consumption analysis from minor sources (EPA 1989).

5.5.3 New Source Performance Standards (42 USC 4311)

Although there may be some air emissions of nonradioactive hazardous materials resulting from evaporative loss of volatile substances used in experimental areas and for site and equipment maintenance, none of the SSC air contaminants qualify under the New Source Performance Standards (NSPS) list of source categories as found in 40 CFR 60.

5.5.4 National Emission Standards for Hazardous Air Pollutants (42 USC 7412)

Section 112 of the CAA restricts emissions of hazardous air pollutants, which are defined in 40 CFR 6101(a) to include radionuclides. Therefore, emissions of radionuclides must comply with the requirements of 40 CFR 61, Subpart H [54 FR 51,695-97 (1989)]. The EPA promulgated revisions to the National Emission Standards for Hazardous Air Pollutants (NESHAPS) for radionuclides on December 15, 1989 (40 CFR 61, 54 FR 51,654-715). The new standards for DOE facilities were changed from a whole-body dose equivalent of 25 mrem/yr and critical organ dose equivalent of 75 mrem/yr to an effective dose equivalent of 10 mrem/yr. The standard specifies that compliance can be determined with the CAP-88, AIRDOS-PC, or COMPLY computer codes, or other procedure for which EPA has granted prior approval [40 CFR 61.93(a)]. The impact analysis in the EIS utilized the Clean Air Act Code (CAAC) system of models, which is the previous approved EPA method. That analysis indicated that a negligible whole-body dose equivalent of 0.002 mrem/yr to the maximally exposed individual would result from SSC operations. Reanalysis to determine compliance with the new standards shows negligible impacts to the maximally exposed individual (Section 4.7).

Pursuant to 40 CFR 61.05, the DOE cannot construct the SSC without first obtaining written approval from the Administrator of the EPA in accordance with Subpart A. Pursuant to 40 CFR 61.07, an application for approval of construction is to be filed before construction commences. The application is to include the location and all technical information describing the proposed nature, size, design, operating design capacity, and method of operation of the source, as well as the calculations of emission estimates in sufficient detail to permit validation. The Administrator must notify the

DOE of approval or intention to deny within 60 days after receipt of sufficient information to evaluate the application (40 CFR 61.08). Approval will be given if the Administrator determines that the SSC, if properly operated, will not cause emissions in violation of a standard. Further, prior to the initial startup of SSC operations, the DOE must provide written notification to the Administrator no more than 60 or less than 30 days before the anticipated date of initial startup (40 CFR 61.09).

An annual report showing the results of the monitoring as recorded in DOE's Effluent Information System and the dose calculations required by 40 CFR 61.93(a) for the previous year must be filed with EPA headquarters. Further, the DOE must also provide annually (1) information on radioactive materials used at the facility and a description of the handling and processing thereof; (2) a list of the points from which radioactive materials are released, the effluent controls used thereon, and an estimate of the efficiency of each control device; (3) the distances from the points of release and the nearest residence, school, business, or office and the nearest farms producing vegetables, milk, and meat; and (4) any modifications taking place that year. However, the SSC is exempt from the reporting and testing requirements of 40 CFR 61.10.

5.5.5 Nonattainment Provisions

Part D of the CAA requires that states develop plans for cleaning up areas that have not demonstrated compliance with the NAAQS. Adjacent Dallas and Tarrant counties are currently designated nonattainment areas for ozone. Because the SSC is a minor source and is located in Ellis County, which is an attainment area for all criteria air pollutants, the nonattainment new source review requirements do not apply (EPA 1989).

5.6 SOLID WASTE

5.6.1 State Regulation

Treatment, storage, or disposal of solid, both nonhazardous and hazardous, waste is regulated under the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (RCRA) (42 USC 6901 et seq.) and the Hazardous and Solid Waste Amendments of 1984 (HSWA). The Texas Solid Waste Disposal Act is an approved state plan under RCRA, with regulations in 31 TAC 335 et seq. On May 24, 1990, the EPA approved an immediate final rule to authorize revisions to the Texas hazardous waste management program (31 TAC 335 et seq.), including adopting certain HSWA provisions (55 FR 21383). Those HSWA provisions not included in the immediate final rule remain under the jurisdiction of the EPA (40 CFR 260 et seq.).

The Texas Solid Waste Disposal Act is found in Title V, Subtitle B, Chapter 361, of the new Texas Health and Safety Code and any sections of Texas Revised Civil Statutes Annotated, Article 477-7, amended by the 71st Texas legislature. Texas regulations concerning solid waste are set forth at 31 TAC 335 et seq.

Texas regulations on solid waste in general prohibit the collection, handling, storage, processing, or disposing of industrial solid waste so as to cause discharge of waste into or adjacent to the waters in the state without obtaining specific authority for the discharge from the Texas Water Commission or to create or maintain a nuisance or to endanger the public health and welfare (31 TAC 335.4).

Texas regulations define a generator as any person who produces or possesses municipal hazardous waste or industrial solid waste to be shipped to any other person, except a person who generates or possesses only Class III wastes. Industrial solid waste includes hazardous and nonhazardous industrial solid waste. Industrial solid waste can also include industrial wastewater while it is being collected, stored, or processed before discharge. Class I wastes are any industrial solid waste that, because of its concentration or physical or chemical characteristics, is toxic; corrosive; flammable; a strong sensitizer or irritant; and a generator of sudden pressure by decomposition, heat, or other means; and may pose a substantial present or potential danger to human health or the environment when improperly processed, stored, transported, or otherwise managed. Hazardous solid waste is any waste identified or listed as a hazardous waste by the Administrator of the EPA pursuant to RCRA (42 USC 6901 et seq.). Class III includes inert wastes and essentially insoluble industrial solid waste, usually including (but not limited to) materials such as rock, brick, glass, dirt, and certain rubber and plastics, that are not readily decomposable. Class II wastes are any wastes that cannot be classified as Class I or Class III.

For hazardous waste, the restrictions and requirements vary depending on the amount of waste generated. A "conditionally exempt small quantity" generator generates less than 100 kg/mo; a "small quantity" generator generates more than 100 kg/mo but less than 1,000 kg/mo. The SSC will generate 3,000 tons/yr of nonhazardous industrial solid waste, 45 tons/yr of hazardous industrial solid waste, and 100 tons/yr of low-level radioactive waste (Section 4.7.2 and FEIS, Vol. I, Section 4.2.6). Therefore, the SSC will generate over 1000 kg/mo and cannot qualify as a small generator.

5.6.2 Registration and Permits

5.6.2.1 Waste Generators

All generators of hazardous and nonhazardous industrial solid waste must notify the Texas Water Commission of such activity by filing an Industrial Solid Waste Management Inventory Form and thereby obtain an industrial solid waste registration number (31 TAC 335.6). All generators of hazardous waste must also, pursuant to 42 USC 6930, notify the EPA and obtain an EPA identification number. Facilities that store hazardous waste for more than 90 days are required to obtain a Part B RCRA permit (40 CFR 264).

5.6.2.2 Nonhazardous Waste

No permit is necessary for the storage, processing, or disposal of nonhazardous industrial solid waste, if the storage is on property owned or otherwise effectively controlled by the owner or operator of the industrial plant where the waste results or is produced. However, at least 90 days prior to engaging in such storage activities, the facility owner or operator must notify the Texas Water Commission in writing. Nonhazardous industrial solid waste would be deposited in local landfills (Section 4.7.3.2).

5.6.3 Hazardous Waste Generator

40 CFR 262 provides that generators must meet certain requirements of 40 CFR 265. A hazardous waste generator must place the waste in containers that meet the requirements in 40 CFR 265 - Subparts I (containers) and J (tanks), except for those requirements set forth in 40 CFR 265.197(c) (tank system closure) and 265.200 (Waste Analysis and Trial Tests). The generator also must package, label, and mark the containers before transporting them in accordance with requirements set forth at 31 TAC 335.65 through 335.68. No hazardous waste will be stored at the SSC site for more than 90 days.

Generators are not required to comply with the requirements in 40 CFR 265 -- Subparts G (Closure and Post-Closure) and H (Financial Requirements), except that they must comply with the requirements set forth at 40 CFR 265.111 (Closure Performance Standards) and 265.114 (Disposal or Decontamination of Equipment, Structures, and Soils). A generator must mark each container with the date accumulation began and must label the container with the words "Hazardous Waste" [31 TAC 335.69(2) and (3)].

A generator also must comply with the requirements contained in 40 CFR 265 -- Subpart C (Preparedness and Prevention) and Subpart D (Contingency Plan and Emergency Procedures). Under Subpart C, the generator must maintain its facilities to minimize the possibility of a fire, explosion, or any unplanned release of hazardous waste or hazardous waste constituents to air, soil, or surface water.

The generator must make arrangements, as appropriate, with local police and fire departments, hospitals, and emergency response teams regarding the waste handled at the facility and the associated hazards, places where facility personnel would normally be working, entrances to roads inside the facility, and possible evacuation routes. Should local authorities refuse to cooperate, the generator should document such refusal (40 CFR 265.37).

Under Subpart D, each generator must have a contingency plan for the facility that is designed to minimize hazards to human health or the environment from any fire, explosion, or unplanned release of hazardous waste. At all times there must be at least one employee either on the premises or on call to respond to an emergency within a short period of time, with the responsibility for coordinating all emergency response measures. The emergency coordinator must take all steps required in 40 CFR 265.56, except for 265.56(d), concerning a release that would endanger human health or the

environment outside the facility. Upon such a release, the emergency coordinator must take all steps required in 31 TAC 335.113 concerning notification of the authorities as set forth in the Texas Oil and Hazardous Substances Spill Contingency Plan.

A generator must also comply with 40 CFR 265.16 concerning training of personnel, including a program of classroom instruction or on-the-job training that teaches employees to respond effectively to emergencies by familiarizing them with emergency procedures and equipment. Facility personnel must take part in annual reviews of such training.

5.6.4 Manifests

A generator of Class I waste (hazardous and nonhazardous) who intends to ship the waste must prepare a manifest form. The generator must designate on the manifest the facility authorized to receive the waste described on the manifest; however, the generator also may designate an alternative facility to receive the waste in the event an emergency prevents delivery to the primary designated facility. The manifest must contain the information set forth in 31 TAC 335.10. Further, the DOE must comply with U.S. Department of Transportation requirements as set forth in 49 CFR 100-199.

5.6.5 Record Keeping

Each generator of solid waste must keep records of all hazardous waste and industrial solid waste activities regarding the quantities generated, stored, processed, and disposed of on the site or shipped off the site for storage, processing, or disposal [31 TAC 335.9(a)(1)]. The generator must submit to the Texas Water Commission on or before January 25 of each year an annual generation, storage, processing, and disposal summary for all hazardous and Class I wastes [31 TAC 335.9(a)(2)].

In addition to the annual summary required under 31 TAC 335.9, a generator of hazardous waste must file an annual report pursuant to 31 TAC 335.71. Further, any generator who processes, stores, or disposes of hazardous waste on site must submit reports in accordance with the provisions of 31 TAC 335.114 (Reporting Requirements) and 335.154 (Reporting Requirements for Owners and Operators).

5.7 LOW-LEVEL RADIOACTIVE WASTE

The SSC expects to have 10,500 ft^3/yr of low-level radioactive waste with an average yearly curie content of 13 Ci (Section 4.7.1.3). It is not anticipated that mixed waste will be generated. The DOE is responsible for DOE-generated or -owned waste; pursuant to DOE Order 5820.2A, DOE low-level radioactive waste must be disposed of on the site at which it is generated, if practical, or, if on-site disposal is unavailable, at another DOE disposal facility. Pursuant to these regulations, it is proposed that any low-level radioactive waste generated at the SSC would be shipped to DOE's disposal facility at its Hanford Reservation in Washington (Section 4.7.1.3).

The Texas Low-Level Radioactive Waste Disposal Authority is establishing and operating an authorized site in Hudspeth County. Such a site is a state responsibility under the Low-Level Radioactive Waste Policy Act (LLRWPA), 42 USC 2021b et seq. The DOE is responsible for DOE-generated or -owned waste; however, under LLRWPA, state sites are authorized to accept waste generated by federal facilities. The Texas site has indicated it would accept the low-level radioactive waste generated at the SSC (Section 4.7.1); however, to use the site, the SSC would have to obtain an exemption from the requirements of DOE Order 5820.2A. An exemption can be granted only on the basis of appropriate documented safety, health protection, and economic analyses.

No permit is necessary to generate such waste, but SSC will need proper manifests for shipments to off-site disposal facilities (DOE Orders 5400.5, 5420.2, 5480.3, 5400.1, 5820.2A, and 1540.1; 10 CFR 962; 10 CFR 61; and 49 CFR 100-178). No permit is necessary for the storage or handling of radioactive materials under Texas Department of Health regulations, a delegated authority under the Atomic Energy Act (42 USC 2021 et seq.) because the SSC is exempt from regulation as a U.S. Nuclear Regulatory Commission certificated or exempted facility [Texas Health and Safety Code, Subtitle D, Chapter 401.003(13)]. The SSC also must comply with the radiation protection standards and guidelines for employees, the public, and the environment, as set forth in DOE Orders 3790.1A, 5483.1A, 5400.5, 5480.1B, 15480.4, 5480.11, and 5820.2A.

5.8 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT (42 USC 9601 et seq.)

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) primarily applies to sites where there has been a release of hazardous substances into the environment that would present substantial danger to the public health or welfare. If the release of a reportable substance were to occur at the SSC, certain regulations would have to be followed (DOE Order 5400.4).

5.9 EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT OF 1986 (42 USC 11001 et seq.)

The Emergency Planning and Community Right-to-Know Act is applicable to any facility where extremely hazardous substances, as defined in 40 CFR 355, Appendix A, are present in an amount in excess of the threshold planning quantity established for such substance. The owner or operator of such a facility must notify the state emergency response commission, the local emergency planning commission, and the local fire department of the presence of such substances. The owner or operator of such a facility also must appoint a facility emergency coordinator who will participate with the local emergency planning committee in the preparation of an emergency plan.

Should a release occur that would require notification under Section 103(a) of CERCLA, or as otherwise specified in the act (42 USC 11004), the owner or operator of the facility must immediately notify the community emergency coordinator for the local

emergency planning committee and the state emergency response commission. However, releases that result in exposure to persons solely within the site on which the facility is located are exempt from this notification requirement.

5.10 AMERICAN INDIAN RELIGIOUS FREEDOM ACT (42 USC 1996)

The American Indian Religious Freedom Act provides for the protection and preservation of sites identified as or suspected to be sacred. According to the Texas Indian Commission, there currently are no listed sacred sites in the area; however, burial sites have been located during field study. The Texas Indian Commission and the Chairmen of the Caddo and Wichita tribes stated that no sacred sites are recorded in Ellis County (Section 3.10.4). During construction, care must be taken not to disturb any possible burial, historic, or archaeological sites that may be unearthed until the appropriate parties have been consulted.

5.11 NATIONAL HISTORIC PRESERVATION ACT (16 USC 470a - 470w-6)

Under 16 USC 470f, the DOE must take into account the effect of the undertaking on any district, site, building, structure, or object that is included or is eligible for inclusion in the National Register. An historic property includes any artifacts, records, or remains that are related to and located within such district, site, building, structure, or object. Furthermore, the term *eligible for inclusion in the National Register* includes properties formally determined as such by the Secretary of the Interior and all other properties that satisfy National Register listing criteria (36 CFR 800.2). The DOE must afford the Advisory Council on Historic Preservation (Advisory Council) a reasonable opportunity to comment with regard to such undertaking. Further, Section 110(f) of the Act requires federal agencies to minimize harm to any National Historic Landmark.

Texas has an agreement with the federal Advisory Council under 36 CFR 800.7; therefore, under Section 106 of the Act [16 USC 470a(b)(3)], primary responsibility for the State Historic Preservation Program lies with the State Historic Preservation Officer, who is the Chairman of the Texas Historical Commission. It is the responsibility of the agency official with jurisdiction over the undertaking to identify and evaluate affected historic properties, assess the effect thereon, and afford the Council its comment opportunity. Meetings have been held with Texas Historical Commission and Advisory Council personnel to identify and evaluate the effect of SSC construction on area historic properties.

A programmatic agreement pursuant to 36 CFR 800.13 has been negotiated between the DOE, the Texas Historical Commission, the Texas National Research Laboratory Commission, and the Advisory Council on Historic Preservation. The programmatic agreement will contain appropriate mitigative measures.

5.12 ENDANGERED SPECIES ACT (16 USC 1531-1543)

The federal Endangered Species Act requires federal agencies to consult with the U.S. Fish and Wildlife Service before undertaking any action, to ensure that the action is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of the critical habitats of such species.

Surface facilities would be located predominantly on agricultural lands that do not provide optimal habitat for the listed species. Biologists and representatives from the U.S. Army Corps of Engineers, DOE, the U.S. Fish and Wildlife Service, and the Texas Parks and Wildlife Department have conducted surveys at the site and found no critical habitats for protected species, but did find habitats with the potential to attract listed species. Therefore, the Texas Parks and Wildlife Department would be consulted before landscaping plans are completed to determine the effect on the habitat.

General commitments for preconstruction surveys and mitigative measures made in the siting EIS are still applicable. In addition, certain mitigative measures set forth in Section 4.3.8 may be incorporated.

5.13 BALD AND GOLDEN EAGLE PROTECTION ACT [16 USC 668-668(d)]

The Bald and Golden Eagle Protection Act provides that anyone who knowingly, or with wanton disregard, takes, possesses, sells, purchases, barters, offers for sale, purchase, or barter, transports, exports, or imports at any time any bald eagle or golden eagle, alive or dead, or any part, nest, or egg thereof, shall be fined $5,000 or imprisoned not more than one year or both. No bald or golden eagles nest in this area, although some may winter in the area. No routine SSC operations or construction methods should have any effect on bald or golden eagles; however, care would be taken not to disturb or harm any birds found in the area.

5.14 MIGRATORY BIRD TREATY ACT (16 USC 703-712)

Under the Migratory Bird Treaty Act, it is unlawful to pursue, hunt, take, capture, kill, attempt to take, capture or kill, possess, offer for sale, purchase or barter, or cause to transported any migratory bird, any part, nest, or egg thereof. Consultation has taken place and will continue with the U.S. Fish and Wildlife Service to determine which migratory birds are in the area and to evaluate ways to avoid or minimize the effects of the SSC project on any such birds.

5.15 FISH AND WILDLIFE COORDINATION ACT (16 USC 661-666c)

The Fish and Wildlife Coordination Act pertains mostly to undertakings that involve the impounding, diverting, or controlling of waters in excess of 10 acres of surface area in such as manner as to affect natural habitats. If there will be change to nearby wetlands in excess of 10 acres of surface area (e.g., destruction of wetlands due

to fill materials or dredging during construction), an assessment may have to be made in conjunction with the U.S. Fish and Wildlife Service before construction to incorporate appropriate mitigation measures.

5.16 FARMLAND PROTECTION POLICY ACT (7 USC 4201 et seq.)

Under the Farmland Protection Policy Act, the U.S. Department of Agriculture and other federal agencies must take steps to ensure that the actions of the federal government do not cause U.S. farmland to be irreversibly converted to nonagricultural uses in cases in which other national interests do not override the importance of the protection of farmland nor otherwise outweigh the benefits of maintaining farmland resources.

This Act is administered by the U.S. Department of Agriculture, Soil Conservation Service (SCS), pursuant to 7 CFR 658. The SCS has been requested to determine if the SSC site is farmland subject to the Act. If the site is subject to the Act, then the SCS will measure the relative value of the site as farmland (on a scale of 0 to 100). The DOE made a site assessment determination pursuant to criteria set forth at 7 CFR 658.5(b). The Texas SCS will then determine the land evaluation and calculate the relative value of the farmland to be converted (on a scale of 1 to 100). Taking into consideration the criteria found at 7 CFR 658.3(c), the agency can determinate the effect of its program on farmland.

Further, additional regulations would have to be met for the four parcels covered by contracts to protect highly erodible lands under the provisions of the Food Security Act of 1985, pursuant to the Conservation Reserve Program. Under the Act, farmers who agree to institute conservation plans on lands identified as highly erodible become eligible for financial assistance from the Secretary of Agriculture. The transfer of the rights and interest of the land subject to such a contract requires the landowner to forfeit all rights to rental payments and cost-sharing payments under the contract and to refund to the United States all rental payments and cost-sharing payments received by the owner (or to accept such payment adjustments or make such refunds the Secretary considers appropriate), unless the transferee agrees with the Secretary to assume all obligations under the contract for the preservation of such erodible lands. The transferee may continue under the same terms or conditions, may enter into a new contract with the Secretary, or may elect not to participate in the program [16 USC 3832(a6) and 16 USC 3835(b)].

5.17 UNIFORM RELOCATION AND REAL PROPERTY ACQUISITION POLICIES ACT (42 USC 4601 et seq.)

Pursuant to 42 USC 4627, whenever real property is acquired by a state agency and furnished as a required contribution incident to a federal program or project, the federal agency having authority over the program or project may not accept such property unless the state agency has made all payments and provided all assistance and assurances as are required of a state agency by Sections 42 USC 4630 and 4655. The Texas National Research Laboratory Commission, the proponent of the Texas site for the

SSC, has agreed to discharge these duties in conformance with this Act. The Commission must give satisfactory assurances to the U.S. Army Corps of Engineers, as the accepting agency under a DOE/COE agreement, that in acquiring real property it has been guided, to the greatest extent practicable under state law, by the land acquisition policies in Section 42 USC 4651 and the provisions of 42 USC 4652 and that the property owners will be paid or reimbursed for necessary expenses, as specified in 42 USC 4653 and 4654.

Pursuant to 42 USC 4630, the Texas National Research Laboratory Commission must give satisfactory assurances that fair and reasonable relocation payments and assistance shall be provided to or for displaced persons, as required under 42 USC 4622-4624; that the relocation assistance programs offering the services described in 42 USC 4625 shall be provided to such displaced persons; and, that, within a reasonable period of time prior to displacement, decent, safe, and sanitary replacement dwellings will be available to displaced persons, in accordance with 42 USC 4625(c)(3).

Included in DOE Order 4300.1B are requirements that must be met before property can be acquired for DOE facilities, including compliance with this Act.

5.18 FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT (7 USC 136 et seq.)

Should a pesticide (e.g., fire ant and cockroach control) or an algicide (e.g., cooling pond control) registered under provisions of this Act be used during construction or during normal SSC operations, pursuant to 40 CFR 171 et seq., the application of such a chemical must be performed by a certified applicator. Texas has primary enforcement responsibility for certification; only an applicator certified under 4 TAC 7 should be used.

5.19 REFERENCE FOR SECTION 5

EPA, 1989, J.R. Hepola, Chief, Air Enforcement Branch, U.S. Environmental Protection Agency, Region VI, Dallas, letter to M.A. Lazaro, Argonne National Laboratory, Argonne, Ill., Nov. 8.

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APPENDIX A

GLOSSARY AND LIST OF ACRONYMS AND ABBREVIATIONS

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GLOSSARY AND LIST OF ACRONYMS AND ABBREVIATIONS

A.1 LIST OF ACRONYMS AND ABBREVIATIONS

AAP	air activation product
ADT	average daily traffic
ALARA	as low as reasonably achievable
ANL	Argonne National Laboratory
ASB	accelerator shop building
ASCS	Agricultural Stabilization and Conservation Service
ASST	accelerator system string test
BEIR	biological effects of ionizing radiation
BQL	best qualified list
CAA	Clean Air Act
CAAC	Clean Air Act Code
CAP-88	Clean Air Act Assessment Package - 1988 (computer codes)
CEDE	committed effective dose equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (commonly referred to as "Superfund")
CERN	Centre Europeenne Pour La Recherche Nucleaire (now called the "Organisation Europeenne Pour La Recherche Nucleaire")
CFR	Code of Federal Regulations
CNR	composite noise rating
CWA	Clean Water Act
dB	decibel
dBA	adjusted decibel
DC-NSL	design-critical/noise-sensitive location
DE	dose equivalent
DEIS	draft environmental impact statement
DFW	Dallas-Fort Worth International Airport
DOE	U.S. Department of Energy
EC	east campus
EDE	effective dose equivalent
EDR	environmental data requirements
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
FDEI	fugitive dust emission inventory
FEIS	final environmental impact statement
FmHA	Farmers Home Administration
F.M.	Farm-to-Market

FR	Federal Register
FSEIS	final supplemental environmental impact statement
FY	fiscal year
GeV	billion electron volts
GOCO	government owned, contractor operated
HEB	high-energy booster (one of the synchrotrons in the injector of the SSC)
HEPAP	High-Energy Physics Advisory Panel
HSWA	Hazardous and Solid Waste Amendments
I-35	Interstate I-35
IAP	individual annoyance prediction
IR	interaction regions
ISC	industrial source complex
ISCLT	industrial source complex, long-term
ISCST	industrial source complex, short-term
ISD	independent school district
ISP	invitation for site proposals
LEB	low-energy booster
LEP	large electron-positron collider (under construction at CERN)
LET	linear energy transfer
Linac	linear accelerator
LLRWPA	Low-Level Radioactive Waste Policy Act
LLW	low-level radioactive waste
LT	long term
LVN	licensed vocational nurse
MAAS	magnetic acceptance and storage
MDL	Magnet Development Laboratory
MEB	medium-energy booster
MM	Modified Mercalli
MSDS	material safety data sheet
MSFC	magnet support facility complex (includes MDL, MTL, MAAS)
msl	mean sea level
MTL	Magnet Test Laboratory
NAAQS	National Ambient Air Quality Standard
NCTCOG	North Central Texas Council of Governments
NEPA	National Environmental Policy Act of 1969
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NPDWS	National Primary Drinking Water Standards
NSDWS	National Secondary Drinking Water Standards
NSL	noise-sensitive location
NSPS	New Source Performance Standards
NWS	National Weather Service

PM	particulate matter
PNA	Probabilistic Noise Audibility
p-p	peak-to-peak
PPV	peak particle velocity
PSD	prevention of significant (air quality) deterioration
RCRA	Resource Conservation and Recovery Act
ROD	record of decision
ROI	region of influence
RN	registered nurse
RWC	reasonable worst case
SCS	Soil Conservation Service
SEIS	supplemental environmental impact statement
SIP	state implementation plan
SSC	superconducting super collider
SSCL	Superconducting Super Collider Laboratory
ST	short term
SWDU	solid waste disposal unit
TCWCID	Tarrant County Water Control and Improvement District No. 1
TDS	total dissolved solids
TeV	trillion electron volts
TI	transport index
TOC	total organic carbon
TRA	Trinity River Authority
TSP	total suspended particulates
VM	visual modification
VOC	volatile organic compound(s)
WC	west campus

A.2 GLOSSARY

Absolute zero: A hypothetical temperature characterized by complete absence of atomic vibration; equivalent to approximately -273.16C or -459.69F.

Absorbed dose: The energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest. The unit of absorbed dose is the rad.

Absorber: In electromagnetic systems, a material that absorbs or reduces the intensity of radiation.

Absorption: In electromagnetic systems, the physical process by which the number of particles or photons entering a body of matter is reduced or attenuated by interaction with the matter. In acoustics, the physical process by which the intensity of acoustic waves is reduced by interaction with reactive surfaces. The process by which noise reduction occurs when surface acoustic treatment is used, or when outdoor noise propagates over vegetation or certain ground features.

Accelerator: An experimental physics device for imparting large amounts of kinetic energy to electrically charged atomic and subatomic particles such as electrons and protons. The path of the particles is controlled by magnetic fields, while kinetic energy is typically imparted by radiowaves. If the particle path is linear, the device is called a linear accelerator or LINAC. If the particle path is circular or oval, the device is a cyclotron, synchrocyclotron, or synchrotron. The main collider ring of the SSC is a synchrotron (actually a variation of a synchrotron called a collider). The injector consists of a LINAC and three progressively larger synchrotrons (low energy booster [LEB], medium energy booster [MEB], and high energy booster [HEB]) that together will generate, accelerate, and inject protons into the main collider ring.

Acreage: An area of land comprising a number of acres.

ALARA: As low as reasonably achievable. A DOE policy to minimize the exposure of workers to ionizing radiation as much as practical. This minimization is in addition to keeping exposures below mandatory guidelines.

Aquifer: A saturated, permeable geologic unit that can transmit significant (usable) quantities of water under ordinary hydraulic gradients.

Aquitard: Less permeable beds in a stratigraphic sequence (relative to the aquifer).

Archaeology: The science that investigates past human life and activities based on the study of material remains (fossils, relics, artifacts, monuments).

Archival: Relating to the preservation of records and documents, or constituting the place where the material is preserved.

Attenuation: In electromagnetic systems, the process by which a beam of radiation is reduced in intensity when passing through some material. It is a combination of absorption and scattering processes and leads to a decrease in flux density of the beam when projected through matter. In acoustics, it is the reduction in sound level that results from the conversion of acoustic energy to heat energy through interaction of the particles of the conduction medium. (See Absorption.)

Background radiation: Naturally occurring radiation due primarily to cosmic rays and natural radioactivity.

Beam: A unidirectional or approximately unidirectional flow of electromagnetic radiation or particles.

Berm: A narrow shelf, path, or ledge typically at the top or bottom of a slope; also a mound or wall of earth.

Biota: Flora and fauna of a region.

Borehole: A hole bored or drilled in the earth.

CAP-88: Clean Air Act Assessment Package - 1988 (computer codes). A dose and risk assessment methodology for radionuclide emissions to air.

CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act (commonly referred to as "Superfund"). CERCLA gives the federal government power to respond to releases and threatened releases of hazardous substances that present a danger to human health and the environment. CERCLA established a Hazardous Substance Trust Fund (Superfund) available to finance responses taken by the federal government instead of waiting to resolve questions of legal responsibility.

CERN: Centre Europeenne Pour La Recherche Nucleaire (now called the "Organisation Europeenne Pour La Recherche Nucleaire"). The European organization for nuclear research located in Geneva, Switzerland.

Chalk: A very soft, unindurated (uncemented) limestone often containing the hard parts of microorganisms.

Code of Federal Regulations: A publication of the federal government that contains the rules and regulations established by all federal agencies for regulating their areas of responsibility. Essentially, it details what is required to comply with laws passed by Congress as interpreted by federal agencies.

Cohort: A group of individuals in a demographic study having a statistical factor in common (such as age or class membership).

Collider: A shortening of "colliding beam storage ring synchrotron." A type of synchrotron in which two beams of particles orbit in opposite directions in concentric rings. The beams can be accelerated and stored independently until brought together. The SSC is a collider.

Collision: An encounter between two subatomic energetic particles.

Conductivity: The quality or property of a material to transmit electricity. The reciprocal of electrical resistivity.

Confined aquifer: An aquifer that is confined between two confining strata, i.e., aqutards or aquicludes.

Conventional facilities: The normal buildings, structures, and utilities required to house and/or support the technical components of the SSC.

Cooling tower: A heat exchange device designed to transfer heat from a process to the atmosphere either directly or through the use of an intermediate fluid. Alternative cooling methods transfer heat to bodies of water.

Craton: A relatively stable, immobile part of the earth's crust, generally of large size.

Cretaceous: The last period in the Mesozoic Era in the history of the earth, estimated to have occurred from approximately 140 to 65 million years ago. The period is characterized by the culmination of the dinosaurs. At the end of the Cretaceous period, the dinosaurs became extinct.

Cryogenic: Of or relating to the production of very low temperatures; in particular, temperatures approaching absolute zero.

Cut-and-cover: A construction technique where a cut trench is first excavated. After installation of components in the trench, the trench is then backfilled with the previously excavated material.

Daughter: In radioactive decay, the nuclide produced as the result of the decay; in high-energy physics, the nuclide or subatomic particle produced as the result of an interaction (collision).

Decibel: One-tenth of a Bel; a measure of the magnitude of sound pressure, sound intensity.

Deciduous: Referring to plants that lose leaves seasonally. Most commonly used in connection with trees that lose their leaves in specific seasons, such as autumn, or dry seasons.

Demographics: The study of the dynamic balance of a population, especially with regard to density and capacity for expansion or decline.

Dendritic: An irregular branching pattern resembling shrub or tree.

Detrital: Referring to material derived from the erosion of pre-existing rocks.

Dewpoint: The temperature at which vapor begins to condense.

Dose equivalent (DE): A quantity used to express exposure in radiation protection. It expresses all radiations on a common scale for calculating the effective absorbed dose. It is defined as the product of the absorbed dose in rads and certain modifying factors (DE = absorbed dose [D] x quantity factor [Q] x any other modifying factor [N]). The conventional unit of DE is the REM.

Dose rate: The radiation dose delivered per unit of time.

Dosimetry: The theory and application of the principles and techniques involved in measuring and recording radiation doses. A practical aspect is concerned with the use of various types of radiation instruments with which measurements are made.

Ecosystem: The complex of a plant or animal community and its environment, functioning as an ecological unit in nature.

Effective dose equivalent (EDE): A relatively new quantity that has virtually replaced dose equivalent (DE) in the radiation protection community. It is more closely related to risk and simpler to understand than DE. The EDE is the weighted sum of the doses to the individual organs of the body. The dose to each organ is weighted according to the risk that dose represents. These organ doses are then added together to get the EDE. (EDE = $\sum_i$ dose for organ i times weighting factor for organ i).

Electromagnetic force: A long-range force associated with electric and magnetic properties of particles. Current theory proposes that the electromagnetic force is carried by a boson called a photon.

Element: A chemical substance that consists of atoms of one kind; a substance composed of atoms with the same atomic number.

Elementary particle: A subatomic particle that has no apparent substructure, i.e., that cannot be subdivided into other particles.

Encroachment: Advanced beyond the usual or proper limits.

Endangered species: Any species that is in danger of extinction throughout all or a significant portion of its range.

Ephemeral: Lasting only a few days. An ephemeral stream is one that has flowing water present only immediately after a rain.

Erosion: The action or process of being worn away.

Farmland of statewide importance: Land, in addition to prime and unique farmland, that is of statewide importance for the production of food, feed, fiber, forage, and oil-seed crops. Criteria for defining and delineating this land are determined by appropriate state agencies.

Fauna: The animal species characteristic of a region, time period, or special environment.

Federal Register: A document published daily that summarizes the actions of Congress and the proposed actions of federal agencies.

Fee simple: A real estate transaction in which the purchaser receives the property without any limitations or restrictions.

Floodplain: That portion of a river valley that becomes covered with water when the river overflows its banks at flood stage.

Flora: The plant species characteristic of a region, time period, or special environment.

Forbs: Herbaceous plants that are not grass.

Fungal spores: A primitive reproductive body produced by fungus.

Gamma rays: Electromagnetic radiation whose wave lengths are shorter than those of X-rays, and hence are of higher energy.

Habitat: Where a species lives.

Hydrology: The branch of earth science dealing with the properties, distribution, and circulation of water primarily on the land surface, in the soil, and in the underlying rocks. Also a branch of engineering that studies the flow of fluids.

Important farmland: Farmland classified as prime farmland, unique farmland, or additional farmland of statewide importance.

Infrastructure: The basic facilities, equipment, and installations supporting the function of a system.

In-migrate: To move into or come to live in a region or community; especially as part of a large-scale and continuing movement of population.

Isotope: Atoms (of the same element) having the identical number of protons in the nucleus, but a different number of neutrons. Isotopes have the same atomic number, but a different atomic weight. Because of the slight difference in atomic weight, isotopes have slightly different chemical and physical properties. Different isotopes of the same element may exhibit significantly different radioactive behavior.

Lattice: (also magnet lattice) The sequence of bending (dipole), focusing (quadrupole), and correction (sextupole) magnets, together with magnet-free straight sections that define the accelerator structure.

Ldn: Day/night equivalent sound level. A single-number measure that expresses the magnitude of sound as the level obtained by averaging the energy equivalent of the A-weighted sound levels representative of a specific area over a 24-hour period. Levels occurring after 10:00 p.m. and before 7:00 a.m. are weighted by adding 10 dB to account for increased human sensitivity to sound during normal sleeping hours. The value is expressed in decibels (dB) or optionally in A-weighted decibels (dBA).

Lepton: Current theory proposes leptons as any of six particles that experience the weak force but not the strong force. Known leptons include the electron, muon, and tau; their three associated neutrinos (electron neutrino, muon neutrino, and tau neutrino); and their corresponding antiparticle forms.

Linear accelerator: An accelerator designed to accelerate electrically charged atomic and subatomic particles in a straight line. (See Accelerator.)

Luminosity: A measure of the number of potentially interacting particles available in two colliding beams.

Marl: A calcareous clay or intimate mixture of clay with particles of calcite or dolomite, usually occurring as fragments of shells.

Median: The middle value of a set of data ordered by magnitude.

Mitigation: Methods used to reduce the significance of or eliminate an anticipated adverse environmental impact.

Morphology: A branch of biology that deals with the form and structure of animals and plants.

Muon: An unstable lepton that has the same charge as an electron but 207 times the mass. At rest, it decays in seconds into an electron and a neutrino.

Natural radioactivity: Radioactivity exhibited by naturally occurring radionuclides. (There are more than 50 naturally occurring radionuclides.)

NEPA review: A formal review process required of certain federal and federally funded projects that involves the identification and analysis of potential environmental impacts and mitigation measures made pursuant to the National Environmental Policy Act (NEPA).

Nuclide: Generally used to refer to atoms of a specific isotope.

Overdraft: In hydrology, to remove more groundwater (by pumping) than is being replaced by natural processes. The result is generally a decline in the water table.

Parcel: A tract or plot of land with a recorded title.

Parent: In radioactive decay, the initial, unstable nuclide; in particle physics, the initial nuclide or particle.

Percolate: To pass or move through fine interstices; to filter.

Period: A division of geologic time; a subdivision of the era.

Permeability: A measure of the capacity of a material to transmit a fluid.

Photon: A particle of light (a quantum of electromagnetic radiation). Current physical theory views electromagnetic radiation as having the characteristics of either a wave or a particle, depending upon the measurement being made.

Physiography: The study of the genesis and evolution of land forms; physical geography.

Porosity: The ratio of the volume of openings in a rock to the total volume of the rock.

Potable: Water suitable for drinking.

Predator: An animal that preys on other animals for food.

Prime farmland: Land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses (urban areas are not included). It has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed, including water management, according to acceptable farming methods.

Rad: The unit of absorbed (radiation) dose that is equal to 100 ergs/g in any medium.

Radiation: Originally, the emission of fast atomic and subatomic particles or rays (photons) from the nucleus of radionuclides during radioactive decay; now includes all energy radiated in the form of waves (photons) or particles.

Radioactive decay: The spontaneous transformation of an unstable nuclide to another nuclide (stable or unstable) as a result of the emission of charged particles from the nucleus.

Radioactivity: The property shown by some isotopes of elements to undergo radioactive decay.

Radionuclide: An unstable isotope that will undergo radioactive decay; referring to the specific atoms of the isotope.

Radon: A naturally occurring radioactive, gaseous element formed by the disintegration of radium; part of the uranium decay series.

RADTRAN III: An analytical computer code for calculating both the incident-free and accident impacts of transporting radioactive material.

Rem: A special unit of dose equivalent. The dose equivalent in rems is numerically equal to the absorbed dose in rads multiplied by a number of modifying factors that account for the type of radiation, the portion of the body, and other necessary factors.

Resource Conservation and Recovery Act: RCRA gives the federal government power to regulate hazardous waste from the time it is generated to its ultimate disposal, in effect from "cradle to grave." In addition, RCRA regulates nonhazardous solid waste (e.g., garbage, ash from municipal incinerators) and certain underground storage tanks.

Scenario: An account or synopsis of a projected course of action or events.

Sedimentary: Referring to rocks formed by the accumulation of sediments in water (aqueous deposits) or in air (eolian deposits).

Seismic: Pertaining to an earthquake or earth vibrations, including vibrations that are artificially induced.

Socioeconomic: Of, relating to, or involving a combination of social and economic factors.

Spoils: Earthen material removed from an excavation and not used for aggregate, backfill, or other construction.

Strata: Plural of stratum; a section of a formation that consists of the same type of distinguishable geologic layer.

Stratified fee: A real estate transaction in which the purchaser receives the ownership of a volume of ground between two depths. The original owner retains the rights to the surface, down to the top of the volume of ground, and probably any mineral rights below the volume of ground.

Stratigraphy: The branch of geology that studies the formation, composition, sequence, and correlation of the stratified rocks as parts of the earth's crust.

Subatomic particle: A particle smaller than the size of an atom.

TDS: total dissolved solids, the quantity of material dissolved in a water sample.

Threatened species: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Topography: The configuration of a surface including its relief and the position of its natural and man-made features.

Transmissivity: A measure of the ease with which water will flow through the entire saturated thickness of an aquifer. Specifically defined as the product of the hydraulic conductivity of the aquifer material and the thickness of the aquifer.

TSP: Total suspended particulates. The amount of material suspended (not dissolved) in a water sample

Unconfined aquifer: An aquifer in which the water table forms the upper boundary.

Unique farmland: Land other than prime farmland that is used for the production of specific high value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to economically produce sustained high quality and/or high yields of a specific crop when treated and managed according to acceptable farming methods.

Viewshed: The area between major ridgelines coinciding with watershed boundaries.

Water table: The upper surface of the saturated zone.

Watershed: A region or area where all water drains ultimately to a particular body of water or watercourse.

Wetland: Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly aquatic plants; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season each year.

APPENDIX B

LISTS OF VERTEBRATE BIOTA OCCURRING IN THE SITE VICINITY

TABLE B.1 Fish Species Normally Occurring in the Dallas-Fort Worth Project Area

Species[a]	Scientific Name	Habitat	Habitat Availability on Site[b]	Long-Term Project Impact[c]
*Spotted gar	*Lepisosteus oculatus*	Quiet, clean streams and reservoirs with aquatic vegetation	Limited to moderate	0
*Longnose gar	*Lepisosteus osseus*	Quiet, clean streams and reservoirs with aquatic vegetation	Minimal	0
*Gizzard shad	*Dorosoma cepedianum*	Reservoirs, ponds, low-gradient backwaters	Ample	0
*Threadfin shad	*Dorosoma petenense*	Reservoirs, large creeks	Ample	0
*Goldfish	*Carassius auritus*	Streams, reservoirs, ponds	Ample	+
*Common carp	*Cyprinus carpio*	Streams, reservoirs, and ponds	Ample	+
Pugnose minnow	*Opsopoedus emiliae*	Clean, slow-moving waters often with herbaceous vegetation	Limited	P
*Golden shiner	*Notemigonus crysoleucas*	Vegetated, shallow ponds and reservoirs; sluggish streams	Ample	+
*Red shiner	*Notropis lutrensis*	Low-gradient back-waters, creeks and streams with sand/silt bottoms	Ample	P
*Blacktail shiner	*Notropis venustus*	Moderately large, clear-to-turbid streams with gravel and rubble bottoms	Limited	0
Mimic shiner	*Notropis volucellus*	Rivers and streams, near riffles	Minimal to limited	0
Ghost shiner	*Notropis buchanani*	Pools in large creeks and rivers, low-flow backwaters	Limited to moderate	0
*Bullhead minnow	*Pimephales vigilax*	Sluggish pools and backwaters of streams	Ample	P
Central stoneroller	*Campostoma anomalum*	Clear, cool streams with moderate to rapid current and gravel to rubble bottoms in pools or riffles	Limited to moderate	0

TABLE B.1 (Cont'd)

Species[a]	Scientific Name	Habitat	Habitat Availability on Site[b]	Long-Term Project Impact[c]
*Smallmouth buffalo	*Ictiobus bubalus*	Clear water with moderate current	Moderate	0
*River carpsucker	*Carpiodes carpio*	Quiet, silt-bottomed pools of rivers with low to moderate gradient; impoundments	Ample	0
*Channel catfish	*Ictalurus punctatus*	Clear, medium to large fast rivers over sand or gravel/ rocky bottoms; impoundments	Ample	+
*Blue catfish	*Ictalurus furcatus*	Reservoirs	Limited	0
*Black bullhead	*Ictalurus melas*	Ponds, reservoirs, pools in streams	Ample	+
*Yellow bullhead	*Ictalurus natalis*	Shallow vegetated bays of reservoirs, ponds, and slow-moving streams	Ample	+
*Flathead catfish	*Pylodictis olivaris*	Deep holes of medium to large rivers, reservoirs	Moderate	0
*Tadpole madtom	*Noturus gyrinus*	Quiet water over soft bottoms with dense vegetation	Limited	P
*Blackstripe topminnow	*Zygonectes notatus*	Variable-sized lowland streams	Moderate	P
*Mosquitofish	*Gambusia affinis*	Vegetated ponds, reservoirs, ditches, backwaters of streams	Ample	+
*Inland silverside	*Menidia beryllina*	Streams with sand and gravel-bottom pools or riffles	Moderate	0
*White bass	*Morone chrysops*	Clear reservoirs and rivers	Moderate	0
*Striped bass	*Morone saxatilis*	Reservoirs	Moderate	0
Spotted bass	*Micropterus punctulatus*	Rivers, larger streams, reservoirs	Moderate	0
*Largemouth bass	*Micropterus salmoides*	Ponds, reservoirs, rivers, streams	Ample	+

TABLE B.1 (Cont'd)

Species[a]	Scientific Name	Habitat	Habitat Availability on Site[b]	Long-Term Project Impact[c]
*Warmouth	*Lepomis gulosus*	Ponds, reservoirs, streams	Ample	+
Spotted sunfish	*Lepomis punctatus*	Slow to moderately flowing waters with dense cover and vegetation	Moderate	P
*Green sunfish	*Lepomis cyanellus*	Most aquatic habitats	Ample	+
*Longear sunfish	*Lepomis megalotis*	Reservoirs, small streams	Ample	P
*Redear sunfish	*Lepomis microlophus*	Reservoirs, ponds, low-gradient streams	Moderate	+
*Bluegill	*Lepomis macrochirus*	Shallow warm lakes, ponds, slow-flowing streams with vegetation	Ample	+
*Orangespotted sunfish	*Lepomis humilis*	Quiet streams, vegetated reservoirs, ponds	Ample	+
Redbreast sunfish	*Lepomis auritus*	Reservoirs, rivers, ponds	Moderate	+
*White crappie	*Pomoxis annularis*	Streams, reservoirs, ponds, slow-moving reaches of large rivers	Ample	+
Dusky darter	*Percina sciera*	Large streams and rivers over gravel/sand raceways	Limited to moderate	0
*Bigscale logperch	*Percina macrolepida*	Gravel raceways of moderate to swift-current streams, reservoirs	Limited to moderate	0
Orangethroat darter	*Etheostoma spectabile*	Small, turbid streams with silted bottoms	Limited to moderate	P
*Freshwater drum	*Aplodinotus grunniens*	Large, silty reservoirs and rivers	Limited	0

TABLE B.1 (Cont'd)

[a]An asterisk (*) indicates that the species was collected via seining, electrofishing, gill netting, frame netting, or cove rotenoning.

[b]Within the collider ring:

Ample = habitat available over most of the site area;
Moderate = habitat available over less than half of the site area but more than 10% of the site area;
Limited = habitat available over less than approximately 10% of the site area;
Minimal = habitat coverage very small and of marginal quality.

[c]Qualitative assessment based on (1) limited types of developments that would be allowed in stratified fee areas, (2) minimal development over much of the fee simple areas, and (3) habitats that could be developed at service areas and campus sites following construction:

+ = increase in available habitat could result from project;
0 = no major change in available habitat would result from project and no significant occurrence of habitat in fee simple areas;
- = decrease in available habitat could result from project;
P = potential for habitat protection in fee simple areas;
P/+ = potential for habitat protection and increase in habitat might also result.

Sources: Spain 1990; Texas National Research Laboratory Commission 1988.

TABLE B.2 Amphibian Species Normally Occurring in the Dallas-Fort Worth Project Area

Species[a]	Scientific Name	Habitat	Habitat Availability on Site[b]	Long-Term Project Impact[c]
Lesser siren	*Siren intermedia*	Warm, shallow, quiet waters; sloughs; weedy ponds	Ample	+
Eastern newt	*Notophthalmus viridescens*	Ponds, lakes, back waters, streams with dense submerged vegetation	Limited	+
*Small-mouthed salamander	*Ambystoma texanum*	Deciduous forest bottomlands; tallgrass prairies and farming areas near water	Limited	P/+
Tiger salamander	*Ambystoma tigrinum*	Variety of moist habitat types in arid plains to wet meadows	Ample	+
*Couch's spadefoot	*Scaphiopus couchi*	Tolerant of dry terrain: shortgrass prairie and mesquite savannah	Ample	+
Eastern spadefoot	*Scaphiopus holbrooki*	Forested, brushy, or farmed areas with loose or soft soils	Ample	+
*Crawfish frog	*Rana areolata*	Wet meadows, prairie woodlands	Limited	+
*Bullfrog	*Rana catesbeiana*	Aquatic; still waters	Ample	+
Green frog	*Rana clamitans*	Still to slow-moving waters, swamps amid fallen litter	Moderate to ample	+
*Rio Grande leopard frog	*Rana berlandieri*	Any aquatic or moist conditions	Ample	+
*Southern leopard frog	*Rana sphenocephala*	Wet areas amid moist vegetation in summer, aquatic habitats in other seasons	Ample	+
Eastern narrow-mouthed frog	*Gastrophryne carolinensis*	Near water, ponds, ditches amid litter	Ample	+

TABLE B.2 (Cont'd)

Species[a]	Scientific Name	Habitat	Habitat Availability on Site[b]	Long-Term Project Impact[c]
Great Plains narrow-mouthed frog	*Gastrophryne olivacea*	Woodlands and grasslands; moist litter and rodent burrows	Ample	+
Green toad	*Bufo debilis*	Prairies	Ample	+
Red-spotted toad	*Bufo punctatus*	Prairies near permanent water or dampness	Ample	+
Texas toad	*Bufo speciosus*	Prairie grasslands and open woodlands; adapted to dry conditions	Ample	+
*Gulf Coast toad	*Bufo valiceps*	Variety of moist habitats	Ample	+
*Woodhouse's toad	*Bufo woodhousei*	Variety of moist habitats	Ample	+
*Northern cricket frog	*Acris crepitans*	Open shallow water with vegetation cover; ditches	Ample	+
*Gray treefrog	*Hyla chrysoscelis/ Hyla versicolor*	Trees and shrubs growing in or near water	Limited to moderate	+
*Green treefrog	*Hyla cinerea*	Vegetation near permanent water	Moderate	+
*Spotted chorus frog	*Pseudacris clarki*	Shortgrass prairies	Moderate	P/+
*Strecker's chorus frog	*Pseudacris streckeri*	Variety of moist habitats	Ample	+
*Upland chorus frog	*Pseudacris triseriata*	Grassy areas from dry to swampy to agricultural; also woodlands	Ample	+

TABLE B.2 (Cont'd)

[a]An asterisk (*) means that literature records indicate that the species has been collected from Ellis County (in vicinity of project).

[b]Within the collider ring:

Ample = habitat available over most of the site area;
Moderate = habitat available over less than half of the site area but more than 10% of the site area;
Limited = habitat available over less than approximately 10% of the site area;
Minimal = habitat coverage very small and of marginal quality.

[c]Qualitative assessment based on (1) limited types of developments that would be allowed in stratified fee areas, (2) minimal development over much of the fee simple areas, and (3) habitats that could be developed at service areas and campus sites following construction:

+ = increase in available habitat could result from project;
0 = no major change in available habitat would result from project and no significant occurrence of habitat in fee simple areas;
- = decrease in available habitat could result from project;
P = potential for habitat protection in fee simple areas;
P/+ = potential for habitat protection and increase in habitat might also result.

Sources: Spain 1990; Texas National Research Laboratory Commission 1988.

TABLE B.3 Reptile Species Normally Occurring in the Dallas-Fort Worth Project Area

Species[a]	Scientific Name	Habitat	Habitat Availability on Site[b]	Long-Term Project Impact[c]
*American alligator	*Alligator mississippiensis*	Variety of aquatic and wetland habitats	Limited	0 to +
*Common snapping turtle	*Chelydra serpentina*	Soft-bottom aquatic habitats with dense vegetation	Ample	+
*Yellow mud turtle	*Kinosternon flavescens*	Quieter, slow-moving bodies of water with sand or mud bottoms; ponds	Moderate	P/+
*Mud turtle	*Kinosternon subrubrum*	Shallow, soft-bottom quiet water with dense vegetation	Limited to moderate	P/+
Razor-backed musk	*Sternotherus carinatus*	Swamps, slow-moving water courses with dense vegetation	Limited to moderate	P/+
Stinkpot	*Sternotherus odoratus*	Quiet, shallow muddy-bottom waters	Ample	+
Chicken turtle	*Deirochelys reticularia*	Shallow ponds and ditches with dense vegetation	Limited	+
River cooter	*Chrysemys concinna*	Streams with moderate currents, large reservoirs	Limited	0
*Pond slider	*Trachemys scripta*	Slow, shallow streams, ponds, and reservoirs with soft bottoms and dense vegetation	Ample	+
*Mississippi map turtle	*Graptemys kohni*	Streams, reservoirs, and sloughs with mud bottoms, dense vegetation, and basking sites	Moderate	0 to +
*Eastern box turtle	*Terrapene carolina*	Moist upland habitats, flood-plains	Moderate	+

TABLE B.3 (Cont'd)

Species[a]	Scientific Name	Habitat	Habitat Availability on Site[b]	Long-Term Project Impact[c]
*Western box turtle	*Terrapene ornata*	Open prairies, pasturelands, open woodlands, and waterways in arid, sandy-soiled terrain	Ample	+
Smooth softshell	*Trionyx muticus*	Large streams, moderate to fast currents, sand or mud bottoms	Limited	0
Spiny softshell	*Trionyx spiniferus*	Small marshy creeks, farm ponds, fast-flowing streams and reservoirs	Ample	+
Green anole	*Anolis carolinensis*	Arboreal; trees, fence posts, walls, woody vegetation, vines	Ample	+
Greater earless lizard	*Cophosaurus texanus*	Stretches of rocks, limestone cliffs, dry sandy stream beds, washes	Minimal to limited	0
Collared lizard	*Crotaphytus collaris*	Hardwood forests to arid areas with large rocks for basking; usually hilly regions	Minimal	0
*Lesser earless lizard	*Holbrookia maculata*	Sandy soil in grassy prairies, cultivated fields, dry stream beds; desert grasslands	Moderate	+
*Texas horned lizard	*Phrynosoma cornutum*	Dry areas, open lands with loose soil and grasses, mesquite	Ample	P/+
*Texas spiny lizard	*Sceloporus olivaceus*	Arboreal; mesquite, live oaks, other trees, buildings	Moderate	+

TABLE B.3 (Cont'd)

Species[a]	Scientific Name	Habitat	Habitat Availability on Site[b]	Long-Term Project Impact[c]
Eastern fence lizard	*Sceloporus undulatus*	Open upland woodlands, dry prairies near fallen logs and stumps	Ample	+
Slender glass lizard	*Ophisaurus attenuatus*	Dry grasslands, dry open woods	Moderate	+
17 *Texas spotted whiptail	*Cnemidophorus gularis*	Semiarid prairie grassland, open bushy areas, washes	Limited	+
*Racerunner	*Cnemidophorus sexlineatus*	Dry sunny areas, open grasslands, open woods, well-drained soils	Ample	+
*Five-lined skink	*Eumeces fasciatus*	Moist woods with litter, stumps, and fallen logs	Moderate	+
*Broad-headed skink	*Eumeces laticeps*	Moist woods, open areas with litter and rubble cover	Limited to moderate	+
*Prairie skink	*Eumeces septentrionalis*	Moist areas with vegetation and loose soil, rocky or gravelly washes	Moderate	+
*Ground skink	*Scinella lateralis*	Moist woods and wooded grasslands with abundant leaf litter	Ample	+
Blind snake	*Leptotyphlops dulcis*	Subterranean in loose moist soil; beneath leaf and plant litter; under decaying logs	Moderate	+
156 *Racer	*Coluber constrictor*	Fields, grasslands, brushy areas, open woods	Ample	+
Ringneck snake	*Diadophis punctatus*	Damp meadows and woodlands, overgrown fields near water, litter-filled bottoms and gullies	Ample	+
Corn snake	*Elaphe guttata*	Wide variety of habitats	Ample	0
*Rat snake	*Elaphe obsoleta*	Wide variety of habitats	Ample	0

TABLE B.3 (Cont'd)

Species[a]	Scientific Name	Habitat	Habitat Availability on Site[b]	Long-Term Project Impact[c]
*Eastern hognose snake	*Heterodon platyrhinos*	Open deciduous woods or pine woodlands, forested grasslands near streams or ponds	Limited to moderate	+
Western hognose snake	*Heterodon nasicus*	Sandy shortgrass prairies, rocky semideserts, pasture and woodland interfaces	Limited	+
Night snake	*Hypsiglena torguata*	Sandy or gravelly ground broken by rocky bluffs or overlaid by flat stones and litter	Minimal to limited	0
*Prairie kingsnake	*Lampropeltis calligaster*	Grasslands, less frequently riparian woodlands	Ample	+
*Common kingsnake	*Lampropeltis getulus*	Beneath litter or debris, damp, grassy pastures	Ample	0
Milk snake	*Lampropeltis triangulum*	Wooded riparian lands, rolling grass prairie hillsides with loose soil and rocks	Limited	P/+
*Coachwhip	*Masticophis flagellum*	Grasslands, mesquite, savannahs, brushlands	Ample	+
*Plain-bellied water snake	*Nerodia erythrogaster*	Aquatic habitats	Ample	+
Southern water snake	*Nerodia fasciata*	Calm permanent bodies of water	Ample	+
*Diamondback water snake	*Nerodia rhombifera*	Aquatic habitats	Ample	+
*Rough green snake	*Opheodrys aestivus*	Arboreal; leafy trees and shrubs, edges of woods and open areas	Ample	+
*Bullsnake	*Pituophis melanoleucus*	Open terrain	Ample	0
Graham's crayfish snake	*Regina grahamii*	Streams, ponds, ditches	Ample	+

TABLE B.3 (Cont'd)

Species[a]	Scientific Name	Habitat	Habitat Availability on Site[b]	Long-Term Project Impact[c]
Ground snake	*Sonora semiannulata*	Well-vegetated habitats; debris piles	Ample	+
*Brown snake	*Storeria dekayi*	Moist soils beneath litter, logs, rocks, riparian bottomland of hill country and oak or juniper brakes	Limited to moderate	+
*Flat-headed snake	*Tantilla gracilis*	Loose, slightly damp soil; most often in moist deciduous woods, grasslands or brushlands	Moderate	+
Checkered garter snake	*Thamnophis marcianus*	Arid and semiarid grasslands near water	Ample	+
*Western ribbon snake	*Thamnophis proximus*	Pond and creek margins	Ample	+
*Common garter snake	*Thamnophis sirtalis*	Wet meadows and pastures, riparian areas	Ample	+
*Rough earth snake	*Virginia striatula*	Beneath debris, logs, stones	Ample	+
Smooth earth snake	*Virginia valeriae*	Beneath rocks or logs on open wooded hillsides	Limited to moderate	+
*Lined snake	*Tropidoclonion lineatum*	Grasslands, pasture/woodland interfaces	Ample	+
*Coral snake	*Micrurus fulvius*	Dry oak/juniper brakes with rock or litter cover	Minimal	0
*Copperhead	*Agkistrodon contortrix*	Mesic upland woods or bottomlands with litter cover	Moderate	P/+
*Cottonmouth	*Agkistrodon piscivorus*	Variety of habitats near water	Ample	P/+
Western diamondback rattlesnake	*Crotalus atrox*	Variety of habitats	Ample	P/+

TABLE B.3 (Cont'd)

Species[a]	Scientific Name	Habitat	Habitat Availability on Site[b]	Long-Term Project Impact[c]
*Timber rattlesnake	*Crotalus horridus*	Wooded areas in wet bottomlands	Minimal	P/+
Western massasauga	*Sistrurus catentatus*	Grasslands	Ample	+
Pigmy rattlesnake	*Sistrurus miliarius*	Riparian woods with litter and shrub layers	Minimal	P

[a]An asterisk (*) indicates that literature records indicate that the species has been collected from Ellis County (in vicinity of project).

[b]Within the collider ring:
Ample = habitat available over most of the site area;
Moderate = habitat available over less than half of the site area but more than 10% of the site area;
Limited = habitat available over less than approximately 10% of the site area;
Minimal = habitat coverage very small and of marginal quality.

[c]Qualitative assessment based on (1) limited types of developments that would be allowed in stratified fee areas, (2) minimal development over much of the fee simple areas, and (3) habitats that could be developed at service areas and campus sites following construction:
+ = increase in available habitat could result from project;
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P/+ = potential for habitat protection and increase in habitat might also result.

Sources: Spain 1990; Texas National Research Laboratory Commission 1988.

TABLE B.4 Bird Species Normally Occurring in the Dallas-Fort Worth Project Area

Species[a]	Status[b]	Habitat	Habitat Availability on Site[c]	Long-Term Project Impact[d]
*Pied-billed grebe	P	Marshes, ponds, reservoirs	Ample	+
*Eared grebe	W	Marshes, ponds	Ample	+
*American white pelican	M	Reservoirs; impoundments	Limited	0 to +
*Double-crested cormorant	W	Reservoirs; impoundments	Ample	+
*Olivaceous cormorant	S	Reservoirs; nests in shrubs/trees in water or on islands	Limited	0
*Anhinga	S	Wooded ponds, nests in shrubs/trees in water or on islands/uplands	Minimal	+
**American bittern	W	Marshes	Limited	P/+
*Least bittern	S	Marshes	Limited	P/+
*Great blue heron	P	Ponds, marshes, reservoirs; nests in trees in or near water	Limited nesting; ample feeding	+
*Green-backed heron	S	Reservoirs, ponds, streamsides	Ample	+
*Great egret	P	Ponds, marshes, reservoir edges; nests in shrub stands in water, on islands with shrubs and trees and woodlands	Limited nesting; ample feeding	+
*Snowy egret	S	Ponds, marshes; nests in shrub stands in water, on islands with shrubs and trees, and upland woodlands	Limited nesting; ample feeding	+
*Little blue heron	S	Ponds, marshes; nests in shrub stands in water, on islands with shrubs and trees, and upland woodlands	Limited nesting; ample feeding	+
*Tricolored heron	S	Ponds, reservoirs	Limited	+
*Cattle egret	S	Pastures, roadsides, open fields; nests in shrub stands in water, on islands with trees and shrubs, and upland woodlands	Limited nesting; ample feeding	0

TABLE B.4 (Cont'd)

Species[a]	Status[b]	Habitat	Habitat Availability on Site[c]	Long-Term Project Impact[d]
*Yellow-crowned night-heron	S	Freshwater habitat types; nests in trees and shrubs in water and upland woodlands	Limited nesting; ample feeding	+
*Black-crowned night-heron	S	Freshwater habitat types; nests in trees and shrubs in water and upland woodlands	Limited nesting; ample feeding	+
*White ibis	S	Ponds, marshes, reservoirs; nests in shrubs/trees in water or on islands/uplands	Limited	+
*White-faced ibis	S	Ponds, marshes, reservoirs; nests in shrubs/trees in water or on islands/uplands	Limited	+
*Roseate spoonbill	SV	Ponds, marshes, reservoirs	Limited	+
*Wood stork	SV	Ponds, marshes, reservoirs	Limited	+
*Tundra swan	WV	Reservoirs	Limited	0
*Canada goose	W	Fields, short grasslands, grain fields, ponds	Ample	+
**Greater white-fronted goose	W	Fields, short grasslands, grain fields, ponds	Ample	+
*Snow/blue goose	W	Fields, short grasslands, grain fields, ponds	Ample	+
*Green-winged teal	M	Ponds, marshes, reservoirs	Ample	+
*Blue-winged teal	M	Ponds, marshes, reservoirs	Ample	+
*Cinnamon teal	T	Ponds, marshes, reservoirs	Ample	+
**Mallard	W	Grain fields, ponds, marshes, reservoirs	Ample	+
*Northern pintail	W	Shallow reservoirs, ponds, marshes	Ample	+
**Northern shoveler	W	Shallow water	Moderate	+
*Gadwall	W	Ponds, reservoirs	Ample	+
*American wigeon	W	Ponds, marshes	Ample	+

TABLE B.4 (Cont'd)

Species[a]	Status[b]	Habitat	Habitat Availability on Site[c]	Long-Term Project Impact[d]
*Canvasback	W	Large reservoirs, ponds	Limited to minimal	+
*Redhead	W	Shallow reservoirs, ponds	Ample	+
*Ring-necked duck	W	Wooded ponds, reservoirs, flooded bottomlands	Ample	+
*Lesser scaup	W	Ponds, reservoirs	Ample	+
*White-winged scoter	T	Reservoirs	Limited	0
**Common goldeneye	W	Reservoirs, ponds	Ample	+
**Bufflehead	W	Reservoirs, ponds	Ample	+
**Ruddy duck	W	Marshy reservoirs, ponds	Ample	+
*Hooded merganser	W	Wooded ponds, reservoirs, flooded bottomlands	Ample	P/+
*Common merganser	WV	Reservoirs, ponds	Limited	+
*Black vulture	P	Open habitats	Ample	0
*Turkey vulture	P	Open habitats	Ample	0
*Osprey	P	Reservoirs, rivers, marshes	Ample to moderate	0
*Mississippi kite	T	Open woods near water	Limited	P/+
*Northern harrier	W	Open fields, marshes	Ample	+
*Sharp-shinned hawk	W	Woodlands, shrublands	Limited	P/+
**Cooper's hawk	W	Woodlands	Limited	P/+
*Red-shouldered hawk	P	Moist deciduous woods, usually mature	Limited	P
**Broad-winged hawk	W	Large stands of mixed deciduous woods	Limited to minimal	P/+
*Swainson's hawk	M	Open plains; nests in trees and shrubs along water courses, wetlands, hedgerows	Ample	+
*Red-tailed hawk	P	Open fields, open woods	Ample	+
*Rough-legged hawk	WV	Open fields	Ample	+
**Bald eagle	W	Reservoirs	Ample	0

TABLE B.4 (Cont'd)

Species[a]	Status[b]	Habitat	Habitat Availability on Site[c]	Long-Term Project Impact[d]
*Crested caracara	P	Prairies; roadsides	Ample	+
*American kestrel	W	Prairies, open areas	Ample	+
*Merlin	T,WV	Open areas	Ample	+
*Peregrine falcon	T,WV	Open areas	Ample	+
***Ring-necked pheasant	P	Agricultural land	Ample	+
*Wild turkey	P	Open forests, forest edges	Limited	P
*Northern bobwhite	P	Open forests, fields with scattered shrubs	Ample	+
King rail	S	Marshes	Moderate	P/+
*Virginia rail	T	Marshes, ponds	Limited	+
*Sora rail	W	Marshes, wet meadows, margins of ponds and reservoirs	Moderate	+
*Purple gallinule	S	Marshes, ponds	Limited	+
*American coot	W	Ponds, reservoirs	Ample	+
*Sandhill crane	T	Prairies, fields, marshes	Ample	+
*Whooping crane	T	Prairie ponds	Limited	+
*Killdeer	P	Fields, marshes, pastures, mudflats	Ample	0
*American avocet	T	Shallow reservoirs, prairie ponds	Limited	+
*Greater yellowlegs	T	Open marshes, mud flats, streams, ponds	Limited	+
*Lesser yellowlegs	T,WV	Marshes, mud flats, shores, pond edges	Limited	+
*Spotted sandpiper	W	Edge of aquatic habitats	Ample	+
*Solitary sandpiper	W	Streamsides, shores of ponds and reservoirs	Ample	+
*Upland sandpiper	M	Grassy prairies, open meadows, fields	Ample	+
*Long-billed curlew	T	Prairies, open pasture	Ample	+
**Hudsonian godwit	M	Mud flats, shores	Limited	+

TABLE B.4 (Cont'd)

Species[a]	Status[b]	Habitat	Habitat Availability on Site[c]	Long-Term Project Impact[d]
*Least sandpiper	W	Mud flats, shores of ponds and reservoirs	Ample	+
*Long-billed dowitcher	T	Mud flats, shores	Limited	+
*Common snipe	W	Marshes, fields	Ample	+
*Franklin's gull	T	Reservoirs	Limited	0
**Ring-billed gull	W	Ponds, wet fields, reservoirs, marshes	Ample	+
*Common tern	T	Reservoirs	Limited	0
*Black tern	T	Reservoirs	Limited	0
*Herring gull	W	Reservoirs	Ample	0
*Rock dove	P	Urban and farm areas	Ample	+
*Mourning dove	P	Upland open and semiopen habitats	Ample	+
*Inca dove	V	Towns, parks, farms	Ample	+
*Common ground-dove	T	Farms, orchards, wood edges, roadsides	Ample	+
*Yellow-billed cuckoo	S	Woods, forest edges, brushlands	Ample	+
*Greater roadrunner	P	Open woodlands, grasslands, farming areas	Ample	+
*Common barn owl	P	Prairie, farmland, marshes	Ample	0 to +
*Eastern screech-owl	P	Open woods, floodplain woods, farms	Ample	+
*Great horned owl	P	Variety of upland habitat types	Ample	+
**Burrowing owl	P	Open grasslands, deserts	Moderate	+
*Barred owl	P	Wooded swamps, forests	Moderate	P
**Long-eared owl	W	Woodlands, thickets, conifer trees	Moderate	+
*Short-eared owl	W	Open habitats, grasslands, farm fields, marshes	Ample	+
*Common nighthawk	S	Variety of habitat types	Ample	+
Chuck-will's widow	S	Forest, forest edges, riparian woods	Limited	P/+

TABLE B.4 (Cont'd)

Species[a]	Status[b]	Habitat	Habitat Availability on Site[c]	Long-Term Project Impact[d]
*Whip-poor-will	T	Leafy woodlands	Limited	P/+
*Chimney swift	S	Buildings, open woods	Ample	+
*Ruby-throated hummingbird	S	Woods, parks, gardens	Ample	+
*Black-chinned hummingbird	S	Riparian woods, oaks of canyons and lowlands	Limited	P
*Belted kingfisher	P	Streams, reservoirs, ponds	Moderate	P/+
*Red-bellied woodpecker	P	Wooded areas	Moderate	+
*Red-headed woodpecker	P	Open woods, groves of trees on prairies	Limited	+
*Yellow-bellied sapsucker	W	Wooded habitats	Ample	+
*Ladder-backed woodpecker	P	Scrublands, riparian trees, parks	Moderate	P/+
*Downy woodpecker	P	Variety of wooded habitat types	Ample	+
*Hairy woodpecker	P	Large trees in forests and woodlots	Moderate to limited	+
*Northern flicker	W	Variety of wooded habitats	Ample	+
*Pileated woodpecker	P	Tall trees along river bottoms	Minimal	P
*Olive-sided flycatcher	T	Woods	Moderate	P/+
*Eastern wood-pewee	S	Deciduous and mixed woods	Moderate	P/+
*Yellow-bellied flycatcher	T	Woods	Limited	P/+
*Least flycatcher	M	Open woods, orchards, shade trees	Moderate	P/+
*Eastern phoebe	P	Near running water and ponds, in trees and at buildings	Ample	+
*Great crested flycatcher	S	Wooded suburban areas, clearings in forests, small woodlots	Ample	+
*Western kingbird	S	Open habitats with perches	Ample	+
*Eastern kingbird	S	Open habitats with perches	Ample	+
*Scissor-tailed flycatcher	S	Open plains with perches	Ample	+
*Horned lark	P	Open prairies, pastures, fields	Ample	0
*Purple martin	S	Open habitat types, usually near water	Ample	+

TABLE B.4 (Cont'd)

Species[a]	Status[b]	Habitat	Habitat Availability on Site[c]	Long-Term Project Impact[d]
Northern rough-winged swallow	S	Near stream banks, gravel pits, dams, bridges, road cuts	Limited	P/+
*Cliff swallow	T	Open to semiopen land, farms, reservoirs, ponds	Ample	+
*Barn swallow	S	Buildings and structures	Ample	+
1 *Blue jay	P	Variety of habitat types, usually with brush or woodlands	Ample	+
*American crow	P	Open and semiopen habitats	Ample	+
*Carolina chickadee	P	Forests, forest edges	Ample	+
*Tufted titmouse	P	Forests, woodlots	Ample	+
Red-breasted nuthatch	W	Forests, usually coniferous	Limited	0
**White-breasted nuthatch	W	Bottomlands, woodlots, groves	Ample	+
1 *Brown creeper	W	Woodlots, forests	Ample	+
*Carolina wren	P	Lower story forests, open woods	Ample	+
*Bewick's wren	P	Brushy clearings, scrub woods, suburban areas	Ample	+
*House wren	P	Thickets, forest edges	Moderate	+
*Winter wren	W	Streams in woods, floodplain woods	Moderate	P
*Sedge wren	T,W	Grassy marshes, sedgy meadows	Minimal	P/+
Marsh wren	S	Marshes and pond shores	Limited	+
*Golden-crowned kinglet	W	Forests, forest edges, coniferous stands	Moderate	0
*Ruby-crowned kinglet	W	Open woods, shrub areas	Ample	+
*Blue-gray gnatcatcher	P	Brushy areas, woods	Moderate	+
*Eastern bluebird	P	Open wooded areas, farmlands	Ample	+
*Swainson's thrush	T	River bottoms, shaded woods, residential areas	Limited	P/+
*Hermit thrush	W	Upland woods	Limited	P
*American robin	P	Woods, open wooded areas, pastures, fields	Ample	+

TABLE B.4 (Cont'd)

Species[a]	Status[b]	Habitat	Habitat Availability on Site[c]	Long-Term Project Impact[d]
*Northern mockingbird	P	Open habitat with perches	Ample	+
*Gray catbird	S	Brushy habitats, edges of woods	Ample	+
*Brown thrasher	W	Hedgerows, woodlots	Ample	+
*Water pipit	W	Shorelines and fields with little vegetation	Ample	+
*Sprague's pipit	W	Short grass prairie	Limited	+
*Cedar waxwing	W	Brushy and shrub habitats with berry-producing plants	Ample	+
*Loggerhead shrike	P	Open habitats with perches, thorn trees, barbed wire	Ample	+
*European starling	P	Variety of habitat types	Ample	+
*Red-eyed vireo	S	Mixed and deciduous forest	Moderate	0
*White-eyed vireo	S	Edges of woods, tall shrubby areas	Ample	+
*Bell's vireo	S	Riparian woods, marshes with mesquite	Limited	P/+
*Black-capped vireo	S	Low oak scrub of dry hillsides and ravines	Minimal	0
*Yellow-throated vireo	S	Mixed and deciduous forests, often in floodplains	Ample	P/+
*Solitary vireo	W	Mixed forests, brushlands	Limited	P/+
*Warbling vireo	S	Deciduous and mixed woods	Ample	P/+
*Philadelphia vireo	T	Open woodlands, streamside willows	Limited	P/+
*Tennessee warbler	T	Mixed woods	Limited	P/+
*Orange-crowned warbler	W	Variety of shrubs and wooded habitats	Ample	+
*Nashville warbler	T	Mixed woods with undergrowth	Limited	P
*Northern parula	T	Mixed woods near water	Limited	P
*Yellow warbler	T	Streamside willows, open woodlands, gardens, orchards	Moderate	P/+
*Chestnut-sided warbler	T	Second-growth deciduous woodlands	Limited	P/+

TABLE B.4 (Cont'd)

Species[a]	Status[b]	Habitat	Habitat Availability on Site[c]	Long-Term Project Impact[d]
*Magnolia warbler	T	Coniferous woods	Limited	0
*Yellow-rumped warbler	W	Varied woods and thickets	Ample	+
*Black-throated green warbler	T	Coniferous trees	Minimal	0
*Blackburnian warbler	T	Mostly coniferous woods	Limited	0
*Yellow-throated warbler	S	Pines, sycamores	Limited	0
*Bay-breasted warbler	T	Mostly coniferous woodlands	Limited	0
*Common yellowthroat	P	Adjacent to water and shrub areas with openings	Moderate	+
*Black and white warbler	S	Deciduous woods	Limited	+
*American redstart	T	Second-growth woodlands, small groves	Limited	+
*Ovenbird	T	Leafy deciduous woods, thickets	Limited	+
*Louisiana waterthrush	T	Streams in dense woodlands	Minimal	P
*Kentucky warbler	S,T	Woodland undergrowth	Limited	P/+
*Yellow-breasted chat	S	Shrublands, forest edges, thickets	Ample	+
*Summer tanager	S	Forests	Limited	P
*Northern cardinal	P	Brushy areas, woods	Ample	+
*Rose-breasted grosbeak	T	Deciduous woods, orchards, groves, thickets	Limited	+
*Blue grosbeak	S	Shrublands, hedgerows	Moderate to ample	+
*Lazuli bunting	T	Open brush, streamside shrubs	Limited	P/+
*Indigo bunting	S	Open woods, shrublands, forest edges	Ample	+
*Painted bunting	S	Open woods, semiopen habitats	Moderate	+
*Dickcissel	S	Grasslands	Ample	+
*Rufous-sided towhee	W	Forest edges, shrublands	Ample	+
*Cassin's sparrow	S	Short grass in old fields with scattered bushes	Limited	P/+
*Chipping sparrow	W	Woodland, fields, shrublands	Ample	+

TABLE B.4 (Cont'd)

Species[a]	Status[b]	Habitat	Habitat Availability on Site[c]	Long-Term Project Impact[d]
*Clay-colored sparrow	T	Shrub, brushy prairies	Limited	P/+
*Field sparrow	W	Fields	Ample	+
*Vesper sparrow	W	Dry open fields with fruited vegetation	Ample	+
*Lark sparrow	P	Open habitats with scattered trees and shrubs	Moderate	+
*Savannah sparrow	W	Moist grasslands, marshes	Moderate	+
*Grasshopper sparrow	P	Grasslands, hayfields, prairies	Ample	+
*LeConte's sparrow	W	Thick, damp, grassy areas containing broomsedge and cattails	Limited	P/+
*Fox sparrow	W	Undergrowth in wooded areas	Moderate	P/+
*Lincoln's sparrow	W	Thickets, weedy areas, bushes	Ample	+
*Swamp sparrow	T	Marshy areas with bushes or cattails	Limited	P/+
*Song sparrow	W	Stream banks, brush piles, wet meadows	Moderate	+
*White-throated sparrow	W	Dense undergrowth and brush	Ample	+
*White-crowned sparrow	W	Shrublands with open areas	Moderate	+
*Harris sparrow	W	Hedgerows, edges of woodlots	Ample	+
*Dark-eyed junco	W	Variety of habitat types	Ample	+
*McCown's longspur	W	Open fields with limited vegetation	Moderate	0
*Lapland longspur	W	Fields, prairies	Ample	0
*Smith's longspur	W	Fields, prairies	Ample	0
*Chestnut collared longspur	W	Grasslands	Ample	+
17 *Bobolink	T	Hayfields, meadows, marshes	Moderate	+
*Red-winged blackbird	P	Marshes, wet fields	Moderate	+
*Eastern meadowlark	P	Fields, grasslands	Ample	+
*Western meadowlark	P	Fields, grasslands	Ample	+
*Yellow-headed blackbird	T	Marshes, fields, open country	Limited	+

TABLE B.4 (Cont'd)

Species[a]	Status[b]	Habitat	Habitat Availability on Site[c]	Long-Term Project Impact[d]
*Rusty blackbird	WV	Wet wooded areas	Limited	P/+
*Brewer's blackbird	W	Open habitats with trees	Moderate	+
*Great-tailed grackle	P	Open wooded areas, suburban areas	Ample	+
*Common grackle	P	Croplands, fields, woods	Ample	+
*Brown-headed cowbird	P	Fields, pastures, woods	Ample	+
*Orchard oriole	S	Open woods	Moderate	+
*Northern oriole	T	Open woods, elms, shade trees	Limited	+
*Purple finch	W	Open woods, suburban areas	Moderate	+
*House finch	P	Open woods, suburban areas	Moderate	+
*Red crossbill	WV	Conifers	Minimal	0
*Pine siskin	W	Conifers	Ample	0
*American goldfinch	W	Open fields, woodlands	Moderate	+
*House sparrow	P	Open fields, buildings, pastures	Ample	+

[a]Meaning of asterisks is as follows:
*Literature records indicate that the species has been sited or collected from Ellis County (in vicinity of project).
**Presence reported by R.C. Telfair, II, 1987, environmental assessment biologist, Texas Parks and Wildlife Department, personal communication.
***Introduced species.

[b]M = migrant; P = permanent (individuals may be present throughout the year); S = summer inhabitant; T = transient; V = visitor; W = winter inhabitant.

[c]Within the collider ring:
Ample = habitat available over most of the site area;
Moderate = habitat available over less than half of the site area but more than 10% of the site area;
Limited = habitat available over less than approximately 10% of the site area;
Minimal = habitat coverage very small and of marginal quality.

TABLE B.4 (Cont'd)

[d]Qualitative assessment based on (1) limited types of developments that would be allowed in stratified fee areas, (2) minimal development over much of the fee simple areas, and (3) habitats that could be developed at service areas and campus sites following construction:

+ = increase in available habitat could result from project;
0 = no major change in available habitat would result from project and no significant occurrence of habitat in fee simple areas;
- = decrease in available habitat could result from project;
P = potential for habitat protection in fee simple areas;
P/+ = potential for habitat protection and increase in habitat might also result.

Sources: Spain 1990; Texas National Research Laboratory Commission 1988.

TABLE B.5 Mammal Species Normally Occurring in the Dallas-Fort Worth Project Area

Species[a]	Scientific Name	Habitat	Habitat Availability on Site[b]	Long-Term Project Impact[c]
*Opossum	*Didelphis virginiana*	Deciduous woodlands, prairies, marshes, farmlands	Ample	+
Least shrew	*Cryptotis parva*	Dense grasslands, areas of dense herbaceous ground cover	Ample	+
Eastern mole	*Scalopus aquaticus*	Open fields, waste areas, loose soils	Minimal	0 to +
Eastern pipistrelle	*Pipistrellus subflavus*	Crevices, buildings, stumps, trees, culverts	Ample	+
Big brown bat	*Eptesicus fuscus*	Loose bark of dead trees, tree cavities, buildings	Ample	+
Hoary bat	*Lasiurus cinereus*	Wooded areas	Moderate	+
**Red bat	*Lasiurus borealis*	Wooded areas	Moderate	+
Brazilian free-tailed bat	*Tadarida brasiliensis*	Buildings	Ample	+
**Nine-banded armadillo	*Dasypus novemcinctus*	Soft soils near water	Ample	+
**Black-tailed jack rabbit	*Lepus californicus*	Pastures, haylands, cultivated areas	Ample	+
*Eastern cottontail	*Sylvilagus floridanus*	Bushlands, fields	Ample	+
Swamp rabbit	*Sylvilagus aquaticus*	Swamplands, bottomlands (edge of range)	Minimal	P
**Thirteen-lined Ground squirrel	*Spermophilus tridecemlineatus*	Short and tall grass prairies, pastures	Moderate	+
**Fox squirrel	*Sciurus niger*	Open mixed forests	Moderate	+
**Southern flying squirrel	*Glaucomys volans*	Forests	Limited	P
Plains pocket gopher	*Geomys bursarius*	Sandy soils where topsoil is greater than 10 cm in depth	Minimal	0

TABLE B.5 (Cont'd)

Species[a]	Scientific Name	Habitat	Habitat Availability on Site[b]	Long-Term Project Impact[c]
Hispid pocket mouse	*Perognathus hispidus*	Sand and other soft soils with scattered to moderate vegetation stands	Ample	+
*Beaver	*Castor canadensis*	Various aquatic habitats	Moderate	0 to +
*Fulvous harvest mouse	*Reithrodontomys fulvescens*	Grasslands with a few shrubs or creek bottoms	Ample	+
Plains harvest mouse	*Reithrodontomys montanus*	Mature grasslands which are well drained	Limited	+
Deer mouse	*Peromyscus leucopus*	Wide variety of habitat types (edge of range)	Ample	+
White-footed mouse	*Peromyscus maniculatus*	Forests, wooded creeks, and river bottoms	Moderate	+
*Hispid cotton rat	*Sigmondon hispidus*	Tall grass areas, old fields	Ample	+
**Eastern woodrat	*Neotoma floridana*	Swamplands, forest lands, rocky areas	Limited	0
Pygmy mouse	*Baiomys taylori*	Low grassy or weedy areas	Ample	+
Woodland vole	*Microtus pinetorum*	Deciduous woods with dense herbaceous cover	Limited	+
*House mouse	*Mus musculus*	Fields, buildings	Ample	+
*Black rat	*Rattus rattus*	Buildings	Ample	+
**Norway rat	*Rattus norvegicus*	Buildings, landfills, waste areas	Ample	+
*Nutria	*Myocastor coypus*	Swamps, marshes, ponds, reservoirs	Limited	P/+
*Coyote	*Canis latrans*	Wide variety of habitats	Ample	+
**Red fox	*Vulpes vulpes*	Woodlands interspersed with farms and pastures	Limited	+
*Gray fox	*Urocyon cinereo-argenteus*	Mixed hardwoods (uplands and bottomlands)	Limited	+

TABLE B.5 (Cont'd)

Species[a]	Scientific Name	Habitat	Habitat Availability on Site[b]	Long-Term Project Impact[c]
*Raccoon	*Procyon lotor*	Wide variety of habitat types often near water	Ample	+
*Ringtail	*Bassariscus astutus*	Wooded areas	Limited	P/+
Long-tailed weasel	*Mustela frenata*	Variety of habitat types (edge of range)	Ample	+
*Mink	*Mustela vison*	Near streams, lakes, marshes, ponds	Ample	+
*Eastern spotted skunk	*Spirogale putorius*	Wooded areas and tallgrass prairies	Moderate	+
*Striped skunk	*Mephitis mephitis*	Woody and brushy areas, associated farmlands	Ample	+
*Bobcat	*Lynx rufus*	Wide variety of habitat types with preference for rocky areas and outcrops	Ample	P/+
**White-tailed deer	*Odocoileus virginianus*	Brush and woodlands with open areas, frequents riparian habitat	Minimal	P/+

[a]Meaning of asterisks is as follows:
*Specimens examined and/or trapper records in literature for Ellis County;
**Presence reported by R.C. Telfair, II, 1987, environmental assessment biologist, Texas and Wildlife Department, personal communication.

[b]Within the collider ring:
Ample = habitat available over most of the site area;
Moderate = habitat available over less than half of the site area but more than 10% of the site area;
Limited = habitat available over less than approximately 10% of the site area;
Minimal = habitat coverage very small and of marginal quality.

TABLE B.5 (Cont'd)

[c]Qualitative assessment based on (1) limited types of developments that would be allowed in stratified fee areas, (2) minimal development over much of the fee simple areas, and (3) habitats that could be developed at service areas and campus sites following construction:

+ = increase in available habitat could result from project;
0 = no major change in available habitat would result from project and no significant occurrence of habitat in fee simple areas;
- = decrease in available habitat could result from project;
P = potential for habitat protection in fee simple areas;
P/+ = potential for habitat protection and increase in habitat might also result.

Source: Texas National Research Laboratory Commission 1988.

REFERENCES FOR APPENDIX B

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APPENDIX C

AIR QUALITY AND RADIOLOGICAL IMPACT ASSESSMENT METHODS AND RESULTS

APPENDIX C

AIR QUALITY AND RADIOLOGICAL IMPACT ASSESSMENT METHODS AND RESULTS

C.1 INTRODUCTION

This appendix provides additional supporting documentation for the environmental assessments described in Sections 4.5 and 4.7.1.2. Additional or further details are provided on the (1) general approach for developing the fugitive dust emission inventory (FDEI), (2) list of the assumptions made in the development of the FDEI, (3) rationale used to select the reasonable-worst-case (RWC) day and year, (4) rationale employed to select the variables necessary to estimate the emission rate, (5) control techniques necessary during SSC construction, (6) summary tables presenting the short-term (ST) and long-term (LT) emission inventory results, (7) development of the source term for air activation product (radionuclide) releases, and (8) air quality modeling results.

C.2 EMISSION INVENTORY DEVELOPMENT FOR THE CONSTRUCTION-GENERATED FUGITIVE DUST (PM_{10}) EMISSIONS

The general approach to develop an emission inventory for construction dust emissions involves identification of those sources most likely to have the greatest air quality impact. During the SSC construction effort, the sources with the greatest impact will be located at the west campus as well as at E10, F1, and F9. In this analysis, the mitigation necessary to meet both the short- and long-term PM_{10} National Ambient Air Quality Standards (NAAQS) at the boundaries of the west campus, E10, and F1 is also recommended for similar sources at other service and access areas and the east campus.

The preparation of ST and LT emission inventories for PM_{10} required two steps. First, the RWC day and year were identified. The term reasonable is used here first to convey that variables affecting emissions were estimated at the mean of the measured values rather than at the extreme. For example, the road surface silt dust loading on F.M. 1493, F.M. 1446, and F.M. 66 for construction traffic was estimated at the mean of 12 g/m^2, given a range from 0.09 to 79 g/m^2 (EPA, 1988a, Section 11.2.6). Another implication of using RWC analysis is that the construction schedule was considered to avoid unrealistic concurrent activity assumptions.

The second step involved using the following equation to prepare emission inventories for activities occurring during these RWC periods:

$$ER = EF \times SE \times (1 - CEF)$$

where:

ER = controlled emission rate (mass/time),

EF = uncontrolled emission factor (mass/unit of source extent),

SE = source extent (units of source extent/time), and

CEF = control efficiency fraction.

To identify the RWC periods and determine the applicable values of SE listed in the above equation, heavy reliance was placed on three documents (Morris 1989; SSCL 1989; Briggs 1990). Documents used to determine EF and CEF are presented later in the text. Table C.1 shows the predictive emission factor equations (i.e., EF in the above equation) for estimating PM_{10} emissions from fugitive dust sources generated during construction activities.

TABLE C.1 Predictive Fugitive Dust Emission Factor Equations for PM_{10}

Source Category	Measure of Extent	Emission Factor[a,b] (lb/unit of source extent)
1. Unpaved roads	Vehicle-miles traveled	$2.1 \left(\frac{s}{12}\right)\left(\frac{S}{30}\right)\left(\frac{W}{3}\right)^{0.7}\left(\frac{w}{4}\right)^{0.5}\left(\frac{d}{365}\right)$
2. Industrial paved roads	Vehicle-miles traveled	$0.77 \left(\frac{L}{0.35}\right)^{0.3}$
3. Wind erosion of exposed areas -- limited potential case	m^2-hr of exposed area	$\frac{5.56\ f\ (u^t - u_t)\ (1 - v)}{(PE/50)^2}$
4. Dozing overburden -- like material	hours dozer is in motion	$0.75\ \frac{(s)^{1.5}}{(M)^{1.4}}$

[a]Represents particulate matter smaller than 10 μm in aerodynamic diameter.

[b]Correction parameters: d = number of dry days per year; f = frequency of disturbance per month; s = silt content of aggregate or road surface material (%); u^t = mean fastest mile of wind speed (m/s); u_t = erosion threshold wind speed at 7 m height (m/s); v = fraction of surface covered by vegetation; w = average number of vehicle wheels; L = surface dust silt loading on traveled portion of road (oz/yd^2); M = unbound moisture content of aggregate material (%); PE = Thornthwaite's Precipitation-Evaporation Index; S = average vehicle speed (mph); W = average vehicle weight (tons).

C.2.1 Basic Assumptions Necessary for Development of the RWC Emission Inventory

Development of the RWC fugitive dust construction inventory required several basic assumptions about construction scheduling and construction activities. The following set of assumptions was used in development of the emissions inventory:

- All tunnel concrete will be hauled from off site, either from Waxahachie or Ennis, Texas, whichever is closer;
- Conceptual equipment identification is an integration of conceptual ideas only and based on assumptions that will certainly change;
- The access road and cooling pond excavation will be completed prior to the start of tunneling;
- An average topsoil depth of 2 ft will be removed at the lake and spoils application areas;
- All E and F sites are to be treated the same with respect to design and with respect to necessary dust control measures applied uniformly, on the basis of RWC analysis results;
- Only those activities identified in the detailed Network schedule (Baseline 11, Rev. 2) by Morris (1989) and the preliminary schedule provided in SSCL (1989) will be addressed;
- TBM boring production is based on a 14-ft inside diameter bore, and all production rates were theoretically assumed;
- Assume 12-in. shotcrete walls in chalk tunnel sections;
- Assume shotcrete tunnel lining used at all locations in lieu of precast-grouted liners in unstable or fractured rock zones;
- The emission inventory developed through the analysis of the construction schedule is based on the SEIS Record of Decision (ROD) scheduled for issuance on December 30, 1990; and
- Construction activities occur on a five-day work week and eight hours per day from 7 a.m. to 4 p.m.

In addition to the aforementioned major technical assumptions, the following general assumptions are critical to the validity of the emission inventory and air quality analysis results:

- The schedule and activity data provided by the SSCL (Morris 1989; SSCL 1989) have neither undergone substantive (i.e., an increase in

the estimated volume of excavated topsoil by more than 10-20%) changes during this analysis, except as described in Briggs (1990) and Schwitters (1990), nor will substantive changes occur throughout the final design phase.

C.2.2 Selection of the Reasonable-Worst-Case Short-Term Period

To find the single RWC day during the construction period, a computer program was written to identify activities that were both contiguous and concurrent because this is the most likely RWC situation. The collider ring was divided into 10 segments labeled clockwise as west campus (WC), north ring service and access areas (A-D), east campus (EC), and south ring service and access areas (E-H). Activities were defined as contiguous if they occurred in any of three adjacent segments. Because the schedule is not expected to be accurate on a daily level, any activities that occurred in the same month were assumed to have a reasonably high probability of occurring on the same day, unless they were obviously consecutive subactivities. On the basis of this analysis of the schedule, the months with the most activity were found to be March 1992 and April 1992 at the E10 service area and the west campus. During these months, the following major activities are scheduled to occur at E10 and WC:

1. Construct office building 2 (WC),
2. Construct visitor center (WC),
3. Construct office building 3 (WC),
4. Bore collider tunnel (starting at E10 through WC),
5. Build common support and services building (WC),
6. Construct IR1 experimental hall* (WC),
7. Bore high-energy booster (HEB) tunnel (WC),
8. Excavate linear accelerator (Linac) tunnel (WC),
9. Construction worker traffic to and from WC, and
10. SSCL staff traffic to and from WC.

The earliest start date and the latest completion date for the above 10 concurrent and contiguous activities were used to define a 40-month window extending

*The initial construction schedule for the large experimental hall (November 1991 through October 1993) was used in developing the emissions inventory; Briggs (1990) rescheduled the construction of this hall (January 1994 through July 1996).

from April 1991 to July 1994. The RWC month was defined as the month with the highest emission rate, and this month was most likely to occur during this 40-month window.

The above 10 construction activities were subdivided into a collection of subactivities specific enough to permit application of predictive emission factor equations for each subactivity. For example, activity 1 (construct office building 2) was divided into seven subactivities: (1) haul topsoil in truck, (2) grade topsoil on pile, (3) haul excavated spoils in truck, (4) haul foundation concrete, (5) haul slab base material, (6) grade slab base material with dozer, and (7) haul slab concrete. None of the subactivities for activity 1 are concurrent; rather, they are consecutive. The subactivities for activities 2, 3, and 5 above are identical to those for activity 1. The number of subactivities associated with the remaining major construction activities ranged from 3 (activity 10) to 26 (activity 6), for a total of 95.

A Lotus spreadsheet was used to spread the emission rates for each subactivity over the months of occurrence for all 10 activities. The control strategies employed at this point in the analysis were those anticipated to be the most cost effective and easily achievable. Past experience indicated that some control was going to be necessary; therefore, an analysis with all uncontrolled sources could have led to an error in identifying the RWC. The month with the highest emission rate was identified as March 1992, with April 1992 predicted to have the second highest emission rate. Eighteen concurrent subactivities occurring in March 1992 were used to develop the RWC emissions. Six of these activities were relatively small (i.e., emissions lower than 11 lb/d) and could therefore be excluded from further consideration.

A second method of identifying a RWC condition is to identify a dust intensive activity that is located close to a boundary. The construction of the L* experimental hall (IR4) in the southern portion of the west campus is such an activity, with the centerline through the three rectangular shafts only 1400 ft from the eastern boundary. The month with the highest emission rate was January 1993. The air quality impact of IR4 construction during this month was analyzed, in addition to the impacts of the west campus and E10 sources in March 1992.

C.2.3 Calculation of the Short-Term Uncontrolled Emission Rate

The short-term uncontrolled emission rates (ER) were calculated by applying the earlier equation (without the control efficiency fraction) on a subactivity-by-subactivity basis. The uncontrolled emission factors (EF) for each source were taken from EPA (1988a), with the exception of wind erosion. That EF was taken from EPA (1985), a document recommended by EPA in the Superfund Exposure Assessment Manual (EPA 1988b). Nearly all of these fugitive dust emission factors are in the form of predictive equations. This form is needed because fugitive dust emission factors can vary by a factor of 100, depending on such classes of variables as meteorological conditions, equipment characteristics, and physical characteristics of the material being disturbed. Many of the equipment characteristics were quantified in SSCL (1989). The meteorological characteristics were extracted primarily from the Dallas-Fort Worth surface meteorological measurements for 1982-1986. Wind erosion fugitive dust

emissions occur when winds exceed a threshold speed of 8.75 m/s. Finally, physical characteristics of the material being handled were based on values recommended in EPA (1988a) and measurements presented in Texas National Research Laboratory Commission (1987). The source extent data (SE) needed in the earlier equation were taken from SSCL (1989).

There were 12 concurrent subactivities during March 1992 in service area E10 and in the WC:

1. Clear topsoil and stockpile at IR1 access shaft to accommodate buildings and lake (activity 4);

2. Haul topsoil originally cleared from beneath spoils pile to cover tunnel spoils pile at E10 (activity 4);

3. Clear and stockpile topsoil from IR1 excess spoils pile laydown area (activity 4);

4. Cut IR1 overburden using scraper and short-haul distance (activity 6);

5. Clear and stockpile HEB topsoil to accommodate buildings, lakes, and storage pile laydown areas (activity 7);

6. Construction traffic on unpaved road extending from F.M. 1493 (activity 10);

7. Construction traffic on unpaved roads extending from F.M. 66 (activity 10);

8. Construction traffic on unpaved road extending from F.M. 1446 (activity 10);

9. Construction and SSCL staff traffic on F.M. 1493 (activity 10);

10. Construction and SSCL staff traffic on F.M. 66 (activities 9 and 10);

11. Construction and SSCL staff traffic on F.M. 1446 (activities 9 and 10); and

12. Wind erosion from E10 spoils pile prior to revegetation (activity 4).

During the tunnel boring process from E10 through the west campus, spoils will be brought to the surface at the IR1 access shaft.

There were six significant concurrent activities at IR4 during January 1993:

1. Remove topsoil,

2. Haul spoils with scraper over short haul,

3. Maintain topsoil pile with bulldozer,

4. Maintain spoils pile with bulldozer,

5. Wind erosion from topsoil pile, and

6. Wind erosion from spoils pile before revegetation.

C.2.4 Selection of the Reasonable-Worst-Case Long-Term Period

The window expected to contain the ST RWC, based on the first analysis method discussed in Section 2.2, was also expected to contain the LT RWC. Therefore, the major construction activities listed in Section 2.2 also formed the basis for the LT RWC period search. However, because the LT period was 11 months longer than the ST period, additional activities occurred. The following three additional activities are an extension of the 10 activities listed in Section 2.2.

1. Bore collider tunnel, starting at E10 and moving in the direction of F9;

2. Excavate low-energy booster (LEB) tunnel in WC; and

3. Bore middle-energy booster (MEB).

The LT window was extended from January 1991 to September 1994 in order to analyze the complete fiscal year (FY) 1994 year. As with the ST analysis, a Lotus spreadsheet and the monthly emissions from all activities calculated were used to spread the subactivity emissions over the actual months in which they occurred. The maximum emission rate from a series of running 12-month totals indicated that January 1992 to December 1992 was the RWC annual period and that the emissions during this period will occur in the three contiguous segments containing service area E10, WC, and access areas F1 and F9. Note that emission sources from access areas F1 and F9 occur during the LT RWC period but not during the ST RWC period. The period from December 1992 to November 1993 at segment WC, and those segments containing access area F9 and service area E10, produced a very close second highest annual emission rate.

No analysis was performed to determine the LT RWC, based on the second analysis method, which identified IR4 as a potential RWC site. The RWC period for this case, as well as the subsequent emission inventory and modeling effort, were not identified because experience has shown that, if fugitive dust control strategies meet the ST NAAQS for PM_{10}, there is seldom a problem with the LT NAAQS.

C.2.5 Calculation of the Long-Term Uncontrolled Emission Rate

The earlier equation was used for the long-term analysis just as it had been for the short-term analysis; the only difference was that the unit of time was a year rather than a day. The documents used to obtain the input data for the earlier equation are also the same as those listed in Section 2.3, except for two additions. The number of wet days (90 days) in the normal year was taken from EPA (1988a, Section 11.2.1), and the Thornthwaite Precipitation-Evaporation index (62) was taken from EPA (1985).

The number of subactivities during the LT RWC period of January 1992 to December 1992 was 44, excluding subactivities generating less than 2,000 lb/yr. The emission rate from all subactivities generating less than 2,000 lb/yr was less than 1% of the total annual emission rate. The 44 subactivities (i.e., quantifiable sources) in service area E10, WC, and access area F1 are:

1. Cut (i.e., excavate hole for) lake and store spoils at F10 (activity 4);

2. Move topsoil at the lake and tunnel spoils storage pile area at IR4 access shaft (activity 4);

3. Clear and stockpile topsoil from the lake and buildings areas as well as the lake spoils laydown area at E1 (activity 4);

4. Clear and stockpile topsoil from the lake and buildings areas as well as the lake spoils laydown area at F1 (activity 4);

5. Cut lake and stockpile spoils at E1 (activity 4);

6. Cut lake and stockpile spoils at F1 (activity 4);

7. Move topsoil at the lake and tunnel spoils storage pile area at E1 (activity 4);

8. Move topsoil at the lake and tunnel spoils storage pile area at F1 (activity 4);

9. Clear and stockpile topsoil from the lake and buildings areas as well as the lake spoils laydown area at E10 (activity 4);

10. Clear and stockpile topsoil from the lake and buildings areas as well as the lake spoils laydown area at F9 (activity 4);

11. Cut lake and stockpile spoils at E10 (activity 4);

12. Cut lake and stockpile spoils at F9 (activity 11);

13. Move topsoil at the lake and tunnel spoils storage pile area at E10 (activity 4).

14. Cut IR2 overburden using scraper and long haul distance (activity 6);

15. Truck hauling of overburden to permanent spoils pile at IR1 (activity 6);

16. Clear and stockpile topsoil to accommodate buildings, lakes, and stockpile laydown area at HEB (activity 7);

17. Cut lakes at stockpile spoils at HEB (activity 7);

18. Haul tunnel spoils from shafts to piles at HEB (activity 7);

19. Clear and stockpile topsoil at Linac (activity 8);

20. Clear and stockpile topsoil at Linac (activity 8);

21. Construction traffic on unpaved road extending from F.M. 1493 (activity 9);

22. Construction traffic on unpaved roads extending from F.M. 66 (activity 9);

23. Construction traffic on unpaved road extending from F.M. 1446 (activity 9);

24. Construction and SSCL staff traffic on F.M. 1493 (activities 9 and 10);

25. Construction and SSCL staff traffic on F.M. 66 (activities 9 and 10);

26. Construction and SSCL staff traffic on F.M. 1446 (activities 9 and 10);

27. Wind erosion at E10 spoils pile (activity 4);

28. Wind erosion at IR4 access shaft spoils pile (activity 4);

29. Wind erosion at IR4 access shaft topsoil pile (activity 4);

30. Wind erosion at E1 spoils pile (activity 4);

31. Wind erosion at F1 spoils pile (activity 4);

32. Wind erosion at E1 topsoil pile (activity 4);

33. Wind erosion at F1 topsoil pile (activity 4);

34. Wind erosion at E10 spoils pile (listed twice since two contractors begin here) (activity 11);

35. Wind erosion at E10 topsoil pile (activity 4);

36. Wind erosion at IR2 temporary spoils pile (activity 6);

37. Wind erosion at IR2 permanent spoils pile (activity 6);

38. Wind erosion at IR2 temporary topsoil pile (activity 6);

39. Wind erosion at IR2 topsoil pile at permanent spoils pile area (activity 6);

40. Wind erosion at HEB landscaping area 1 spoils pile (activity 7);

41. Wind erosion at HEB landscaping area 2 spoils pile (activity 7);

42. Wind erosion at HEB landscaping area 1 topsoil pile (activity 7);

43. Wind erosion at HEB landscaping area 2 topsoil pile (activity 7); and

44. Wind erosion at LEB temporary spoils pile (activity 12).

C.3 SOURCE TERM FOR AIR ACTIVATION PRODUCT RELEASES

Because of changes in the conceptual design of the SSC since the EIS was published, the annual amount of radioactivity released into the atmosphere by the SSC was reestimated. These changes include an enlarged test beam program and redesign of the size and ventilation of both the beam tunnel and experimental halls. Table C.2 gives the release coordinates for the six release points in the east and west campuses for air activation products.

C.3.1 Test Beams

Experience with the hadron colliders at Fermilab and CERN and with the large electron-positron collider (LEP) has indicated that the calibration needs of experiments at the SSC will be substantial.

TABLE C.2 Release Point Coordinates

Release Point	Texas Coordinates
Test beam 2-TeV target	N 237,832 E 2,174,959
Beam scraper exhaust	N 251,508 E 2,171,621
IR5	N 266,346 E 2,250,661
IR8	N 273,856 E 2,247,633
IR1	N 239,013 E 2,175,513
IR4	N 231,376 E 2,178,674

The laboratory will need approximately one high-quality calibration beam per experiment. The calibration beams that have been designed for the SSCL have a high flux capability and a large dynamic range. The primary use of the test beams will be for system verification, for study of the systematics of detector components, for performance verification, and for calibration of modules before they are installed in collision halls. The largest use is expected to be calorimeters; however, tracking chambers and special lepton identification devices are also expected to use substantial beam time. By the time extracted beams will exist at the SSCL, the initial round of experiments will have passed the prototype and development stage. Thus, the primary need will be for calibration, mapping, and system verification.

The estimate of the amount of airborne radiation produced by the test beam targets at the SSC was calculated on the basis of measurements performed at Fermilab. Butala et al. (1989) measured the induced radioactivity concentration in air and at several target halls at Fermilab and calculated the normalized release rate of total activity. The airborne radiation activity for the SSC test beam targets was calculated directly from the activity measured at targets of similar design at Fermilab.

The initial scope of the test beam includes three 200-GeV target halls. These halls will not be ventilated; thus, no airborne activity will be released from them. An upgrade of the test beam facility for the future includes a target hall containing three 2-TeV target piles. These piles will be shielded with concrete, similar to the MW6 target at Fermilab. Butala et al. (1989) determined the activity to be 4.5 μBq per 800-GeV proton, measured at the release point and assuming a 15-min delay time. It is intended that this target hall will be ventilated only when personnel are present; however, for this calculation, it is assumed that the hall will be continuously ventilated at a rate of 1,000 ft^3/min. The average delay period between activation and exhaust of the nuclides was taken to be half of the air exchange rate, which is 125 min for the 250,000 ft^3 target halls. After this amount of time, most of the N-13 and O-15 will have decayed away, leaving only C-11 as the major component of the released activity. Scaling the values obtained by Butala et al. (1989) to the higher energy protons and multiplying by the annual proton flux expected at these targets (1.5×10^{19} protons/yr), the annual airborne activity released at the 2-TeV target piles would be 48 Ci/yr of C-11 (taking into account the 125-min delay time). Table C.3 summarizes the annual activity released for the different nuclides. It should be noted that Butala et al. (1989) attributed most of the airborne activity produced at MW6 to a 15-m air column following the target and a transport magnet located upstream of the target pile. With proper design modifications, the activity from these two sources can be reduced at the SSC targets.

C.3.2 Interaction Region Halls

In the IR halls, the airborne activity is produced from the interactions of the colliding beams. The activity in curies, R_i, produced in the IR halls can be calculated by using the formula:

$$R_i = \frac{N_p S_a K_i}{(3.7 \times 10^{10} (i/s)\ Ci^{-1})\ T_i} - e^{t/t_i}$$

TABLE C.3 Estimated Annual Gaseous Air Activation Product Releases from SSC Normal Operations (Ci/yr)

Radionuclide	Half-life (min)	Test Beam (200 GeV)	Test Beam (2 TeV)	IR5 and IR8	IR1 and IR4	Beam Scraper
H-3	6.47×10^{6}	0	0	5.2×10^{-4}	5.2×10^{-4}	7.2×10^{-4}
Be-7	7.67×10^{4}	0	0	1.0×10^{-1}	1.0×10^{-1}	1.4×10^{-1}
C-11	2.04×10^{1}	0	4.8×10^{1}	2.2×10^{1}	4.8×10^{0}	2.2×10^{1}
N-13	9.99×10^{0}	0	4.8×10^{-1}	5.6×10^{0}	2.6×10^{-1}	4.0×10^{0}
O-15	2.03×10^{0}	0	0	1.0×10^{-2}	0	4.6×10^{-4}
Cl-39	5.55×10^{1}	0	0	1.1×10^{-1}	6.6×10^{-2}	1.4×10^{-1}
Ar-41	1.10×10^{2}	7.5×10^{0}	0	1.8×10^{1}	3.8×10^{0}	1.8×10^{1}
Totals		7.5×10^{0}	4.9×10^{1}	4.5×10^{1}	9.0×10^{0}	4.4×10^{1}

where:

N_p = number of proton interactions;

S_a = number of stars produced in air per interaction, K_i and t_i, for the production factor and the mean half-life of isotope i, respectively; and

t = delay time for the air to exit the hall.

Values of K_i and t_i for the isotopes of interest are listed in Table C.4. The Ar-41 activity was determined following the methods used in the EIS. On the basis of measurements performed at Fermilab, the EIS assumed the Ar-41 activity was 81% of the activity of C-11 at the release point.

In each of the IR halls, up to 2×10^{16} proton-proton interactions can occur annually, and each interaction produces two stars. The delay time used in the calculations was half the air exchange time. Thus, for the large IR halls (IR1 and IR4), the delay time is 75 min; for the smaller halls (IR5 and IR8), it is only 30 min. If these values are used, the total airborne activity produced by the small IR halls is 23 Ci/yr, whereas the large IR halls release 4.5 Ci/yr. Table C.3 shows the released activity broken down by nuclide.

C.3.3 Beam Scrapers

The airborne activity due to the beam scrapers can also be determined from the equation used to calculate the activity from the IR halls. Including both beam lines, up to 8×10^{16} protons can strike the scrapers annually, with each proton producing 1.4 stars. The amount of air vented from the collider tunnel is controllable, from a minimum of no tunnel air released to a maximum of all of the air released into the

atmosphere. For these calculations, a worst case is assumed, namely that all the activated air is released. The nearest surface to that of the beam scrapers is the RF shaft, which is located approximately 2,000 ft from the scrapers. An air speed of 50 ft/min established a delay time of 40 min. The total activity released from the beam scrapers is then 44 Ci/yr. A breakdown of this activity by nuclide is shown in Table C.3.

TABLE C.4 Airborne Radioactive Nuclide Parameters

Isotope	Mean Life (s)	Production Factor
H-3	5.5×10^8	0.131
Be-7	6.7×10^5	0.031
C-11	1.75×10^3	0.05
N-13	8.74×10^2	0.018
O-15	1.75×10^2	0.024
Cl-39	4.8×10^3	0.00037
Ar-41	(81% of C-11 activity at release point)	

C.4 CONTROL STRATEGY DEVELOPMENT

As stated in Sections 2.3 and 2.5, the initial worst-case determinations for ST and LT were made by using the most cost effective and easiest to achieve control strategies. These strategies included chemical dust suppression at a 90% level with petroleum resins on all unpaved traveled surfaces, with the exception of topsoil surfaces. Also included was vacuum sweeping of paved roads to achieve 50% control.

However, once the worst-case periods were identified and the models executed, it was observed that additional controls were required on some sources to meet the NAAQS, while other source controls could be relaxed. The impact analysis performed with five years of meteorological data indicated that transport and dispersion conditions during 1982 required the most emission reduction in the west campus area, and transport and dispersion conditions during 1984 required the most emission reduction in the E10 service area, both on the basis of the ST analyses.

Table C.5 shows the control technique and efficiency required during years with the most restrictive meteorological conditions for each subactivity listed in Section 2.3. Rather than identify the subactivities again, Table C.5 simply uses the same identification number used in Section 2.3. There are four basic control techniques listed in the table: (1) petroleum resin application on unpaved roads and haul routes; (2) watering of unimproved, unpaved haul routes; (3) vacuum sweeping of paved roads; and (4) watering of the active areas of storage piles on days when wind gusts exceed about 25 mph. In addition to the sources shown in Table C.5, it was assumed that other E and F site construction activities and east campus construction activities not occurring within the RWC period would require the same emission controls as indicated for similar activities in E10 and F1. Other control options that would involve a more refined analysis of source-receptor contributions (e.g., rescheduling of construction activities, use of alternative construction equipment, and/or use of an alternative approach for assessing impacts from paved and unpaved roads) would provide control alternatives that could be potentially less costly. However, time constraints necessitated that the necessary assumptions on control strategies be environmentally conservative.

TABLE C.5 Short-Term Control Strategy

Concurrent Subactivity ID	Control Efficiency (%)	Control Technique
RWC Scenario 1 -- Service Area E10 and West Campus[a]		
1	-	None
2	93	Petroleum resins on unpaved roads
3	68.5	Petroleum resins on unpaved roads
4	90	Petroleum resins on unpaved roads
5	60	Watering of scraper haul surfaces (much of haul is over unimproved, topsoil-covered surface)
6	90	Petroleum resins on unpaved roads
7	90	Petroleum resins on unpaved roads
8	90	Petroleum resins on unpaved roads
9	25	Vacuum sweeping of F.M. 1493
10	71.2	Vacuum sweeping of F.M. 66
11	25	Vacuum sweeping of F.M. 1446
12	50	Watering on days with high wind speed; covering with topsoil and planting vegetation immediately upon completion of E and F site spoils piles
RWC Scenario 2 -- IR4[b]		
1	86.4	Petroleum resin on unpaved surface
2	90	Petroleum resin on unpaved roads
3	-	None
4	-	None
5	50	Watering on days with high wind speed; covering with topsoil and planting vegetation immediately upon completion of IR4 site topsoil pile
6	75	Watering on days with high wind speed; covering with topsoil and planting vegetation immediately upon completion of IR4 site spoils pile

[a]These controls are assumed applicable to similar activities in all other service and access areas, except for IR5 and IR8 construction in the east campus.

[b]These controls are assumed to be applicable to IR5 and IR8 construction in the east campus.

Some of the techniques listed in Table C.5 have undergone significant field testing. For example, application of petroleum resins to unpaved roads has been tested enough to develop the following predictive equation for control efficiency (EPA 1984; Cuscino 1984):

$$CEI = 100 - 0.00430 \times V$$

where CEI = the instantaneous control efficiency (%), and V = the number of vehicle passes.

Testing to support this empirical equation was conducted with vehicles weighing an average of 43 tons and traveling on a road of moderate strength. The road was treated with an application intensity of 1 gal/yd^2 and a dilution ratio of 1:8 (chemical:water). The instantaneous control efficiency in the above equation decays linearly as a function of the number of vehicle passes. If this equation is used, reapplication of petroleum resin is required after 7330, 2320, and 1630 vehicle passes to achieve the desired instantaneous control efficiencies of 68.5%, 90%, and 93%, respectively, on the last day prior to reapplication. In other words, the efficiency decays from 100% to 68.5%, 90%, or 93%, with the average therefore being greater than 68.5%, 90%, and 93% and the lowest single day, the last day, being exactly 68.5%, 90%, or 93%.

Watering of the scraper haul route during topsoil removal at the HEB will require 60% control. This formidable effort will probably require a dedicated water truck, especially if watering occurs on hot, dry summer days. On such days, eight reapplications of water would not be unusual. Fortunately, this subactivity will require about two calendar months of effort; if it occurs in winter, as currently scheduled, the number of reapplications could be reduced.

Only four tests have been conducted to quantify the control efficiency from the vacuum sweeping of paved roads (EPA 1983; Cuscino 1984). The highest efficiency measured indicates a control efficiency of about 60% when measured 24 hours after vacuum sweeping on a road traveled upon by heavy-duty vehicles. To be conservative, it is assumed here that daily vacuuming will provide 50% control and twice-daily vacuuming will yield 25% control. It is also assumed that twice-daily vacuum sweeping on F.M. 66 will yield 75% control.

There are no field tests quantifying the extent to which watering at storage piles reduces wind erosion. However, it is clear that the interparticle adhesion created by watering will reduce emissions. The need to water is limited in that only days with wind gusts in excess of about 25 mph at 10 m will require storage pile watering. Such gusts have occurred on about 16% of the days over the period from 1982 to 1986, given the Dallas-Fort Worth airport data provided by the National Climatic Data Center. Of course, none of those days have 24 full hours of winds greater than 25 mph, and only about 2% of the hours per year will actually contain a wind erosion event. The need to water is further limited in that only active areas of the pile may require watering. Inactive areas (i.e., those not traveled upon) are likely to remain crusted and will probably not be susceptible to wind erosion (depending on the wind speed and crust strength). Some days may require watering only once; others may require many applications. Watering will have to occur at night if winds are high.

Table C.6 shows the control technique and efficiency required, using the most restrictive meteorological data from a LT viewpoint, for each subactivity listed in Section C.2.5. Rather than identify the subactivities again, Table C.6 uses the same identification number used in Section C.2.5. The same four basic control techniques listed in Table C.5 are also listed in Table C.6: (1) petroleum resin application on unpaved roads and haul routes; (2) watering of unimproved, unpaved haul routes; (3) vacuum sweeping of paved roads; and (4) watering of the active areas of storage piles on days when wind gusts exceed 25 mph. The discussion of the data base supporting the ST control strategy also applies to the LT control strategy.

TABLE C.6 Long-Term Control Strategy

Concurrent Subactivity ID	Control Efficiency (%)	Control Technique
1	-	None
2	-	None
3	-	None
4	-	None
5	-	None
6	-	None
7	-	None
8	-	None
9	-	None
10	-	None
11	-	None
12	-	None
13	-	None
14	90	Petroleum resin on unpaved roads
15	90	Petroleum resin on unpaved roads
16	60	Watering of scraper haul surfaces (much of haul over unimproved, topsoil-covered surface)
17	-	None
18	90	Petroleum resin on unpaved roads
19	-	None
20	-	None
21	90	Petroleum resin on unpaved roads
22	90	Petroleum resin on unpaved roads
23	90	Petroleum resin on unpaved roads
24	25	Vacuum sweeping of F.M. 1493
25	71.2	Vacuum sweeping of F.M. 66
26	25	Vacuum sweeping of F.M. 1446
27-44	50	Watering on days with high wind speed; covering with topsoil and planting vegetation immediately upon completion of E and F site spoils piles

The cost of the control measures listed in Table C.6, when applied to similar sources throughout the SSC, is shown in Table C.7. This table defines the specific control strategy, the sources to which each strategy applies, and the FY 1990 cost. The total cost to control fugitive dust during the 10-year construction project is estimated at about $4.8 million (FY 1990 dollars), which is less than 0.1% of the total construction project cost. Consequently, with a relatively small investment, the PM_{10} NAAQS can be achieved. A little over half of the control cost will be required to mitigate dust from unpaved roads traveled on by construction employees and construction materials delivery trucks.

C.5 SUMMARY OF CONTROLLED EMISSION INVENTORY RESULTS

The results of the ST emission inventory are given in Table C.8. Rather than repeat each subactivity description, the same identification number in Section C.2.3 is used.

TABLE C.7 SSC Fugitive Dust Control Program Cost Estimates

Control Strategy	Source	FY 1990 Unit Cost	Units	Total Cost
Petroleum resins on unpaved roads at 1 gal/yd^2 of 12% solution	E/F sites cut and cover	7,000	20	140,000
	IR halls	220,000	4	880,000
	Injector area			90,000
	Campus bldgs, >40,000 ft^2	5,000	10	50,000
	Construction traffic			2,500,000
Vacuum Sweeping F.M. paved roads twice daily for 10 yr	1 mi each of F.M. 1493, 1446, and 66			550,000
Watering of storage piles on high wind days				750,000
Automatic traffic counters for enforceability		1000	20	20,000
Total cost				4,980,000

TABLE C.8 Summary of the Short-Term Emission Inventory

Concurrent Subactivity ID	No. of Sources (ISCST ID)	Controlled Emission Rate (lb/d)	Controlled Source Strength (g/s/source)
RWC Scenario 1 -- Service Area E10 and West Campus			
1	4 (10-40)	404	1.27
2	8 (50-120)	80.7	0.127
3	8 (130-200)	381	0.752
4	8 (210-280)	42.9	0.0845
5	6 (290-340)	270	0.568
6	5 (350-390)	208	0.218
7	11 (400-500)	86.5	0.238
8	6 (510-560)	17.5	0.0367
9	11 (570-670)	1015	1.16
10	11 (680-780)	793	0.909
11	11 (790-890)	266	0.305
12	1 (900)	146	0.00184[a]
Total	90	3710.6	
RWC Scenario 2 -- IR4			
1	9 (10-90)	443	0.621
2	7 (100-160)	36.2	0.0812
3	1 (170)	54.9	0.000132[a]
4	4 (180-210)	10.6	8.96×10^{-6}[a]
5	1 (220)	95.8	0.00161[a]
6	4 (230-260)	183	0.00092[a]
Total	26	823.5	

[a]Units are grams per square meter per second because this is an area source.

Table C.8 also shows the number of sources that actually constitute a subactivity category, along with the source ID actually used in the ISCST model. The ST controlled emission rate given in Table C.8 represents the pounds of PM_{10} emitted into the air by all the sources of a particular subactivity on the RWC day. This emission rate is higher than the average day not only because a peak day of activity is assumed but also because it does not include nonworkdays like weekends and holidays as the LT emission rate does. Finally, Table C.8 shows the actual controlled emission rate, called the source strength, that was entered into the model for each source in units of grams per second per source (units for wind erosion are grams per square meter per second). Since the ISCST model was structured for this application to allow each nonwind-erosion source to

emit only during the actual work hours on a RWC day, the source strength represents the emission rate spread evenly only over those work hours.

For wind erosion, the emissions are spread only over the first hour in the day when the wind speed exceeds the wind erosion threshold. This approach is taken because storage pile surfaces present only a limited amount of erodible surface dust, and it is nearly all airborne within the first hour of a wind erosion event. Only another surface disturbance could replenish the erodible surface material during the same day.

Caution should be used in interpreting the values in Table C.8. The actual impact of a source on the ambient concentrations at the DOE property lines will not necessarily be in proportion to the emission rate. Other variables (e.g., physical size of each source and distance and direction from each source to the property lines) will also affect the concentration. This variability explains why a source with a small emission rate that is also physically compact and located near a boundary line can affect air quality more severely than one with a high emission rate that is located far from the boundary.

The results of the LT inventory are given in Table C.9. As with Table C.6, the subactivity identification is keyed to the ID number (Section C.2.5). The number of sources actually constituting a given subactivity is also given in Table C.9, along with the source ID used in the ISCLT model. The controlled emission rate for the subactivity is expressed in pounds per year and in grams per second or grams per square meter per second for each source. For nonwind-erosion sources, the actual emission rate used in the ISCLT model (i.e., the source strength) is an annual average value spread over the daylight hours only because no construction is expected to occur at night. The model is structured to allow no emissions at night for these nonwind-erosion sources. There is no way to structure the model to allow no emissions on the weekend, so the emissions are spread evenly over weekdays and weekends. On an annual average basis, this configuration should present no difficulty because there is no reason to believe that weekend meteorological conditions differ from those on weekdays. For wind erosion sources, the emission rate is spread only over those hours of the year when the wind speed is high enough to cause wind erosion. The model was structured to allow dust from wind erosion only during those high wind speeds.

These same warnings should be applied in interpreting Table C.9. Source strength alone does not determine which sources will cause the largest concentration impact. Such variables as the physical size of the source as well as the distance and direction from the source to the boundary lines are also important.

In conclusion, Appendix C provides more detailed information on how the ST and LT emission inventories were prepared and presents the results of the inventories. Also presented are the control strategies employed and a detailed discussion of possible control strategies. Also explained is how the dispersion models were implemented to accommodate the emitting versus nonemitting periods for each source.

TABLE C.9 Summary of the Long-Term Emission Inventory

Concurrent Subactivity ID	No. of Sources (ISCLT ID)	Controlled Emission Rate (lb/yr)	Controlled Source Strength (g/s/source)
1	5 (10-50)	12,400	0.0537
2	2 (60-70)	2,720	0.0293
3	5 (80-120)	5,120	0.0221
4	5 (130-170)	5,120	0.0221
5	15 (180-320)	12,400	0.0179
6	15 (330-470)	12,400	0.0179
7	5 (480-520)	2,720	0.0117
8	5 (530-570)	2,720	0.0117
9	5 (580-620)	5,120	0.0221
10	5 (630-670)	5,120	0.0221
11	15 (680-820)	12,400	0.0179
12	15 (830-970)	3,450	0.00497
13	5 (980-1020)	2,720	0.0117
14	13 (1030-1150)	16,200	0.0269
15	20 (1160-1350)	23,000	0.0249
16	3 (1360-1380)	27,600	0.199
17	13 (1390-1510)	9,290	0.0154
18	13 (1520-1640)	2,520	0.00418
19	3 (1650-1670)	11,200	0.0806
20	3 (1680-1700)	11,200	0.0806
21	5 (1710-1750)	23,000	0.0995
22	11 (1760-1860)	41,200	0.0808
23	6 (1870-1910)	4,980	0.0179
24	11 (1920-2020)	301,000	0.590
25	11 (2030-2130)	234,000	0.459
26	11 (2140-2240)	78,900	0.155
27	4 (2250-2280)	4,820	6.93×10^{-6}[a]
28	1 (2290)	15,100	2.17×10^{-5}[a]
29	1 (2300)	5,900	1.70×10^{-5}[a]
30	4 (2310-2340)	15,100	2.17×10^{-5}[a]
31	4 (2350-2380)	13,400	1.93×10^{-5}[a]
32	4 (2390-2420)	5,900	1.70×10^{-5}[a]
33	4 (2430-2460)	5,900	1.70×10^{-5}[a]
34	4 (2470-2500)	9,660	1.39×10^{-5}[a]
35	4 (2510-2540)	3,180	9.16×10^{-6}[a]
36	1 (2550)	116,000	3.34×10^{-5}[a]
37	1 (2560)	14,500	2.08×10^{-5}[a]
38	1 (2570)	10,700	1.54×10^{-5}[a]
39	1 (2580)	11,800	1.70×10^{-5}[a]
40	4 (2590-2620)	15,100	2.17×10^{-5}[a]
41	4 (2630-2660)	11,300	1.62×10^{-5}[a]

TABLE C.9 (Cont'd)

Concurrent Subactivity ID	No. of Sources (ISCLT ID)	Controlled Emission Rate (lb/yr)	Controlled Source Strength (g/s/source)
42	4 (2670-2700)	5,900	1.70×10^{-5}[a]
43	4 (2710-2740)	5,250	1.51×10^{-5}[a]
44	4 (2750-2780)	4,020	1.16×10^{-5}[a]
Total	279	1,142,030	

[a]These are wind erosion sources that are modeled as area sources; consequently, the source strengths are in units of grams per square meter per second. The values shown represent the source strength if the emissions were spread over the entire year. To calculate the actual values used in the ISCLT model, divide the values shown by 0.01997, 0.02338, 0.02423, 0.01926, and 0.01151 for 1982-1986, respectively. These values represent the fraction of time that wind erosion could occur in each of those years.

C.5 REFERENCES FOR APPENDIX C

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APPENDIX D

DOE RESPONSES TO COMMENTS ON THE SSC DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

APPENDIX D

DOE RESPONSES TO COMMENTS ON THE SSC DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

BACKGROUND

The draft Supplemental Environmental Impact Statement (SEIS) for the Superconducting Super Collider (SSC) was issued by the U.S. Department of Energy (DOE) on August 31, 1990, for a 45-day public comment period that ended on October 15, 1990.

The draft SEIS derives from a DOE decision in January 1989 to prepare a more detailed site-specific analysis to follow the EIS for the SSC released in December 1988. The draft SEIS presents an evaluation of the environmental impacts associated with constructing and operating the SSC at the site in Ellis County, Texas. It also takes into account SSC design modifications made since the earlier EIS was issued. Also included is an examination of the site-specific mitigation measures that could be implemented to minimize potential adverse impacts.

The DOE solicited comments on the draft SEIS. The comments could be submitted orally at public hearings or in writing. One hearing was held in Waxahachie, Texas, on September 19, 1990, and the other in Ennis, Texas, on September 20, 1990.

CONSIDERATION OF COMMENTS

The comments received on the draft SEIS were considered in a three-step process: (1) analyze and categorize each comment, (2) prepare a written response, and (3) determine whether and how each comment would affect the final SEIS. For reference purposes, the comment letters and the transcript containing the oral statements were assigned sequential tracking numbers. Each discrete comment was then assigned to a category or subcategory based on the technical content of the comment. The subcategories generally parallel the SEIS outline. Table D.1 lists the 20 categories, along with the subcategories, that were set up to subdivide comments. There were no submissions for some of the subcategories; that result is noted, when appropriate, in the sections that present the responses.

Volume 2 of the SEIS comprises copies of the transcripts of the public hearings and all exhibits submitted during the hearings, as well as all comment letters received. Part 1 of Vol. 2 contains transcripts of testimony (and related exhibits) provided at public hearings held in Waxahachie and Ennis, Texas, in September 1990. Part 2 contains reproductions of the comment letters sent to DOE during the public comment period. The testimony submissions are numbered 104 through 139, and the comment letters are numbered 1 through 103 and 140 through 231. For each submission, passages judged to represent discrete comments are individually numbered. In Vol. 2, the first index lists the commentors alphabetically and gives their submission number. The second index lists the submissions numerically and identifies the commentor.

TABLE D.1 Comment Categories and Subcategories

No.	Technical Area
1	Engineering design, construction, and operation
1.1	Accelerator design
1.2	Accelerator components
1.3	Equipment, buildings, and construction schedule
1.4	Experimental facilities
1.5	Utilities
2	Basis for project cost estimates
3	Policy issues
4	Decommissioning
5	Land acquisition
5.1	Type of ownership
5.2	Schedule for land acquisition
5.3	Land acquisition laws
5.4	Affected parcels, owners, relocations, and property values
5.5	Easements
6	Earth resources
6.1	Geology
6.2	Topography
6.3	Mineral resources
7	Water resources
7.1	Surface water
7.2	Groundwater
7.3	Floodplains
7.4	Wetlands
8	Biotic resources
8.1	Terrestrial species
8.2	Aquatic species
8.3	Commercially, recreationally, and culturally important species
8.4	Sensitive and unique communities
8.5	Protected species
9	Land resources
9.1	Land use and zoning
9.2	Prime and important farmlands
9.3	Land use plans
10	Air resources
10.1	Climate and meteorology
10.2	Fugitive construction dust
10.3	Air quality and definition of ambient air
10.4	Mitigation measures
10.5	Demonstration of compliance with NAAQS
11	Noise and vibration

TABLE D.1 (Cont'd)

No.	Technical Area
12	Waste management
	12.1 Low-level radioactive waste
	12.2 Mixed waste
	12.3 Toxic waste
	12.4 Sanitary, sewage, and solid waste
	12.5 Wastewater
13	Environmental hazards and health effects
	13.1 Radiation exposure and effects
	13.2 Air activation product releases and exposure
	13.3 Disposal of low-level radioactive waste
	13.4 Hazardous and toxic mixed and sanitary wastes
	13.5 Industrial safety
	13.6 Fire ants
14	Socioeconomics and infrastructure
	14.1 Relocation and housing
	14.2 Roads and traffic
	14.3 Transportation and utilities
	14.4 Public services
	14.5 Economic activity, public finance, and property values
	14.6 Labor force, income, and demographics
	14.7 Quality of life
15	Cultural and paleontological resources
16	Visual resources
17	Federal permits, licenses, and other entitlements
18	Out of scope
19	No technical, policy, cost, or engineering/physics issues
20	Submissions not addressed elsewhere

The responses to the comments are found in this appendix; Table D.2 is an index to those responses. In the index, the categories (and subcategories) to which specific comments were assigned are given. This index can help individuals (listed alphabetically) in locating the responses to their comments. Each response has a heading keyed to the category, to the letter or testimony submission number, and comment number. If a comment duplicates another comment, the individual is referred to the appropriate response.

TABLE D.2 Response Index

Name	Affiliation	Submission	Category	Comment	Page
Adams, John		42	14.2	1	D-76
Aday, Weldon		186	20.0	1	D-84
Allen, A.		37	14.2	1	D-76
Babroski, Edward		88	14.2	1	D-76
Ballard, Charlene		43	14.2	1	D-76
Barnes, Daniel		194	20.0	1	D-84
Becker, Robert		124	2.0	4	D-28
			4.0	2	D-36
			13.1	3	D-68
			18.0	1	D-83
Biddy, Robert	Allen Samuels Chevrolet-Olds-Pontiac	77	14.2	1	D-76
Bingler, Ed	Texas National Research Laboratory Commission	104	19.0	1	D-83
Blain, John	State Dept. of Highways and Public Transportation	179	14.2	1	D-78
			14.2	2	D-78
			14.2	3	D-78
			14.2	4	D-78
Bonks, Sonny		41	14.2	1	D-76
Booher, W.		203	14.5	1	D-81
Bowles, Kevin		93	14.2	1	D-76
Bozz, Pat, Mr. and Mrs.		178	2.0	2	D-29
			14.0	1	D-76
Bradshaw, Deatra		196	20.0	1	D-84
Branscum, Connie		44	14.2	1	D-76
Brigma, David		211	19.0	1	D-83
Brown, Edward		40	14.2	1	D-76

TABLE D.2 (Cont'd)

Name	Affiliation	Submission	Category	Comment	Page
Brown, Michael		199	20.0	1	D-84
Brown, Terry		38	14.2	1	D-76
Bryant, Matt		120	13.1	1	D-67
			13.1	2	D-68
			19.0	3	D-83
Bryant, Matthew		222	13.0	1	D-61
Bryson, Verna		214	20.0	1	D-84
Buchley, Suzanne		227	14.7	1	D-82
Buie, David		146	20.0	1	D-84
Burnett, Kipp	Ennis Chamber of Commerce	8	14.2	1	D-76
Burnett, Kipp	Ennis Chamber of Commerce	113	14.2	1	D-76
		113	14.2	3	D-76
		113	14.2	4	D-76
		113	19.0	2	D-83
Caddel, George and Jean		80	2.0	10	D-27
			3.0	4	D-30
			3.0	6	D-30
			3.0	13	D-30
			3.0	20	D-31
			7.0	15	D-40
			10.0	17	D-50
			11.0	17	D-57
			12.1	18	D-58
			12.2	19	D-59
			13.0	9	D-60
			13.1	14	D-61
			13.1	16	D-62
			14.0	11	D-75
			14.0	12	D-75
			14.3	8	D-79
			14.5	7	D-80
			14.7	2	D-81
			18.0	3	D-83
			18.0	5	D-83
			19.0	1	D-83
Caddel, George	(Comments 9-17 on page 1-115 of transcript, Vol. 2)	110	1.0	7	D-22

TABLE D.2 (Cont'd)

Name	Affiliation	Submission	Category	Comment	Page
Caddel, George		110	6.0	16	D-39
			7.1	9	D-41
			7.1	17	D-41
			7.2	5	D-43
			7.2	11	D-43
			10.0	3	D-51
			13.1	2	D-62
			13.1	4	D-62
			13.1	12	D-62
			13.1	13	D-63
			13.1	15	D-63
			14.4	6	D-80
			19.0	1	D-83
			19.0	8	D-83
			19.0	10	D-83
			19.0	14	D-83
Caddel, George		132	13.1	1	D-69
			13.1	2	D-69
Caddel, George		144	1.0	4	D-22
			3.0	3	D-33
			3.0	8	D-33
			3.0	9	D-33
			3.0	10	D-33
			12.2	2	D-59
			13.1	1	D-70
			13.1	5	D-70
			13.1	6	D-71
			13.1	7	D-72
			19.0	11	D-83
Caddel, Jean		108	1.1	2	D-23
			1.1	3	D-23
			3.0	6	D-31
			3.0	9	D-31
			7.2	5	D-42
			7.2	7	D-43
			12.2	4	D-59
			13.1	1	D-62
			13.1	8	D-62
Caddel, Jean		229	20.0	1	D-84
Caddel, Jean		230	(same as submission 144)		
Callahn, Roy		56	14.2	1	D-76
Cerante, Ruben		66	14.2	1	D-76
Clements, William	The State of Texas	29	19.0	1	D-83

TABLE D.2 (Cont'd)

Name	Affiliation	Submission	Category	Comment	Page
Cook, Ava		107	12.1	1	D-58
Cook, Ava		172	20.0	1	D-84
Cook, Dale		118	1.1	2	D-24
			13.1	3	D-67
			14.7	4	D-82
			19.0	1	D-83
Cook, Dale		174	20.0	1	D-84
Couch, Cleo		158	20.0	1	D-84
Crawford, Dorothy		160	20.0	1	D-84
Crawford, Ross		216	20.0	1	D-84
Crowder, J.		204	2.0	1	D-29
			20.0	2	D-84
Dammon, William		90	14.2	1	D-76
Davis, A.	Eiki International, Inc.	12	14.2	1	D-76
Davis, R.E., Mr. and Mrs.		153	2.0	1	D-28
Deason, Jonathan	U.S. Department of the Interior	231	7.4	1	D-45
Doherty, Donald		84	14.2	1	D-76
Echols, Joan		131	13.0	1	D-61
Ely, Joanne		210	20.0	1	D-84
Everett, John	Everett Sales Co.	103	20.0	1	D-84
Fira, Mario		70	14.2	1	D-76
Fudge, Mary		60	14.2	1	D-76
Fuller, Jewel		185	20.0	1	D-84
Gagliano, J. and B.		212	20.0	1	D-84
Goodwin, Jeanne		152	20.0	1	D-84

TABLE D.2 (Cont'd)

Name	Affiliation	Submission	Category	Comment	Page
Graham, Dorothy		175	20.0	1	D-84
Graves, Stan	Texas Historical Commission	142	15.0	1	D-82
Gray, Sylvia		182	20.0	1	D-84
Greer, Clifton		81	14.2	1	D-76
Gregory, Terry	Terry Gregory Ford Mercury	11	14.2	1	D-76
Grimes, Mary, and Raper, Hattie	Grimes & Raper Family Shoes	78	14.2	1	D-76
Griztmaker, Carolyn		1	8.1	1	D-46
			8.1	2	D-47
Hall, Preston, Mrs.		171	14.1	1	D-76
Harrison, Bart		32	14.2	1	D-76
Hicks, Joyce		201	13.1	1	D-72
Higgins, Ann		98	20.0	1	D-84
Higgins, T., Mrs.		205	20.0	1	D-84
Hill, W.	U.S. Army Corps of Engineers	170	7.4	1	D-45
Hollingsworth, James		68	14.2	1	D-76
Holt, Dale	Ennis Police Department	50	14.2	1	D-76
Hopkins, David	City of Ennis, Fire Chief	35	14.2	1	D-76
Howell, H.	The Red Oak State Bank	26	14.2	1	D-76
Howerton, Steve	City of Ennis	2	5.1	5	D-37
			7.3	4	D-44
			12.1	2	D-57
			14.2	1	D-76
			14.2	3	D-76
			16.0	6	D-82

TABLE D.2 (Cont'd)

Name	Affiliation	Submission	Category	Comment	Page
Howerton, Steve	City of Ennis	3	14.3	1	D-79
			14.4	2	D-79
Howerton, Steve	City of Ennis	4	14.2	1	D-76
			14.2	2	D-76
			14.2	3	D-76
			14.2	4	D-76
Howerton, Steve	City of Ennis	16	(same as submission 2)		
Howerton, Steve	City of Ennis	24	(same as submission 4)		
Howerton, Steve	City of Ennis	95	14.2	1	D-76
Howerton, Steve	City of Ennis	96	14.2	1	D-76
Howerton, Steve	City of Ennis	97	14.2	1	D-76
Howerton, Steve	City of Ennis	102	14.2	1	D-76
Howerton, Steve	City of Ennis	139	19.0	1	D-83
Hrabina, Dolfie		137	14.2	1	D-76
Huff, Charles		181	20.0	1	D-84
Humert, Vick		126	2.0	2	D-28
			8.0	3	D-46
			13.1	4	D-68
			19.0	1	D-83
			19.0	5	D-83
			19.0	6	D-83
			19.0	7	D-83
			19.0	8	D-83
Hunter, Melvin		221	14.2	1	D-76
Huskins, Charles		119	3.0	11	D-32
			6.2	1	D-40
			6.2	3	D-40
			7.1	8	D-41
			7.2	5	D-43
			7.2	7	D-43
			7.3	4	D-44
			7.3	9	D-45
			10.2	2	D-51
			13.1	6	D-67
			14.7	10	D-82
Huskins, Charles		138	6.1	1	D-39
			6.2	6	D-40
			7.2	8	D-44
			7.3	7	D-45
			10.2	5	D-51
			13.1	9	D-70

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Name	Affiliation	Submission	Category	Comment	Page
Huskins, Charles		138	5.4	10	D-38
			13.2	2	D-72
			13.2	3	D-72
			13.2	4	D-73
Hyatt, Sue		117	5.4	1	D-38
			5.4	3	D-38
			5.4	4	D-38
			13.1	2	D-67
Hyatt, Sue		133	13.1	1	D-70
Jackson, Henry		73	14.2	1	D-76
Jackson, M.S.		151	20.0	1	D-84
Jeffcoat, Betty		173	20.0	1	D-84
Jeffcoat, Billy		197	20.0	1	D-84
Johnson, Carol		109	13.1	1	D-62
			13.1	2	D-62
Jordan, John		147	20.0	1	D-84
Jordan, Lester		72	14.2	1	D-76
Jordan, Susan		149	20.0	1	D-84
Keisel, James	City of Midlothian	76	9.3	1	D-49
			10.3	2	D-52
			10.3	3	D-52
Kerr, Neally		123	3.0	4	D-32
			14.5	2	D-80
			18.0	3	D-83
			19.0	1	D-83
Kincart, Karen	Agriculture Warehouse	20	14.2	1	D-76
Kinzie, William	Medical Arts Clinic	10	14.2	1	D-76
Knight, John		57	14.2	1	D-76
Kovar, Ray, Mrs.		46	14.2	1	D-76

TABLE D.2 (Cont'd)

Name	Affiliation	Submission	Category	Comment	Page
Lambert, Stan	Ellis County Citizen's Advisory Committee to URA	134	19.0	1	D-83
Lambert, Standard	First National Bank of Ennis	101	14.2	1	D-76
Lawrence, Ronald	Lawrence Funeral Home	13	14.2	1	D-76
Lawton, George		167	13.1	1	D-72
Lawton, Karen		166	20.0	1	D-84
Layton, Robert	U.S. Environmental Protection Agency	169	10.3	2	D-52
			10.5	3	D-53
			10.5	4	D-54
			13.2	5	D-73
			13.3	6	D-73
			19.0	1	D-83
Levin, Cecil		55	14.2	1	D-76
Lewis, Bill	Ennis Chamber of Commerce	23	14.2	1	D-76
Lewis, Bill		135	14.2	1	D-76
Lisman, Jim		198	20.0	1	D-84
Lowry, Harris		215	20.0	1	D-84
Luther, David		61	14.2	1	D-76
Lutz, Sylvia		176	2.0	1	D-29
Markham, Fred	Ennis Banking Center	6	14.2	1	D-76
Mayes, Jack	Sardis-Lone Elm Water Supply Corp.	105	7.2	1	D-42
McBee, W.		51	14.2	1	D-76
McCarty, Jerry	McCarty, Wilson, Mash & Grubbs, P.C.	15	14.2	1	D-76

TABLE D.2 (Cont'd)

Name	Affiliation	Submission	Category	Comment	Page
McClary		206	20.0	1	D-84
McConnell, Robert		94	14.2	1	D-76
McCoy, Ronald	Ellis County Real Estate	9	14.2	1	D-76
McCrary, T.J.	SSC Laboratory	164	20.0	1	D-84
McElroy, Mary		48	14.2	1	D-76
McKenna, Mary		228	20.0	1	D-84
McMullan, M., Ms.		219	20.0	1	D-84
McNair, Melanie		209	14.5	1	D-81
McWhorter, Dorothy		184	20.0	1	D-84
Medford, I. and A.		5	2.0	3	D-27
			13.1	2	D-61
			18.0	4	D-83
			19.0	1	D-83
Medford, I.		157	20.0	1	D-84
Milholland, Larry		213	20.0	1	D-84
Milholland, Larry		217	20.0	1	D-84
Moreland, Mike	State Farm Insurance	74	14.2	1	D-76
Morris, Allen	Ennis Chamber of Commerce	21	14.2	1	D-76
Morris, Nancy	Ennis Chamber of Commerce	22	14.2	1	D-76
Mosher, John		145	7.2	1	D-44
Muhl, Rika		141	20.0	1	D-84
Muncaster, John	Polyguard Products, Inc.	14	14.2	1	D-76
Munday, Ron		47	14.2	1	D-76

TABLE D.2 (Cont'd)

Name	Affiliation	Submission	Category	Comment	Page
Neff, Robert	Tennessee Sierra Club	223	4.0	5	D-37
			8.2	4	D-48
			10.0	3	D-51
			13.1	2	D-72
			14.6	1	D-81
Nieto, Robert	Walmart	18	14.2	1	D-76
Novotny, Frank	Frank's Town	79	14.2	1	D-76
Nutt, Riley		62	14.2	1	D-76
Page, Wallace		49	14.2	1	D-76
Parsons, Claudia		115	13.1	1	D-66
Parsons, John		114	2.0	6	D-27
			5.4	2	D-38
			5.4	5	D-38
			13.1	3	D-65
			19.0	1	D-83
			19.0	4	D-83
			19.0	7	D-83
Partin, Terri		162	20.0	1	D-84
Patterson, James	Ennis Fire Department	36	14.2	1	D-76
Paul, Jay		130	13.0	1	D-60
Paul, Kathleen		128	19.0	1	D-83
Peeler, Ann		45	14.2	1	D-76
Percival, John		136	14.2	1	D-76
Pierce, Claire	(Comment 7 on page 1-119 of transcript, Vol. 2)	111	3.0	5	D-31
			3.0	6	D-32
			13.6	2	D-74
			13.6	4	D-74
			19.0	1	D-83
			19.0	3	D-83
			19.0	7	D-83

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Name	Affiliation	Submission	Category	Comment	Page
Pierce, Claire		224	3.0	1	D-34
			3.0	4	D-34
			3.0	5	D-35
			3.0	6	D-35
			3.0	7	D-35
			7.2	8	D-44
			12.1	3	D-59
			13.1	2	D-72
Pierce, Miles		122	14.5	1	D-80
Pierce, Stephen		112	3.0	1	D-32
			6.1	2	D-39
			7.2	8	D-43
			13.1	3	D-63
			13.1	4	D-64
			13.1	5	D-64
			13.1	6	D-64
			13.1	7	D-65
Presley, Harlan		190	20.0	1	D-84
Putman, James		63	14.2	1	D-76
Reasoner, F.		161	7.0	1	D-41
			14.2	2	D-76
Reed, Charles		25	14.2	1	D-76
Rhone, Larry		83	14.2	1	D-76
Richardson, Bobby		28	14.2	1	D-76
Riddle, Charles		187	20.0	1	D-84
Riddle, Dorothy		188	20.0	1	D-84
Risley, Darel		34	14.2	1	D-76
Roark, Ron		53	12.1	2	D-58
			14.2	1	D-76
Roberts, Linda		154	2.0	1	D-28
Roberts, Ronnie		82	14.2	1	D-76
Rodriguez, Ramon		71	14.2	1	D-76

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Name	Affiliation	Submission	Category	Comment	Page
Ross, R.		54	14.2	1	D-76
Roybol, James		65	14.2	1	D-76
Ruhl, Helen	Coldwell Banker	19	14.2	1	D-76
Russell, Lozzel		92	14.2	1	D-76
Scasta, R. and B.		200	20.0	1	D-84
Schroeder, Dave		125	2.0	4	D-28
			2.0	10	D-28
			3.0	3	D-32
			3.0	8	D-32
			4.0	6	D-36
			6.1	5	D-39
			6.1	7	D-39
			7.2	2	D-44
			13.1	9	D-68
			13.6	11	D-74
			19.0	1	D-83
			19.0	12	D-83
Seward, Stan		69	14.2	1	D-76
Shivers, Jeanie		183	20.0	1	D-84
Shubert, Richard		39	14.2	1	D-76
Simpson, Earlane		207	20.0	1	D-84
Simpson, Susan		180	20.0	1	D-84
Sims, Ronald		67	14.2	1	D-76
Skinner, Larry		59	14.2	1	D-76
Slytok, Mark		30	14.2	1	D-76
Smith, David		52	14.2	1	D-76
Smith, J. and D.		191	20.0	1	D-84
Smith, Phillip	(Comment 6 in Exhibit 15 of transcript, Vol. 2)	121	14.2	1	D-77

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Name	Affiliation	Submission	Category	Comment	Page
Smith, Phillip		121	14.2	2	D-77
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			14.2	4	D-77
			14.2	5	D-77
			14.2	6	D-77
Smith, Wayne		155	2.0	1	D-28
Snepsih, Edward		89	14.2	1	D-76
Solik, Danny		85	14.2	1	D-76
Southworth, Robert		127	2.0	5	D-28
			4.0	6	D-37
			7.2	4	D-44
			9.2	3	D-49
			13.1	2	D-69
			19.0	1	D-83
Spain, Robert	Texas Parks and Wildlife Dept.	156	8.1	1	D-47
Stafford, Phillip	Texas National Research Laboratory Commission	177	19.0	1	D-83
Stewart, James		195	20.0	1	D-84
Stroud, Danny		87	14.2	1	D-76
Swinney, C. and E.		189	2.0	1	D-29
Tamminga, Kars	(Comments 10-14 in Exhibit 12 of transcript, Vol. 2)	116	1.1	12	D-24
			1.3	5	D-24
			1.3	12	D-25
			1.4	4	D-26
			3.0	14	D-32
			5.4	9	D-38
			7.2	3	D-43
			7.2	11	D-43
			13.1	2	D-66
			13.1	6	D-66
			13.1	8	D-66
			13.1	10	D-66
			13.1	13	D-66
			19.0	1	D-83

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Name	Affiliation	Submission	Category	Comment	Page
Tamminga, Kars		116	5.4	9	D-38
			19.0	7	D-83
Telfair, Ray	Texas Parks and Wildlife Dept.	17	8.1	1	D-47
			8.1	2	D-47
			8.1	3	D-47
			8.1	4	D-47
			8.1	5	D-47
			8.1	6	D-47
			8.1	7	D-47
			8.1	8	D-47
			8.1	9	D-47
Threodgill, J.		86	14.2	1	D-76
Timmerman, Charlie		129	12.1	1	D-58
			14.5	2	D-80
Timmermann, Charles		150	20.0	1	D-84
Trimble, Owen	Kuhlman-Trimble	75	1.1	7	D-22
			2.0	6	D-27
			3.0	8	D-30
			13.4	2	D-73
			18.0	1	D-83
			18.0	3	D-83
			18.0	4	D-83
			18.0	5	D-83
			18.0	9	D-83
Tucker, Jeanie		218	2.0	1	D-29
Tucker, Jeanie		99	20.0	1	D-84
Tucker, Jeanie		100	20.0	1	D-84
(Unsigned)		220	3.0	1	D-33
Vance, Leroy		91	14.2	1	D-76
Vasquez, Elias		27	14.2	1	D-76
Walker, Don	Buena Vista Bethel Water Supply Corp.	140	1.5	1	D-26
Walker, George		64	14.2	1	D-76
Watkins, Milton		163	20.0	1	D-84
Watts, W., Mrs.		193	2.0	1	D-29

TABLE D.2 (Cont'd)

Name	Affiliation	Submission	Category	Comment	Page
West, Mitchell		192	20.0	1	D-84
Whitt, J. & J.		202	20.0	1	D-84
Wiggins, Sammie		33	14.2	1	D-76
Wilborn, Granrriere		31	12.1	2	D-58
			14.2	1	D-76
			19.0	3	D-83
Williams, Roger		106	1.5	6	D-26
			2.0	9	D-27
			5.0	8	D-37
			7.2	1	D-42
			7.2	2	D-42
			7.2	3	D-42
			7.2	10	D-42
			9.0	11	D-48
			9.3	5	D-50
			14.4	4	D-80
			19.0	7	D-83
Williams, Roger		165	6.1	1	D-40
			9.1	2	D-49
Williams, Selma		208	20.0	1	D-84
Wilson, Sylvia		159	20.0	1	D-84
Winningham, Jack		168	20.0	1	D-84
Winningham, Wilda		148	20.0	1	D-84
Witherspoon, Gary	Shaw, Willis & Witherspoon	7	14.2	1	D-76
Worsham, Michael		143	20.0	1	D-84
Zapata, Juan		58	12.1	2	D-58
			14.2	1	D-76

SUMMARY OF COMMENTS

The DOE received 195 comment letters, 65 of which were considered duplicates. At the public hearings, 36 oral statements (some of which were accompanied by hard-copy submissions) were transcribed. The 231 submissions were subdivided into approximately 370 individual comments that were assigned to the categories and subcategories listed in Table D.1.

By far the greatest number of comments (109) related to planned road improvements (Category 14). Radiation hazards associated with SSC operation (Category 13) received the next most numerous number of comments (53). Multiple comments were also received on Category 7 (groundwater impacts) (19), Category 2 (project costs) (19), and Category 8 (terrestrial species present at the site) (12). One or more comments were received on the remaining categories, with the exception of Category 17 (federal permits, licenses, and other entitlements). Each major section of the comment response portion of this appendix begins with a summary statement of the issues raised in the comments classified under that comment category.

In addition to the letters and testimony received from individuals, the DOE received comments from the following federal and Texas agencies with which this environmental impact analysis has been coordinated:

- U.S. Department of the Interior,
- U.S. Fish and Wildlife Service (Ft. Worth Office),
- U.S. Army Corps of Engineers (Ft. Worth District),
- Texas Parks and Wildlife Department,
- Texas Department of Highways and Public Transportation,
- Texas Historical Commission, and
- U.S. Environmental Protection Agency, Region 6 (Dallas).

In its letter of comment (Submission 169) on the draft SEIS, the U.S. Environmental Protection Agency classified the document as "lack of objection," which is the highest rating for an EIS.

CATEGORY 1: ENGINEERING DESIGN, CONSTRUCTION, AND OPERATION

Several of the comments in this category concerned the fixed-target experimental program. Commentors were concerned about the extent of the program and how that extent might affect the amount of low-level radioactive waste generated and how that amount might affect groundwater contamination. In addition, comments were received concerning the extent of the experimental program with respect to the breadth of the environmental impact study. Concern was expressed about the adequacy of shielding cover and containment of the magnetic fields of the magnets. Commentors also expressed concern about local political jurisdiction over water resources in the site area and questioned the value of the SSC relative to a linear collider.

Category 1, Submission 110, Comment 7 (Fixed-Target Experimental Program)

The number of fixed-target experiments to be conducted at the SSC facility is expected to be smaller than the number conducted at Fermilab. For this reason, much less low-level radioactive waste will be generated at the SSC facility.

The comment concerning "50% or more of the radiation" refers to the production of low-level radioactive waste. Fermilab data indicate that 50% of the low-level radioactive waste generated at that facility is generated by the fixed-target program. The other 50% (i.e., the waste generated by the accelerator research program) was the basis for projecting the expected amount of low-level radioactive waste generated by the SSC. The addition of the test beam program described in the SEIS should not significantly increase the total amount of radioactive waste produced by the SSC (Vol. 1, Section 4.7.1.3).

For the response to the comment concerning the likelihood of a fixed-target program, see Category 1.1, Submission 108, Comment 3.

Category 1, Submission 144, Comment 4 (Fixed-Target Experimental Program)

See Category 1.1, Submission 108, Comment 3.

Category 1.1: Accelerator Design

Category 1.1, Submission 75, Comment 7 (Accelerator Design Alternatives)

Technical design alternatives, along with siting and programmatic alternatives, were considered and reported in the EIS (Vol. I, Section 3.2). The purpose of and scientific need for the SSC cannot be met with currently available high-energy physics facilities. Current research indicates that the energies needed to meet the scientific objectives of the SSC are not technologically achievable with advanced linear accelerator designs.

Category 1.1, Submission 108, Comment 2 (Monitoring and Quality Control)

The conditions reported by the special environmental survey team have been carefully investigated and are being monitored by Fermilab to ensure that these potential sources of contamination do not become actual sources. The results of these investigations are reported in detail in the annual site environmental monitoring reports, which are public documents. The results confirm that there are no actual sources of groundwater contamination at Fermilab.

The SSC is being designed to contain and control all potential sources of soil and groundwater contamination. The results of a monitoring program will be made available annually to the public in the SSC environmental report. In addition, a continuous monitoring system is being designed to ensure that actual performance matches design specifications. The system will be connected to special devices that will turn off the machines if the operating parameters are not within allowable tolerances.

In addition, the SSC will be designed, constructed, and operated under a comprehensive quality assurance program. Tight quality controls will be imposed to ensure that design objectives are met.

Category 1.1, Submission 108, Comment 3 (Status of the Fixed-Target Program and Soil and Groundwater Contamination)

There are no plans for a high-intensity fixed-target program for the SSC. However, depending on scientific needs and the direction of the SSC program, a fixed-target program of relatively low intensity may be added. If such experiments were contemplated, appropriate environmental analyses would be performed. (Also see Category 3, Submission 108, Comment 6, and Category 1, Submission 110, Comment 7.)

The designers of the early fixed-target experimental areas at Fermilab elected to use available, very dense soil as the medium for absorbing the radiation from the targets. The soil was contained within an impervious membrane to prevent groundwater contamination. The series of drains incorporated into the containment was connected to a monitored sump for the purpose of collecting any water within the containment. In addition, a series of underdrains was provided beneath the containment to monitor performance and sample any water in the vicinity of the containment. The water collected from outside the containment meets discharge criteria for release to surface water. The bulk of the radiation is absorbed in the shielding close to the target.

Massive iron slabs, rather than contained soil, are now being used as the primary radiation absorber. A concrete enclosure, rather than a membrane, surrounds the absorber. This newer design is similar to what is proposed for the SSC beam absorbers and to what would be used for fixed-target experimental areas at the SSC.

In the conceptual design report for the SSC, which was the basis of the Invitation for Site Proposals, and in the site-specific conceptual design report,* which is the basis for the SEIS, it was always foreseen that there would be modest fixed-target stations associated with the high-energy booster. The purpose of these stations was for developing and testing detector components.

The potential environmental impact associated with release of activation products to the atmosphere from the fixed-target test beams is assessed in Vol. 1, Section 4.7.1.3. This assessment demonstrates that the maximum exposure to radiation of the maximally exposed member of the public will be less than 0.03% of the exposure of that individual to naturally occurring background radiation.

The issue raised by the commentor is the possibility of extracting some fraction of the 20-TeV protons from the collider ring for fixed-target operation. The design of the machine is such that only a small portion of the beam can be extracted to a fixed-target area. Like the newer Fermilab stations, these areas will be designed to completely isolate the radiation at the target from soil and groundwater. The amount of energy available for new physics phenomena in a fixed-target collision is small relative to that available in head-on collisions. However, a limited class of experiments, particularly those relying on relativistic phenomena, are more suitable for fixed targets. The potential number of experiments of this type for the SSC would be quite small relative to the full fixed-target program of Fermilab.

Category 1.1, Submission 116, Comment 12 (Fixed-Target Experimental Program)

See Category 1.1, Submission 108, Comment 3.

Category 1.1, Submission 118, Comment 2 (Fixed-Target Experimental Program)

See Category 1.1, Submission 108, Comment 3.

Category 1.2: Accelerator Components

No submission addressed this issue.

Category 1.3: Equipment, Buildings, and Construction Schedule

Category 1.3, Submission 116, Comment 5 (Earth Cover over Tunnel)

The amount of cover needed over the tunnel depends on the beam intensity (i.e., on the number of protons circulating in each beam) and on the density of the earthen or

*Superconducting Super Collider Laboratory, 1990, *Superconducting Super Collider Site-Specific Conceptual Design*, Report SSCL-SR-1056, Dallas, July.

rock cover. The siting parameters document* assumes a cover density of 2.24 g/cm^3 and a beam intensity of 1.3×10^{14} protons per beam. At the time the site parameters document was written, the site had not yet been chosen. The density of the cover is site-specific, with soil and rock densities expected to range from about 1.8 to 2.5 g/cm^3. After the siting parameters document was written, the DOE decided that the accelerator shielding should be conservative enough to allow for a possible threefold increase in beam intensity (i.e., as much as 4×10^{14} protons per beam) and for the minimum soil density.

The earth cover requirements in the Invitation for Site Proposals (ISP), which was released in April 1987, took into account this possible increase in beam intensity. The ISP indicates that, for light soils of 1.8 g/cm^3, 30 feet of cover would be needed to meet the 10-mrem-per-accidental-beam-loss criterion if the beam intensity were 4×10^{14} protons. It also indicates that, for denser soils, less cover would be needed. In addition, the ISP introduced the requirement that, if the surface were not owned by the DOE, then an additional 15-foot vertical buffer (not dependent on the soil density) would be required. This stipulation means that, in stratified fee areas, 45 feet of cover over the tunnel would be required if the density were 1.8 g/cm^3. In the ISP, a tunnel diameter of 10 feet is assumed. Therefore, the ISP required that the tunnel centerline be at least 50 feet below the surface in stratified fee areas.

The current design provides for 45 feet of cover over the tunnel in stratified fee areas even though the measured density is about 2.24 g/cm^3, a density that would actually warrant less cover. With 45 feet of cover, the aboveground dose under all conditions for the most serious accident will be well below the annual exposure to members of the public from naturally occurring background radiation.

Category 1.3, Submission 116, Comment 12 (Experimental Halls)

The locations of the interaction regions on the east campus at IR5 and IR8 will be provided in the collider lattice (i.e., arrangement of the various magnetic types that define the accelerator structure). (A technical definition of "lattice" is given in Vol. 1, Section A.2). Completion of the experimental halls and associated facilities to exploit the positions at IR5 and IR8 will depend on decisions of the High Energy Physics Advisory Panel, which will not make its recommendations for the first set of experiments until 1991. Implementation of its recommendations will depend strongly on the funding provided by the DOE and the Texas National Research Laboratory Commission for the SSC project. The experimental program beyond the first set of experiments is less well defined. (Also see Category 12.1, Submission 2, Comment 2.)

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*Superconducting Super Collider Laboratory, 1985, *Siting Parameters Document*, Report SSC-115.

Category 1.4: Experimental Facilities

Category 1.4, Submission 116, Comment 4 (Fixed-Target Experimental Program)

The current SSC project specification includes an initial complement of four experimental halls and provides for potential expansion to a total of eight experimental halls. The Invitation for Site Proposals, which was the basis of the EIS, provided for a bypass with the potential for six experimental halls in addition to the initial complement of four. There is no conflict with previous program correspondence. Whereas a high-intensity fixed-target experimental program is not being considered for the SSC, lower-intensity test beams have always been part of SSC design and have been assessed (Vol. 1, Section 4.7).

For the response concerning the test-beam and fixed-target options, see Category 1.1, Submission 108, Comment 3. For the response concerning the additional environmental studies that would be conducted before initiation of any construction or program of a nature substantially different from what is evaluated in the EIS and SEIS, see Category 3, Submission 108, Comment 6.

Category 1.5: Utilities

Category 1.5, Submission 106, Comment 6 (External Magnetic Fields)

Within the SSC tunnel, the two proton beam lines are separated by less than 30 inches. Each beam line has its own set of magnets. If the stray magnetic field from either one of these beam lines were not contained within its own set of magnets, the other proton beam would be disturbed, and the machine would not operate. Because of the nature of magnetic fields, containment is not difficult to effect. Further, it is highly desirable to do so, both to prevent the beams from perturbing one another and to enhance the field within the magnets. Gas, water, and petroleum-product pipelines cross the site in various places. None of these locations is close to the tunnel; therefore, these distribution systems would not be affected by stray fields.

Category 1.5, Submission 140, Comment 1 (Affected Water Resources)

In Vol. 1, Section 3.2 describes the water resources in the area of the SSC site. This description was to used to assess how available water resources might be affected by construction and operation of the SSC (Vol. 1, Section 4.2). There was no intent to provide a final resolution as to exactly what governmental or public utility entities would be involved and how.

CATEGORY 2: BASIS FOR PROJECT COST ESTIMATES

Category 2 comments addressed issues related to the proposed action's affordability, the reliability of the calculated cost estimate, and the justification for this national financial expenditure.

Category 2, Submission 5, Comment 3 (Affordability)

The question of affordability has been and will continue to be deliberated in Congress. The results of efforts to solicit financial contributions from nations expressing a high degree of interest in collaborating and participating in the unique research capabilities offered by the SSC will help reduce the cost to U.S. taxpayers. (Also see Category 2, Submission 75, Comment 6, and Category 2, Submission 80, Comment 10.)

Category 2, Submission 75, Comment 6 (Cost versus Benefits)

The SSC will be a unique scientific instrument for exploring the frontiers of particle physics. Its capabilities for investigating many aspects of the fundamental constituents of matter and new physics phenomena afford major opportunities to benefit society. The executive and legislative branches of the federal government have weighed, and are continuing to weigh, these potential benefits against the benefits of other national priorities. (Also see Category 2, Submission 80, Comment 10, and General Accounting Office report.*)

Category 2, Submission 80, Comment 10 (Variability in Budget Estimates and Cost Control)

The cost estimates for the SSC project have been based on the current site-specific conceptual design. Organizations involved in the preparation of these estimates include the SSCL, DOE's Office of High Energy Physics, the High Energy Physics Advisory Panel, and DOE's Independent Cost Estimating Group. The differences in the estimates from the four groups can be attributed to different estimates of contingency necessary to address technical and schedule uncertainty, and to different approaches to separating construction and operating costs. The cost estimate presented to Congress will reflect careful consideration of each estimate and its basis. Congress will then have to factor the cost of the SSC into its budget process. The decision to proceed with the SSC, or with any other federal program, ultimately rests with Congress. The DOE, on its part, will implement a strict cost and schedule control system to manage the project.

Category 2, Submission 106, Comment 9 (Variability in Budget Estimates)

See Category 2, Submission 80, Comment 10.

Category 2, Submission 114, Comment 6 (Cost versus Benefits)

See Category 2, Submission 75, Comment 6.

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*General Accounting Office, 1988, *Risks and Benefits of Building the Superconducting Super Collider, A Special Report*, Congressional Budget Office.

Category 2, Submission 124, Comment 4 (Life-Cycle Impacts)

The analyses presented in Vol. 1 indicate that many of the socioeconomic impacts on local communities from the SSC will be positive and that, where negative, they can be managed effectively. The socioeconomic impacts of operation, the evolving research program, and an eventual decommissioning can be managed through planning and coordination among the DOE, the state of Texas, and local governmental units. This type of forward-looking development planning is already underway in Ellis County.

Cost concerns are addressed in Category 2, Submission 80, Comment 10. Decommissioning of the SSC is addressed in Category 4, Submission 124, Comment 2.

Category 2, Submission 125, Comment 4 (Cost Control and Variability of Budget Estimates)

See Category 2, Submission 80, Comment 10.

Category 2, Submission 125, Comment 10 (Cost of Tunnel Lining)

Regarding the specific issue of lining the tunnel, the geological borings taken to date indicate that the whole tunnel will not have to be lined. The cost of the lining required is included in the SSC cost estimate.

Category 2, Submission 126, Comment 2 (Variability in Budget Estimates)

See Category 2, Submission 80, Comment 10.

Category 2, Submission 127, Comment 5 (Cost Control and Variability of Budget Estimates)

See Category 2, Submission 80, Comment 10.

Category 2, Submission 153, Comment 1 (Project Affordability)

See Category 2, Submission 5, Comment 3, and Category 2, Submission 75, Comment 6.

Category 2, Submission 154, Comment 1 (Cost versus Benefits)

See Category 2, Submission 75, Comment 6.

Category 2, Submission 155, Comment 1 (Affordability and Cost versus Benefits)

See Category 2, Submission 5, Comment 3, and Category 2, Submission 75, Comment 6.

Category 2, Submission 176, Comment 1 (Project Affordability)

See Category 2, Submission 5, Comment 3, and Category 2, Submission 80, Comment 10.

Category 2, Submission 178, Comment 2 (Affordability)

See Category 2, Submission 5, Comment 3.

Category 2, Submission 189, Comment 1 (Variability in Budget Estimates and Cost Control)

See Category 2, Submission 5, Comment 3, and Category 2, Submission 75, Comment 6.

Category 2, Submission 193, Comment 1 (Project Affordability)

See Category 2, Submission 5, Comment 3, and Category 2, Submission 75, Comment 6.

Category 2, Submission 204, Comment 1 (Project Affordability)

See Category 2, Submission 5, Comment 3, and Category 2, Submission 80, Comment 10.

Category 2, Submission 218, Comment 1 (Cost versus Benefits)

The purpose and benefits of having the SSC are summarized in Vol. 1, Section 1.1, and in the 1988 EIS (Vol. I, Section 1.1). Further details on purpose and benefits can be found in the executive summary of the site-specific conceptual design report* and in *To the Heart of Matter — The Superconducting Super Collider.*‡ (Also see Category 2, Submission 75, Comment 6.)

CATEGORY 3: POLICY ISSUES

A number of commentors expressed concern about current zoning activities in Ellis County as a result of the selection of the site. One commentor wanted assurance that the current land use planning efforts in Ellis County would continue. Some commentors questioned the appropriateness of SSC land acquisition in advance of a Record of Decision on the SEIS. Other commentors expressed concern about the

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*Superconducting Super Collider Laboratory, 1990, *Superconducting Super Collider Site-Specific Conceptual Design*, Report SSCL-SR-1056, Dallas, July.

‡Universities Research Association, 1989, *To the Heart of Matter — The Superconducting Super Collider*, April.

possible future uses to which the SSC might be put and requested assurance that additional environmental review would accompany any future design modifications. The geologic suitability of the site to host the SSC was questioned by several commentors. Additionally, commentors expressed a desire for independent technical oversight of the SSC project.

Category 3, Submission 75, Comment 8 (SSC Design Criteria)

The SSC is sized so it can achieve the necessary design parameters to carry out the contemplated research associated with very high energy particle collisions.

Category 3, Submission 80, Comment 4 (Zoning)

Zoning in Ellis County is the responsibility of the Ellis County Planning and Zoning Commission and the Ellis County Commissioners Court. In 1989, the Texas legislature authorized establishment of the Commission for the purpose of limiting uncontrolled and unsafe development that might otherwise accompany construction of the SSC. Its jurisdiction includes (1) those unincorporated lands located within 10 miles of the site and (2) any appurtenant facility in Ellis County for which the Commissioners Court of Ellis County determines that zoning regulations are necessary or desirable.

The goals of the zoning program are to minimize traffic congestion; promote fire safety; provide adequate light and air; prevent overcrowding; and facilitate delivery of public services (e.g., schools, parks, sewage treatment facilities, and water supplies). Within the subject area, zoning regulations would be applied to building location and use, building size, percentage of lot occupied, size of yards and open spaces, and population density. The Ellis County zoning program is similar to zoning and land use programs already in effect in Texas municipalities. Neither the new zoning program nor the presence of the SSC will affect voting rights in Ellis County.

Category 3, Submission 80, Comment 6 (Land Acquisition)

The land acquisition process is being undertaken by the state of Texas, which is using state and local funds. This preconstruction activity is acceptable under the National Environmental Policy Act of 1969. The current land purchase is neither irreversible nor an irretrievable commitment of resources.

Category 3, Submission 80, Comment 13 (Thoroughness of Geotechnical Evaluation)

A comparable level of basic geological site information was provided for each of the sites evaluated by the DOE as finalists in the SSC site-selection process. This information was deemed sufficient for site selection; indeed, the information was more detailed than is usual for screening sites for major energy research facilities. The DOE site evaluation task force determined that gathering additional information for any candidate site would probably not have changed the site evaluation. Since site selection, a more detailed geoengineering investigation has been conducted to aid in site-specific design and selection of construction techniques. These studies

have confirmed the site evaluation analysis presented in the 1988 EIS (Vol. III, Chapters 2 and 3).

The construction characteristics of the different rock units in Ellis County and the presence of shallow groundwater were evaluated by DOE's Site Evaluation Task Force. The geology and tunneling characteristics for the site were rated outstanding. Shallow groundwater was found to occur discontinuously in stream terrace deposits, in the weathered upper zone of the Austin chalk, and as small flows along open fractures. All of these occurrences are mentioned in the 1988 EIS (Vol. I, Section 4.1). When encountered during tunneling, water inflows can be readily treated by grouting and lining the tunnel in fractured zones. These measures will also ensure that water supplies are isolated from construction activities.

Recognizing that the SSC will be a major user of water in Ellis County, the DOE, in conjunction with the Texas National Research Laboratory Commission, has initiated a comprehensive hydrologic study of the region. To limit the impact on groundwater supplies, a feasibility study is in progress to evaluate surface-water use at all SSC facilities. On the basis of this study, a water use plan for the operating period of the SSC project will be developed. (Also see Category 6.1 for responses pertaining to geology and Category 7.2 for responses pertaining to groundwater use.)

Category 3, Submission 80, Comment 20 (Future Use of SSC)

The purpose and use of the SSC are described in the proposed action (Vol. 1, Section 2.1). See Category 3, Submission 108, Comment 6, regarding the National Environmental Policy Act of 1969 process, and Category 1.1, Submission 108, Comment 3, regarding the fixed-target program.

Category 3, Submission 108, Comment 6 (Environmental Evaluation Process)

The DOE will require further environmental evaluations before any construction or program can be initiated whose nature might be different from what has been evaluated in the EIS and SEIS.

Category 3, Submission 108, Comment 9 (Independent Oversight)

See Category 3, Submission 111, Comment 6.

Category 3, Submission 111, Comment 5 (Environmental Evaluation)

The DOE believes that the SEIS provides a complete and accurate analysis of impacts likely to result from construction and operation of the SSC in Ellis County. Also see Category 3, Submission 224, Comment 5, for a discussion of the process used to prepare and review the SEIS.

Category 3, Submission 111, Comment 6 (Independent Oversight)

The SSC comes under the independent oversight of a variety of federal and state regulatory agencies for all phases of construction and operation. In Vol. 1, Chapter 5 lists the federal permits required in implementing the SSC project in Texas. Each of the permits or licenses cited constitutes an independent check on some aspect of the SSC project. In addition, the DOE SSC Project Office is establishing an independent advisory group for the SSC project. This group is planned to consist of members of the scientific community, public citizens from the SSC area, Texas political leaders, and qualified legal professionals. The basic function of this group is expected to be that of analyzing the SSC annual site environmental reports and offering advice to the DOE on the results of its analyses. The commitment of the DOE to establish this advisory group will be contained in the mitigation action plan for the SSC.

Category 3, Submission 112, Comment 1 (Alternative Sites for the SSC)

The analysis of alternative sites for the SSC and the basis for selecting the Ellis County site are described in the 1988 EIS. Also see Category 3, Submission 80, Comment 13, and Category 3, Submission 125, Comments 3 and 8.

Category 3, Submission 116, Comment 14 (Independent Oversight)

See Category 3, Submission 111, Comments 5 and 6, and Category 3, Submission 224, Comment 5.

Category 3, Submission 119, Comment 11 (Environmental Evaluation and Independent Oversight)

For a discussion of environmental evaluation, see Category 3, Submission 111, Comment 5. For a discussion of independent oversight of the project, see Category 3, Submission 111, Comment 6.

Category 3, Submission 123, Comment 4 (Ellis County Land Use Plan)

Ellis County is working very diligently on a comprehensive land use plan and on necessary controls. Were the "no action" alternative to be chosen, County officials would modify the land use plans, as appropriate, in consultation with the state of Texas and in accordance with applicable laws and regulations.

Category 3, Submission 125, Comments 3 and 8 (Site Selection)

The SSC requires a location with adequate available infrastructure and appropriate surface and geological conditions. The Texas site provides an ideal location. Surface disruption will be minimal, and the required infrastructure is present. For all stratified fee lands, existing surface uses and activities (including farming) will be allowed to continue, so long as those activities do not penetrate the underground

stratified fee zone. Agricultural and prime and important farmland impacts attributable to the SSC are discussed in Vol. 1, Section 4.4.4.

Category 3, Submission 144, Comment 3 (Additional EIS and Hearings for the Fermilab Survey)

No experiments at Fermilab have required additional environmental impact statements and hearings to date because there has been no change in impact. All experiments have been performed on the 6,800-acre site acquired by the state of Illinois for the Department of Energy more than 20 years ago. The same tunnel has been used for the main accelerator, and the same experimental area has been used for the experiments. Shielding was upgraded to maintain radiation levels at the same or at reduced levels as the energy of the accelerator was increased from an operating energy of 400 to 800 GeV for fixed-target operation and 900 GeV for collider operation. A proposed modification to the main ring injector at Fermilab will be the subject of an EIS.

Category 3, Submission 144, Comment 8 (Independent Oversight)

Regarding independent oversight, see Category 3, Submission 111, Comment 6. For the results of the Fermilab environmental survey, see Category 13.1, Submission 112, Comment 4.

Category 3, Submission 144, Comment 9 (Documents as Part of the Public Record)

The referenced reports are all available to the public through the DOE. In addition, copies of these documents have been acquired by the SSC library in Dallas, Texas. Another document that might be of interest to the commentor is Fermilab's *Environmental Restoration and Waste Management Site-Specific Plan*.* This plan describes in detail the activities being conducted at Fermilab to maintain environmental compliance and to safely manage all waste generated. A copy of this plan is available at the SSC library. (Also see Category 1.1, Submission 108, Comment 2.)

Category 3, Submission 144, Comment 10 (Monitoring and Quality Control)

See Category 1.1, Submission 108, Comment 2.

Category 3, Submission 220, Comment 1 (Independent Oversight)

See Category 3, Submission 111, Comment 6.

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*U.S. Department of Energy, 1990, *Environmental Restoration and Waste Management Site-Specific Plan*, Report DOE/CH-9001(2), Chicago Operations Office, Argonne, Ill.

Category 3, Submission 224, Comment 1 (Inadequate Notification for the Public Hearings for the Draft SEIS)

The purpose of the public comment period for a draft EIS is to allow the public time to review the document and provide comments. The public meeting is but one mechanism for providing the opportunity for the public to comment on the document. The public also has the opportunity to write to the DOE with comments. While federal agencies are required to publish a notice in the *Federal Register*, it is also suggested that local newspapers, radio stations, and television stations be notified. In the case of the public hearings on the draft SEIS, paid advertisements were purchased in the *Waxahachie Daily Light* and *Ennis Daily News* prior to the Waxahachie/Ennis hearings. In addition, news stories appeared in local newspapers and were broadcast by at least one local radio station before the hearings. Articles and advertisements are listed below (articles and advertisements can be found as Exhibit 2 of the meeting transcripts of Vol. 2 of this document):

Articles:	
Waxahachie Daily Light	August 23, 1990
Waxahachie Daily Light	August 30, 1990
Waxahachie Daily Light	September 13, 1990
Ennis Daily News	September 13, 1990
Waxahachie Daily Light	September 16, 1990
Advertisements:	
Waxahachie Daily Light	September 14 and 16, 1990
Ennis Daily News	September 14 and 16, 1990

The Texas National Research Laboratory Commission mailed a special edition newsletter to each property owner impacted by the SSC footprint. This newsletter described the SEIS hearing process, gave the location and time for each hearing, and encouraged landowners to either attend the hearings or submit written comments. Written comments carry equal weight to those made orally at the hearings. All comments received on the draft SEIS (even those postmarked after the October 19, 1990, deadline) are included in Vol. 2 and have been considered in producing this SEIS.

Category 3, Submission 224, Comment 4 (DOE Not Forthcoming with Information and SSC Safety)

In Vol. 1, Section 1.6 describes three potential areas for future expansion of the SSC: (1) 2-TeV test-beam target halls, (2) additional experimental halls, and (3) a high-energy fixed-target program. Additional areas for expansion are always possible as new discoveries are made that indicate new research avenues. As indicated in Vol. 1, Section 2.1.4, it is unlikely that future construction and operation would be different in nature from the present design and operating characteristics. Further National Environmental Policy Act of 1969 review would be performed for any proposal to modify or expand the SSC. There is absolutely no intent to use the SSC for any military application.

Almost all DOE high-energy research facilities are located near centers of population. In many cases, residential neighborhoods have grown up adjacent to DOE research laboratories. Monitoring of facility operation by the DOE and independent regulatory agencies has shown that the risk to the off-site public from these research centers has been insignificant.

The Secretary of Energy has set environmental compliance and public health and safety at DOE facilities ahead of other mission areas. This policy will be followed fully, during all project phases, by the SSC project.

Category 3, Submission 224, Comment 5 (Independent Environmental Analysis)

Federal regulations (40 CFR 1500-1508) require that preparers of an EIS have no financial or other interest in the outcome of the activity being assessed. In the case of the SSC, the DOE chose a team of scientists at Argonne National Laboratory to conduct the assessment studies and compile the SEIS. The list of preparers, with a brief statement of each individual's professional credentials, is included in Vol. 1, Chapter 6. In addition, the SEIS has gone through multiple levels of review by oversight groups within the DOE to assure its completeness and accuracy.

The SEIS was issued for public review specifically to allow people to identify any omissions or inaccuracies they feel need to be addressed. The U.S. Environmental Protection Agency in its review (Submission 169) gave the document a grade of "lack of objection," the highest rating possible for an EIS.

Category 3, Submission 224, Comment 6 (Inadequate Notification on the Public Hearings for the Draft SEIS)

See Category 3, Submission 224, Comment 1.

Category 3, Submission 224, Comment 7 (Independence of Hydrologic Studies)

The Texas Bureau of Economic Geology has been selected to conduct the study of the regional hydrology around the SSC site because of its extensive knowledge and experience in this area. The bureau maintains an effective quality assurance program to ensure that its research is conducted without bias. The report, when complete, will be available to the public.

Geological studies of the site, which are being conducted as part of the design process, are the responsibility of the organizations that must certify the soundness of the SSC designs and construction methodology. These designs, and the data on which they are based, will be reviewed extensively by a variety of groups, both internal and external to the DOE. (Also see Category 3, Submission 111, Comment 6).

CATEGORY 4: DECOMMISSIONING

Several commentors asked what the future use of the SSC might be, how decommissioning would be accomplished, and what the socioeconomic impacts of eventually closing the facility were likely to be.

Category 4, Submission 124, Comment 2 (Radiation Impacts)

Firm plans for decommissioning the SSC have not been developed because there are many possible futures for this research facility beyond the initial experimental program. As has been the case with other national laboratories, the SSC research program will probably evolve beyond the currently targeted 25-30-year operating period. Accelerators are often upgraded; some are eventually integrated into new ones, as has been done at CERN and Fermilab. Although the SSC will likely operate over many decades, the nature of its evolving research program cannot now be known. However, any major changes in SSC design or operating characteristics will be accompanied by appropriate environmental analysis and documentation.

The 1988 EIS (Vol. IV, Appendix 3) includes an analysis of a plausible decommissioning of the SSC site. The analysts conclude that the SSC could be decommissioned, its buildings removed, and the site restored to unrestricted use at a reasonable cost and without significant risk to the general public. The socio-economic impacts of operation, the evolving research program, and an eventual decommissioning can be managed through planning and coordination among the DOE, the state of Texas, and local governmental units. This type of forward-looking development planning is already underway in Ellis County.

The SSC will not become increasingly radioactive through ongoing use. Radioactivity has never been the reason for decommissioning an accelerator. Several accelerators have operated for more than 20 years. For example, the Brookhaven and CERN accelerators have been operating for 30 years and are still going strong. Some of the Fermilab accelerators have been operating for more than 20 years, and there is no thought of closing them down because of radioactivity. In fact, the level of radioactivity has not increased since the first few years of operation. When these accelerators are finally decommissioned, it will be because their usefulness as scientific research tools is judged to be at an end, not because they are too radioactive.

Category 4, Submission 125, Comment 6 (Planning)

A proposed plan for decommissioning the SSC, along with an estimate of the decommissioning cost, is provided in the 1988 DEIS (Vol. IV, Appendix 3). At this time, plans for decommissioning are limited in scope and will need to be considered in greater detail at the appropriate time. The cost of decommissioning will be paid by the DOE. (Also see Category 4, Submission 124, Comment 2.)

Category 4, Submission 127, Comment 6 (Planning)

See Category 4, Submission 125, Comment 6.

Category 4, Submission 223, Comment 5 (Radiation Impacts and Planning)

A particle accelerator does not develop levels of residual radioactivity as a nuclear reactor does. Decommissioning of the SSC is evaluated in the 1988 EIS (Vol. IV, Appendix 3). (Also see Category 4, Submission 124, Comment 2.)

CATEGORY 5: LAND ACQUISITION

The issues raised in this category dealt with the amount and type of land required for the SSC, the relationship of the SSC to corporate and extraterritorial jurisdictions, and the effect of the SSC on property values.

Category 5, Submission 106, Comment 8 (Land Requirements)

The Texas proposal, which was assessed in the 1988 EIS, was for a total of 16,748 acres, of which 8,649 acres was to be in fee simple and the remainder in stratified fee estate. After the SSC was fitted to the Texas site, the DOE requested a total of 16,553 acres, of which 10,283 acres was in fee simple. In addition to the land specified, the state of Texas, in responding to the Invitation for Site Proposals, offered a portion of the County Farm site for early occupation and development.

Category 5.1: Type of Ownership

Category 5.1, Submission 2, Comment 5 (Corporate Boundaries)

Most of the east campus, including all of the interaction halls (i.e., IR5, IR6, IR7, and IR8), E5, F6, and M6, is within the corporate limits or the extraterritorial limits of the city of Ennis. A small portion of the northern part of the east campus lies within the municipal boundary of the city of Palmer. Portions of E4 lie within the extraterritorial jurisdiction of the city of Pecan Hill. Volume 1, Section 4.4.5, was revised to reflect the above information.

Category 5.2: Schedule for Land Acquisition

No submission addressed this issue.

Category 5.3: Land Acquisition Laws

No submission addressed this issue.

Category 5.4: Affected Parcels, Owners, Relocations, and Property Values

Category 5.4, Submission 114, Comment 2 (Property Values)

The regional economy is expected to experience increases in employment, income, and sales during construction and operation of the SSC project. Ellis County, in particular, should experience beneficial increases in economic activity as a result of the project. Most evidence suggests that property values rise under favorable economic conditions. The literature on the effects of various types of facilities on property value is inconclusive and therefore such effects have not been projected in the SEIS. (See Vol. 1, Section 4.8.7, as to other potential impacts on quality of life.)

Category 5.4, Submission 114, Comment 5 (Property Values and the Economy)

See Category 5.4, Submission 117, Comments 1, 3, and 4.

Category 5.4, Submission 116, Comment 9 (Compensation and Safety)

See Category 5.4, Submission 117, Comments 1, 3, and 4, for the response pertaining to compensation for subsurface rights. See Category 13, Submission 80, Comment 9, for the response pertaining to safety of the SSC facility.

Category 5.4, Submission 117, Comments 1, 3, and 4 (Property Values and the Economy)

Property owners from whom underground rights are acquired (stratified fee) will be compensated by the Texas National Research Laboratory Commission. The potential health effects of living above and around the SSC are evaluated in Vol. 1, Section 4.7.1.3, and are within acceptable regulatory limits. Section 4.8.7 acknowledges that residents living adjacent to the SSC, including those whose property will be required in stratified fee, could be inconvenienced by ongoing construction noise and increased traffic, especially during construction, and also affected by the visual impacts of the project after construction. The SSC mitigation action plan will be used to implement all mitigation measures designed to minimize impacts to surrounding areas. (Also see Category 13.1, Submission 116, Comment 2.)

Category 5.4, Submission 138, Comment 10 (Property Values and the Economy)

See Category 5.4, Submission 117, Comments 1, 3, and 4.

Category 5.5: Easements

No submission addressed this issue.

CATEGORY 6: EARTH RESOURCES

The comments related to earth resources fell into two groups: those related to the geological characteristics of the site and those addressing the plan for disposing of tunnel excavation spoils. Some commentors expressed the opinion that the site was not suitable for constructing the SSC. Faulting of the rock and the presence of water-bearing fractures were issues raised with respect to construction and water quality impacts.

Category 6, Submission 110, Comment 16 (Groundwater Resources)

As reported in Vol. 1, Section 3.2.2.1, weathered portions of the Austin chalk can constitute what is termed a shallow aquifer in the vicinity of the proposed SSC site. Unweathered portions of the Austin chalk are not thought to be capable of delivering large quantities of groundwater on a sustained basis, but are recognized as having a finite, but low, permeability (Vol. 1, Table 3.8).

Category 6.1: Geology

Category 6.1, Submission 112, Comment 2 (Geologic Characteristics)

The geologic characteristics of the several sites proposed for the SSC are reported in the 1988 EIS (Vol. I, Section 4.1). The various geologic and geoengineering factors considered indicate that the Texas site is well suited for the proposed SSC project. (Also see Category 3, Submission 80, Comment 13.)

The SSC has been designed so that, even under the most severe accident scenario (i.e., complete loss of the beam in an uncontrolled manner), nearby wells would not experience radioactivity above regulatory limits established by the U.S. Environmental Protection Agency. Even at sites proposed for the SSC where the tunnel would have been located in a high-yield aquifer zone, there was never a risk of radioactive contamination of groundwater above safe limits.*

Category 6.1, Submission 125, Comments 5 and 7 (Seismic Stability)

As reported in Vol. 1, Section 3.1.3, faulting at the proposed site is both ancient and inactive. The SSC site is in one of the most stable seismic regions in the United States. The simple nature of the faulting around the SSC site, together with the small scale of individual faults, means that construction across fractures will be very straightforward. (Also see Category 3, Submission 80, Comment 13.)

Category 6.1, Submission 138, Comment 1 (Seismic Stability)

See Category 6.1, Submission 125, Comments 5 and 7.

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*SSC Central Design Group, 1987, *SSC Environmental Radiation Shielding*, Task Force Report, July.

Category 6.1, Submission 165, Comment 1 (Geologic Stability)

See Category 6, Submission 110, Comment 16; Category 6.1, Submission 112, Comment 2; and Category 7.2, Submission 106, Comment 1.

Category 6.2: Topography

Category 6.2, Submission 119, Comments 1 and 3 (Landscape Restoration)

The distribution of spoils for a typical service area is reported in Vol. 1, Section 2.2.1.4. The spoil material will be contoured into the existing topography through creation of berms. These berms are expected to be less than 10 feet high. Also discussed in Vol. 1, Section 4.1.2.2, are the contouring and placing of spoil material at the experimental halls, linear accelerator, low-energy booster, and medium-energy booster. In these areas, the goal will be to place spoil material such that it blends in with existing landforms. Slopes will be of a gentle character, similar to those in the immediate area. The spoils disposal plan accounts for all spoil material generated during construction.

Category 6.2, Submission 138, Comment 6 (Landscape Restoration)

See Category 6.2, Submission 119, Comments 1 and 3.

Category 6.3: Mineral Resources

No submission addressed this issue.

CATEGORY 7: WATER RESOURCES

The comments that addressed water resource issues included potential impacts on surface runoff, surface-water quality, shallow aquifers, springs, and water use. In addition, floodplain impacts from surface facility siting, spoil placement, erosion and sedimentation, and pollutant migration were addressed. The issue of groundwater impact was raised specifically in several comments.

Category 7, Submission 80, Comment 15 (Construction Impacts on Streams and Shallow Aquifers)

The potential impacts of excavation on streams are assessed in the SEIS. In Vol. 1, Section 4.2.2.1 covers surface runoff and stream flow; Section 4.2.2.4 covers erosion and sedimentation; and Section 4.2.2.5 covers water quality. The potential impacts of excavation and tunneling on springs and shallow aquifers are assessed in Section 4.2.3.1. Mitigation measures are also discussed in the respective sections. Implementation of the mitigation measures and monitoring of the potential effects should result in minimal residual impacts on streams, shallow aquifers, and springs.

At the request of the DOE, an independent study of springs and shallow aquifers in the SSC project area has been initiated by the Texas Bureau of Economic Geology. Study results will be used for project design and for minimizing potential impacts during construction.

Category 7, Submission 161, Comment 1 (Local Water Co-ops)

In Vol. 1, Section 4.2.4 assesses potential impacts on the overall water supply in Ellis County. The analysis indicates that existing water users, including local water co-ops that rely on surface-water sources, will not be adversely affected by the SSC project. Groundwater users that may be affected will be provided with an alternative water supply or compensated for their loss by other means. (Also see Category 7.2, Submission 106, Comment 10.)

Category 7.1: Surface Water

Category 7.1, Submission 110, Comment 9 (Chemical and Radioactive Contamination)

SSC operations will not induce radioactivity above applicable standards in any body of groundwater or surface water. Any process waters contaminated with pollutants, including radionuclides, above the release standards of the state of Texas will be disposed of in compliance with federal and state regulations. If such liquids contain low levels of radionuclides, the radioactive material will be immobilized through an appropriate waste management solidification process. The solidified material will be disposed of as low-level radioactive waste. Liquid radioactive waste will not be evaporated or discharged into surface waters.

Category 7.1, Submission 110, Comment 17 (Surface Runoff and Stream Flow)

The cooling ponds, which will be subject to permitting by the Texas Water Commission, will be designed to accommodate appropriate design storm frequencies. The inflow or diversion of storm water runoff will be such that improper discharge or failure of retention structures does not occur. (Also see Category 7, Submission 80, Comment 15.)

Category 7.1, Submission 119, Comment 8 (Surface Runoff)

As discussed in Vol. 1, Section 4.2.2.1, vegetation clearing, excavation, grading, and construction activities will potentially affect surface runoff. With the implementation of the mitigative measures discussed in that section, the residual impacts are expected to be small.

Category 7.2: Groundwater

Category 7.2, Submission 105, Comment 1 (Groundwater Use)

In Vol. 1, Figure 3.11 was corrected to show 0.75 million gallons per day for the Sardis-Lone Elm Water Supply Corp. (Also see Category 7.2, Submission 106, Comment 10.)

Category 7.2, Submission 106, Comment 1 (Groundwater Use)

As reported in Vol. 1, Section 4.2.3.1, groundwater from shallow aquifers in the SSC project area will be considered for use only as a supplemental resource. The current plan is to withdraw any required groundwater only from the deep, confined aquifers.

Category 7.2, Submission 106, Comment 2 (Cooling Pond Seepage)

As reported in Vol. 1, Section 2.2.1.4, the cooling ponds will be lined with a geotextile polymer mat or equivalent liner. This configuration will mitigate potential seepage from the pond to underlying rock units.

Category 7.2, Submission 106, Comment 3 (Groundwater Resources)

See Category 7.2, Submission 106, Comment 10, and Category 6, Submission 110, Comment 16.

Category 7.2, Submission 106, Comment 10 (Groundwater Use Impacts)

As reported in Vol. 1, Section 4.2.3.1, groundwater use attributable to SSC construction and operation, in combination with other uses, will measurably affect potentiometric levels within the Woodbine and Twin Mountains aquifers. The projected potentiometric declines at the pumping wells vary depending on pumping rate and the aquifer. No decline in water level caused by SSC requirements is anticipated for the shallow aquifers. On the basis of the results of an ongoing study conducted by the Texas Bureau of Economic Geology, the DOE will implement mitigative measures, as appropriate. Groundwater resources will be monitored throughout the life of the SSC project. However, as an alternative, surface water, whether collected as runoff or delivered by pipeline, will be considered for SSC use when impacts to groundwater resources are unacceptable. Surface water will be the preferred option for the SSC.

Category 7.2, Submission 108, Comment 5 (Groundwater Use)

As reported in Vol. 1, Section 4.2.3.3, available state records of the affected groundwater wells have been obtained. As the land acquisition process proceeds, all existing groundwater well data and available related information will be obtained. This process, in conjunction with ongoing studies performed by the Texas Bureau of Economic Geology (Vol. 1, Section 4.2.5), will constitute the basis of a more complete geologic and hydrogeologic data set.

Category 7.2, Submission 108, Comment 7 (Groundwater Contamination and Radioactivation)

The impact of tunnel construction on local shallow aquifers is expected to be negligible (Vol. 1, Section 4.2.3.1). The SSC is designed such that, even under a worst-case accident scenario (i.e., complete loss of the beam in an uncontrolled manner), nearby wells will not experience radioactivity above regulatory limits established by the U.S. Environmental Protection Agency. (Also see Category 3, Submission 80, Comment 13; Category 6.1, Submission 112, Comment 2; and Category 7.2, Submission 106, Comment 10.)

Category 7.2, Submission 110, Comment 5 (Groundwater Use)

In Vol. 1, Section 4.2.3.1, SSC water use is projected as being 14% of 1986 Ellis County total groundwater consumption. The reported percentage refers to the total quantity of groundwater actually used within Ellis County and not to the total quantity of groundwater available within Ellis County. (Also see Category 7.2, Submission 106, Comment 10.)

Category 7.2, Submission 110, Comment 11 (Groundwater Use)

See Category 7.2, Submission 106, Comment 10, and Category 7.2, Submission 110, Comment 5.

Category 7.2, Submission 112, Comment 8 (Groundwater Contamination and Radioactivation)

See Category 7.2, Submission 108, Comment 7.

Category 7.2, Submission 116, Comment 3 (Groundwater Use)

A feasibility study is in progress to evaluate the use of surface water at all SSC facilities. The objective is to limit the impact to groundwater supplies. (Also see Category 7.2, Submission 106, Comment 10.)

Category 7.2, Submission 116, Comment 11 (Groundwater Use)

See Category 7.2, Submission 106, Comment 10, and Category 6.1, Submission 112, Comment 2.

Category 7.2, Submission 119, Comment 5 (Impact Assessment)

See Category 7.2, Submission 106, Comment 10.

Category 7.2, Submission 119, Comment 7 (Impacts)

See Category 7.2, Submission 106, Comment 10.

Category 7.2, Submission 125, Comment 2 (General Water and Land Use Concern)

See Category 7.2, Submission 108, Comment 7.

Category 7.2, Submission 127, Comment 4 (General Water and Land Use Concern)

No fee simple or any other land in and around the SSC will become uninhabitable. Volume 1, Section 4.4.4, discusses agricultural land use impacts, including impacts to prime and important farmland. (Also see Category 7.2, Submission 106, Comment 10.)

Category 7.2, Submission 138, Comment 8 (General Contamination Concern)

See Category 7.2, Submission 106, Comments 2 and 10, and Category 7.2, Submission 112, Comment 8.

Category 7.2, Submission 145, Comment 1 (General Concern about Drinking Water Impact)

See Category 7.2, Submission 106, Comment 10, and Category 13.1, Submission 112, Comment 5.

Category 7.2, Submission 224, Comment 8 (Groundwater Contamination)

As stated in the Invitation for Site Proposals, all wells within 150 feet of the centerline of the tunnel that penetrate the stratified fee area are subject to closure. Although natural springs may exist in the area, there is no basis for concern that they will transport radioactivity above U.S. Environmental Protection Agency regulatory limits. (Also see Category 7.2, Submission 112, Comment 8.)

Category 7.3: Floodplains

Category 7.3, Submission 2, Comment 4 (Impacts)

In Vol. 1, Table 3.3 and Figure 3.5 were revised to show Cottonwood Creek as one of the principal hydrologic features in the east campus area. As stated in Vol. 1, Section 4.2.2.2, SSC surface facilities in the east campus will be located outside of the identified floodplains.

Category 7.3, Submission 119, Comment 4 (Spoils Management Plan)

The comprehensive spoils management plan, which will be developed during the project design stage, will ensure that spoils are not placed in 100-year stream floodplains. (See Vol. 1, Sections 4.1.2.1 and 4.1.2.2 for further discussion of this topic.)

Category 7.3, Submission 119, Comment 9 (Studies)

As stated in Vol. 1, Section 4.2.2.2, more detailed and complete floodplain studies will be conducted during the design stage for areas that could affect SSC surface facilities. Except possibly at service area E8, SSC facilities will be sited to avoid impacts to 100-year floodplains. A preferred option outside the floodplain has been identified in Vol. 1, Section 2.2.1.

Category 7.3, Submission 138, Comment 7 (Spoils Leachate)

The potential migration of pollutants caused by runoff will be mitigated through a combination of measures, including sediment and runoff control basins (Vol. 1, Section 4.2.2.4), during both the construction and operation phases of the SSC project. Potential pollution due to leaching of spoils is expected to be low because leachate quality is similar to area shallow groundwater quality (Vol. 1, Section 4.2.3.4). However, additional leaching tests will be conducted during the construction phase, and the spoil disposal areas will be monitored for leachate quality. Appropriate mitigative measures will be implemented to comply with relevant regulations.

Category 7.4: Wetlands

Category 7.4, Submission 170, Comment 1 (Effects)

The potential effects of the SSC project on the streams (and associated wetlands) identified on the set of U.S. Geological Survey maps referenced in the comment are assessed in Vol. 1, Section 4.2.2. Additional information will be submitted to the U.S. Army Corps of Engineers during the design stage when application is made for Section 404 permit(s) under the Clean Water Act (Vol. 1, Section 5.2.2).

Category 7.4, Submission 231, Comment 1 (Cooling Pond Design)

Cooling ponds for the SSC service areas are not projected to become replacement wetlands. Engineered wetlands, such as those described in Vol. 1, Section 4.2.2.3, will be developed, as necessary, within the east and west campus areas. The local office of the U.S. Fish and Wildlife Service will be consulted regarding the placement and design characteristics of any replacement wetlands. The U.S. Fish and Wildlife Service will also be consulted about the feasibility of using cooling ponds to attract migratory waterfowl in light of the relatively high temperature of the water and the need to use algicides.

The SSC cooling ponds will be supplied with a continual supply of make-up water. Replacement or engineered wetland ponds will be designed to catch runoff or to be artificially recharged, as appropriate.

CATEGORY 8: BIOTIC RESOURCES

One commentor was concerned that the SSC project would be detrimental to ecological resources in the area, while another was concerned about impacts that could occur to aquatic resources if spoils were not adequately contained. Twelve of the 18 comments expressed minor concerns about the status or nomenclature for several of the species listed in Vol. 1, Appendix B.

Category 8, Submission 126, Comment 3 (Detrimental Effects on Ecological Resources)

In contrast to the stated concerns, both the U.S. Fish and Wildlife Service and the Texas Parks and Wildlife Department view the SSC as a project that could significantly benefit ecological resources in an area that has been adversely affected by agricultural activities and urban encroachment.* The SSCL intends to work with these agencies to establish natural areas (e.g., blackland prairies and wetlands) and preserve high quality areas (e.g., riparian habitats). As stated in Vol. 1, Section 4.3.2, about 8,500 acres of mostly agricultural land can be enhanced to create habitats conducive to use by a diverse array of wildlife species.

Category 8.1: Terrestrial Species

Category 8.1, Submission 1, Comment 1 (Status and Occurrence of Swainson's Hawk)

To assist in responding to the comment on the status of the Swainson's hawk, a Texas Parks and Wildlife Department field biologist was consulted. The Swainson's hawk is a migrant in the immediate project area. This categorization is supported by information in the book *Birds of North Central Texas*. Nestings are known more from western counties in north-central Texas. Therefore, although the potential exists for this species to nest in the project area (Vol. 1, Table 3.13), such nestings would be rare events. Further, the species is not common in Ellis County during the summer months.

In any event, measures will be taken to minimize impacts to important wildlife species, including raptors. For example, in attempts to avoid riparian and other wooded habitats, surface facilities have been located, whenever feasible, in agricultural areas. The consultation required in complying with the Migratory Bird Treaty Act (Vol. 1, Section 5.14) should result in measures to minimize impacts to the Swainson's hawk. These measures should be adequate even for the unlikely event of nests in the immediate area of a surface facility associated with the project.

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*Short, R.W., 1990, U.S. Fish and Wildlife Service, letters to T.A. Baillieul, U.S. Department of Energy, Chicago Operations Office, Argonne, Ill., April 3 and May 22.

Category 8.1, Submission 1, Comment 2 (Status Correction for Several Bird Species)

On the basis of information obtained from the Texas Parks and Wildlife Department, the status of Swainson's hawk (Vol. 1, Table B.4) was changed to M (migrant) (see Category 8.1, Submission 1, Comment 1). In the same table, the status of the belted kingfisher and blue jay was changed to P (permanent resident), and the status of the brown creeper was changed to W (winter) (see Category 8.1, Submission 1, Comment 1).

Category 8.1, Submission 17, Comment 1 (Spelling Correction for Snake Genus)

In Vol. 1, Table B.3, the spelling of the genus name for the Texas spotted whiptail and the racerunner was corrected.

Category 8.1, Submission 17, Comment 2 (Habitat Correction for Snake Species)

In Vol. 1, Table B.3, the habitat description for the eastern hognose snake was corrected.

Category 8.1, Submission 17, Comment 3 (Status Correction for Bird Species)

In Vol. 1, Table B.4, the status of Swainson's hawk was changed to M (migrant).

Category 8.1, Submission 17, Comments 4-6 (Status Corrections for Bird Species)

See Category 8.1, Submission 1, Comment 2.

Category 8.1, Submission 17, Comment 7 (Siting Confirmation Correction for a Bird Species)

In Vol. 1, Table B.4, the species listing for the Chipping sparrow was corrected to indicate that there have been confirmed sightings or that the species has been collected in the vicinity of the project site.

Category 8.1, Submission 17, Comment 8 (Habitat Availability Correction for a Bird Species)

In Vol. 1, Table B.4, the habitat availability for the bobolink was corrected.

Category 8.1, Submission 17, Comment 9 (Text Reference for Area Birds)

Although *Birds of North Central Texas* by Warren Pulich would have been a valuable source for the bird species in the area, it was not added as a reference for Vol. 1, Table B.4, because it was not directly used for the information provided in the table.

Category 8.1, Submission 156, Comment 1 (Name Change for Snake Species)

In Vol. 1, Table B.3, the eastern racer was changed to racer.

Category 8.2: Aquatic Species

Category 8.2, Submission 223, Comment 4 (Spoils Disposal Impacts on Aquatic Biota)

Where practicable, spoils will not be disposed of near the few streams that do occur within the fee simple sites. This precaution will be taken to protect both the stream habitats and the adjacent riparian habitats. Mitigative measures will be taken to minimize the leachate entering streams, cooling ponds, existing ponds, and wetlands. It will not matter whether the wetlands already exist or whether they have been established to mitigate other wetland impacts. Mitigative measures to control runoff, including leachate from disposal piles, are discussed in Vol. 1, Sections 4.1.6, 4.2.2.1, 4.2.2.4, 4.2.2.5, 4.2.3.4, and 4.3.8. No adverse impacts to aquatic biota are expected from spoils disposal runoff (see Category 7.3, Submission 119, Comment 4).

Category 8.3: Commercially, Recreationally, and Culturally Important Species

No submission addressed this issue.

Category 8.4: Sensitive and Unique Communities

No submission addressed this issue.

Category 8.5: Protected Species

No submission addressed this issue.

CATEGORY 9: LAND RESOURCES

The few comments received pertaining to land resources concerned reducing the local agricultural base by removing land from agricultural use or converting land to SSC use. Comments also concerned land use controls and land use plans within Ellis County and the city of Midlothian. In addition, comments addressed land use on property adjacent to the SSC with respect to land management and public safety.

Category 9, Submission 106, Comment 11 (Agricultural Land Base)

Volume 1 contains analyses of the likely environmental consequences of constructing and operating the SSC at the Ellis County site. Impacts to water resources are addressed in Vol. 1, Section 4.2; impacts to agricultural use of the land are addressed in Vol. 1, Section 4.4.4. These analyses show that the SSC project will have little effect on water availability in the vicinity of the site and that the amount of productive land removed from agricultural use will be a small fraction (Vol. 1, Table 1.1 and Section 4.4) of the land available within Ellis County. The regional

planning now being initiated as a result of the SSC project serves to assure that local growth and development are controlled and that the agricultural base for the County is maintained.

Category 9.1: Land Use and Zoning

Category 9.1, Submission 165, Comment 2 (Land Use Controls)

The Texas legislature (S.B. 8520) granted Ellis County the power to develop and implement a comprehensive land use plan. The legislature specifically granted the County the authority to implement land use controls in unincorporated areas of the County within 10 miles of the SSC or its appurtenant facilities. The Commissioners Court was also granted the authority to enlarge, reduce, or otherwise change the unincorporated areas subject to the regulation. The Planning and Zoning Commission passed a resolution enlarging the unincorporated area subject to this regulation to encompass the entire County. This action is being forwarded to the County Commissioners for final approval. Extending land use controls to the County boundaries will ensure a more orderly implementation of the final plan.

Category 9.2: Prime and Important Farmlands

Category 9.2, Submission 127, Comment 3 (Withdrawal of Prime and Important Farmland)

Consultations with and communications from the Soil Conservation Service on September 20, 1990, indicate that 4,632 acres of prime and unique farmland will be converted for SSC use. In Vol. 1, Table 1.1 and Section 4.4.4 were revised to incorporate this information. (Also see Category 6.1, Submission 125, Comments 5 and 7.)

Category 9.3: Land Use Plans

Category 9.3, Submission 2, Comment 6 (Revegetation)

Landscape revegetation plans will be prepared for areas disturbed by construction. The local context and view impacts will be considered in developing such plans. The SSC facilities will be designed in accordance with a coordinated system and in a way to achieve a desirable character. See Vol. 1, Sections 2.2.1.4, 4.3.8, and 4.10, for additional discussion of revegetation plans.

Category 9.3, Submission 76, Comment 1 (Land Use Planning)

In Vol. 1, Section 3.4.5, the text was revised to reflect the existence of the city of Midlothian's land use plan.

Category 9.3, Submission 106, Comment 5 (Land Use Management)

All fee simple SSC land will be properly managed to ensure safety as far as possible fire and rodent problems. Some areas will be mowed as part of a regular maintenance program. Areas identified as suitable for habitat reestablishment will be properly managed through such activities as "controlled burns" and periodic mowing, and possibly through rotation of program activities. The SSCL intends to consider leasing portions of the SSC property when such leasing is consistent with the proposed adjacent land use.

CATEGORY 10: AIR RESOURCES

Testimony given at the public hearings expressed general concerns about fugitive dust generated during construction and about several other more general environmental issues such as groundwater use and radiation exposure. Authors of letters were concerned about impacts on air quality during construction and operation and the significance of the level of and the associated health impacts from suspended fugitive dust generated during SSC construction. Questions were also raised concerning the need for further detail on air resource issues or clarification as to the specifics of the assessment methodology.

Category 10, Submission 80, Comment 17 (Impacts during Construction and Operation)

A detailed assessment of the potential air pollution impacts from constructing and operating the SSC is presented in Vol. 1, Section 4.5 and Appendix C, and in the EIS (Vol. I, Section 5.1.2, and Vol. IV, Appendix 8). The SSC mitigation action plan will incorporate the air pollution measures consistent with the upcoming Record of Decision, the SEIS, and any subsequent mitigation actions deemed warranted by the DOE as a result of data collected during the SSC mitigation monitoring program.

The SSC is considered to be a minor air pollutant source; therefore, it is exempt from a full "Prevention of Significant Deterioration" review for a construction permit under the Clean Air Act (Vol. 1, Section 5.5.2). As a minor source, the SSC will not be an air pollution concern to local communities during its operation.

Local communities could be concerned about the fugitive dust associated with facility construction; however, their concerns should be minimized by the stringent mitigative measures developed for controlling fugitive dust emissions during SSC construction. In Vol. 1, Section 4.5.5 discusses four aggressive measures for controlling fugitive dust. The results of the detailed air quality modeling analyses performed (Vol. 1, Section 4.5.3) demonstrate that appropriate implementation of these mitigative measures will assure compliance with the National Ambient Air Quality Standards for PM_{10} (i.e., 50 and 150 $\mu g/m^3$ for the annual mean and 24-hour averages, respectively). (For the response concerning noise, see Category 11, Submission 80, Comment 17.)

Category 10, Submission 110, Comment 3 (General Air Pollution Concern)

See Category 10, Submission 80, Comment 17.

Category 10, Submission 223, Comment 3 (Air and Water Pollution)

Mitigative measures to control fugitive dust generated during construction are addressed in Vol. 1, Section 4.5.5 and Appendix C. Appropriate implementation of such measures will ensure that SSC activities comply with the U.S. Environmental Protection Agency's health and welfare standards for suspended particulate matter. (Also see Category 10, Submission 80, Comment 17.)

Leachate from limestone excavated from the tunnel is not expected to contain sufficient phosphorus to cause eutrophication of area streams and reservoirs. However, additional leaching tests to be conducted during the construction phase will include determination of phosphorus. The spoil disposal areas will be monitored for leachate quality, and appropriate mitigative measures will be implemented, if necessary, to minimize eutrophication potential. One mitigative measure to control algae is discussed in Vol. 1, Section 4.3.3. Mitigative measures for stream siltation are discussed in Vol. 1, Section 4.2.2.4.

Category 10.1: Climate and Meteorology

No submission addressed this issue.

Category 10.2: Fugitive Construction Dust

Category 10.2, Submission 119, Comment 2 (Significance of Impacts)

The present National Ambient Air Quality Standards for particulate matter regulate suspended dust particles with an aerodynamic diameter less than or equal to a nominal 10 μm (i.e., PM_{10} standards). The key issue is not the transporting and stockpiling of 8.8 million yd^3 of dirt and rock during the 10-year construction period, but how much PM_{10} fugitive dust might be generated as a result of this activity. In Vol. 1, Appendix C contains detailed estimates of fugitive dust emissions (i.e., PM_{10}) associated with transporting and stockpiling topsoil and spoils during construction. (Also see Category 10, Submission 80, Comment 17.)

Category 10.2, Submission 138, Comment 5 (Public Health Impacts)

The air pollution impacts associated with removing, transporting, and stockpiling topsoil and spoils during SSC construction are addressed in Category 10.2, Submission 119, Comment 2. The mitigation action plan will commit to implementing the control measures deemed necessary to protect public health and welfare.

Soils at the SSC site tend to be unconsolidated accumulations of gravel, sand, silt, and clay. The tunnel along the 54-mile ring will be bored at an average depth below ground of 150 feet by tunnel boring machines. Because of the relatively soft soil conditions in Ellis County, underground blasting should not be necessary for tunnel construction. However, some blasting may be required for constructing shafts, starter tunnels, and experimental halls. If needed, this blasting should be of short duration and, with appropriate prewatering of the area, cause limited fugitive dust impacts.

Category 10.3: Air Quality and Definition of Ambient Air

Category 10.3, Submission 76, Comment 2 (Spelling Correction)

In Vol. 1, Table 3.16, the spelling of air pollution source number 12 was corrected to "Box-Crow Cement."

Category 10.3, Submission 76, Comment 3 (Figure Correction)

In Vol. 1, Figure 3.13, the location of air pollution source number 6 (Texas Industries) was corrected to reflect its closer proximity to source number 2 (Chaparral Steel).

Category 10.3, Submission 169, Comment 2 (PM_{10} "Background" Concentrations)

The term "background" concentration has a number of different interpretations. The U.S. Environmental Protection Agency* defines it, for the purpose of developing State Implementation Plans, as that portion of ambient air pollutant concentrations from natural sources and from nearby known existing anthropogenic sources, other than the source(s) currently under consideration or unidentified sources. In Vol. 1, Section 3.6.1 describes the method used to estimate PM_{10} annual and 24-hour background concentrations. The 41.2-$\mu g/m^3$ (24-hour) and 22.1-$\mu g/m^3$ (annual) concentrations were intended to reasonably but conservatively represent contributions from both natural and existing sources in Ellis County. The basis for the conservativeness in these values is provided in Category 10.4, Submission 169, Comment 3. The referenced 10-15-$\mu g/m^3$ 24-hour concentration range was an estimate of the natural (nondust-storm) contribution to PM_{10} background in Ellis County. Section 3.6.1 has been clarified to indicate that the derived background reflects both natural and anthropogenic contributions.

Category 10.4: Mitigation Measures

No submission addressed this issue.

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*U.S. Environmental Protection Agency, 1987, *PM_{10} SIP Development Guideline*, Office of Air Quality Planning and Standards Publication EPA-450/2-86-001, Appendix D, Research Triangle Park, N.C.

Category 10.5: Demonstration of Compliance with NAAQS

Category 10.5, Submission 169, Comment 3 (Impact Assessment Methodology)

The analysis methodology and the impact assessment used for developing the fugitive dust mitigation measures are described in Vol. 1, Section 4.5 and Appendix C. The impact assessment demonstrates that appropriate implementation of these measures will provide for the attainment and maintenance of the public health and welfare standards for particulate matter. The approach suggested by the U.S. Environmental Protection Agency (i.e., reanalysis of SSC impacts to include existing PM_{10} emissions) would result in less conservative air quality impacts and less stringent control measures on fugitive dust generated by SSC construction.

The PM_{10} air quality impact assessment methodology used in the draft SEIS for developing mitigation measures for fugitive dust generated during SSC construction was substantially similar to the one used in the assessment for the 1988 EIS. The major differences include: (1) the development of a refined fugitive dust emissions inventory that carefully factored in construction activity scheduling and accounted for more site-specific engineering design information; (2) the use of the most recent versions of the Industrial Source Complex (ISC) model; and (3) the use of five years of the most recent and representative meteorological data available. The approach adopted in the 1988 EIS of accounting for existing PM_{10} source contributions as a portion of a regional background concentration in Ellis County, to be added to the projected or modeled SSC impacts, did not change from the EIS to the draft SEIS analysis. Concern with this approach was not raised by the U.S. Environmental Protection Agency's Office of Federal Activities in its comments on the DEIS, or by Region VI and the Texas Air Control Board during consultations with Argonne National Laboratory before release of the draft SEIS in August 1990 (see Category 10.3, Submission 169, Comment 2).

Changing the approach to include existing PM_{10} sources in the modeling analysis would most likely significantly reduce the total predicted PM_{10} impacts (SSC contributions plus "background"). The end result would be less stringent measures to control SSC-generated fugitive dust. This result would primarily be attributable to the following: (1) the nearest PM_{10} source to major SSC construction activity is more than 10 kilometers away, a distance that would not, from a modeling perspective, be considered "nearby" (see Category 10.3, Submission 169, Category 2); (2) the maximum impact from these sources would, in most cases, be well within 3 kilometers of their release point; (3) the maximum impact from these sources (elevated stack emissions) would occur under meteorological conditions different from those associated with the maximum impacts associated with SSC ground-level fugitive emissions; and (4) existing point sources of particulate matter in Ellis County are well controlled. For these reasons, it is unlikely that the concentrations used to represent both existing and natural "background" sources in the modeling analysis would be less than "background" estimates derived from directly modeling existing sources.

It should be noted that the average 24-hour and annual "background" concentrations of 41.2 $\mu g/m^3$ and 22.1 $\mu g/m^3$, respectively, represent 27% and 44% of the 24-hour and annual PM_{10} health standards. If natural "background" could be reasonably estimated to be 10-15 $\mu g/m^3$ in Ellis County, the anthropogenic portion of "background" would consume about 20% of the short-term health standard. Given the four points made above, the anthropogenic "background" represents a conservative contribution to the total PM_{10} "background" at locations where maximum SSC impacts are predicted.

Nevertheless, upon further consultation on October 18, 1990, with the U.S. Environmental Protection Agency, Region VI, an agreement was reached to run a screening analysis of impacts from existing sources to confirm the conservativeness of the approach used in the draft SEIS. The emissions inventory for these sources was provided by the Texas Air Control Board.* The screening methodology used a conservatively based U.S. Environmental Protection Agency screening model (SCREEN-1.1) with total suspended particulate (TSP) emissions within a 25-kilometer radius of the maximum predicted SSC impact (near service area E10) and the meteorology associated with this impact (Julian day 295, 1982, and Julian day 239, 1984). The selection of sources for inclusion in the screening analysis was determined by the source-receptor and downwind sector‡ plots shown in Figures D.1 and D.2. The modeling results from this analysis indicate the maximum impact (one-hour average) of allowable TSP emissions from existing sources is 9.9 $\mu g/m^3$. This impact is about a factor of two less (about 66% smaller) than the impact represented from existing sources in the "background" concentration used for the draft SEIS impact assessment (about 29 $\mu g/m^3$ after subtracting natural background).§

Category 10.5, Submission 169, Comment 4 (Assessment Methodology)

The meteorology associated with the "highest-sixth-highest"+-modeled PM_{10} concentration, including "wind-erosion" meteorology, was accounted for in developing the mitigation strategy described in Vol. 1, Section 4.5.4.4 and Appendix C.

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*Texas Air Control Board, 1990, Modeling Data from the Point Source Data Base for Particulates, October 23.

‡Determined from the winds associated with the critical meteorology during 13 hours of extensive SSC construction activity.

§Since a PM_{10} emission inventory does not exist for Ellis County sources, TSP emissions were used in the modeling analysis.

+See definition in Vol. 1, Section 4.5.3.

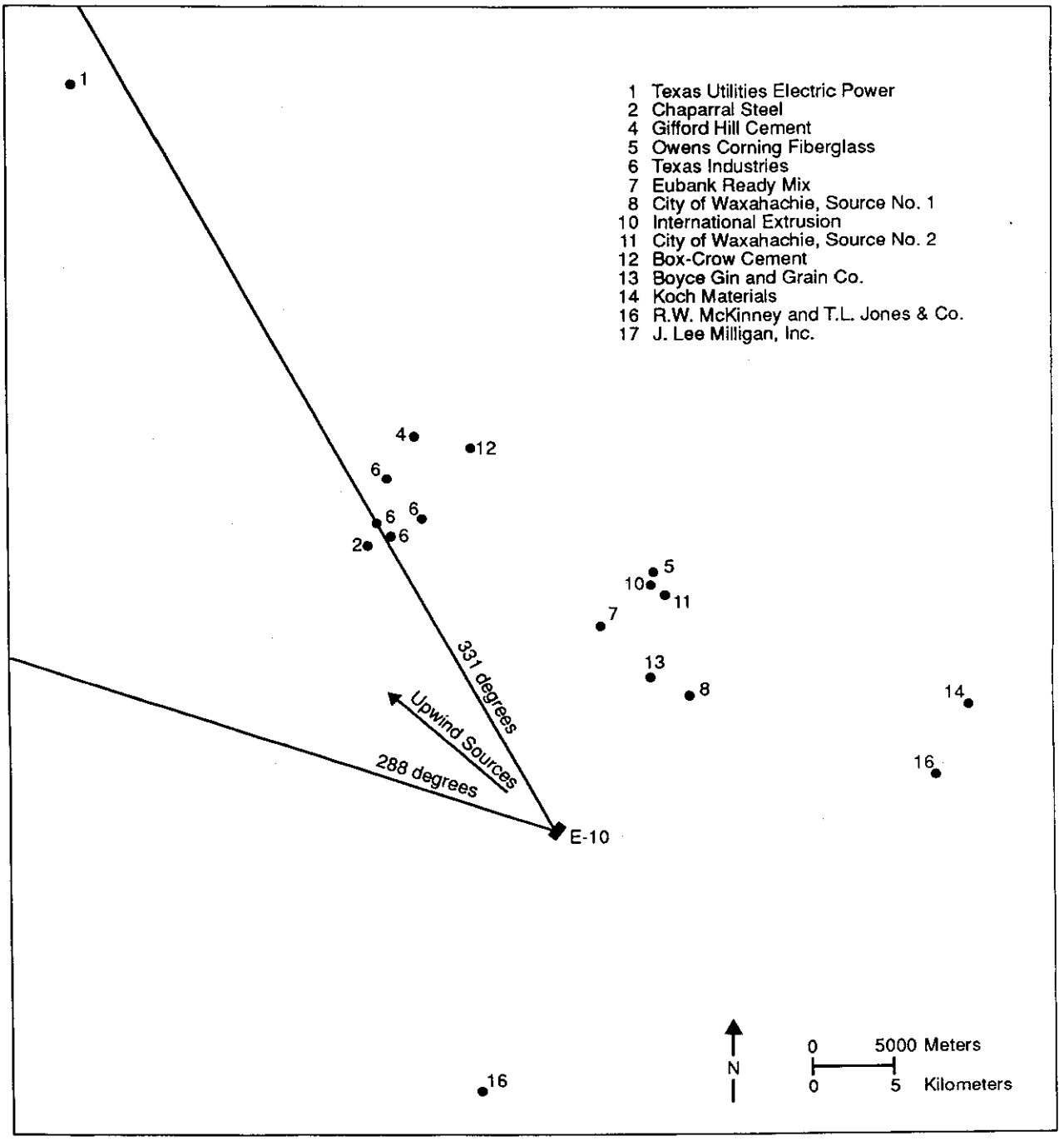

FIGURE D.1 Source-Receptor Relationship for E10 Controlling Meteorology, November 24, 1984 (Julian day 239, 1984)

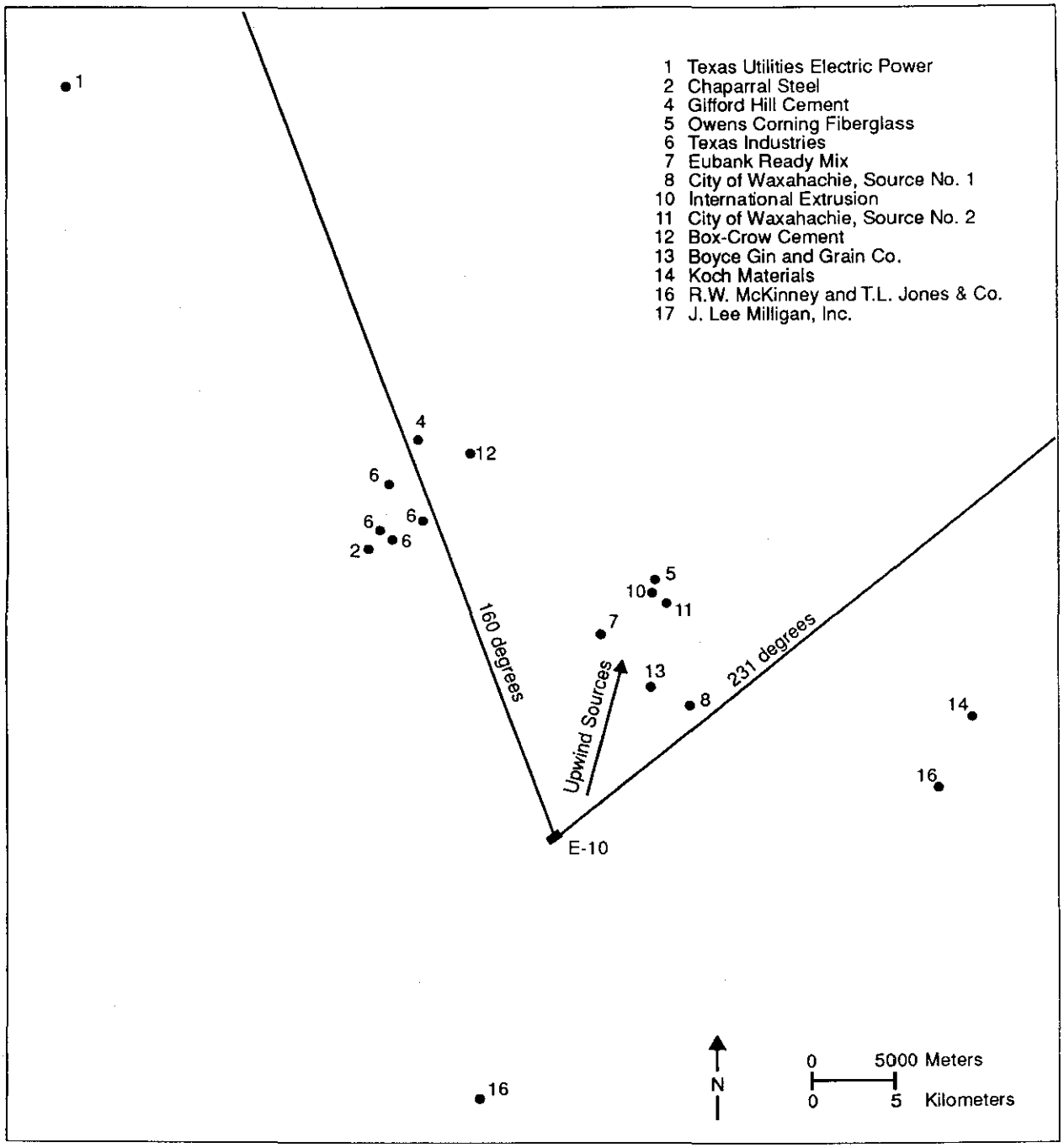

FIGURE D.2 Source-Receptor Relationship for E10 Controlling Meteorology, October 22, 1982 (Julian day 295, 1982)

CATEGORY 11: NOISE AND VIBRATION

Several general comments were submitted regarding noise and vibration from both constructing and operating the SSC (see Category 20 for the inventory of duplicate comments). All of these comments are addressed together in the response below, which discusses the mitigation action plan and references the SEIS.

Category 11, Submission 80, Comment 17 (Mitigation of Noise and Vibration Impacts)

Noise and vibration impacts from both construction and operation of SSC facilities are discussed in Vol. 1, Section 4.6. The SSC mitigation action plan will incorporate the noise abatement measures consistent with the upcoming Record of Decision, the SEIS, and any subsequent mitigation actions deemed warranted by DOE as a result of data collected during the SSC mitigation monitoring program.

Care will be taken initially to avoid situations that could be expected to cause noise impacts. Such avoidance is discussed in Vol. 1, Section 4.6.3.1, for service area construction and in Section 4.6.3.2 for campus area construction. However, many of the service areas and campus facilities are so far from existing residences that noise is not expected to be a problem. When residences are nearer and when equipment is operated at and near locations susceptible to noise impact, appropriate measures will be taken to mitigate the impacts (see the SEIS sections referenced above). Similar measures for avoiding significant noise impacts from SSC operation are described in Vol. 1, Section 4.6.4.1. (Also see Category 10, Submission 80, Comment 17.)

CATEGORY 12: WASTE MANAGEMENT

Several comments received dealt with low-level radioactive waste and expressed concerns about the risks of transporting the wastes, either on local roads or into and out of the state of Texas. Comments were also concerned about radioactive materials from the SSC being used for weapons. A few comments dealt with mixed waste being produced by SSC, stored on SSC property, and spilled.

Category 12.1: Low-Level Radioactive Waste

Category 12.1, Submission 2, Comment 2 (Waste Disposal Regulatory Compliance)

In handling and transporting radioactive waste generated by the SSC, the DOE will comply with all packaging standards set by the U.S. Department of Transportation and the U.S. Nuclear Regulatory Commission. Transportation routes will be selected to minimize the possibility of accidents and to reduce the potential for members of the public to be exposed.

Category 12.1, Submission 31, Comment 2 (Waste Disposal Regulatory Compliance)

The potential impacts from waste transportation and the appropriate regulations are discussed in Vol. 1, Sections 4.7.4 and 5.7, respectively. Also see Category 12.1, Submission 2, Comment 2.

Category 12.1, Submission 53, Comment 2 (Waste Disposal Regulatory Compliance)

See Category 12.1, Submission 2, Comment 2.

Comment 12.1, Submission 58, Comment 2 (Waste Disposal Regulatory Compliance)

See Category 12.1, Submission 2, Comment 2.

Category 12.1, Submission 80, Comment 18 (Waste Disposal)

Two disposal alternatives are evaluated in Vol. 1, Section 4.7.1.3: shipment to Hanford, Washington, or to Hudspeth County, Texas. Disposal at the Texas site was shown to have the lowest overall risk. The difference was directly proportional to the distance the waste is transported. In either case, the health risk to the general population from disposal of SSC-generated low-level radioactive waste is very small, that is, nearly one chance in one million for a cancer or genetic effect. By comparison, the risk of a fatal injury for a person driving along the same routes is on the order of one in ten thousand. (Also see Category 12.1, Submission 2, Comment 2.)

No permanent on-site storage of low-level radioactive waste is planned. The SSC will not generate any high-level radioactive waste.

Category 12.1, Submission 107, Comment 1 (Waste Disposal)

See Category 12.1, Submission 80, Comment 18.

Category 12.1, Submission 129, Comment 1 (Waste Disposal Regulatory Compliance)

In Vol. 1, Section 4.7.1.3 discusses disposal options for low-level radioactive waste. The 71st Texas legislature recodified and amended Chapter 401 (Radioactive Materials and Other Sources of Radiation) of Subtitle D (Nuclear and Radioactive Materials) of the Health and Safety Code, effective September 1, 1989 (Acts 1989, Chapter 678, §1). Thereunder, the Board of Health, by rule, may prohibit a licensed radioactive waste processor (e.g., the low-level radioactive disposal site established under the Texas Low-Level Radioactive Waste Disposal Authority Act) from accepting for processing low-level radioactive waste generated outside the state of Texas (§401.153). Also, a license holder may not accept radioactive waste generated in another state for processing or disposal under license issued by the Board unless the waste is (1) accepted under a compact to which Texas is a contracting party (Texas is not in a compact with any other state at this time); (2) from a state having an operating low-level radioactive waste disposal site at which it is willing to accept

waste generated in Texas; or (3) generated from manufactured sources or devices originating in Texas (§401.207). Therefore, there is no current legislation that prevents radioactive waste from leaving Texas. There is only legislation preventing the acceptance of out-of-state waste at Texas-licensed disposal facilities.

Category 12.1, Submission 224, Comment 3 (Production of Radioactive Material)

None of the radioactive material produced by the SSC, or by the SSC with the proposed additions, will be utilized by the U.S. nuclear weapons industry. The accelerator is not designed to produce radioactive materials. Rather, some components will become radioactive as a result of their use to produce and study high-energy protons and their interactions. The components that can no longer do the job for which they were designed because of failure or changes in operations will be removed from service. If they are not functional, they may be recycled (used to make functional components) or declared radioactive waste and disposed of properly. If they are still functional, they may be used in other experiments or at other accelerator facilities. The radioactive waste will be shipped off the site to an approved disposal facility. Disposition of these materials is discussed in the 1988 EIS (Vol. IV, Appendix 3). (Also see Category 12.1, Submission 80, Comment 18.)

Category 12.2: Mixed Waste

Category 12.2, Submission 80, Comment 19 (Mixed Waste Production)

Mixed waste contains both radioactive and hazardous components. The SSCL does not anticipate producing any waste of this type. However, in the event that some mixed waste were generated, proper handling procedures will be included in the SSC site waste management plan required under DOE Order 5820.2A.

Category 12.2, Submission 108, Comment 4 (Mixed Waste Production)

See Category 12.2, Submission 80, Comment 19.

Category 12.2, Submission 144, Comment 2 (Mixed Waste Production)

See Category 12.2, Submission 80, Comment 19.

Category 12.3: Toxic Waste

No submission addressed this issue.

Category 12.4: Sanitary, Sewage, and Solid Waste

No submission addressed this issue.

Category 12.5: Wastewater

No submission addressed this issue.

CATEGORY 13: ENVIRONMENTAL HAZARDS AND HEALTH EFFECTS

More than 50 comments addressed environmental hazards and health effects. The commentors were concerned about radiation exposure resulting from the addition of a fixed-target experimental program, improper monitoring or control, movement of contaminated groundwater through fractures in the Austin chalk, and use of the SSC for purposes other than basic physics research. Thirty of the comments concerned the potential for groundwater or soil contamination and the risks associated with SSC operations. Several comments were directed toward general health and safety issues related to SSC operations. Concern was also raised about air activation product releases and exposure and the impacts of transporting low-level radioactive waste. Potential problems with fire ants and the pesticides used to control them were also mentioned.

Category 13, Submission 80, Comment 9 (Radiation Exposure and Safety)

Radiation levels will not exceed 10 mrem/yr outside the subsurface (stratified fee) volume. At the surface, the rock and soil of the stratified fee volume will absorb the radiation, and thus radiation exposure to humans will be negligible. The minimum depth of cover above the accelerator tunnel in privately owned surface areas will be 45 feet. The most serious conceivable SSC accident would be the loss of the full beam at a location other than the heavily shielded beam absorbers (EIS, Vol. I, Section 5.1.6.3, and Vol. IV, Section 12.4.1). The aboveground dose from such an accident would be less than 10 mrem, well below the annual public exposure received from naturally occurring background radiation.

Groundwater wells that penetrate the stratified fee volume within 150 feet on either side of the tunnel centerline will be sealed. Thus, wells for families living directly over or adjacent to the tunnel will be located outside the restricted zone. (Also see Category 13.1, Submission 112, Comment 3.)

Because of these precautions, no risks will be associated with magnetic fields at the surface. (Also see Category 1.5, Submission 106, Comment 6.)

Category 13, Submission 130, Comment 1 (Radiation Risk)

In Vol. 1, Section 4.7.1.3 describes the risks to the public of low-level ionizing radiation resulting from operation of the SSC (also see Category 13, Submission 80, Comment 9). Groundwater use impacts are addressed in Vol. 1, Section 4.2.3.1 (also see Category 7.2, Submission 106, Comment 10).

Category 13, Submission 131, Comment 1 (Radiation Risk)

In Vol. 1, Section 4.7.1.3 describes the risks to the public of low-level ionizing radiation resulting from operation of the SSC (also see Category 13, Submission 80, Comment 9). See Category 3, Submission 111, Comment 6, for the response pertaining to independent oversight of DOE's environmental monitoring program.

Category 13, Submission 222, Comment 1 (General Public Health and Safety)

A comprehensive environmental impact assessment of the construction and operation of the SSC is provided in Vol. 1, Section 4.

Category 13.1: Radiation Exposure and Effects

Category 13.1, Submission 5, Comment 2 (Differences in Impacts Associated with Air Activation Product Releases

The differences in the estimates of radiation exposure through the air pathway presented in the EIS and the SEIS are due primarily to the following changes from the EIS assessment: (1) inclusion of a fixed test-beam target in the west campus, (2) changes in the proposed locations of release points, (3) use of a revised assessment methodology,* and (4) changes in the source term. In addition to regulatory compliance, the basis for these revisions was the use of more precise site-specific data not previously available. The resulting changes in the impact assessment still show that the overall health risks from exposure to air activation products would be very small (Vol. 1, Tables 4.19 and 4.20). In addition, most of the apparent increase in the dose to the maximally exposed individual expressed as the percentage of the regulatory limit (40 CFR 61) shown in Vol. 1, Table 1.1, is due to a lowering of that limit in December 1989.

Category 13.1, Submission 80, Comment 14 (Severe Accident Beam Loss)

The 1988 EIS (Vol. XII, Section 12.4.1) analyzed in detail the radiological impacts to drinking water resulting from the most severe accident, defined as an uncontrolled beam loss. For conditions of groundwater flow much more significant than found at the Texas site, this accident scenario was computed to result in a one-time dose immediately adjacent to the collider tunnel equivalent to 12.5% of the U.S. Environmental Protection Agency limit (4 mrem/yr). Under normal operating conditions, the annual dose equivalent in drinking water from the SSC will be far below regulatory limits. (Also see Category 13.1, Submission 112, Comment 3.)

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*The CAP-88 model (approved by the U.S. Environmental Protection Agency) was used to estimate the population dose, effective dose equivalent, in a form consistent with the newly promulgated (December 15, 1989) NESHAPS regulations. In the EIS assessment, population dose was computed as a dose equivalent with the AIRDOSE-EPA model.

Category 13.1, Submission 80, Comment 16 (Risk of Low-Level Ionizing Radiation)

The risks of low-level ionizing radiation are discussed in Vol. 1, Section 4.7.1.3. (Also see Category 12.2, Submission 80, Comment 19; Category 13.1, Submission 110, Comment 2; Category 13.1, Submission 124, Comment 3; and Category 13.1, Submission 138, Comment 9.)

Category 13.1, Submission 108, Comments 1 and 8 (Severe Accident Beam Loss, and Risk of Low-Level Ionizing Radiation and Soil and Groundwater Contamination)

Regarding the adequacy of the radiation shielding during an accident, see Category 13, Submission 80, Comment 9; Category 13.1, Submission 80, Comment 14; and Category 13.1, Submission 112, Comment 3. Regarding the risks of low-level radiation, see Category 1.1, Submission 108, Comment 3, and Category 13.1, Submission 112, Comment 6.

Category 13.1, Submission 109, Comments 1 and 2 (Contamination of Cooling Ponds and Groundwater Impact from Severe Accident Scenario)

No radioactivity will be released to the cooling ponds. The cooling water from the ponds will not come in contact with radioactive materials, nor will it receive any radiation exposure. Heat exchangers will separate pond water from the closed-loop systems that will cool the beam absorbers, scrapers, and other components.

For the response to the severe accident impact analysis and associated groundwater contamination, see Category 13.1, Submission 80, Comment 14.

Category 13.1, Submission 110, Comment 2 (Radiation Exposure Limits)

The current Occupational Safety and Health Administration occupational dose limit is 5 rem/yr. The exposure limit to members of the general public set by DOE Order 5400.5 is 0.1 rem/yr, not 1.0 rem. In addition, the engineering design mitigation of the SSC will follow all applicable DOE Orders (i.e., 5480.1B and 5480.4) to operate the facility such that exposures to workers can be maintained at levels as low as reasonably achievable (ALARA concept). This topic is discussed in Vol. 1, Section 4.7.1.2. (Also see Category 13, Submission 80, Comment 9.)

Category 13.1, Submission 110, Comment 4 (Severe Accident Beam Loss)

See Category 13.1, Submission 80, Comment 14, and Category 13.1, Submission 112, Comment 3.

Category 13.1, Submission 110, Comment 12 (Population Dose)

The total person-rem exposure is the sum of the total exposures of all persons within a 50-mile radius of the facility. In other words, if 10 people are exposed, and the combined exposure for the 10 people totals 1 rem, the total population dose would be 1 person-rem. The exposure that could be attributed to SSC operation for any

individual will be less than 10 mrem per year, or one-hundredth of a rem. (Also see Category 13.1, Submission 112, Comment 6, and Category 13, Submission 80, Comment 9.)

Category 13.1, Submission 110, Comment 13 (Groundwater Standard)

The national drinking water standard (maximum individual dose) is 4 mrem/yr (U.S. Environmental Protection Agency, 40 CFR 141, September 30, 1986). The annual dose equivalent in drinking water from SSC operations is expected to be well within regulatory limits. (Also see Category 13.1, Submission 80, Comment 14.)

Category 13.1, Submission 110, Comment 15 (Natural Radioactivity Comparisons)

The reference is not to the radiant heat of the burning gas, but to the natural radioactivity (radon) in the gas. The ionizing radiation associated with natural gas has been well documented. For example, the concentration of the radioactive isotope radon-222 in natural gas is 10 to 20 pCi/L.* Because gas ranges vent their combustion products into the house, occupants receive a low-level radiation dose from the radon. Estimates of the resulting radiation dose vary somewhat, but the referenced report indicates that the annual dose to the bronchial region of the lung would be about 9 mrem/yr. If this dose is averaged over the entire body, the associated effective annual dose equivalent would be about 0.5 mrem/yr. The estimated maximum individual site boundary dose for the SSC is 0.027 mrem/yr (from airborne releases), which is much less than that received from exposure to natural gas. The quotation was that the maximum dose that any member of the public will receive from the SSC is about what one would receive if one had a natural gas stove. The reference to the test at Fermilab, which was 100 times the standard, is answered in Category 13.1, Submission 132, Comment 2.

Category 13.1, Submission 112, Comment 3 (Severe Accident Beam Loss)

The calculations made to understand the potential effects of SSC radiation on groundwater assumed for the most severe accident situation that all of the accelerator beam was lost at a single point and that the tunnel was surrounded by groundwater in a porous medium. Under these conditions, which are worse than the fractured rock conditions in Ellis County, there was still no excess radiation in a nearby well. With no well within the 150-foot minimum of the tunnel (as sited in Ellis County), the actual probability is even lower than that for the hypothetical severe accident case assumed in the analysis. (See *SSC Environmental Shielding*‡; also see Category 13.1, Submission 112, Comments 4 and 5; Category 13.1, Submission 110, Comment 13; and Category 13.1, Submission 118, Comment 3.)

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*National Council on Radiation Protection and Measurement, 1987, *Radiation Exposure of the U.S. Population from Consumer Products and Miscellaneous Sources*, Report 95.

‡Superconducting Super Collider Laboratory, *1987 Environmental Radiation Shielding*, Report SSC-SR-1026, July.

Category 13.1, Submission 112, Comment 4 (Groundwater Contamination and Soil Radioactivation)

The three areas referred to involve chromates, mineral oil, and polychlorinated biphenyls. The results of subsequent investigations are reported in the Fermilab environmental monitoring reports numbered 89/63 and 90/15. These comprehensive studies show that the subject areas pose no threat to groundwater. The cleanup of the polychlorinated biphenyls, in accordance with U.S. Environmental Protection Agency regulations, has almost been completed.

Soil radioactivation in the areas of concern has been characterized. In one location, radioactivity was indicated in the soil below the region of the collection drains. However, subsequent water samples indicated concentrations less than the detection limit of 3 pCi/mL.

Subsequent to the 1988 report, monitoring wells were installed at nine additional locations to improve the groundwater monitoring capability. Cores were recovered from six holes drilled at a 45-degree angle under the targets and beam absorbers. Potential paths for radioactivity to move laterally through more permeable sand and gravel layers before reaching bedrock were investigated. Monitoring of sand and gravel layers was initiated wherever such layers were found. No threat to groundwater resources has been discovered.

See Category 1.1, Submission 108, Comments 2 and 3. Also see the Fermilab environmental health and safety reports for 1989 and 1990, both of which were published after the report mentioned in the testimony.

Category 13.1, Submission 112, Comment 5 (Groundwater Monitoring)

The SSCL is designing a groundwater monitoring program to acquire groundwater data over the life of the SSC project.

Category 13.1, Submission 112, Comment 6 (Risks of Ionizing Radiation)

The radiation risks associated with the SSC operation are discussed in Vol. 1, Section 4.7.1. All radiation exposures associated with SSC construction and operation will be kept as low as reasonably achievable (ALARA). The DOE requires application of the ALARA concept in the design of new facilities and specifically calls for a radiation limit that is five times lower than that set by regulations. The SSCL has adopted a guideline for design and operation of the facility that limits radiation levels in areas accessible to the general public to less than 10 mrem per year. For comparison, background radiation levels in Texas -- naturally occurring and unavoidable -- are about 100 mrem/yr. Background radiation in some mountain states exceeds 200 mrem/yr.

In the BEIR V report,* studies of the effects on populations in regions where naturally occurring background radiation levels are high (200-600 mrem per year) have been examined. Using these data minimizes the problem of extrapolating from high to lower levels. Although an increased frequency of chromosome aberrations has been noted in these populations, no increase in the frequency of cancer has been documented. The risks calculated using BEIR V risk factors would be about a factor of two higher than the U.S. Environmental Protection Agency values used in the SEIS assessment. This change would not significantly alter the risk estimates presented in Vol. 1.

Category 13.1, Submission 112, Comment 7 (DOE Position on Well Closing)

Radiation safety is not the primary reason for closing wells in the SSC project area. In the absence of a specific site, the 1984 Reference Designs Study for the SSC considered many different geological conditions. One of the situations considered was the presence of a groundwater aquifer composed of sand and claylike silt. Under such conditions, radiation safety (i.e., groundwater protection) would have been the primary reason for sealing the wells. These conditions do not occur at the Texas site.

Wells penetrating the stratified fee volume, and within 150 feet of the tunnel centerline, will be sealed. No permits will be issued for new wells so as to protect the physical integrity of the tunnel from subsidence or from unrelated construction activities.

Testing for tritium and sodium-22 will be part of an extensive environmental monitoring program that has already been initiated to ensure that the SSC is operating as designed and safely. Water samples will be collected from wells and analyzed for many substances, including radioactive ones. Such analyses are not expected to find any radiation, but will provide assurances that none is present. (Also see Category 1.1, Submission 108, Comment 2.)

Category 13.1, Submission 114, Comment 3 (Significance of SSC Air Emissions)

The statement in the Site-Specific Conceptual Design Report was not intended to indicate that safety is not significant, but rather that the amount of radioactivation and release of noxious gases are not significant. That the amounts are negligible is stated explicitly on pages 276 and 589 of the site-specific conceptual design report.‡ This statement is repeated on page 753 with respect to the experimental halls. The basis of this statement is documented in several of the SSC publications

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*National Research Council, 1990, *Health Effects of Exposure to Low Levels of Ionizing Radiation*, BEIR V (Committee on the Biological Effects of Ionizing Radiation), National Academy Press, Washington, D.C.

‡Superconducting Super Collider Laboratory, 1990, *Superconducting Super Collider Site-Specific Conceptual Design*, Report SSCL-SR-1056, Dallas, July.

made available for the environmental impact statement process (e.g., SSC-SR-1027, *An Introduction to Radiation Protection for the Superconducting Super Collider*, and SSC-54, *Radiation Safety of the Superconducting Super Collider*). In Vol. 1, Section 4.7.1 provides a detailed assessment of radioactive air quality impacts, and Section 4.5.3 discusses nonradioactive impacts likely to result from SSC construction and operation.

Category 13.1, Submission 115, Comment 1 (Radiation Risk)

The risks of low-level ionizing radiation resulting from SSC operations are discussed in Vol. 1, Section 4.7.1.3.

Category 13.1, Submission 116, Comment 2 (Groundwater Contamination)

Investigation has shown that the wells in question are more than 150 feet from the tunnel and would not be subject to closure. The "abort tunnel," or the beam tunnel leading to the beam absorbers, is entirely within the fee simple area of the west campus. Therefore, none of the wells in the stratified fee areas is in the path of the abort tunnel.

Wells penetrating the stratified fee volume and within 150 feet of the SSC tunnel centerline will be sealed even though the water in those wells would be safe on the basis of meeting the 4-mrem limit in a well pumping only 40 gallons of water per day. This pumping rate provides far less dilution than will occur in one well providing water for a dairy. (Also see Category 1.1, Submission 108, Comment 2; Category 13, Submission 80, Comment 9; and Category 13.1, Submission 112, Comments 6 and 7.)

Category 13.1, Submission 116, Comment 6 (Radiation Exposure Estimates)

See Category 13.1, Submission 5, Comment 2.

Category 13.1, Submission 116, Comment 8 (Groundwater Contamination)

See Category 13.1, Submission 132, Comment 2.

Category 13.1, Submission 116, Comment 10 (Risk of Low-Level Ionizing Radiation and Groundwater Contamination)

See responses for Category 13.1, Submission 80, Comment 16; Category 13.1, Submission 110, Comment 13; and Category 13.1, Submission 116, Comment 2.

Category 13.1, Submission 116, Comment 13 (Depth of Tunnel Cover)

See Category 1.3, Submission 116, Comment 5.

Category 13.1, Submission 117, Comment 2 (Public Health and Safety)

The SSCL has been sensitive to these concerns from the earliest designs in 1984. See especially reports SSC-SR-1026, *Environmental Radiation Shielding* (July 1987); SSC-SR-1027, *An Introduction to Radiation Protection for the SSC* (Nov. 1987); and SSC-SR-1037, *Safety Review Document* (Nov. 1988). In Vol. 1, Section 4.7.1.3 describes the impacts to local residents likely to occur from SSC operation.

Although the SSC will have higher energy protons than any other accelerator, it will result in less total radioactivation. Stray beams will be sent to beam stops or absorbers. The time available is sufficient to detect and remove such beams before they reach the edges of the pipes they travel in. The necessary safety is provided by the conservative design of the facility. (Also see Category 13.1, Submission 132, Comment 2.)

Category 13.1, Submission 118, Comment 3 (Potential for Radioactive Contamination)

Extensive digging has been and is being done in the geological strata underlying Ellis County without any detrimental effects. Examples include the Jefferson Avenue tunnel, the water conveyance tunnels along the Central Expressway, and the TCWCD 90- and 72-inch raw water pipelines.

A mitigation action plan will be prepared following the Record of Decision on the SEIS. This plan will detail what actions will be taken to ensure that the concerns of the public in regard to health and safety receive appropriate consideration. The purpose of environmental monitoring is to detect any problems at an early date and to facilitate their correction. An environmental monitoring program is being developed. (Also see Category 13.1, Submission 117, Comment 2.) Site-specific analyses of radioactive contamination of soil, air, and water are discussed in Vol. 1, Section 4.7.1.

Category 13.1, Submission 119, Comment 6 (Protective Tunnel Lining)

There is no plan to line the portion of the SSC tunnel under Bardwell Lake with lead. A lining would not be necessary even under the most severe accident scenario that can be envisioned. In this scenario, the amounts of radioactivity produced outside the tunnel would be so small that they could not be detected in Bardwell Lake water. (Also see Category 1.1, Submission 108, Comment 2; Category 13, Submission 80, Comment 9; Category 13.1, Submission 112, Comment 7; and Category 13.1, Submission 117, Comment 2.)

Category 13.1, Submission 120, Comment 1 (Monitoring)

The "I" areas referred to in this comment are muon vector areas, established to monitor muons that may penetrate the solid rock some distance at the level of the tunnel. The "I" areas will not contain tunnels, nor will high-energy proton beams pass into these areas. Muons are weakly interacting particles and will not induce radioactivity in materials they pass through. Radiation impacts expected as a result of SSC operation are assessed in Vol. 1, Section 4.7.1.3.

Category 13.1, Submission 120, Comment 2 (Public Risk from SSC Operation)

Several commentors have expressed concern about the safety of the SSC and the risk to citizens living over or near the collider tunnel. In fact, modern particle accelerators are designed for safe operation, and even in the case of an accident, do not present a serious risk to the public. A substantial knowledge base for the safe design and control of today's generation of accelerators has been created through the operation of accelerators for decades in different settings all over the world. As an example, the DESY machine in Germany is located beneath the city of Hamburg and presents no threat to the residents of that large metropolitan area.

Federal regulations require that environmental impact statements be prepared by individuals who are independent of the activity being assessed. This SEIS for the SSC was prepared by scientists and professionals from Argonne National Laboratory who have no interest in a particular outcome for the SSC project. This document and the analyses therein have been reviewed for accuracy by other specialists, both within the DOE and within state and federal regulatory agencies. Such independent analysis has confirmed the safe operating characteristics of the SSC. Volume 1, Chapter 6, lists the preparers of the SEIS.

Category 13.1, Submission 124, Comment 3 (Radiation Safety)

The analyses presented in the SEIS confirm the safe operating characteristics of the SSC. The SSC design criteria are such that even in the case of the worst possible accident, no member of the public would receive a radiation dose higher than 10% of the natural background radiation currently occurring around the site. Further, even this brief increase in radiation would be less than the average annual dose received from natural sources by millions of people in other parts of the United States. During normal operation, increased radiation will not be detectable at the site boundaries or above the collider tunnel. A county referendum, as suggested by the commentor, would need to be initiated by the residents of Ellis County; it is not within the authority of the DOE. (Also see Category 13.1, Submission 120, Comment 2.)

Category 13.1, Submission 125, Comment 9 (Potential for Radioactive Contamination)

The design of the SSC provides special containment for all locations where there will be continuous bombardment by radioactivity, that is, primarily the beam absorbers and the experimental halls. (Also see Category 1.1, Submission 108, Comments 2 and 3, and Category 13.1, Submission 117, Comment 2 [see especially the reports cited].)

Category 13.1, Submission 126, Comment 4 (Radiation Safety)

See Category 13.1, Submission 124, Comment 3.

Category 13.1, Submission 127, Comment 2 (Potential for Radioactive Contamination)

The DOE is committed to safe operation of all its facilities and to safeguarding the health and safety of its workers and the public. (Also see Category 4, Submission 124, Comment 2, and Category 13.1, Submission 120, Comment 2.)

Category 13.1, Submission 132, Comment 1 (SSC Air Pollutant Emissions)

See Category 13.1, Submission 114, Comment 3.

Category 13.1, Submission 132, Comment 2 (Soil and Groundwater Contamination)

Copper and aluminum tags have been used to monitor potential long-term buildup of radioactivation products. Such tags were used inside target areas at Fermilab to monitor the source term for potential soil activation. After June 1982, the Fermilab Tevatron began operating. Copper and aluminum tags were used in the accelerator tunnel during the commissioning of that machine to gain information on radiation patterns within the tunnel associated with the new configuration. These tags were analyzed as part of the commissioning process, and their usefulness ended with the completion of that process. Commissioning of the Tevatron, whose primary mode of operation is as a collider, resulted in a very much reduced fixed-target program. (The number of protons delivered to the fixed targets was less than 10% of the average annual total for the preceding 10 years.) At these levels, the buildup of activation products in the contained volume around the target was small relative to the levels already present from pre-Tevatron operations, making the tags no longer very useful. In addition, other and more sensitive techniques had been developed and implemented for monitoring the number of protons delivered to the targets and for determining the resulting radioactivation level around the targets. For these reasons, use of the tags was also discontinued in the fixed-target areas.

The soil borings were never intended to serve a monitoring purpose. The borings provided soil samples to be analyzed for the presence of radionuclides so as to verify the operation of the containment systems. The presence or absence of radionuclides is determined by leaching the samples with water. After sampling, the boreholes are routinely grouted, just as is done in geotechnical sampling, to restore the integrity of the containment.

The one water sample with a tritium concentration of 2,200 pCi/mL was from a monitoring hole drilled through the concrete floor inside a target hall. The high concentration did not result from soil activation and leaching, but resulted from a leak of water from a closed-loop (recirculating) cooling system for that target in the Proton West experimental area. Only a small amount of water (estimated at about one pint) from the closed-loop system entered the monitoring hole through the cover, which was mounted flush with the floor at the time. The rest was collected and disposed of properly. Subsequently, the casing in the monitoring hole was extended above the floor to prevent a recurrence.

Because the total radioactivity involved in the above spill was so small (even though the concentration was above the drinking water standard of 20 pCi/L) and much of that activity was collected during the sampling, the loss was below reporting levels. The dose from this amount of radioactivity, if diluted in the water pumped from an individual well, would be less than 0.1 mrem, which is well below the 4-mrem drinking water standard. However, no radioactive water reached any well. (Also see Category 1.1, Submission 108, Comments 2 and 3, and Category 13.1, Submission 112, Comments 4 and 5.)

Category 13.1, Submission 133, Comment 1 (Monitoring)

See Category 13.1, Submission 120, Comment 1.

Category 13.1, Submission 138, Comment 9 (Low-Level Radiation)

In Vol. 1, Section 4.7.1.3 discusses radiation impacts associated with SSC operation. (Also see Category 13.1, Submission 144, Comment 5.)

Category 13.1, Submission 144, Comment 1 (Soil and Water Contamination)

See Category 13.1, Submission 112, Comment 7.

Category 13.1, Submission 144, Comment 5 (Source of DOE Radiation Standards)

The question of "safe" levels of radiation exposure is one of continuing debate. Studies that confirm genetic effects or incidences of cancer as a result of exposure to radiation have dealt with high radiation doses. Studies of the incidence of cancer or genetic defects in the general population with variation in radiation background have not detected a difference -- even when levels of background vary by a factor of 10 or more. Because there is not a firm scientific basis for setting a numerical threshold radiation dose for allowable human exposure, regulatory agencies have adopted the policy of ALARA (as low as reasonably achievable).

DOE Order 5400.5 (Radiation Protection of the Public and the Environment) establishes standards and requirements for the operation of all DOE facilities. Following the recommended system of dose limitations of the International Commission on Radiological Protection, DOE has set a dose limit to the public from all DOE sources of radiation at 100 mrem. The SSC project has independently established a lower design and operating guideline of 10 mrem, including the most severe accident analysis. (Also see Category 13.1, Submission 112, Comment 6.)

The estimated volumes of low-level radioactive waste to be produced annually by the SSC are described in Vol. 1, Section 4.7.1.3. This waste will be packaged, transported off-site, and disposed of in accordance with stringent standards and criteria established by the U.S. Nuclear Regulatory Commission and the U.S. Department of Transportation, as well as DOE's own internal regulations. The impacts to the public from shipping and disposing of low-level radioactive waste are discussed also in Vol. 1, Section 4.7.1.3.

Category 13.1, Submission 144, Comment 6 (Exposure from Beam Absorber and Safety of Magnetics)

In the site-specific conceptual design report,* Table 4.2.9.2-1 lists the number of protons going to each of the beam backstops ("beam aborts") of the SSC complex, and the text on the following pages discusses the design of the radiation protection. Detailed discussions of the beam backstops, their operation, and the question of buildup of isotopes are provided in SSC-SR-1037 (SSC Safety Review Document, November 1988), which was made available as part of the EIS process (see Sections 4.4.6, 8.3.2.1, and especially 8.3.2.5). More detailed analyses, including the level of buildup of radioactive isotopes in the absorbers, were provided in SSC-SR-1031 (Workshop on Radiological Aspects of the SSC Operations, May 1987). The choice of carbon as the primary beam absorber in the beam backstop design and the size of the carbon modules are largely predicated on the fact that the buildup of radioactive isotopes is minimized because of the low atomic number of carbon, as discussed in the above report. See Category 13.1, Submission 80, Comment 14, and Category 13.1, Submission 117, Comment 2, for a discussion of groundwater contamination.

In addition, the increase in the inventory of radioactive isotopes expected for the SSC is not large relative to the inventories produced at Fermilab during the peak years of the fixed-target program there. Even at the peak design intensity of 4×10^{14} protons, about 2×10^{17} protons would be produced at the SSC in one year, compared with about 1×10^{19} protons for the target receiving the most protons in one year at Fermilab. Although the SSC intensity will be 50 times lower than that at Fermilab, the energy will be 25 times higher. As a result, the amount of radioactivity produced at the SSC will be comparable to that produced at Fermilab.

The design of the cryogenic magnet system includes a protection system with multiple levels of redundancy to prevent a magnet's rupturing from the pressures that could be generated if it were suddenly to return in an uncontrolled manner to the normally conducting state (quenching). Moreover, the many years of experience with superconducting magnets have made it possible to design the magnets to contain a quench, if it should occur. A description of the quench protection for the collider ring is provided in Sections 5.1.5 and 5.5.2 of SSC-SR-2020 (Conceptual Design of the SSC). These systems have been extensively tested over several years, and data do exist on their performance. The inclusion of the quench protection systems is primarily a question of equipment safety, because personnel are not in the tunnel when the magnets are powered, and such quenches do not present a hazard to people outside of the tunnel enclosure. Personnel safety considerations with respect to the cryogenic systems are discussed in detail in SSC-SR-1037 (SSC Safety Review Document), especially in Section 8.3.3 (Cryogenics). Data are presented from experiments at both Fermilab and the Brookhaven National Laboratory to provide the basis of design of the cryogenic systems and safety measures in the accelerator

*Superconducting Super Collider Laboratory, 1990, *Site-Specific Conceptual Design*, Report SSCL-SR-1056, Dallas, July.

tunnels. These data have been incorporated into the designs of the SSC systems and tunnels. The possibility of a superconducting magnet rupturing (superconducting magnets cannot explode) can be prevented by the types of protection systems already in operation at other facilities. A failure in the liquid helium system would be sensed by the protection system, and the energy in the magnet would be removed quickly by shunting the current out of the magnet coils.

Category 13.1, Submission 144, Comment 7 (Natural Radioactivity Comparisons)

See Category 13.1, Submission 110, Comment 15.

Category 13.1, Submission 167, Comment 1 (Risks of Ionizing Radiation)

See Category 13.1, Submission 112, Comment 6.

Category 13.1, Submission 201, Comment 1 (Radiation Risk)

Radiation impacts from SSC operation are discussed in Vol. 1, Section 4.7.1.

Category 13.1, Submission 223, Comment 2 (General Radiation Concern)

See Category 13.1, Submission 112, Comments 4 and 6, for concerns about groundwater radioactivation and ionizing radiation.

Category 13.1, Submission 224, Comment 2 (Linear Accelerator)

A linear accelerator to produce 600-MeV protons has always been included in the design for the SSC injection system. A separate linear accelerator was never proposed as an addition to the SSC. There are no plans, nor have there ever been plans, to use the SSC to produce nuclear materials (e.g., tritium) for nuclear weapons production. The SSC is intended for basic physics research. (Also see Category 12.1, Submission 224, Comment 3.)

Category 13.2: Air Activation Product Releases and Exposure

Category 13.2, Submission 138, Comments 2 and 3 (Groundwater)

The DOE and the SSCL are very sensitive to the need to protect groundwater from contamination by any pollutant. Groundwater protection will be a high priority in the design, construction, and operation of the SSC. Full advantage will be taken of the techniques developed over the past few decades for controlling any potential source of contamination. The record established by research accelerators in protecting groundwater is excellent. The SSC will not be a source of groundwater pollution in Ellis County.

The areas in which the largest amount of radioactivity will be generated will receive extra attention in design and construction. The designs of the target and backstop

areas will incorporate steel and concrete enclosures inside a concrete hall. All significant amounts of radioactivity generated there will be contained and retained.

Application of shotcrete is planned for the Austin chalk sections of the collider tunnel. Poured or precast concrete liners will be used where the chalk is fractured or water inflow is high. Possible inflows will be treated or reduced by grouting at tunnel depth. (Also see Category 3, Submission 80, Comment 13; Category 7.1, Submission 110, Comment 9; and Category 13.1, Submission 117, Comment 2.)

Category 13.2, Submission 138, Comment 4 (Groundwater Contamination and Soil Radioactivation)

See Category 13.1, Submission 112, Comments 4 and 5.

Category 13.2, Submission 169, Comment 5 (Radiological Impact)

A natural background level of 100 mrem was used in the radiological impact analysis. The text in Vol. 1, Section 4.7.1.3, was corrected.

Category 13.3: Disposal of Low-Level Radioactive Waste

Category 13.3, Submission 169, Comment 6 (Radiation Dose Values)

The gamma disintegration energy given in Vol. 1, Table 4.20, of the draft SEIS was removed. However, the corrected values of disintegration energies were used to recalculate the dose values in Vol. 1, Table 4.26.

Category 13.4: Hazardous and Toxic Mixed and Sanitary Wastes

Category 13.4, Submission 75, Comment 2 (Hazardous Materials Impacts)

In Vol. 1, Section 4.7 discusses in detail the environmental and health impacts associated with the radioactive and hazardous materials expected to be generated during SSC operation.

Category 13.4, Submission 80, Comment 14 (Groundwater Contamination)

See Category 13.1, Submission 112, Comment 3.

Category 13.5: Industrial Safety

No submission addressed this issue.

Category 13.6: Fire Ants

Category 13.6, Submission 111, Comment 2 (Impacts during Construction and Operation)

The impacts from red imported fire ants (i.e., to electrical relays, junction boxes, or other equipment) and the measures to minimize their impacts are discussed in Vol. 1, Sections 3.8.2.2, 4.7.2.5, and 4.7.6.4. Consultation with specialists on this subject from the Department of Entomology at Texas A&M University and the Texas Department of Agriculture will continue.

The entire southeastern United States is infested by red imported fire ants. Although attempts to eradicate the ant have been unsuccessful, this lack of success has not prevented ongoing construction and operation of industries and businesses in that part of the country. Constructing and operating surface facilities for the SSC will be equivalent to constructing and operating a number of separate industrial and business sites.

The agricultural lands in the SSC project area now provide ideal fire ant habitat; therefore, construction of the SSC should not contribute to any increase in fire ant infestation.

Category 13.6, Submission 111, Comment 4 (Insecticides, Herbicides, and Pesticides)

Crop and pasture lands in the SSC project area are now being treated with a variety of insecticides and herbicides. Removing lands from agricultural production will actually decrease pesticide use. It is DOE's stated intention to minimize the use of pesticides. As stated in Vol. 1, Section 4.7.6.4, active use of insecticides is only advised in SSC areas where continuous and frequent contact between fire ants and humans will occur. If such conditions arise, they will occur primarily at the landscaped lawns of the campus areas. Because these sites are not immediately adjacent to any agricultural land, no inadvertent contamination of agricultural lands by pesticides will occur.

The only insecticides that will be used are those labeled and recommended for use against fire ants. The insecticides will be applied, following label directions, by a certified applicator (Vol. 1, Sections 3.8.2.1, 3.8.2.2, 4.7.2.5, and 5.1.8).

Category 13.6, Submission 125, Comment 11 (Impacts during Construction and Operation and Electric Power Needs)

See Category 13.6, Submission 111, Comment 2. With regard to electric power requirements, see Vol. 1, Section 2.2.6.

CATEGORY 14: SOCIOECONOMICS AND INFRASTRUCTURE

More than 100 comments were received regarding socioeconomic and infrastructure issues. The majority of these comments concerned road improvements in Ellis County -- in particular, the perceived need for improvements to Ebenezer Road southeast of the east campus area. A few comments addressed public service issues regarding emergency response personnel and public schools. Others were concerned with public finances and local economic impacts or the potential effects on property owners, the financial burden on local taxpayers, or the fiscal effects of the SSC on Ellis County's operating budget. Several comments were received on the possible change in the quality of life in the SSC area attributable to relocation and potential unknown health problems. Several comments were received regarding potential impacts of the project on the quality of life in the area.

Category 14, Submission 80, Comment 11 (Mitigation Measures)

Mitigation measures to reduce the financial burden on local taxpayers are discussed in Vol. 1, Section 4.8.11. Because some of the additional infrastructure costs are expected to be funded by a combination of DOE and state of Texas funds, as well as by the anticipated increase in the local tax base attributable to project-related local commercial and residential development, the extent of the financial burden is currently uncertain.

In consultation with affected communities, the DOE and the state of Texas (through the Texas National Research Laboratory Commission) are preparing a monitoring and mitigation plan. This plan will establish procedures for monitoring fiscal impacts and will define the types of mitigation and assistance that will be available to alleviate these impacts.

Category 14, Submission 80, Comment 12 (Cost Distribution)

Since one of the requirements set forth in the Invitation for Site Proposals was that the land for the project be provided at no cost to the federal government, the issue of equitable distribution of costs is outside the scope of the SEIS. Ellis, Tarrant, and Dallas counties will be paying (at least in part) for land acquisition for the SSC. The Texas National Research Laboratory Commission has indicated the following: "As with the other 14 sites considered in Texas for the SSC Project, Ellis, Dallas, and Tarrant counties committed funds towards the purchase of land for the SSC Project. This three county area will benefit from the economic development associated with the project." Impacts of the SSC to the economy of the region are discussed in Vol. 1, Section 4.8.3, "Economic Activity."

Category 14, Submission 127, Comments 1 and 5 (Equitable Distribution of Cost)

See Category 14, Submission 80, Comment 11.

Category 14, Submission 178, Comment 1 (Zoning)

Public comments relative to zoning can be directed to the Chair of the Ellis County Planning and Zoning Commission, Marcus Hickerson, at the Ellis County Courthouse. (Also see Category 3, Submission 80, Comment 4.)

Category 14.1: Relocation and Housing

Category 14.1, Submission 171, Comment 1 (Monitoring, Health Effects, Property Values, and Decommissioning)

The Texas National Research Laboratory Commission has confirmed that parcel #716 will be required in stratified fee for the SSC project. The literature on property value effects of various types of facilities is inconclusive, and therefore these effects have not been projected in this EIS. See Section 4.8.7 for other potential quality of life impacts. Parcel #716 is located above the area of a muon vector. Concerns about such a monitoring station (or "dumping station") are addressed in Vol. 1, Section 4.7.1.3.

The presence of a subsurface muon vector is not expected to affect surface habitability. Potential health effects are addressed in Vol. 1, Section 4.7.3. Health effects of living near the ring were calculated to be substantially below regulatory limits.

Current plans are to decommission the SSC at the end of its useful life. The aim of the decommissioning process is to return the SSC site to its pre-SSC condition so far as is practical or desirable. When it is time for the decommissioning of the SSC, additional environmental review will be performed, as is required by the National Environmental Policy Act of 1969.

Category 14.2: Roads and Traffic

Category 14.2, Submission 2, Comments 1 and 3; Submissions 6-15, 18-23, 25-28, 30-74, 77-79, 81-97, 101-102, 135-137, and 221, Comment 1 (in all); Submission 4, Comments 1-4; Submission 113, Comments 1, 3, and 4; Submission 161, Comment 2 (Improvements to Ebenezer Road)

Road improvements for the SSC campus areas are discussed in Vol. 1, Section 2.2.2. Road improvements beyond those necessary to serve the SSC will be decided outside of the SEIS process. The most recent site-specific conceptual design report for the SSC* places the northern half of Ebenezer Road (between F.M. 878 and Tammy Lane) within the east campus area adjacent to several surface facilities, including an

*Superconducting Super Collider Laboratory, 1990, *Superconducting Super Collider Site-Specific Conceptual Design*, Report SSCL-SR-1056, July.

administration/office building, two industrial assembly buildings, and a storage facility.

Although Ebenezer Road is not specifically named in the referenced SSCL document as a road to be improved, the intent of the text is to include any and all necessary *on-site* improvements to serve east campus area facilities. Included are improvements to existing roads and construction of additional roads within the east campus area.

Any improvements to Ebenezer Road between F.M. 878 and Tammy Lane (i.e., within the east campus area) would be included as part of the SSC design; Ebenezer Road and Tammy Lane south to F.M. 879 would not be included in the SSC design. Plans for the east campus buildings and infrastructure have not been finalized; therefore, the precise routing of roads and necessary road improvements within the east campus remain uncertain. Furthermore, the entity or entities that will be responsible for funding the potential southern Ebenezer Road improvements (outside the east campus area) cannot be ascertained. Outside the east campus area, Ebenezer Road is a county road, and improvements to the road are technically the responsibility of Ellis County. Funding for these improvements by other entities, such as the state of Texas, will remain uncertain until the final east campus area structure and road designs are complete and Ebenezer Road's potential for incorporation into the region's transportation plan is determined.

Once road improvement designs are completed, approved, and funded, any improvements to Ebenezer Road, all of which are tied to the east campus area construction schedule, would not likely occur for several years. This is because the initial construction related to the SSC project would focus on the west campus.

In reference to the transport of radioactive materials, see Category 12.1, Submission 2, Comment 2.

Category 14.2, Submission 2, Comment 3 (Figure Correction)

The mislabels in Figure 2.14 of the draft SEIS were corrected. This mislabeling did not affect the analysis in the SEIS.

Category 14.2, Submission 121, Comments 1-6 (Traffic Routing)

For the reasons noted in the comments, the route through Sardis from U.S. 287 is not viable. An engineering firm has been engaged to study the options. Among several alternatives that have been considered, the preferred option is to route traffic via Skinner and the western portion of Honeysuckle roads. The SSCL will study the alternative proposed in your petition, but may find that, because of topographic elevations and floodplain considerations, the route, although shorter, has technical problems. In Vol. 1, Table 2.2 and Figure 2.12 were revised to reflect this option.

Category 14.2, Submission 161, Comment 2 (Road Improvements)

Upgrading and other improvements to local roads are discussed in Vol. 1. The comment addresses roads that currently run through the designated campus boundaries. Improvements to these roads are discussed in Section 2.2.2, and specific roads and road segment improvements are listed in Table 2.2.

Category 14.2, Submission 179, Comments 1-3 (Road Improvements)

The Texas State Department of Highways and Public Transportation pointed out that there were several roadway improvements authorized in the Department's Minute Order on July 29, 1987, that were not included in Vol. 1, Table 2.2. Specific insertions identified in the comment were added to Table 2.2, with the exception of F.M. 66, which will remain at 5.4 miles. (The SSCL calculated the distance of F.M. 66 reconstruction to be 5.4 miles, not 4.5 miles; the difference in numbers is insignificant for the impact assessment.) Corresponding changes were made in Vol. 1, Table 4.31, with no subsequent changes required in the conclusions.

Specific notes in Table 2.2 and Figures 2.11 and 2.12 of Vol. 1 were included at the recommendation of the Texas State Department of Highways and Public Transportation.

Category 14.2, Submission 179, Comment 4 (Road Improvements)

A note was added to Vol. 1, Table 4.31, reflecting that the information in the table may be modified on the basis of further study and finalization of a master plan of roadway improvements for the SSC area. Potential scheduling delays have necessitated the use of the labels "construction" and "operation" years instead of specific calendar years for peak traffic volume impact column headers in Table 4.31, Vol. 1. In addition, clarifications of roadways and segments were incorporated into the relevant text and tables as recommended.

A more detailed examination of the local and regional road network (from which the DSEIS transportation analysis was summarized) is presented in the *Socioeconomic and Infrastructure Impact Assessment for the Superconducting Super Collider in Texas* prepared by R.D. Niehaus, Inc. (1990). Throughout that analysis, traffic volumes were derived from the average annual daily traffic (AADT) counts provided by the Texas State Department of Highways and Public Transportation. Peak hour volumes were assumed to be 10% of the AADT.

The proposed widening of U.S. 287 between the Ellis County line and Sardis (F.M. 528 West) before 1993, prior to peak-year construction, also is presented in the R.D. Niehaus transportation analysis. Because U.S. 287 is expected to be a four-lane highway by the peak construction year, that anticipated capacity was used for the peak-year analysis. A footnote to Table 4.31 of Vol. 1 was modified to clarify the incorporation of these roadway improvements into the transportation analysis.

U.S. 77 was not projected to receive significant amounts of SSC-generated commuter traffic because commuters were anticipated to select I-35E, a limited-access highway, as the primary traveling route between Waxahachie and points to the north and south.

Category 14.3: Transportation and Utilities

Category 14.3, Submission 3, Comment 1 (Insurance Rating)

Comment noted.

Category 14.3, Submission 80, Comment 8 (Utility Services)

The general areas to be disturbed in providing utility services for the SSC project are considered in Vol. 1, Sections 2.2.3-2.2.6. The final routing of distribution lines will be determined by the utility suppliers on the basis of the needs of the SSC and also the needs of Ellis County. Most off-site utilities will be constructed along existing rights-of-way.

Category 14.4: Public Services

Category 14.4, Submission 3, Comment 2 (Service Capabilities)

As described in the SSC site-specific conceptual design report,* police, fire, and emergency medical services at the SSC complexes will be supplied and supported by special on-site staff and facilities and will not solely rely on existing off-campus municipal services. However, new residents who have in-migrated to surrounding communities to work at the SSC facility will rely on existing local police, fire, and emergency medical services outside of the SSC workplace. These local public service capabilities are discussed briefly in the SEIS and in greater detail in a report.‡ The safety coordinator at the SSCL is currently evaluating local safety capabilities with a view toward cooperative arrangements with the Laboratory. Also, public services will be monitored as part of the socioeconomic monitoring and mitigation plan.

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*Superconducting Super Collider Laboratory, 1990, *Superconducting Super Collider Site-Specific Conceptual Design*, Report SSCL-SR-1056, Dallas, July.

‡Robert D. Niehaus, Inc., 1990, *Socioeconomic and Infrastructure Impact Assessment for the Superconducting Super Collider in Texas: An Analysis in Support of the Supplemental Environmental Impact Statement*, Santa Barbara, Calif., draft report.

Category 14.4, Submission 106, Comment 4 (Fire Protection)

To avoid relying solely on existing professional municipal and volunteer county fire protection services, the SEIS suggests that the proposed SSC fire stations for the east and west campuses be constructed at the earliest possible time. These newly constructed fire stations would then be functioning and able to support and protect SSC project areas beginning with the start of construction. See Vol. 1, Section 4.8.5, for comments on public services, and Section 4.8.11 for comments on mitigative measures. (Also see Category 14.4, Submission 3, Comment 2.)

Category 14.4, Submission 110, Comment 6 (Local Financial Impacts)

In Vol. 1, Section 4.8.11 details measures to monitor and mitigate financial impacts.

Category 14.5: Economic Activity, Public Finance, and Property Values

Category 14.5, Submission 80, Comment 7 (Property Value Losses)

Property owners whose land is proposed for use by the SSC project through conveyance in full title will be compensated at current fair market valuations at the time of the purchase, in accordance with federal law. Land acquisition boundaries have been defined to avoid health and safety risks to adjacent property owners. (Also see Category 5.4, Submission 117, Comments 1, 3, and 4.)

Category 14.5, Submission 122, Comment 1 (Public Risk and Local Economic Impact

See Category 13.1, Submission 120, Comment 2, for the response pertaining to public risk from SSC operation. See Category 14.5, Submission 129, Comment 2, for a discussion of local economic impacts.

Category 14.5, Submission 123, Comment 2 (Zoning Plan)

Ellis County has recently been granted authority to develop a zoning plan. Under this plan, local officials will have the power to control the type and location of proposed development so as to minimize potentially adverse development patterns (e.g., development in floodplain areas). (Also see Category 3, Submission 80, Comment 4.) With regard to the issue of spoils disposition, see Category 6.2, Submission 119, Comments 1 and 3.

Category 14.5, Submission 129, Comment 2 (Economic Impacts)

The economic impact analysis is presented in Vol. 1, Section 4.8.1. The overall economic impacts to the region of influence are expected to be positive, while some specific jurisdictions will experience revenue losses due to removal of land from the tax base. The state of Texas may be liable for interest payments for whatever bonds are issued, whether the SSC project is built or not. The extent of the State's liability will depend on how much of the authorized indebtedness is incurred.

Category 14.5, Submission 203, Comment 1 (Radiation Effects, Local Taxes, and Monitoring and Mitigation Plan)

The radiation effects of the SSC are discussed in detail in Vol. 1, Section 4.7.1. In regard to local taxes, Vol. 1, Section 4.8.6, details the net local fiscal impact to Ellis County. A monitoring and mitigation plan is being prepared by the DOE and the state of Texas (through the Texas National Research Laboratory Commission), in consultation with affected communities.

Category 14.5, Submission 209, Comment 1 (Property Values)

The presence of a subsurface muon vector area will not affect surface habitability. (See Category 5.4, Submission 117, Comments 1, 3, and 4, and Category 14.5, Submission 80, Comment 7.) The ability of property owners to sell their property depends largely on local market conditions.

Category 14.6: Labor Force, Income, and Demographics

Category 14.6, Submission 223, Comment 1 (Mitigation Plan)

The comments in this letter are from the Sierra Club -- Tennessee Chapter. The letter was originally sent to a Congressman from Tennessee in May 1988. The letter focuses on issues related to socioeconomic aspects of growth impacts, with the general concern that a mechanism for planning and paying for impacts (infrastructure) be established prior to initiation of construction. The essence of the comment deals with the issue of who will pay for the large amount of infrastructure needs associated with building the SSC in Tennessee. In regard to the Texas situation, it is anticipated that the public sector should be capable of meeting the demand of the SSC and cumulative growth, except that some school districts eventually would need to increase capacity. As stated in Vol. 1, Section 4.8, a monitoring and mitigation program for socioeconomic impacts will be developed in cooperation with the Texas National Research Laboratory Commission and local jurisdictions to monitor impacts and prescribe a method for mitigating impacts. This plan has been drafted and is currently under review by the DOE and the Texas National Research Laboratory Commission. After review, local jurisdictional input on the plan will be requested. The execution of the plan will be identified in the mitigation action plan that will be developed by the SSCL after issuance of the Record of Decision to construct the SSC.

Category 14.7: Quality of Life

Category 14.7, Submission 80, Comment 2 (Quality of Life)

The quality of life could be diminished as a result of the SSC for some residents of Ellis County; however, for other residents, the quality of life would be enhanced.

The analysis of these impacts (Vol. 1, Section 4.8.7) identified potential quality-of-life impacts from SSC development and described the differential effects for groups experiencing these impacts.

Category 14.7, Submission 118, Comment 4 (Quality of Life)

See Category 14.7, Submission 80, Comment 2.

Category 14.7, Submission 119, Comment 10 (Relocation)

The potential adverse effects of displacement and relocation are explicitly considered in Vol. 1, Section 4.8.7. To mitigate relocation impacts, the state of Texas has established two relocation service centers (Vol. 1, Section 4.8.11) to assist in counseling related to relocation benefits. (Also see Category 14.7, Submission 80, Comment 2.)

Category 14.7, Submission 227, Comment 1 (Quality of Life)

Social and environmental risks to the community are addressed extensively in the SEIS. Quality of life will be impacted in the area, with some people impacted positively and others negatively. The people who would be most affected by the project are the estimated 500 persons (192 households) who live on property that would be required in fee simple for the SSC. Quality-of-life impacts are discussed in Vol. 1, Section 4.8.7. In addition, potential contamination to area water is analyzed in the SEIS and is not expected to have significant impact (Vol. 1, Section 4.2.2).

CATEGORY 15: CULTURAL AND PALEONTOLOGICAL RESOURCES

One comment was received regarding cultural and paleontological resource issues.

Category 15, Submission 142, Comment 1 (Historical Resources)

The suggestions provided in the comment will be incorporated in the historical resources management plan being developed as part of the programmatic agreement with the Texas Historical Commission.

CATEGORY 16: VISUAL RESOURCES

The one comment received concerned a mitigation landscape plan for the F6 facility on U.S. 287, the principal east-west artery for the city of Ennis.

Category 16, Submission 2, Comment 6 (Construction and Operation Impacts)

Volume 1, Section 4.11, addresses the visual and scenic impacts arising from both construction and operation of SSC facilities. The planned construction engineering design for the SSC will reduce any perceived adverse visual impact of new surface

facilities through landscape grading of excavated spoils and planting of vegetative screens. In addition, the SSC mitigation action plan will incorporate the visual and scenic abatement measures upon which the Record of Decision is based and any appropriate additional mitigation actions. Details of the visual and scenic resource assessment are provided in Vol. 1, Section 4.11.

CATEGORY 17: FEDERAL PERMITS, LICENSES, AND OTHER ENTITLEMENTS

No submission addressed this issue.

CATEGORY 18: OUT OF SCOPE

Out-of-scope comments are those that do not relate to the SSC or this SEIS. Examples include comments about other DOE programs or comments about actions taken by other federal agencies, the state of Texas, or units of local government.

Categorized in this way were Submission 5, Comment 4; Submission 75, Comments 1, 3, 4, 5, and 9; Submission 80, Comments 3 and 5; Submission 123, Comment 3; and Submission 124, Comment 1.

CATEGORY 19: NO TECHNICAL, POLICY, COST, OR ENGINEERING/ PHYSICS ISSUES

Included in this category are comments that are simply statements in favor of, or against, the SSC project. Also included are comments of a very general nature or those that merely restate factual information contained in the SEIS. Although no specific responses have been provided for the comments, commentors may wish to review those sections of Vol. 1 and Appendix D in which they may have an interest.

Categorized in this way were Submission 5, Comment 1; Submission 29, Comment 1; Submission 31, Comment 3; Submission 80, Comment 1; Submission 104, Comment 1; Submission 106, Comment 7; Submission 110, Comments 1, 8, 10, and 14; Submission 111, Comments 1, 3, and 7; Submission 112, Comment 1; Submission 113, Comment 2; Submission 114, Comments 1, 4, and 7; Submission 116, Comments 1 and 7; Submission 118, Comment 1; Submission 120, Comment 3; Submission 123, Comment 1; Submission 125, Comments 1 and 12; Submission 126, Comments 1, 5, 6, 7, and 8; Submission 127, Comment 1; Submission 128, Comment 1; Submission 132, Comment 2; Submission 134, Comment 1; Submission 139, Comment 1; Submission 144, Comment 11; Submission 169, Comment 1; Submission 177, Comment 1; and Submission 211, Comment 1.

CATEGORY 20: SUBMISSIONS NOT ADDRESSED ELSEWHERE

The comments grouped into Category 20 address multiple issues and are treated explicitly in the responses listed as cross references. Category 20 has also been used to inventory duplicate submissions. These submissions have one comment number that refers to all of the comments in the original Submission 80. A few have additional comments with responses provided in other categories.

Category 20, Submissions 98 and 99, Comment 1 (Groundwater Use, Radiation Exposure, and Fugitive Dust)

See Submission 80, Comment 18; Submission 106, Comment 10; Submission 112, Comments 2 and 8; Submission 119, Comment 2; and Submission 138, Comment 5.

Category 20, Submission 100, Comment 1 (Land Values, Radiation Exposure, Fugitive Dust, and Water Use)

See Submission 80, Comments 17 and 18; Submission 106, Comment 10; Submission 112, Comments 2 and 8; and Submission 117, Comment 4.

Category 20, Submissions 103, Submission 111, Comment 7, 141, 143, 145-155, 157-160, 162-164, 166-168, 171-178, 180-219, 228-229 (Duplicate Submissions)

See Table D.2 for the categorization of Submission 80 (checklist) and the corresponding responses.