SITE ENVIRONMENTAL REPORT

Calendar Year 1991 - Preoperational

Superconducting Super Collider
2550 Beckleymeade Ave., Dallas, TX 75237

D10-000005
SSCL-SR-1217

Superconducting Super Collider
2550 Beckleymeade Avenue
Dallas, Texas 75237

SUPERCONDUCTING SUPER COLLIDER

SITE ENVIRONMENTAL REPORT
for
CALENDAR YEAR 1991

PRE-OPERATIONAL

Operated by Universities Research Association, Inc., for the U.S. Department of Energy under Contract No. DE-AC35-89ER40486.

Superconducting Super Collider Environmental Quality Goals

Although the primary mission of the Superconducting Super Collider (SSC) is research, we are committed to protecting our environment and conserving our natural resource heritage both for ourselves and future generations. To assure fulfillment of our commitment, the project has adopted the following environment quality goals:

- Demonstrate leadership in environmental protection and improvement.
- Minimize adverse environmental and health impacts while accomplishing the scientific research for which the machine is designed.
- Assure that consideration of the environment is an integral part of SSC decision making.
- Initiate aggressive action to comply with all Federal, State, and local environmental quality laws.
- Restore, augment and enhance wetlands and other environmental features during project development and operation.
- Support programs for the recycle and reuse of materials to conserve natural resources, prevent pollution, and minimize the generation of wastes.
- Pursue an active role in addressing environmental quality issues in our relations with neighboring communities.
- Assure through a Pollution Protection Awareness Program, that project plans recognize a requirement for pollution prevention.

To these environmental quality goals, the SSC project remains irrevocably committed.

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Associate Director
U.S. Department of Energy
Office of Energy Research
Superconducting Super Collider
SSC Project Office

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SUPERCONDUCTING SUPER COLLIDER
SITE ENVIRONMENTAL REPORT
FOR CALENDAR YEAR 1991

PRE-OPERATIONAL

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LIST OF ACRONYMS

A-E/CM	Architect-Engineer/Construction Manager
APEMP	Area of Potential Effect Management Plan
BEG	Bureau of Economic Geology
C	Celsius
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	Centimeter
CWA	Clean Water Act
DOE	Department of Energy
ECC	Environmental Compliance Committee
ECP	Environmental Compliance Plan
EG&G/EM	EG&G Energy Measurements, Inc.
EIS	Environmental Impact Statement
EPIP	Environmental Protection Implementation Plan
EPP	Emergency Preparedness Plan
ESA	Endangered Species Act
ES&H	Environmental, Safety, and Health
F	Fahrenheit
FEIS	Final Environmental Impact Statement
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FPPA	Farmland Protection Policy Act
FWCA	Fish and Wildlife Coordination Act
HEB	High Energy Booster
HMP	Habitat Management Plan
HSMP	Historic Structures Management Plan
KeV	Kiloelectron Volt
km	Kilometer
LEB	Low Energy Booster
Linac	Linear Accelerator
m	Meter
MAP	Mitigation Action Plan
MEB	Medium Energy Booster
MSDS	Material Safety Data Sheets
NAAQS	National Ambient Air Quality Standard
NHPA	National Historic Preservation Act
NEPA	National Environmental Policy Act
NPDWS	National Primary Drinking Water Standard

LIST OF ACRONYMS
Continued

NRHP	National Register of Historic Places
PB/MK	Parsons Brinckerhoff and Morrison Knudson
R	Roentgen
RCRA	Resource Conservation and Recovery Act
rem	Radiation Equivalent, Man
ROD	Record of Decision
ROI	Region of Influence
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SEIS	Supplemental Environmental Impact Statement
SER	Site Environmental Report
SHPO	State Historic Preservation Office
SI	Systeme Internationale ("metric" system of units)
SMMP	Socioeconomic Monitoring and Mitigation Plan
SSC	Superconducting Super Collider
SSCL	Superconducting Super Collider Laboratory
Sv	Sievert
TACB	Texas Air Control Board
TeV	Tera (Trillion) Electron Volts
THC	Texas Historical Commission
TNRLC	Texas National Research Laboratory Commission
TSCA	Toxic Substance Control Act
URA	Universities Research Association
μ	Micron
$\mu g/m^3$	Micrograms Per Cubic Meter
μR	Microroentgen (10^{-6} R)

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PREFACE

What are particle accelerators?
Why do we build them?
Do they have any specific effects on the environment?

The Superconducting Super Collider (SSC) is to be the world's largest particle accelerator. But what IS a particle accelerator? It is a scientific instrument, much the same as a microscope or a telescope, built to enable humans to isolate and detect the fundamental particles of which matter is made. Telescopes enable us to see large objects like galaxies deep in outer space; significantly, they also allow us to see these objects as they were many millions of years ago -- to look back in time, since the light that reaches us from deep in space has traveled for many millions of years to reach us. Microscopes enable us to see some very small entities that make up our world. In a sense, a particle accelerator fulfills both these roles; on one hand it is like a microscope, enabling us to "see" the inconceivably tiny fundamental particles of which atomic nuclei are composed. On the other hand, like a telescope, a particle accelerator enables us to "see" into the distant past of our universe, back to the time immediately following the Big Bang when these fundamental particles were formed from the primordial material of our universe. Incredibly, our expanding knowledge of the infinitesimally small is leading us to a greater understanding of the infinitely large.

Among the most basic questions humans have ever asked are: What is the stuff of which the world is made? How did the world begin? Until recently, these questions were the province of philosophy, since science lacked the tools necessary to investigate the basic nature of matter. Now, however, scientists can ask about the structure of matter, the way in which particles are held together to form nuclei, and the beginning of the material universe, with the hope of an answer. The essential scientific tools have been developed; they are the ever-larger particle accelerators that have been in existence for over 60 years. With them, we can use the energy of the accelerated particle beam to blast matter apart into its constituents. The stronger the forces that hold matter together, the higher the beam energy needed to reduce the matter into its most fundamental entities. The higher the beam energy, the smaller the probe, and the better the fundamental entities can be studied. Also, the higher the energy available for the collision, the higher the probability that new particles far heavier than the proton can be produced in the collision.

Working with the low energy radiation emitted by naturally occurring radioactive minerals early in this century, scientists demonstrated that atoms, once thought to be the

indivisible fundamental constituents of matter, are composed of even more fundamental particles called protons, neutrons, and electrons. High energy cosmic rays reaching the Earth from outer space reacted with atoms in the Earth's atmosphere, revealing the existence of many strange new subatomic particles. Previous generations of particle accelerators and colliders of ever higher energies have revealed that protons and neutrons are themselves composed of even more fundamental particles called quarks. The deeper we wish to look into the basic structure of matter, the higher the particle energies we need. The beams of high energy particles produced by the SSC will collide with energy so great that scientists can approximate the energy state of the early universe as it existed fractions of a second after the event known as the Big Bang, in which space, time, and matter as we know them are thought to have begun. It is these beginnings that the SSC seeks to duplicate in order to answer two of the most fundamental of all questions: How did the Universe begin and what is the nature of matter?

Particle accelerators and colliders are capable of boosting charged particles, usually protons or electrons, to speeds close to that of light. The SSC is a particle collider rather than a simple accelerator. An accelerator speeds one beam of particles into a stationary target of some chosen substance. A collider, in contrast, accelerates two beams of particles in opposite directions and steers them into head-on collisions, thereby greatly increasing the effectiveness of the collisions. Colliders are more difficult to design and build, but the dividends in increased collision energy make the added expense worth while. For a particle beam of a given energy, the energy produced by collisions of two beams moving in opposite directions can be many times the energy produced by allowing one beam to impinge on a stationary target.

The SSC is designed to accelerate protons. Several components are necessary to accomplish this acceleration. First, the particles must travel in an extremely high vacuum, because collisions with molecules of air would prevent their reaching the desired energy. Second, several types of magnets must confine the speeding protons to a needle-thin beam and curve the beam around its oval trajectory. Third, electromagnetic waves similar to those that transmit radio and television programs are used to boost the protons to speeds approaching that of light. What are the expected environmental impacts of these three components and of collider operation in general?

To maintain a vacuum in the small tube through which the proton beam will travel requires vacuum pumps, which require electrical power. The magnets used to focus the beam and to curve it around the 87-kilometer (km) (54-mile) track also require electrical power. Since the magnets are made of superconducting material (a niobium-titanium alloy), they require less power to operate than do conventional magnets, resulting in greatly increased efficiency and reduced costs. At our present level of technology, superconductivity in substances that can be coiled to make magnets occurs only at very

low temperatures, hence the magnets must be cooled with liquid nitrogen and liquid helium. These gases are chemically inert and are not hazardous to the environment: the Earth's atmosphere is 78 percent nitrogen, and helium is used to fill dirigibles, weather balloons, and children's toys. There are two beams of protons traveling in opposite directions around the collider ring, so there are two rings of magnets, one ring to guide each beam. Since the magnetic field generated by one ring of magnets must not be felt by the other ring, which is less than a meter away, the system has been designed to produce fields over only a very small distance, and no fields from these magnets will be detectable at the land surface. The radio frequency generators that supply acceleration energy to the protons are not substantially different from those of any radio or television station. Moreover, there is no antenna to transmit the waves through the air.

Impacts on the environment from these three components of an accelerator are no different in type or magnitude from impacts associated with any project that requires extensive conventional construction or large amounts of electrical power. Those impacts will be discussed in Sections 2 and 4 of this Site Environmental Report (SER).

In operation, the beams of protons within the collider pose no environmental hazard. Protons themselves are nothing more than ordinary hydrogen atoms stripped of their electrons. Radiation is emitted by charged particles tracing curved paths within a magnetic field (synchrotron radiation). In the SSC, this radiation is in the form of X-rays, none of which will penetrate the land surface. The enormous length of the collider ring, 87 km (54 miles), minimizes the curvature of the proton path, which in turn minimizes the synchrotron radiation emitted. When the collider is in normal operation, the synchrotron radiation levels, even within the beam tunnel itself, will be negligible.

It must be stressed that there is no generation of high-level radioactive waste at a particle accelerator and no possibility of a runaway-type accident, as there is at a nuclear reactor. The worst that can happen is accidental loss of the beam, a rare occurrence in which the beam strikes the side of its conduit and deposits its energy in the guiding magnets. Section 3 of this report discusses the impact of the worst-case accelerator accident. The type and level of radiation at interaction regions where the two protons beams collide will depend to some extent on the experiments being performed, but experimental areas are designed so that radiation is absorbed by the shielding materials, and radiation levels for public areas on the site will be below natural background levels, even in the worst case. Some radioactive nuclei may be produced when particles strike atoms in rock and soil, but experience with other accelerators suggests that it will be low level and short-lived and will not leave the site. Nonetheless, careful monitoring will be performed to ensure the safety of the public and of employees at the SSC. This monitoring program is discussed in detail in Section 3 of this SER.

"We dance around in a ring and suppose,
But the Secret sits in the middle and knows."
Robert Frost

EXECUTIVE SUMMARY

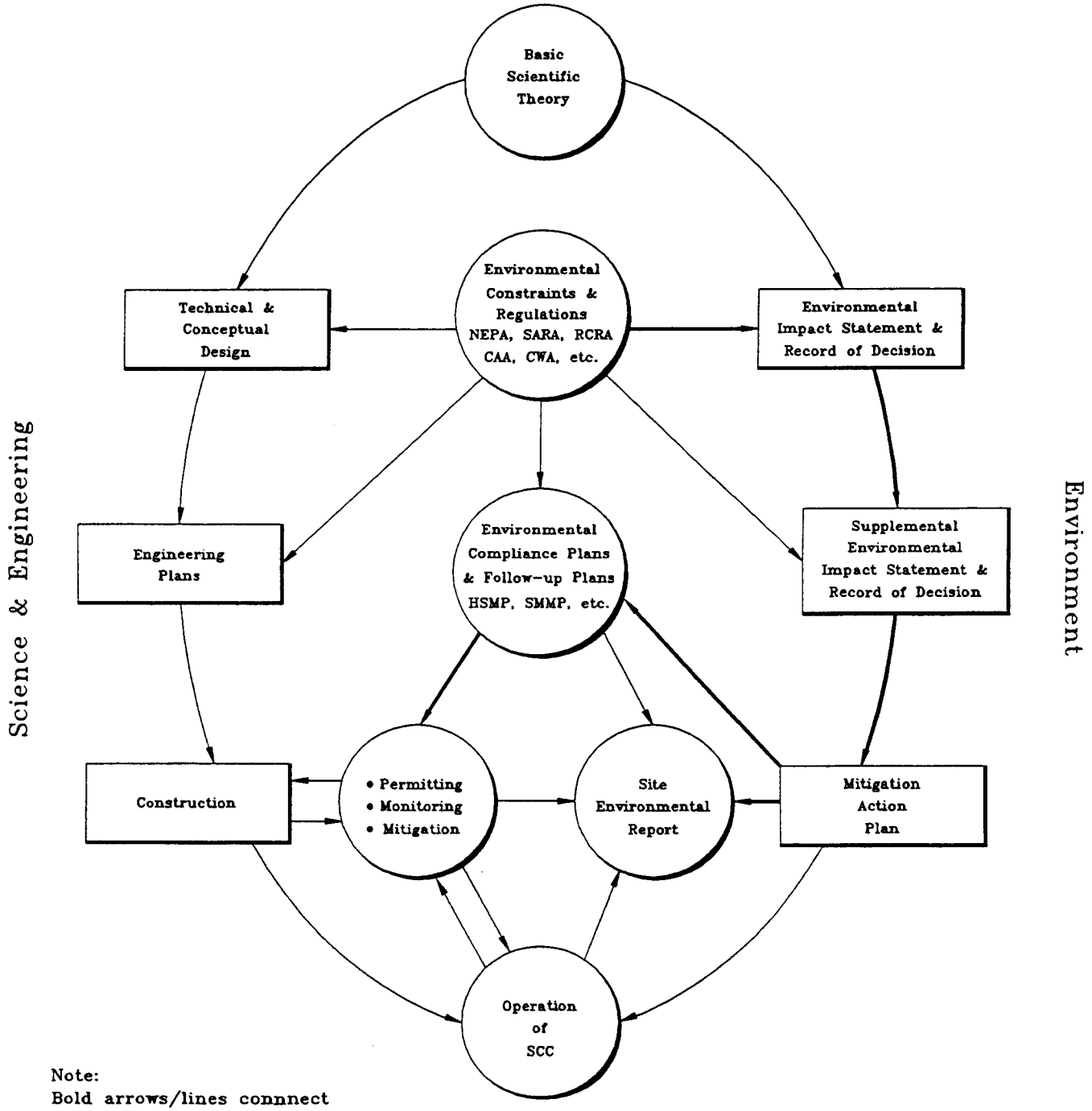
This is the first annual SER prepared for the SSC project. It is a pre-operational report, intended primarily to describe the baseline characterization of the Ellis County, Texas site that has been developed subsequent to the Environmental Impact Statement (EIS) and the Supplemental Environmental Impact Statement (SEIS). As such, the emphasis will be on environmental compliance efforts, including monitoring and mitigation programs. The SER also reports on the measures taken to meet the commitments made in the EIS and SEIS. These measures are detailed in the Mitigation Action Plan (MAP) (Department of Energy (DOE), 1991), which was prepared following the signing of the Record of Decision (ROD) to construct the SSC in Texas. The SER will continue to be pre-operational until the first high-energy (20 trillion electron volt or TeV) protons collisions are observed, at which point the SSC will become operational. At that time, the SER will place more emphasis on the radiological monitoring program. This SER will report on actions taken in 1991 or earlier and briefly mention some of those planned for calendar year 1992. All actions completed in 1992 will be addressed in the SER for calendar year 1992.

For locations of specific sites mentioned in this section and throughout this report, refer to Figure 1-1, which shows a regional view of the SSC site, and Figure 1-2, which shows a more detailed view of the SSC ring, campuses, and service areas. The satellite image on the report cover provides a view from space of the whole Project area.

Because of the complex inter-relationships among factors that govern the construction and operation of the SSC -- basic science, engineering constraints, environmental considerations, Superconducting Super Collider Laboratory (SSCL) documents, and federal regulations -- a "Documents and Procedures Flow Chart" is provided as an overview (Figure S-1).

Report Summary

The following sections summarize the information presented in the main body of this report.



Note:
Bold arrows/lines connnect documents described on following page.

Figure S-1: Documents and procedures flow chart

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Walsh & Associates, Inc.

KEY TO FIGURE S-1:

FEIS (Final Environmental Impact Statement): This document contains an assessment of the environmental effects of the SSC in general, with some discussion that refers specifically to the seven sites on the Best Qualified List. The FEIS identifies a commitment to prepare a site-specific SEIS.

SEIS (Supplemental Environmental Impact Statement): The SEIS explores in a more thorough manner the environmental impact of a site-specific design for the Ellis County site. Continuing study of the Ellis County site generated more detailed information on the site, which in turn led to the refinement of identified impacts on the environment. This new information generated specific ways to mitigate any adverse environmental effects of the SSC upon the Ellis County site.

MAP (Mitigation Action Plan): The MAP is a requirement established in 1990 for a plan of action to implement any commitments made in the various Impact Statements or their RODs for mitigation of environmental impacts associated with the Project. The MAP has three major purposes:

- To catalog the impacts identified in the FEIS, SEIS, or RODs
- To specify responsibility for mitigation of the impacts cataloged
- To ensure implementation of the mitigating actions required

The MAP is organized into the same environmental topic areas as the SEIS, and it is the basis for translating environmental actions analyzed in that document into specific mitigation measures.

ECP (Environmental Compliance Plan): These documents specify the details of mitigation measures, specialized to the actual field and design conditions of each facility. An ECP is required for each Project site and must address:

- Site-specific application of mitigation measures contained in the MAP
- Anticipated permit requirements
- Description of monitoring programs to be incorporated into design and construction

Plans and Programs: Various plans and programs developed by the SSCL establish fundamental principles to be incorporated into the ECPs. These plans also assist the SSCL to develop sound project management guidelines with respect to soil and water resources, wildlife habitat, historic structures, archaeological resources, socioeconomic factors, and other environmental considerations. Some plans initiate monitoring programs.

Statutes, Acts, and Orders: Federal, state, and local legislation has been enacted to ensure responsible practices in projects and actions that affect the environment. CERCLA, SARA, CWA, CAA, TSCA, and other legislation stipulate obligations that must be met by such projects. In addition, certain federal orders must be followed to ensure safe conduct of operations.

SER (Site Environmental Report): It will present environmental data to characterize site environmental management performance, confirm compliance with environmental standards, and highlight significant programs. The SER will also include a summary of information on all mitigation measures taken during the reporting period, describe the environmental monitoring data collected, and summarize the mitigation measures projected for the next reporting period.

Introduction

This section includes background information on the nature of the SSC Project, its history, mission, and management, along with pertinent regulatory issues. The location, climate, hydrogeology, and geology of the Project area are discussed in the last part of the Introduction.

Environmental Program Information

Several environmental characterization studies were initiated or completed in 1991. The studies discussed in Section 2 include the following:

The SSCL has designed monitoring programs and begun collecting and analyzing samples of both surface water and ground water throughout the Project area in order to characterize the baseline hydrology as part of the nonradiological environmental program.

The Parsons Brinckerhoff/Morrison Knudson (PB/MK) Team has initiated a program of intensive monitoring of the N15 site, recording climatic information, as well as construction-related air and water quality data. Construction noise is monitored both at the construction site and at the N15 site boundary.

The draft *Environmental Protection Implementation Plan* (EPIP), completed in 1991, addresses several elements of the SSC Environmental Protection Program. This plan is required by DOE to ensure that the SSCL is operated in a manner that will protect, maintain, and if necessary, restore environmental quality and minimize potential threats to the environment and the public health. The EPIP and the *Mitigation Action Plan* (MAP), in turn, require preparation of other environmental plans, some of which have been completed or begun in 1991. Section 2 discusses these efforts, which include the following:

- The PB/MK Team has submitted a draft *Wetlands Mitigation Plan of Action*, designed to identify and evaluate existing wetlands in the Project area. Wetlands that may need to be filled as a result of construction are identified, as are locations where new wetlands might be created.

- A draft *Soil and Water Resources Protection Plan* was submitted for comments. This Plan identifies earth, soil, and water resources in the Project area, identifies potential impacts on these resources from the SSC Project, and suggests mitigative actions to preserve and enhance these resources.

- A *Conceptual Land Management Plan* addresses cost effective land use that is also compatible with operation of the SSC and with current land uses.

- The draft *Pesticide Management Plan* provides guidance for the management and use of pesticides during construction and operation of the SSC.

- The draft *Habitat Management Plan* (HMP) is concerned with the preservation and enhancement of high quality habitat for wildlife in the Project area.

Radiological Environmental Program

A major study of the baseline radiological characteristics of the SSC Project area was completed in 1991. One element of this study was an aerial survey of the Project area to determine the gamma terrestrial exposure rate. Results of this study are presented in Figure 3.2 (and as a table in Appendix F). The natural background of Ellis County is rather low because of the bedrock geology of the site and because the contribution due to cosmic rays is low in areas of low elevation such as Ellis County. The other element of the radiological characterization program was the radioactivation of Ellis County rocks in the accelerator at Fermilab to simulate irradiation by the proton beam of the SSC. The only leachable radionuclides are expected to be ^{22}Na and tritium, and experience with other accelerators suggests that these isotopes will not impact the environment, even in the worst case occurrence. The results of the leachability study are available in preliminary form.

Section 3 also discusses the various types of radiation associated with particle accelerators and the possible pathways by which radionuclides could enter the environment. Radiological environmental monitoring plans designed to protect the environment, the public, and workers are discussed. Other short sections are devoted to non-ionizing radiation and the employee dosimetry and training programs that were established in 1991.

Ground-water Protection and Monitoring

The Bureau of Economic Geology (BEG) at the University of Texas in Austin completed a study of the shallow alluvial aquifer that underlies part of the northeastern quadrant of the Collider ring. Field data were used to generate a model of water flow in the aquifer (Figure 4.1) and to predict its response to changes in discharge and recharge. It appears that there is little or no cross-formational flow between the aquifer and the underlying

bedrock. Chemically, the water in the aquifer is very hard and in many areas contaminated by nitrates and bacteria (Wickham and Dutton, 1991).

BEG has submitted proposals for further studies of ground water in the Project area, and work is now progressing on characterization of the deep aquifers of the SSC region, an inventory of wells around the Collider ring, and detailed field studies of the structures, lithologies, and fluid flow regimes of the Austin Chalk, Taylor Marl, and Eagle Ford Shale. BEG will also submit plans for a ground-water monitoring program.

Other measures for protection of ground-water resources include a *Pollution Prevention Awareness Program Plan*, the *Spill Prevention Control and Countermeasures Plan*, and the *Soil and Water Resource Protection Plan*, the last two available in draft form.

Socioeconomics

Robert D. Niehaus, Inc. has completed a major socioeconomic study of the Project area to identify SSC-related effects on the Project area. Potential impacts upon housing, public services, public finance, and transportation are considered. A *Socioeconomic Monitoring and Mitigation Plan* has been developed to address potential impacts.

Two claims for reimbursement have been submitted to DOE: one from the Waxahachie Independent School District, which claims a depleted tax base resulting from the purchase of the Revco warehouse by the State for use as the SSCL Central Facility, and one from Ellis County for help with county planning and zoning necessitated by the presence of the SSCL.

An *Emergency Preparedness Plan* (EPP) is in preparation, one purpose of which is to integrate SSCL and local jurisdictions' response to natural disasters or major accidents, either on or off the Project site. Section 5 concludes with a short discussion of land acquisition and the Texas National Research Laboratory Commission (TNRLC) *Land Acquisition Plan.*

Cultural Resources

The architectural firm of Hardy-Heck-Moore conducted a survey of the historic resources of Ellis County (except for Waxahachie and Ennis, which were surveyed in earlier work), which identified 3714 previously unrecorded historic resources. Each property was photographed and classified as high, medium, or low priority, and a map was developed showing the locations of such properties on the SSC Footprint (Figure 6.1).

Using information from the historical resources survey, Delara Almond Architects and the Southern Methodist University developed a *Historic Structures Management Plan* to assure compliance with the National Historic Preservation Act. This Plan defined the statement of historic context, "Agricultural Settlement, Farming, and Building Traditions in Rural Ellis County, Texas: 1850 to 1945 A.D." Some individual historical sites are discussed, and possible mitigation strategies outlined.

The archaeological resources of fee simple land and potential impact areas of the SSC were surveyed by the Archaeology Research Program of Southern Methodist University, which then submitted a major report on their findings. Field crews walked each tract, mapping and photographing potential archaeological sites as they were encountered. No material was removed. The context statement published in the report was "The Emergence of Sedentism in Northeast Texas". Most of the sites identified were in the East Campus region (Figure 6.2).

An *Archaeological Data Recovery Plan* is in draft form, and suggests some areas for future research, as well as methods that would be appropriate to the SSCL region. A *Worker Education Program* has been established to protect any archaeological resources that are discovered during construction activities.

Quality Assurance

The environmental quality goals of the SSCL are discussed, as are some means of accomplishing these goals. The selection procedures for analytical laboratories are reviewed. Section 7 concludes with a short discussion of additional quality assurance plans needed for treatment of land acquired by the Project and decontamination and decommissioning requirements.

Evaluation of Design and Facility Changes Under NEPA Regulations

Design changes to the main SSC tunnel were undertaken in 1991 in response to new information on the geology of the Ellis County site. The original proposers noted that the preliminary geologic data were exactly that -- preliminary. They anticipated that the eventual design of the ring and experimental halls would undoubtedly have to be adjusted slightly to optimize scientific, geologic, and environmental factors: "Any problems ... will be addressed early in the design optimization process". "... a number of options are available [including] some change in the vertical alignment of the tunnel, [or] a lateral change of alignment ..."

Changes in the elevation and inclination of the main SSC ring move it away from the more difficult geological structures and into materials with better engineering properties. The length of the main SSC tunnel excavated in shale and mixed rock types has been reduced. To maintain the proper relationship to the main ring, the elevation of the high energy booster (HEB) ring was raised, and it is now entirely out of shale and mixed face conditions. Finally, the Revco warehouse in Waxahachie was purchased by TNRLC for use as the Central Facility by the SSCL. Impacts of the new ring and experimental hall configuration on the environment were analyzed in 1991 and found to be within the envelope of impacts addressed in the SEIS. Such analyses are required by NEPA regulations. The impacts of these changes are discussed individually in the following sections and in more detail in Appendix A. These design changes are also considered in individual sections of the main body of this report.

Orientation of Collider Ring Tunnel and HEB

The primary driving force of collider ring relocation was the geology of the Ellis County site, but consideration was also given to other important factors: sufficient soil and rock shielding depths where drainages cross the ring, avoidance of residential areas to the north and east, avoidance of 100-year floodplains, and minimization of experimental hall depths at the East Campus. Several different combinations of location, tilt of the ring, and even folding of the ring were considered and analyzed before the final design was approved.

To maximize the final stability of the tunnel and experimental halls and the ease of tunnel excavation, as much tunnel and hall construction as possible should take place within the Austin Chalk Formation. This Formation is soft enough to be easily tunneled, yet competent enough to stand unsupported when excavated. In contrast, the Taylor Marl and the Eagle Ford Shale, (above and below the Austin Chalk, respectively) are rock units with a high concentration of clays and hence a much lower strength. The beam tunnel and detector hall stability in these materials would be seriously compromised by the potential for settlement or heave of the foundation under technical components, and possible risks during construction would be greater.

It has proven difficult to align the long axis of the Collider tunnel oval to the optimum geologic direction because of the commitment to avoid both a major floodplain (Chambers Creek) and several densely populated residential areas. Nonetheless, some improvements in ring orientation were possible, namely:

- The long axis of the Collider tunnel oval has been rotated approximately 8 degrees counter-clockwise.

- The dip of the plane of the Collider ring has been changed from 0.179 degrees to 0.198 degrees to the southeast.

- The elevation of the HEB ring has been raised to match the increase in elevation of the main ring.

The new orientations of the SSC ring are shown in Figure 1-7 (Shelley, 1992). Also shown are the boundaries of the land underground which would have been purchased (existing stratified fee) with the previous tunnel orientation. Environmental impacts of these changes to Collider ring orientation have been reviewed. Appendix A gives a more detailed discussion.

Relocation of Large Experimental Detectors

Like the change in tunnel tilt, the change in location of the large experimental detectors was made to maximize the amount of excavation in the Austin Chalk Formation, and avoid, to the extent possible, placing major experimental halls in the Eagle Ford Shale, which is structurally far less stable than the Austin Chalk. It is particularly important that the system of large detectors be located on as stable a foundation as possible. Geologic information obtained after the site was selected suggested that the large experimental halls planned for the West Campus might be floored in Eagle Ford Shale. This shale is well known for its shrinkage and swelling due to its high clay content, and it would make a particularly unsuitable foundation rock for scientific components requiring a high degree of stability. Hence, a change was made as follows:

- The large experimental detectors will be placed on the East Campus rather than the West Campus.

The SEIS considered the possibility of up to eight experimental halls, four on the East Campus and four on the West Campus; thus the impact of very large-scale excavations on the East Campus has already been addressed in that document. The current change is considered to be a change only in the phasing of construction rather than a change in design.

Change in Tunnel Diameter

The final change in the design of SSC facilities made in 1991 was the increase in the finished inside tunnel diameter from 3.7 meter (m) (12 feet) to 4.3 m (14 feet). Numerous considerations, both scientific and engineering, favor a larger tunnel diameter.

- Larger locomotives and haul cars can be used in a fourteen-foot tunnel, which will reduce the haulage time for spoils.

- Space available for operations and maintenance of the tunnel boring machine is better for the fourteen-foot tunnel.

- The precast concrete segments used to line the tunnel through the Taylor Marl and Eagle Ford Shale can be five feet long for the 14-foot tunnel, rather than four feet, a change that will reduce the cost of the tunneling operation.

- The increased construction tolerances permitted by the 14-foot diameter are expected to allow a higher rate of tunnel advance without deviating from allowed tolerances.

- A larger tunnel diameter will decrease the possibility of damage to magnets as they are being placed in position.

Possible increases in costs associated with a larger tunnel diameter, such as equipment expense or costs of handling larger amounts of earth materials, are expected to be balanced by a reduction in construction time. Ventilation and lighting requirements for the two diameters are not significantly different. Detailed studies of other options suggest that tunnel diameters over 14 feet offer no particular advantage, and that a 14-foot tunnel is optimum. The following action was recommended:

- The finished inside tunnel diameter has been changed from 3.7 m (12 feet) to 4.3 m (14 feet).

The impacts of the change in tunnel diameter to various aspects of the environment have been addressed and are discussed more fully in Appendix A (P. Shelley, personal communication). The most conspicuous difference is the increase in the volume of material to be removed from the larger diameter tunnel, and any impacts are either directly or indirectly associated with this larger volume of spoils. The land already being purchased can accommodate the larger volume within the parameters specified in the SEIS.

Acquisition of the Central Facility

Through the TNRLC, the State of Texas has purchased and is remodelling the Revco Building within the city limits of Waxahachie, Texas, for use as the Central Facility for the SSC Project. This building has sufficient floor space and height to accommodate the

functions of the SSCL Accelerator Shops Building, Magnet Acceptance and Storage Facility, Central Shops, Accelerator Warehouse, and Temporary Storage Warehouse, as well as administrative office space. This facility is centrally located between the East and West Campus, and was available immediately. Both of these criteria, as well as the building's size (48,360 m^2, or 520,000 square feet), made it the best choice of the options available. Use of this space by the SSCL will eliminate the need to construct those facilities at the East and West Campuses and the N15 site. This action will allow critical schedule milestones to be met, in addition to providing operational efficiencies throughout the life of the SSC by locating related and dependent activities in one location.

TNRLC will improve the interior space of the Central Facility to meet the requirements of the SSCL for offices, shops, laboratories, and warehouse and assembly areas. All local building codes and safety codes will be satisfied. In the short term the need for office space dominates other needs; hence, the primary use is for offices. The environmental impacts associated with use of this building by the SSCL have been evaluated and are discussed in Appendix A.

MITIGATION, COMPLIANCE, AND PERMITTING SUMMARY

Mitigation Summary

Actual construction of some components of the SSC began in 1991, hence this is the first year in which mitigation actions have been taken in connection with activities at the Ellis County site.

Mitigation Action Plan (MAP)

In February 1990, Secretary of Energy Notice 15-90 was issued in order to strengthen the National Environmental Policy Act (NEPA) process within the DOE. Among other things, Secretary of Energy Notice 15-90 requires an approved MAP for any project that undertakes commitments to offset adverse effects on the environment. The SSC MAP discusses the mitigative actions specific to the Ellis County site that are required for the construction and operation of the SSC. It also lists the DOE environmental commitments for the SSCL and provides a discussion of how these commitments will be satisfied project-wide.

The MAP, approved in June, 1991, has three major purposes:

- To catalog the environmental impacts requiring mitigation;
- To specify responsibility for the mitigation actions; and
- To ensure implementation of the required actions by the parties responsible.

The DOE has overall responsibility for identifying and mitigating, through appropriate responsible parties, any environmental impacts. These responsible parties have been identified in the MAP, and will be referred to in the appropriate sections of this SER. There are five areas of responsibility, taken from definitions in the MAP (DOE, 1991a), as follows:

Requirement Validation: Verification that a mitigation measure is required. Validation can include baseline monitoring programs, measuring direct or indirect effects of construction or operation of the SSC, and reevaluating assumptions made as part of the environmental assessment.

Mitigation Development: Design of mitigation measures.

Mitigation Implementation: The actual execution of the mitigation measure.

Mitigation Verification and Monitoring: Verification that the mitigation procedure was accomplished as stipulated, and further that the mitigation measure is performing as intended. If the measure is not producing the desired result, verification and monitoring activities may include determining what alternative measures should be taken.

Performance Auditing: Ascertaining the degree of compliance with requirements, which may include auditing all aspects of a mitigation measure.

The combination of the MAP and Environmental Compliance Plans (ECPs) provides the documentation for fulfilling commitments to the preservation and enhancement of the environment as stipulated by NEPA. Figure S-1 (page xiv) shows the relationship between the MAP and other documents that govern the construction and operation of the SSC.

Baseline Characterization and Monitoring

Extensive efforts are being undertaken to characterize various aspects of the SSCL site before major construction begins. Where construction efforts are already underway, monitoring programs are in place to ensure that all mitigation commitments are met. All the characterization and monitoring efforts listed below are discussed more completely in the various sections of this report noted.

- A spoils leachate study was conducted on Ellis County materials. (Section 2.1.2)
- A program to sample and test surface water at 30 locations on and adjacent to SSC sites has been designed. (Section 2.2.3)
- Air quality is monitored regularly at the N15 construction site. (Section 2.5)
- Noise levels at the N15 site are monitored regularly. (Section 2.6.1)
- A major airborne radiological survey was conducted over the SSC area. (Section 3.3.1)
- Rock material from Ellis County was irradiated, and leaching experiments were conducted. (Section 3.3.2)

- An extensive study of a local shallow alluvial aquifer was completed. (Section 4.1.1)

- Historical and archaeological surveys of the present status of the SSC area were completed. (Sections 6.1.4 and 6.2.3)

Mitigation Measures

Efforts have already been made to reduce the environmental impact associated with land acquisition and construction activities even while the Project is in the design phase. A brief list follows, and each topic is discussed in greater detail in other sections of this report.

- Stormwater runoff at the N15 site is treated by erosion control measures. (Section 2.2.2)

- The design of the SSC has been modified in order to avoid locating one of the eighteen service areas (S35, on the south arc of the collider ring) in the floodplain of a creek. (Section 2.2.4)

- Locations for cooling ponds were chosen to take advantage of existing topography, and to minimize the impact on existing wetlands. (Section 2.2.5)

- To reduce the number of landowners impacted by the SSC project, the boundaries of the surface land purchased by the State for the Project were adjusted to conform with existing boundaries where feasible. (Sections 2.4 and 5.4)

- Road construction projects to upgrade or replace local roads have begun. (Section 5.1.2)

- Archaeological and historical sites were avoided wherever possible, and an extensive archaeological survey of each construction site was performed before activity began in order to prevent inadvertent impacts. (Sections 6.2.3 and 6.3)

Enhancements of the Environment

Section 2.8 contains a more extensive discussion of enhancements of the environment undertaken by the SSCL, as do several separate sections of Section 2, Environmental

Program Information. The following paragraphs are intended as a very brief summary only.

Prairie Restoration: It is the intention of the SSC project participants to restore as much of the native blackland prairie of north central Texas as practical. Studies will be conducted in the future to determine the most appropriate native plant species to use in seeding selected areas.

Plans have been made for SSCL personnel to collaborate with local organizations in a controlled burn of the Kachina Prairie in the spring of 1992. This project will help restore the vitality of the area, which was suffering encroachment by shrubs and trees.

Wetlands: The year 1991 saw the development of the Wetlands Mitigation Plan of Action, which is to be used as a guide for construction projects and the creation of new wetlands. Scheduled for construction in 1992 are three on-stream cooling ponds that have been designed specifically to accommodate fish and wildlife wetland habitats, as well as migrating water birds.

Compliance Summary

One of the SSC Environmental Quality Goals is to initiate aggressive action to comply with all Federal, State, and local environmental quality laws. Compliance with the environmental regulations following from those laws is, of course, included. The compliance summary that follows provides the status of the SSC with respect to each applicable environmental statute.

A following Summary section discusses ECPs, Appendix B1 shows part of an ECP, and Appendix B2 presents the status of ECPs for the SSCL in table form.

Environmental Statutes

Environmental issues are addressed in this section according to major statute or executive order, and sections of the SER that address these considerations are listed. Figure S-1 shows the relationship of these statutes to the construction of the SSC.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): This legislation is commonly known as the Superfund and pertains to efforts being made to clean up environmental waste sites that predate the legislation. The SSC Project is

acquiring land whose CERCLA status must be ascertained. To date no CERCLA sites have been identified. The land being purchased for the SSC Project is rural, with no known waste disposal sites.

One small underground gasoline tank belonging to a farmer has been identified. The status of this tank will need to be determined. Removal of the tank is planned, and any necessary remediation will be initiated at that time.

The asbestos abatement program of the SSCL is discussed under the heading Toxic Substance Control Act (TSCA), below.

Emergency Planning and Community Right to Know Act, Superfund Amendments and Reauthorization Act (SARA) Title III: Title III of the 1986 SARA created a system for planning responses to emergency situations involving hazardous materials. It also mandates a system for making available to the public information regarding the use and storage of hazardous materials. The SSCL is required to provide an inventory of hazardous substances stored on the site, materials safety data sheets (MSDS), and completed SARA Tier I forms listing each hazardous substance stored in quantities above a certain threshold quantity (typically 10,000 pounds, but lower for certain substances) to appropriate emergency response agencies. Section 304 of SARA Title III requires that the Local Emergency Planning Committee and state emergency planning agencies be notified of accidental or unplanned releases of certain hazardous substances to the environment. In order to ensure compliance with such notification provisions, the SSCL Emergency Preparedness Plan, currently in draft, will include SARA Title III requirements. Section 7 discusses hazardous materials.

National Environmental Policy Act (NEPA): Several changes in the configuration of the collider ring and experimental areas were considered and adopted during 1991. The effects of these changes on the environment were evaluated under NEPA requirements. These evaluations are also discussed in all relevant sections of this document including Appendix A.

Clean Water Act (CWA): The SSCL is in compliance with the requirements of the CWA. Extensive studies of the surface water and ground-water systems of Ellis County are being conducted in order to characterize the hydrology and chemistry of these systems in the SSCL region and to establish baseline conditions. These studies are described in Section 2 and Section 4.

Executive Order 11988, Floodplain Management: The location of the S35 service area was changed to avoid placing a collider ring access shaft and associated buildings on the

floodplain of a small creek. This and other commitments to avoid impacting floodplains are discussed in Section 2.2.4.

Executive Order 11990, Protection of Wetlands: The SSCL is committed to protecting the wetlands of the region. Specific measures that have been or will be adopted are discussed in Section 2.2.5.

Endangered Species Act (ESA): The EIS and SEIS have established that there are no threatened or endangered species on the SSCL site. Section 2.3 discusses biotic resources.

Bald and Golden Eagle Protection Act: No bald or golden eagles nest in the area of the SSCL, and it has not been established whether or not some may winter in the area. No impact on these eagles is expected.

Migratory Bird Treaty Act: Consultation with the U.S. Fish and Wildlife Service has taken place and will continue, in order to minimize the effect of the SSC project on any such birds. Parts of Section 2 contain relevant discussion.

Fish and Wildlife Coordination Act (FWCA): The U.S. Fish and Wildlife Service will aid the SSCL in ensuring adequate wetland quality and surface area in the region of the SSCL. See Sections 2.2.3, 2.2.4, and 2.2.5.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA): A draft Pesticide Management Plan was submitted to DOE in 1991. Some aspects of this plan address the use of pesticides by the SSCL; others concern the use of pesticides on SSCL land leased to farmers for agricultural use. Refer to Section 2.3.2.

Farmland Protection Policy Act (FPPA): The U.S. Soil Conservation Service has been requested to evaluate the effect of the SSCL on farmland of the region. Farmland owned by the SSCL and leased back to farmers for rangeland or cultivation is subject to protection under various legislation. These issues are discussed in Section 2.4.1.

Clean Air Act (CAA): The SSCL was in compliance with the requirements of the CAA in 1991. Some chemicals are used at the SSCL Magnet Development Laboratory near the N15 site. Emission of these chemicals is tracked through the SSCL chemical inventory to ensure that these emissions fall below the levels where a permit would be required from the Texas Air Control Board (TACB). The SSCL has submitted standard PI-7 TACB exemption forms for the chemicals used in the Magnetic Development Laboratory. All chemicals to be used are in very small quantities, and all fall under the TACB

standard exemption list, Exemptions 106 and 118. Refer to Sections 2.5, 2.7.2, and 7.

Safe Drinking Water Act (SDWA): The N15 site receives its water supply from the Buena Vista-Bethel Water District, which will also supply water to the remainder of the West Campus. The Central Facility receives its water from Waxahachie. Both of these water supplies meet Texas state requirements for safe drinking water. The SSCL has not conducted its own independent tests of these supplies, but plans to do so in 1992.

Uniform Relocation and Real Property Acquisition Policies Act: The TNRLC has agreed to conduct all land acquisition activities in accord with this Act. Sections 2.4.1 and 5.4 discuss the socioeconomic effects of land acquisition.

National Historic Preservation Act (NHPA): Historical and archaeological resources of the SSCL area were the subjects of two extensive reports submitted in 1991. These resources have been identified and the recommended mitigation measures will be implemented. Section 6 discusses these resources and some proposed actions.

American Indian Religious Freedom Act: The Texas Indian Commission and the Chairmen of the Caddo and Wichita tribes have stated that no sacred sites are recorded in Ellis County.

Toxic Substance Control Act (TSCA): The SSCL is in compliance with all terms and conditions of TSCA by requiring that certain substances be controlled. The most notable example is polychlorinated biphenyls. Capacitors were selected from a surplus supply list and obtained from the Stanford Linear Accelerator. When they arrived at the SSCL it was discovered that they contained polychlorinated biphenyls. In compliance with the SSCL's commitment to avoid the use of polychlorinated biphenyls in any facet of laboratory operation, the capacitors were returned to the Stanford Linear Accelerator Laboratory.

The SSC Project (TNRLC) has an active asbestos abatement program. Asbestos is removed from any structure scheduled for demolition. In addition, the buyer of any house to be removed from Project land is informed of any asbestos known to be present in the house. Other compliance measures required under TSCA are discussed in Section 7.

Resource Conservation and Recovery Act (RCRA): The SSCL is in compliance with all terms and conditions required of a hazardous waste generator and also with the RCRA mandated Underground Storage Tank Program. An underground storage tank was located at the Central Facility prior to its purchase by the State of Texas. Although soil gas testing indicated that the tank was not a source of contaminants, the tank was

removed as a precautionary measure. Section 7 discusses other waste issues relevant to the SSCL.

Current Issues and Actions: There are no ongoing compliance issues at the SSCL.

Environmental Compliance Plans (ECP)

An ECP is the site-specific plan for complying with environmental commitments contained in the EIS, SEIS, their associated ROD, and the MAP. ECPs are written for individual facilities and/or for a number of different facilities at the same site. Part of the ECP for the Linear Accelerator (Linac) is included as Appendix B1 as an example of one component of the ECP for the West Campus. ECPs provide the details for implementing the concepts contained in the MAP, and also specify the environmental monitoring program that will be implemented during construction. Table 1 of Appendix B1 contains the environmental commitments pertinent to the Linac, and Table 2 of Appendix B1 specifies how these commitments are to be met.

ECPs generally consist of the following components:

- Introduction (background, relationship to the MAP, purpose)
- Description of the facilities (purpose, general description, construction phase, operation and maintenance
- Compliance requirements (environmental and regulatory)
- Technical approach (general discussion and site-specific details)
- Monitoring (e.g., fugitive dust, noise, surface water quality)
- Implementation of the ECP

ECP Status

The status of various ECPs for SSCL facilities is shown in Tables 1 and 2 of Appendix B2.

Permitting Summary

Many 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. In order to ensure environmental compliance in the construction and operation of the SSCL, permits must be obtained from a variety of local, state, and federal agencies.

In general the PB/MK Team, the Architect-Engineer/Construction Manager (A-E/CM) for the SSCL, will identify the permit considerations for each environmental topic relevant to the facility to be constructed. The Environmental Compliance Committee (ECC), which is chaired by DOE personnel and currently composed of representatives from the DOE SSC Project Office, the TNRLC, the SSCL, and the PB/MK Team, reviews the list from PB/MK and determines what permits and approvals are required to build, operate, and maintain the facility. The actions necessary to obtain timely issuance of the necessary permits are listed and responsibilities are assigned by the committee. The DOE SSC Project Office reviews and approves the list of permits to be obtained and signs the applications or requests for federal agency action. The TNRLC acts as a facilitator for obtaining non-federal permits and approvals.

The status of permits and approvals for the SSCL is shown in Tables A and B of Appendix B3. Section A lists permits applied for or issued before the end of 1991, and Section B identifies applications to be submitted in 1992. Table 2 of Appendix B1 shows the permit assessment for the Linac.

Figure S-1 shows how various federal statutes and measures to protect the environment are incorporated into mitigation and compliance plans, which, in turn, govern permitting and subsequent construction of the SSCL facilities.

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SUPERCONDUCTING SUPER COLLIDER

SITE ENVIRONMENTAL REPORT
for
CALENDAR YEAR 1991

PRE-OPERATIONAL

1. INTRODUCTION

1.1 Facility Management

The Superconducting Super Collider Laboratory (SSCL) is a Department of Energy (DOE) facility devoted to the study of high energy physics by means of a large particle accelerator. A team led by the Universities Research Association (URA) was competitively selected by the DOE to design, construct and operate the laboratory. URA has selected a joint venture of Parsons Brinckerhoff and Morrison Knudson (the PB/MK Team) as their Architect-Engineer/Construction Manager (A-E/CM) for the design and construction of the conventional facilities for the Superconducting Super Collider (SSC) to the specifications provided by DOE and URA. The Texas National Research Laboratory Commission (TNRLC) is a state agency formed to meet the state's responsibility for siting the SSC. At the direction of DOE, the TNRLC may participate in the mitigation of impacts resulting from the project. TNRLC also facilitates interactions with other state agencies and local authorities and administers state funding for the Project.

1.2 Project Mission

The SSC will be the largest scientific instrument ever built. Its purpose is to investigate the fundamental nature of matter and energy and to explore the history of the universe. In operation, the SSC will accelerate two beams of sub-atomic particles (protons) to speeds approaching that of light. The two particle beams, each traveling in opposite directions around a ring 87 kilometers (km) (54 miles) in circumference, will be guided and accelerated by rows of super-conducting magnets placed one above the other. At several interaction points along the ring the magnets will guide the beams of protons into

head-on collisions at energies of 40 trillion electron volts (TeV), energies sufficient to probe inside the protons in order to learn about the more fundamental constituents of matter and the forces that govern their behavior. International teams of scientists will collaborate on various high energy physics projects at the SSC.

The SSC has a second important mission: to serve as a resource for science education. The Secretary of Energy, James Watkins, has challenged the SSCL to develop innovative programs in support of science education in the nation's schools.

1.3 Project History

The SSC project was conceived by the United States DOE in conjunction with members of the high energy physics community. A timetable of major events in the history of the project follows.

1984-1988: The Central Design Group located in Berkeley, California established the siting parameters for the SSC.

April 1987: The DOE issued an Invitation for Site Proposals specifying the parameters of the proposed instrument and requirements for the supporting facilities. Over forty proposals were received by the DOE. Thirty-six of these proposals were further evaluated by the National Academy of Science and the National Academy of Engineers. Following the evaluation phase, DOE issued the Best Qualified List of seven sites.

Argonne National Laboratory was selected by DOE to prepare the Environmental Impact Statement (EIS) for the Project.

November 1988: The DOE selected a site in Ellis County, Texas, submitted by the TNRLC, for the construction of the SSC. President Ronald Reagan announced the selection of the Texas site in January, 1989.

January 1989: The DOE selected Argonne National Laboratory to prepare the Supplemental Environmental Impact Statement (SEIS), and the Final SEIS was published in December 1990. The URA was named the management and operations contractor for the project.

February 1990: The URA selected the PB/MK Team as the A-E/CM to design and construct the conventional facilities for the SSC.

February 1991: Secretary James Watkins signed the Record of Decision to proceed with the construction of the SSC.

March 1991: The DOE released the exact location and configuration of the SSC Ring, the "Footprint", which defined the land requirements for the project. The original configuration was later revised slightly to accommodate better the geology of the site.

June 1991: The Mitigation Action Plan (MAP) was signed. This plan names the parties responsible for carrying out the environmental commitments made in the EIS and its SEIS. It also identifies the Site Environmental Report (SER) as the document for providing information on mitigation actions.

1.4 Facility Description

The SSC will eventually employ over three thousand people at several major facilities, the most important of which are described below. Figure 1-1 shows the locations of the facilities and the cover of this report shows a satellite image of the Project area.

Collider Ring: The major feature of the SSC is the Collider ring, an 87 km (54-mile) long oval tunnel, which will be buried beneath the ground at depths ranging from 15 meters (m) (50 feet) to 73 m (240 feet). The tunnel will be in a tilted plane that dips at an angle of 0.2° to the southeast. The finished inside diameter of the tunnel will be 4.3 m (14 feet), and it will contain approximately 10,000 superconducting magnets within which the two proton beams will travel.

Injector Facilities: The injector facilities will produce, accelerate, and inject the protons into the main Collider ring. There are four main components to this complex: a linear accelerator (Linac), a low energy booster (LEB), a medium energy booster (MEB), and a high energy booster (HEB). All these instruments will be underground in the West Campus.

Campus Areas and Central Facility: Two major experimental and three administrative areas are planned for the SSCL. Initial plans for the 3,000 hectare (7,376-acre) West Campus specify about 20 large buildings, among them an office and laboratory building, six heavy works buildings, three shop buildings, and several support buildings. There will be several large cooling ponds at the ground surface to dissipate heat from the refrigeration systems and power supplies. The Central Facility in Waxahachie is an existing 48,360 m^2 (520,000 square foot) office and laboratory building. It will house 1,500 employees by the end of 1992. The East Campus, about 744 hectares (1,860

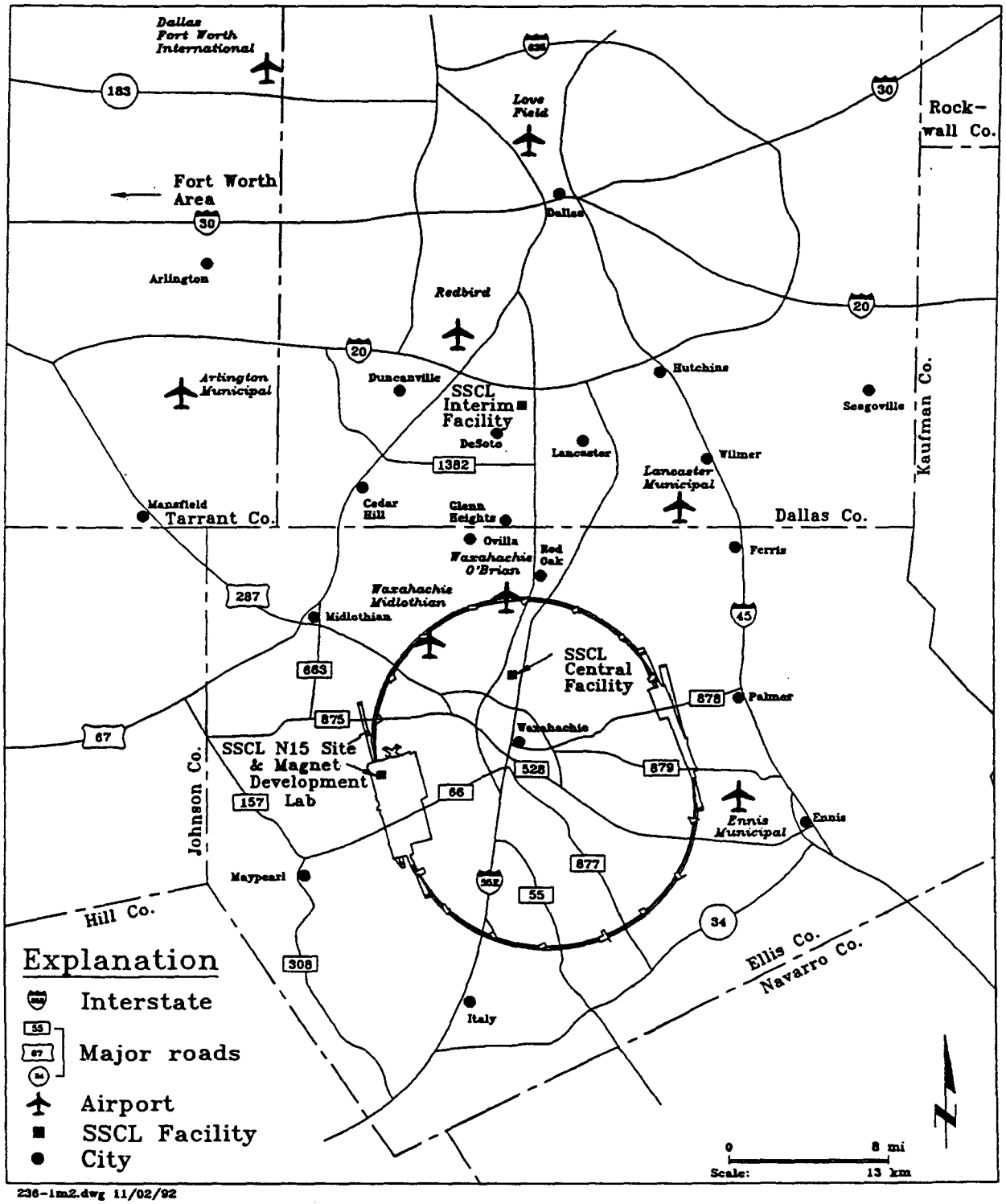

Figure 1-1: Location and infrastructure of the SSCL region.

Walsh & Associates, Inc.

acres), will comprise about 15 large buildings, including experimental halls, and 6 to 8 cooling ponds.

Experimental Facilities: Beneath the East and West Campuses, straight segments of the Collider ring connect the north arc with the south arc. These straight segments will house interaction regions in which beams of protons will be made to collide. The collision points will be surrounded by large detectors to record the properties of the particles produced by the collisions.

Initially there will be two interaction regions on each Campus. A decision was made in December, 1991, to place the largest detectors on the East Campus. Impacts of these changes are discussed in the Summary and Appendix A.

Service Areas: Each of the four quadrants of the Collider ring will consist of 5 tunnel sectors, with either an access facility or a service area between sectors. Access facilities and service areas will each require about 20 hectares (50 acres) of land. Initially half of the service areas will consist of several buildings primarily for refrigeration, storage facilities, a cooling pond, a large-diameter access shaft, and tunnels connecting to the main collider ring. The access facilities will consist of one surface building and a small shaft with tunnels connecting to the Collider ring.

"Footprint": The Footprint of the SSC is defined as the land owned outright in fee simple estate (that is, land with all the surface and subsurface rights that the previous owner had) by the Project, plus the underground volume purchased by the Project in stratified fee estate.

1.5 Location of Facility

The SSC site is near the major metropolitan areas of Dallas and Fort Worth in north central Texas. It is an area that is primarily rural in character, yet close to major population centers and excellent transportation systems, including an international airport.

1.5.1 Location and Size

The SSC site is located in Ellis County, Texas, approximately 32 km (20 miles) due south of Dallas and 48 km (30 miles) southeast of Fort Worth. The Collider ring encircles Waxahachie, the county seat of Ellis County. See Figures 1-1 and 1-2 and the cover image.

When the SSC is completed, the DOE will own approximately 4050 hectares (10,035 acres) in fee simple title. The Laboratory will also have stratified fee title to the subsurface surrounding the collider ring. A volume of land underground will be purchased in the latter case.

1.5.2 Land Use and Ownership

The land within the SSC site is for the most part unincorporated, with no federal parklands, no wilderness areas and no wild and scenic rivers. Traditionally, land use has been almost completely agricultural, with roughly equal areas devoted to ranching and crops. More recently, northern parts of the area are becoming urbanized as the metropolitan areas of Dallas and Fort Worth expand to the south. This trend is evident in the satellite image on the cover of this report.

Land ownership in the project area is predominantly private, with small scattered parcels under federal, state, or local government ownership, most notably Bardwell Lake, a U.S. Army Corps of Engineers project.

1.5.3 Population Distribution of Region

The major metropolitan areas of Dallas and Fort Worth dominate the population distribution of north central Texas. The smaller communities of Waxahachie, Ennis, and Midlothian are in the immediate vicinity of the SSC sites (Figure 1-1). Figure 1-3 shows the distribution of population about the SSC site. Urban areas are the pale purple areas on the satellite image.

1.5.4 Transportation

The Dallas-Fort Worth area is served by abundant public and private transportation systems.

Roads: Figures 1-1 and 1-2 show the distribution of major highways that serve the SSCL site. Of special importance are Interstate Highways 20 (east-west highway about 32 km, or 20 miles, north of site), 35E (north-south highway that approximately bisects the Collider ring), 45 (north-south highway just east of the ring), and U.S. Highway 287 (northwest-southeast highway that approximately bisects the Collider ring).

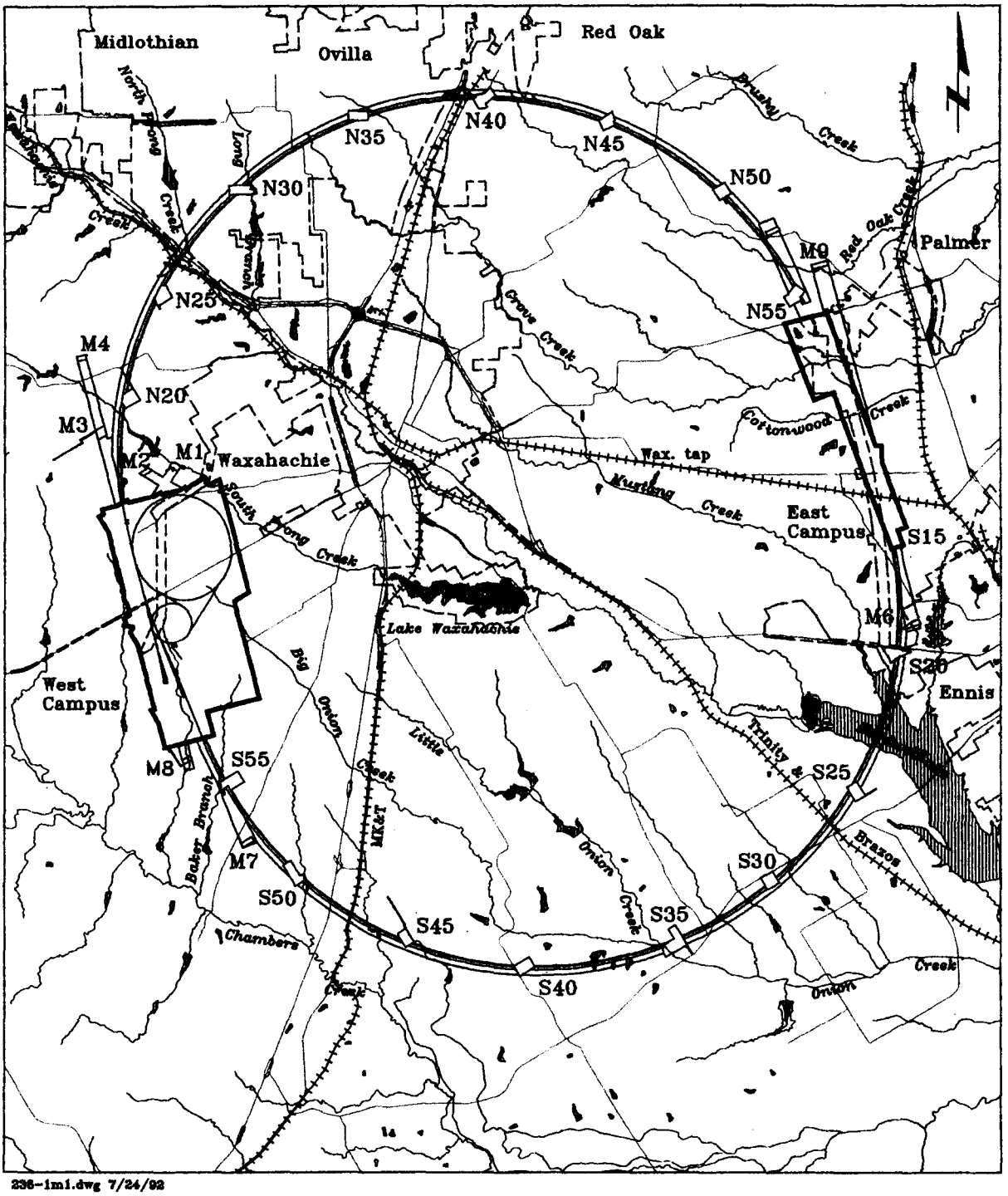

Figure 1-2: Location map of the SSCL, detail

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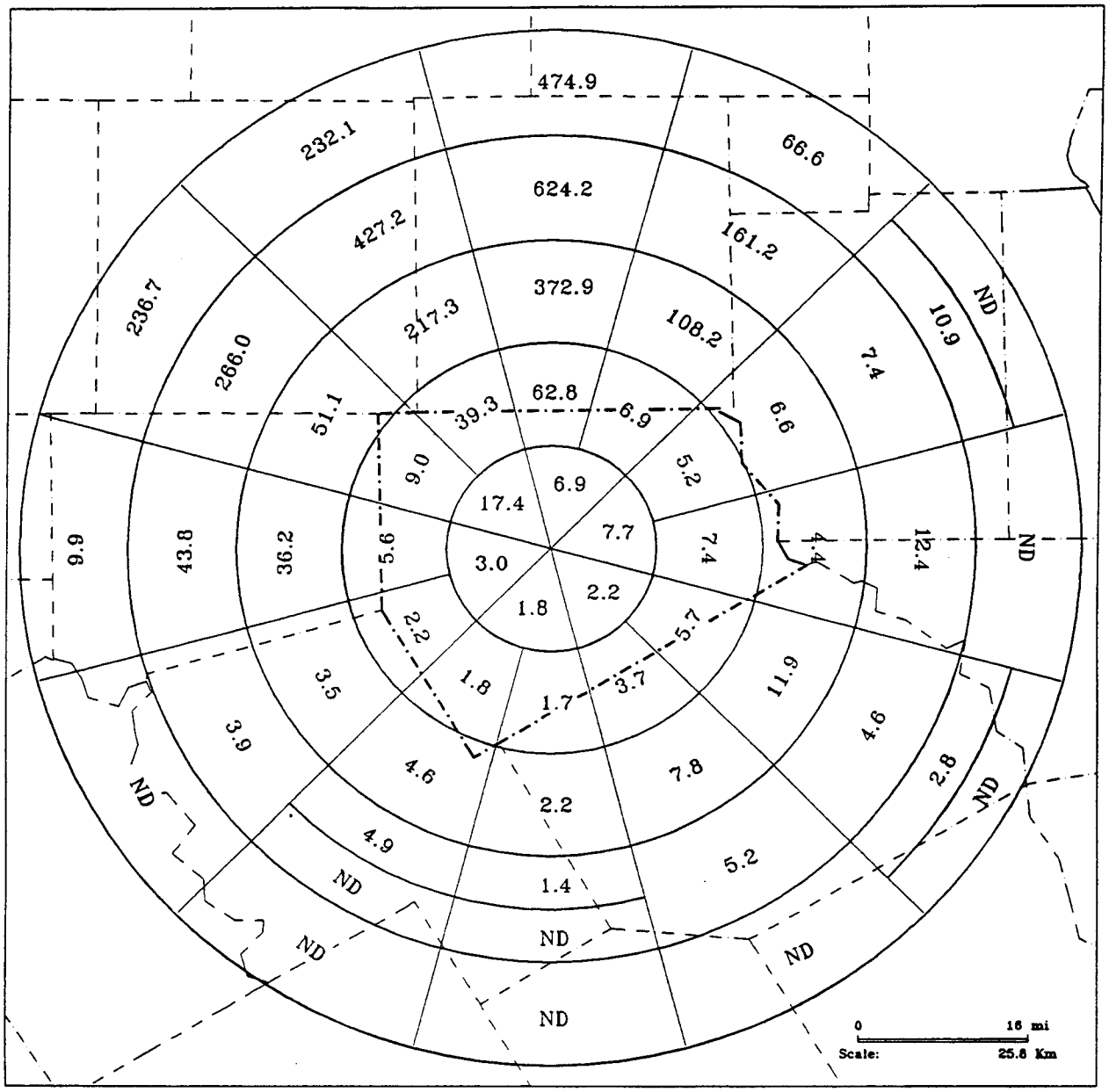

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Explanation

—·— Ellis County
—·— Surrounding Counties
ND No Data

Note: Numbers represent population in thousands and rings are in increments of 10 miles.

Figure 1-3: Population distribution around the SSCL

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Rail: Southern Pacific Transportation Company, Burlington Northern Railroad Company, Missouri-Kansas-Texas Railroad Company, and Santa Fe Railway Company all pass through or near the Collider ring, as shown in Figure 1-2. Amtrak provides passenger service three times a week to the cities of Dallas and Fort Worth.

Air: The principal airport in the Ellis County region is the Dallas-Fort Worth International Airport, a publicly owned and operated airport about 64 km (40 miles) north of the campus areas. This airport is one of the busiest in the United States and is currently undergoing a major expansion program which will double its capacity within the next 20 years. Other publicly owned airports serving the Laboratory area are Love Field, 56 km (35 miles) north of the campus areas, and Redbird Field, 39 km (24 miles) north of the campuses. In addition, there are several general aviation fields nearby. See Figure 1-1.

Bus, Other: At present there are no scheduled bus lines serving the SSC facilities, although there is scheduled bus service to other parts of Ellis County. Taxi and rental car services are available throughout the area.

1.6 Regulatory Issues

The SEIS (DOE, 1990) defined some of the important regulatory issues and major environmental statutes to be addressed during the construction and operation of the SSC. These topics will be discussed in various sections of this SER, as appropriate. The Summary contains short discussions of these statutes with references to specific sections of this report where they are addressed:

Clean Water Act (CWA)
Floodplain Management
Protection of Wetlands
Clean Air Act (CAA)
Safe Drinking Water Act (SDWA)
American Indian Religious Freedom Act
National Historic Preservation Act (NHPA)
Endangered Species Act (ESA)
Bald and Golden Eagle Protection Act
Migratory Bird Treaty Act
Fish and Wildlife Coordination Act (FWCA)
Farmland Protection Policy Act (FPPA)
Uniform Relocation and Real Property Acquisition Policies Act
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

Toxic Substances Control Act (TSCA)
National Environmental Policy Act (NEPA)
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
Occupational Safety and Health Act (OSHA)
Resource Conservation and Recovery Act (RCRA)

1.7 Climate

Warm tropical air from the Gulf of Mexico dominates the climate of north central Texas, creating a humid subtropical climate. The humidity is typically in the 58 percent to 70 percent range, with the yearly mean humidity 65 percent. Temperatures range from an average low of 1.5° C (35° F) in January to an average high of 35° C (95° F) in July and August. Rainfall in the region averages 80 centimeters (cm) (32 inches), with rains occurring most frequently in the late spring. The rainiest month is May; the driest is August. Appendix E compares rainfall and temperature data compiled from long term records for the region with measurements recorded at the N15 site during 1991. The prevailing wind is from the south at an average annual speed of 21 km (13 miles) per hour. Winds in the site area are quite uniform, with monthly averages ranging from 18 km (11 miles) per hour to 24 km (15 miles) per hour. Wind roses compiled from data recorded in 1991 by PB/MK and by the National Weather Service at the Dallas-Fort Worth International Airport are shown in Figure 1-4. Wind direction data from Dallas-Fort Worth International Airport are recorded to the nearest degree (of 360 degrees). These data were grouped into quadrants to facilitate comparison with wind direction data from N15, where wind direction was determined for only four directions during most of the year. New equipment installed by PB/MK at N15 will make possible more detailed comparisons in subsequent years.

The area is experiencing a period of above average rainfall. In 1991 the rainfall at Dallas-Fort Worth International Airport totaled 136 cm (53.5 inches); at the N15 site rainfall for 1991 was 163 cm (64.3 inches). The temperature at the N15 site averaged 19° C or 67° F (high) and -4° C or 25° F (low) in January, 1991, and 38° C or 100° F (high) and 20° C or 68° F (low) in August, 1991 (PB/MK, 1992).

1.8 Regional Geology

The geology of the site chosen for the SSC is well suited to a project of this nature. Significant geologic hazards are absent, and the major rock types of the area lend themselves well to tunneling operations, being both soft and competent (able to withstand pressure without flowage or collapse).

1.8.1 Surface Geology and Topography

The SSC site is in the Western Gulf section of the Coastal Plains physiographic province. Relief is quite low, characterized by slightly rolling prairies that follow the dip direction of the underlying rocks, sloping gently to the southeast. Most creeks flow only intermittently. There are a few incised drainages at the permanent streams (Red Oak, Waxahachie, Onion, and Chambers Creeks), all of which flow northwest to southeast to join the Trinity River. Elevations within the site area range from 256 m (840 feet) to 110 m (360 feet) above mean sea level. Drainages are clearly evident in the satellite image on the cover.

Disconnected patches of alluvium occur unconformably above the bedrock throughout the Project area. This alluvium is composed of gravel, sand, silt and clay deposited as old stream terraces or along present stream channels. Locally important shallow aquifers are developed in the terrace deposits.

The soils most commonly encountered in the Project region are of several associations. The Austin-Houston black association and the Houston-Houston black association are heavy, clay-rich black soils, generally developed over clay-rich bedrock. The Eddy-Stephens association is thinner, grey in color, and is developed over chalk bedrock areas. About 40 percent of the soil in the site area possesses good to excellent properties for plant growth. Other common soils in the area undergo shrink-swell cycles as a result of their specific clay content. Together, these two soil types comprise over 80 percent of the surface material in the fee simple areas of the site. Despite the richness of some of the soils, the overall farming potential of much of the fee simple lands is rated as mediocre because of the erosion hazard of the sloping topography.

1.8.2 Bedrock Geology

The stratigraphic section at the SSC site is dominated by massive beds of chalk and marl, with claystone, shale, and some sandstone, all of Cretaceous age. The oldest unit is the Eagle Ford Shale, 89 to 97 million years old, which crops out in the western part of the region. It is encountered at depth by the Collider tunnel in the west and northwest part of the ring near service areas N15 and N20. The Eagle Ford Shale is a dark gray calcareous shale with interbeds of bentonite and some thin limestone stringers. Some units contain highly expansive clays. Overall the Eagle Ford Shale possesses low strength and high swell potential.

The Austin Chalk, host to most of the Collider tunnel, shafts, and experimental halls, underlies much of the Gulf Coastal plains and central Texas. It lies disconformably over

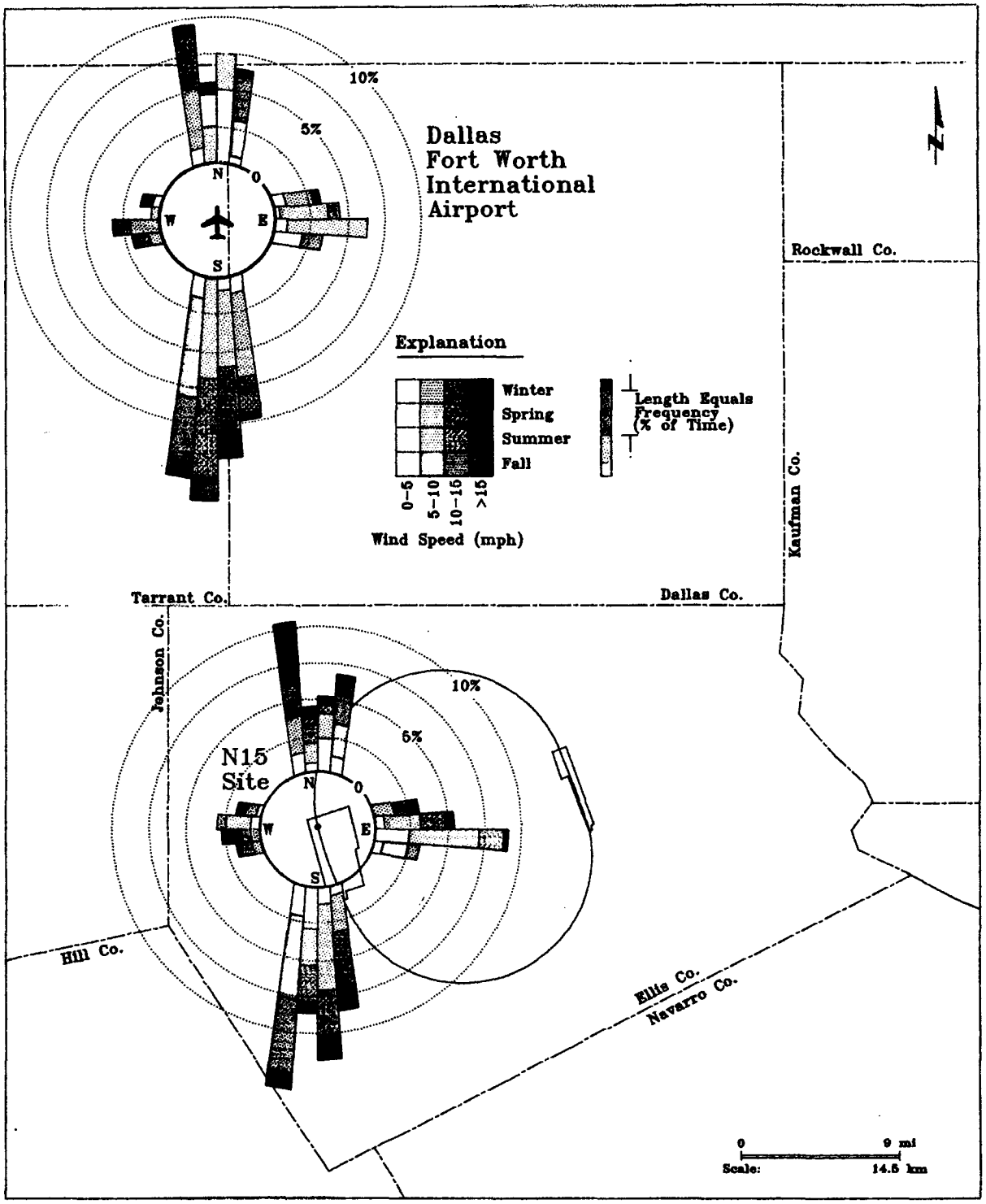

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Figure 1-4 Wind rose patterns around the SSC and DFW airport

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the Eagle Ford Shale (that is, there was a gap in time between the deposition of the two geologic units), and is from 82 to 89 million years old. The Austin Formation was deposited on a wide, shallow, low-energy continental shelf under marine conditions. Lithologically, it is generally a light gray chalk, but may be divided into three horizons based on clay content. The upper and lower parts are mostly massive light gray chalk with occasional bentonite seams and interbeds of calcareous clay. The middle portion is richer in clay, in some horizons being a thin-bedded marl. Pyrite nodules are common in the middle portion, as are fossil beds. Taken as a whole, the Austin Chalk displays moderate strength and durability.

Lower members of the Taylor Marl (Ozan Formation and Wolf City Formation) crop out in the eastern part of the Project region. The Ozan Formation hosts the Collider tunnel and shafts between the N55 and S35 service areas. It overlies the Austin Chalk disconformably, and was deposited in a shallow marine environment. It is predominantly a calcareous dark gray mudstone with low strength and durability.

Figure 1-5 shows the stratigraphic column at the site and surrounding areas, and a geologic map of the site is shown in Figure 1-6. The two main geologic formations are also discernable on the satellite image on the cover. Austin Chalk underlies the areas of thin soil used primarily as rangeland and in the western half of the image, where the white bedrock is clearly visible in stream beds. Ozan Formation underlies the thick soil used as croplands to the east.

About 60 percent of the Collider ring tunnel will be developed in the Austin Chalk, with about 30 percent in the Ozan Formation of the Taylor Marl. In a few areas the tunnel will penetrate the Eagle Ford Shale. Figure 1-7 shows a cross sectional view of the geologic units encountered along the Collider ring. Also shown in Figure 1-7 are the old and new orientations of the Collider tunnel discussed in the Summary.

1.8.3 Geologic Structures

The sedimentary beds strike north-northeast and dip to the southeast. They are exposed at the surface as broad belts trending northeast, progressively younger to the southeast.

Joints (fractures without displacements) are common in the Austin Chalk. Most joints strike in one of three directions: northeast, east, or north. Northwest striking joints are common locally. Joint spacing varies. Near faults the spacing may be as small as 0.5 to 1.0 m (1.6 to 3.3 feet), but away from faults the spacing may be up to tens of meters.

Faults are developed in the Cretaceous sedimentary rocks but are considered to have been inactive since the end of the Miocene (about 5 million years ago). They are generally

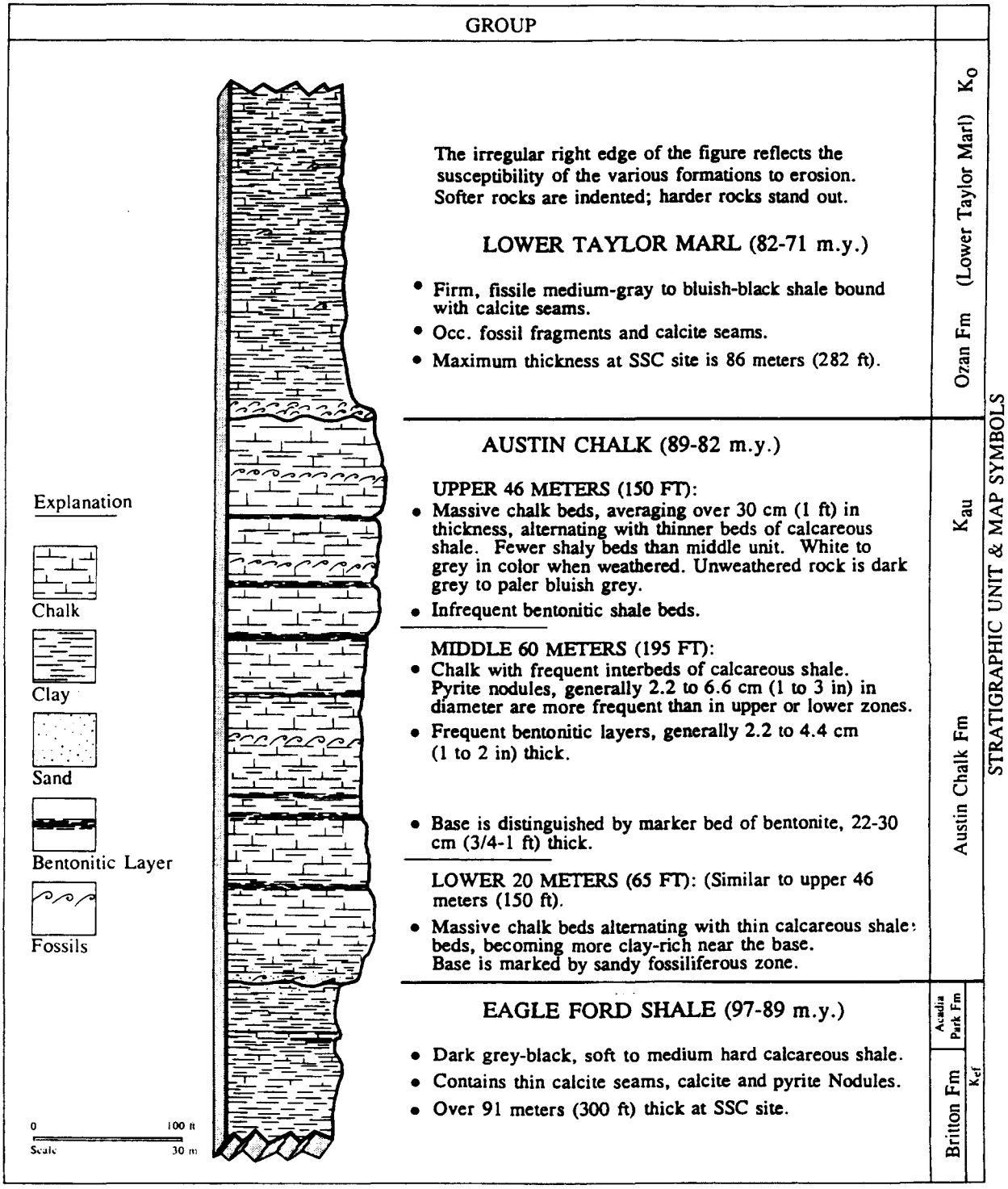
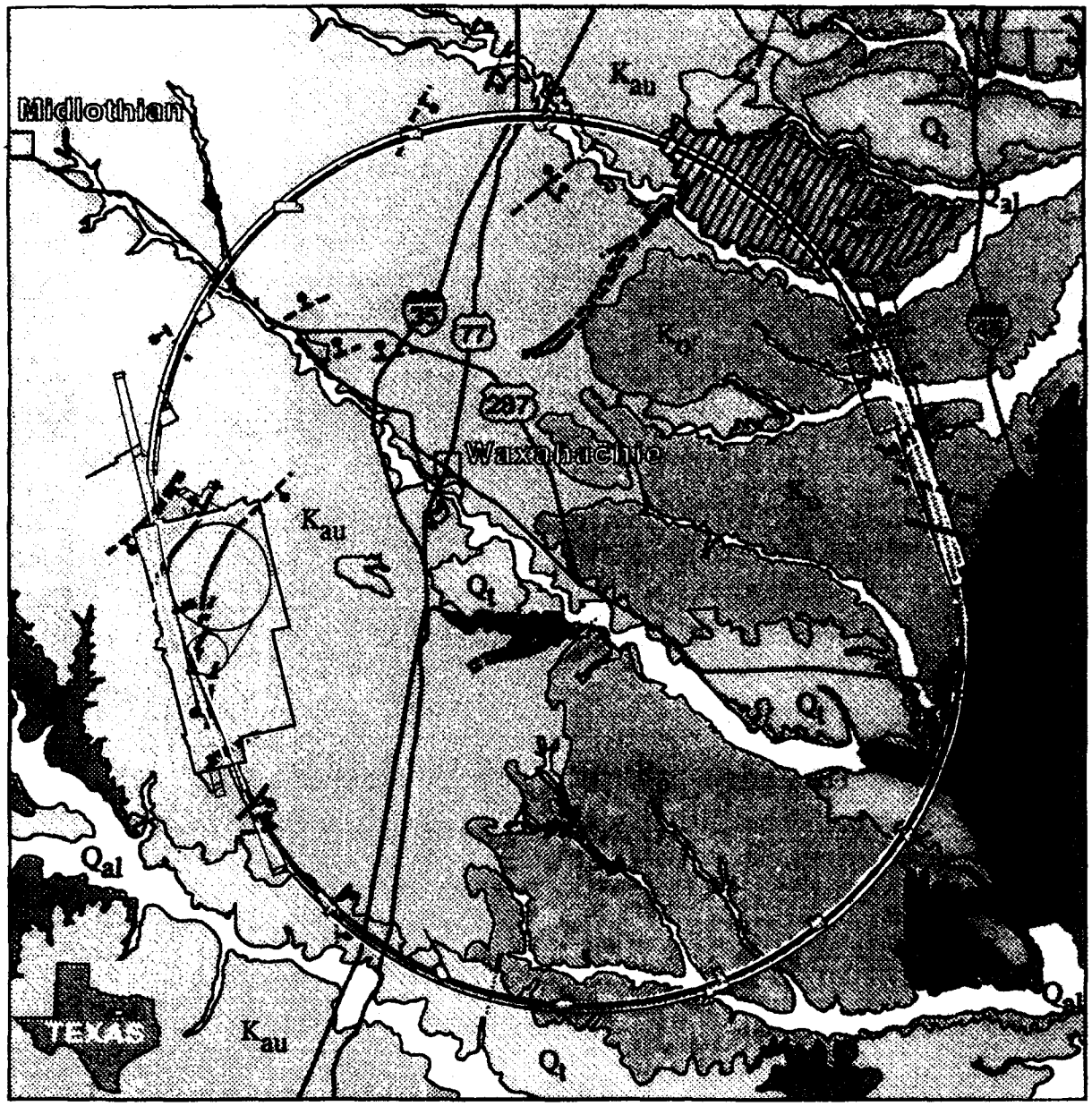


Figure 1-5: Stratigraphic Column of Geologic units encountered by Collider tunnel at SSC site.



QUARTERNARY

Q_{al} Alluvium

Q_t Terrace

UPPER CRETACEOUS

K_{wc} Wolf City

K_o Ozan

Taylor Marl

K_{au} Austin Chalk

K_{ef} Eagle Ford Shale

Q_t Study area for shallow alluvial aquifer, see Section 4.

Fault

0 — 7 mi

Scale: 11.3 km

Figure 1-6: Geologic map of the SSCL area.

Figure adapted from: Bureau of Economic Geology, 1992, generalized geologic map of the project area on file as drawing number QA19267c at The University of Texas at Austin, Bureau of Economic Geology.

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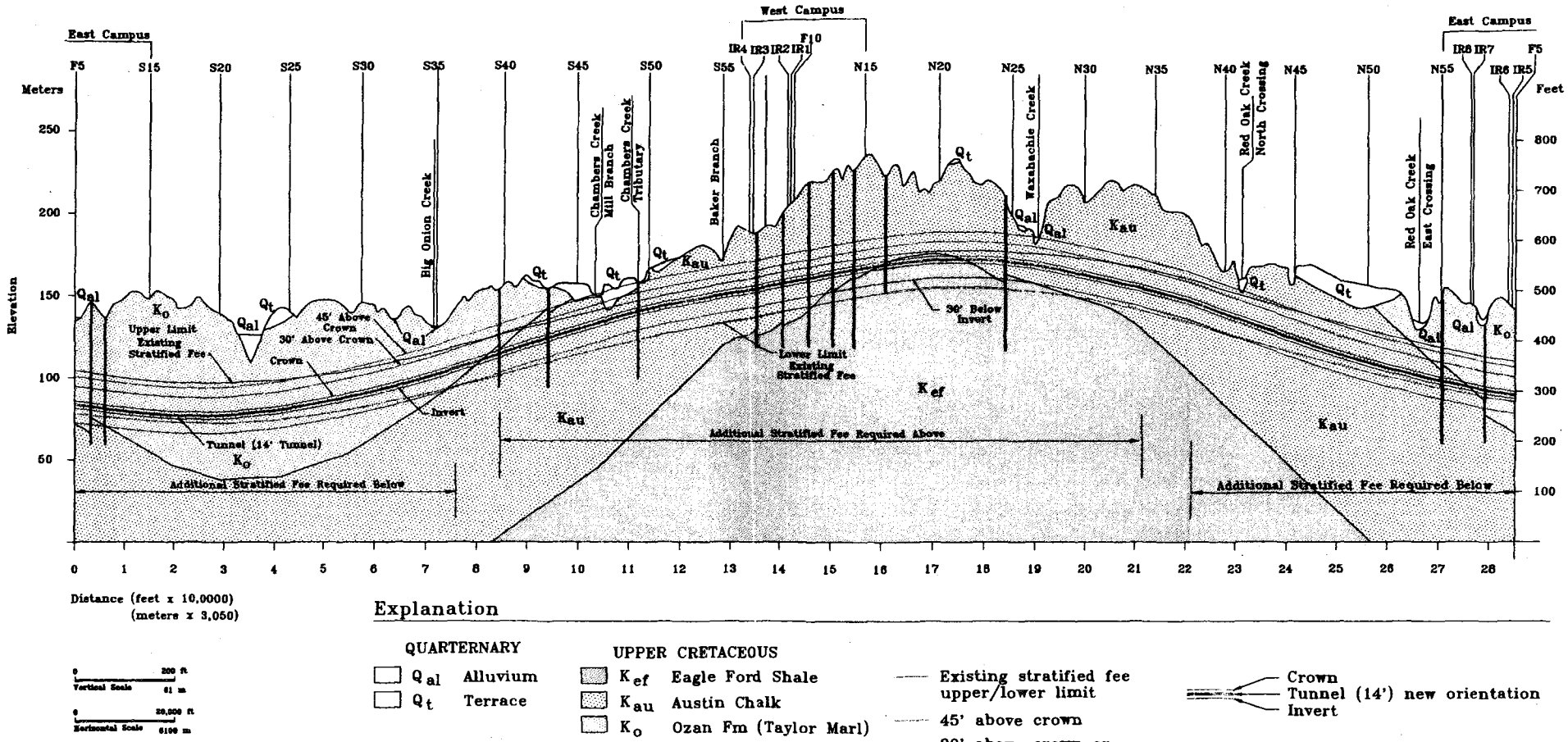

Explanation

QUARTERNARY

- Q_{al} Alluvium
- Q_t Terrace

UPPER CRETACEOUS

- K_{ef} Eagle Ford Shale
- K_{au} Austin Chalk
- K_o Ozan Fm (Taylor Marl)

- Existing stratified fee upper/lower limit
- 45' above crown
- 30' above crown or below invert of new tunnel orientation

- Crown
- Tunnel (14') new orientation
- Invert

- Fault

Figure 1-7: Geological and topologic cross section along the Collider ring, showing old and new tunnel elevations and existing limits of stratified fee

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northeast-trending, steeply dipping, down-to-the-east normal faults, with dips commonly between 45° and 80°. Displacements are on the order of a meter (several feet), occasionally as much as 30 m (100 feet). Numerous small-scale down-dropped blocks (grabens) are developed in the Austin Chalk. Faults are shown on Figure 1-6. It is significant to note that no obvious fault lineations are evident on the satellite image. In areas of active fault movement such lineations are frequently very pronounced.

1.8.4 Economic Resources

The Austin Chalk is used in the manufacture of cement, and there are active quarrying operations near Midlothian, approximately five miles from the Collider ring. Oil and gas are the only known potentially valuable energy resources in the region. There are several abandoned oil wells on or inside the Collider ring, and 35 permanently abandoned wells within eight km (5 miles) of the site. Only one well within 16 km (10 miles) of the site is currently producing oil. The potential for undiscovered resources beneath the site is considered small. No deposits of metallic ores are known or expected in the region.

1.9 Hydrogeology

1.9.1 Surface Water

The SSC site is in the central part of the Trinity River basin of east central Texas. Major drainages within the site include Red Oak, Waxahachie, Big Onion, and Chambers Creeks. Damaging floods are common in all these watersheds. There are two large reservoirs in the project area: Lake Waxahachie and Bardwell Lake. Both are used for water supply and flood control. A segment of the Collider ring passes about 30 m (100 feet) beneath the surface of Bardwell Lake. Figure 1-8 and the satellite image on the cover show major surface hydrologic features of the area. The quality of these surface waters is generally good; on the average, the water met state standards for high quality aquatic habitat and public water supply. Figures 1-9a and 1-9b show drainages and other surface waters in the immediate vicinity of the East and West Campuses.

1.9.2 Ground Water

The most important water-bearing units in the site area are the Twin Mountains Formation and the overlying Woodbine Formation. Both of these units contain confined

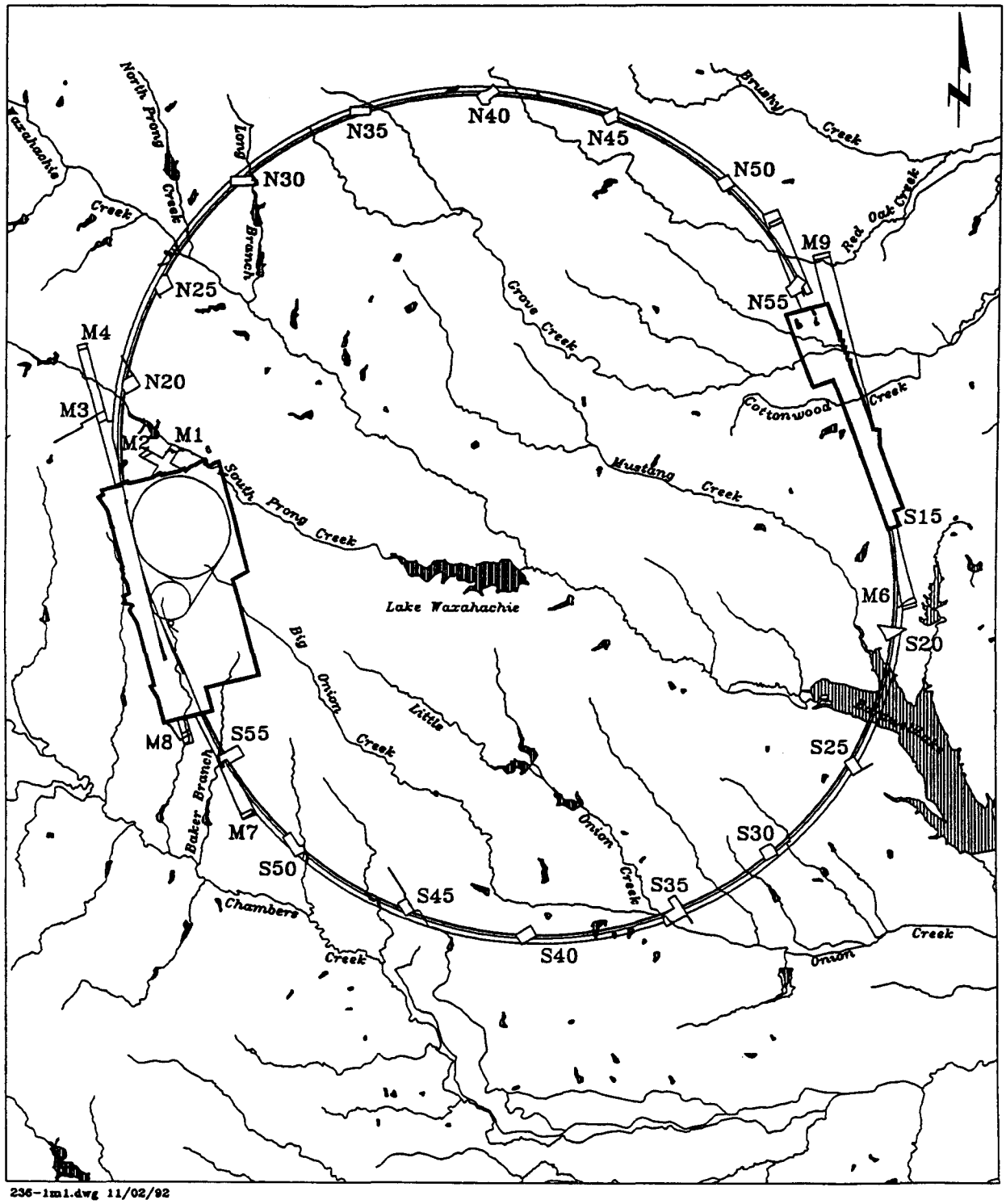

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Figure 1-8: Major surface hydrogeologic features of north central Texas

0 3.5 mi
Scale: 5.6 km

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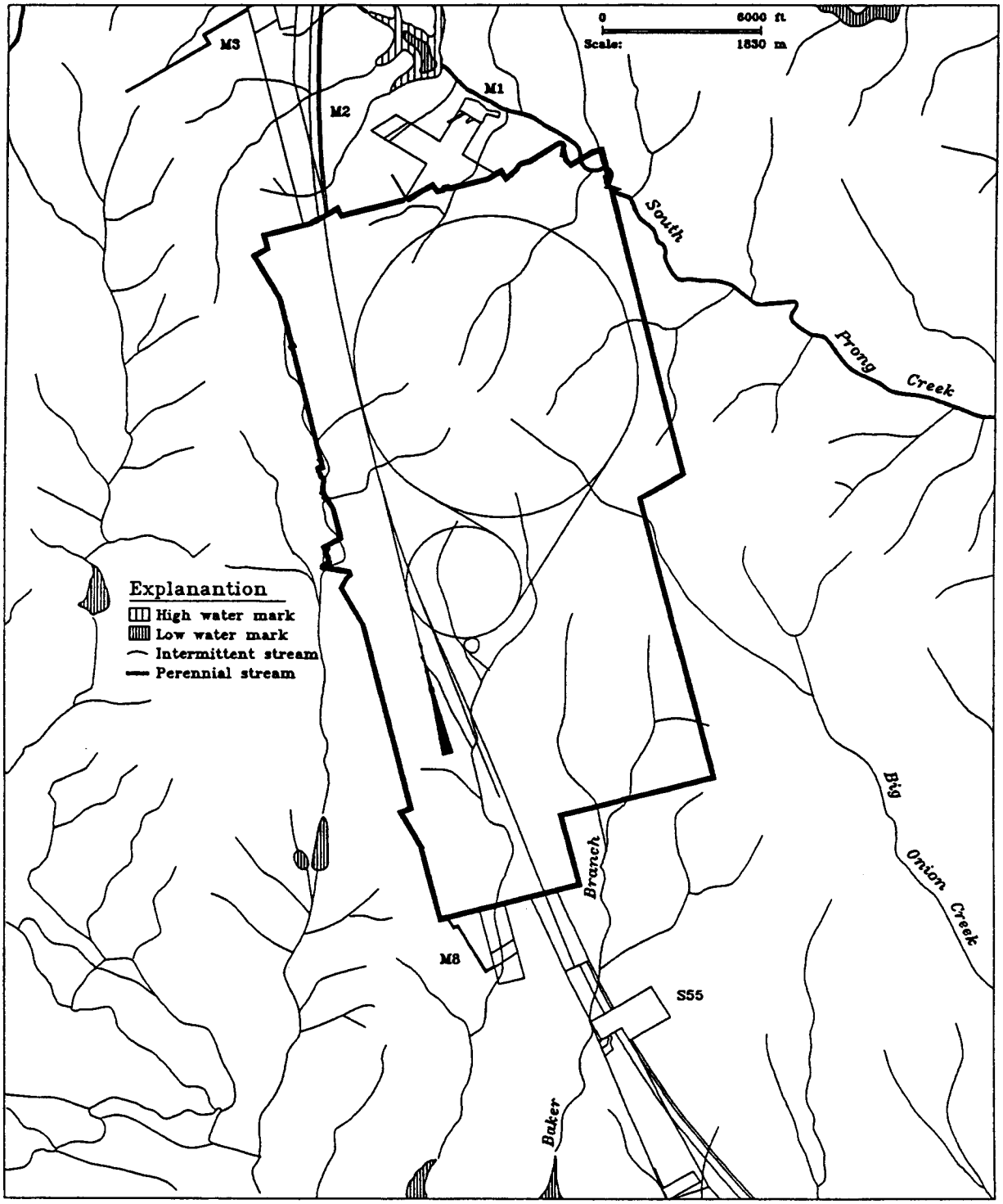

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Figure 1-9a: Hydrogeologic features of the West campus

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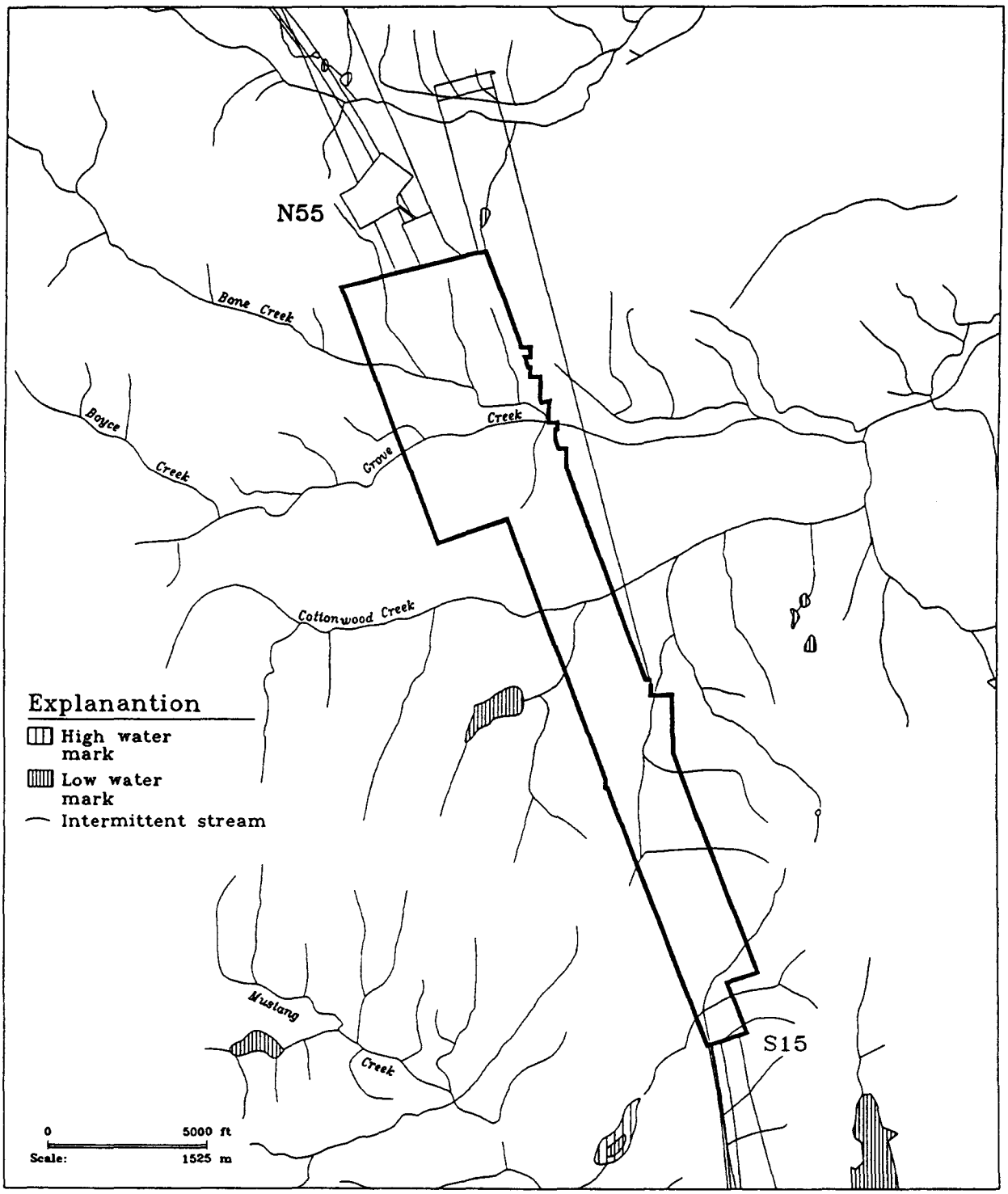

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Figure 1-9b: Hydrogeologic features of the East campus

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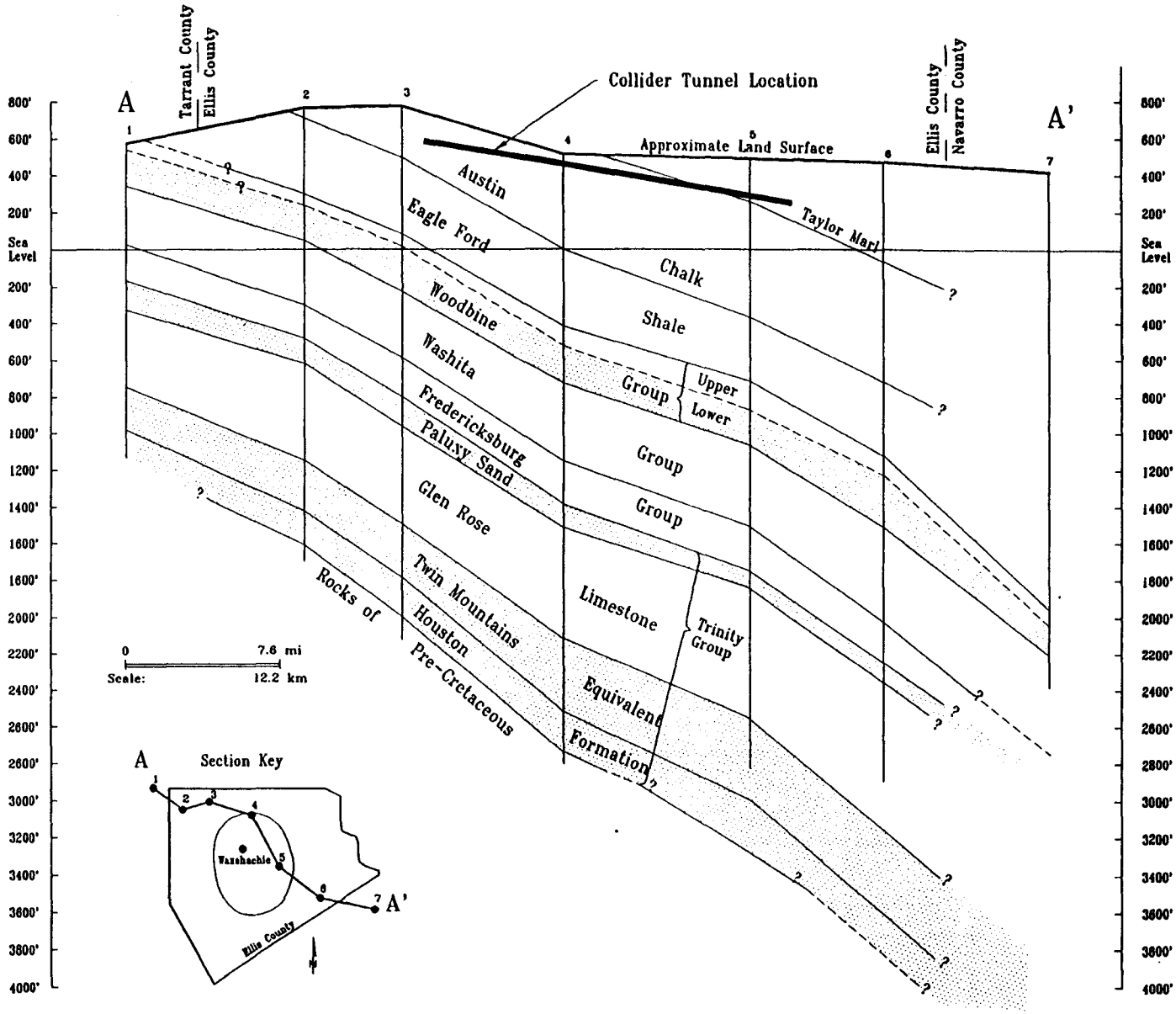
aquifers that lie below the Collider ring, and are not expected to be affected directly by construction activities at the site or by SSC operations. Terrace gravels at the ground surface constitute a locally important source of fair quality ground water in some areas near the site. The Austin Chalk, which hosts 60 percent of the ring tunnel, is not known to yield significant amounts of water, except at the weathered surface. The Taylor Marl likewise yields only very small quantities of water locally for domestic and livestock uses.

Recharge of the deep aquifers in the Twin Mountains and Woodbine Formations is by surface precipitation onto the outcrop areas west of the SSC site. The direction of ground-water flow in the major aquifers was initially to the southeast, semi-parallel to the regional gradient of the host strata. Water levels in both the Twin Mountains and the Woodbine Formations have been declining for over 60 years, due to pumping for public water supplies. Pumping of the Twin Mountains aquifer by municipalities in the Dallas-Fort Worth area has actually reversed the flow of the ground water in that unit, so that flow in Ellis County is now to the northwest (DOE 1990). Figure 1-10 shows a cross sectional view of the important regional aquifers.

1.10 Seismology

The potential for damaging earthquakes at the SSC site is among the lowest in the nation. No faults have been active in the area for the last 5 million years. The absence of pronounced linear features in the satellite image on the cover also testifies to the stability of the region. Large earthquakes in distant active zones such as the New Madrid, Missouri area would have only negligible effects on the SSC. The most severe effects at the Project would register at intensity VI or below on the Modified Mercalli scale (a scale with values from I to XII describing damage caused by earthquakes), described as "Some heavy furniture moved; a few instances or fallen plaster of damaged chimneys. Damage slight." The site is within Zone 0 of the Uniform Building Code seismic risk map: earthquake damage is not expected (DOE, 1990).



Explanation

- Aquifer
- Aquitard
- Collider Tunnel Location

Figure 1-10: East-West Cross Sectional View of Regional Aquifers

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2. ENVIRONMENTAL PROGRAM INFORMATION

The DOE has set forth in the NEPA (1969) documents for the SSC a number of commitments to mitigate any adverse environmental impacts associated with construction and operation of the SSC. The EIS (DOE, 1988) included general statements of expected impacts from the project as well as preliminary evaluations of impacts to the sites included in the final group of seven project proposals. Given the more exact location of the SSC components at the Ellis County Texas, site, the DOE was able to define much more precisely the geologic constraints, infrastructure requirements, cultural resources, surface water and ground-water resources, and specific impacts of the project. The SEIS (DOE, 1990) set forth site-specific analyses and requirements relevant to the exact location (the Footprint) of the SSC project facilities.

Any conceptual design change dictated by constraints of the Ellis County site or by basic accelerator science requires reevaluation of project impacts to ensure compliance with NEPA. Major changes in design that evolved between the EIS and SEIS were primarily due to the specific geologic and topographic features of the Ellis County site and the increase of the proton injector energy from 1 TeV to 2 TeV. Design changes since the SEIS include an increase in tunnel diameter from 3.7 m (12 feet) to 4.3 m (14 feet), a change in the elevation and tilt of the Collider ring, and the relocation of the large detectors from the West to the East Campus. These changes have been thoroughly reviewed to ensure NEPA compliance and are discussed in the Summary of this report, in Appendix A, and throughout Section 2.

The combination of the MAP and Environmental Compliance Plans (ECPs), which were described in the Summary of this report, provides the documentation for fulfilling commitments to the preservation and enhancement of the environment as stipulated by NEPA. Activities designed to preserve and enhance the environment are the main topics of the following sections.

2.1 Earth Resources

2.1.1 Spoils Disposal

Construction activities for the SSC were begun at the N15 service area on the West Campus in 1991. See Figure 2-1 for location. The SEIS allows for on-site disposal of earthen and rock materials generated by excavation but does not require it. On-site

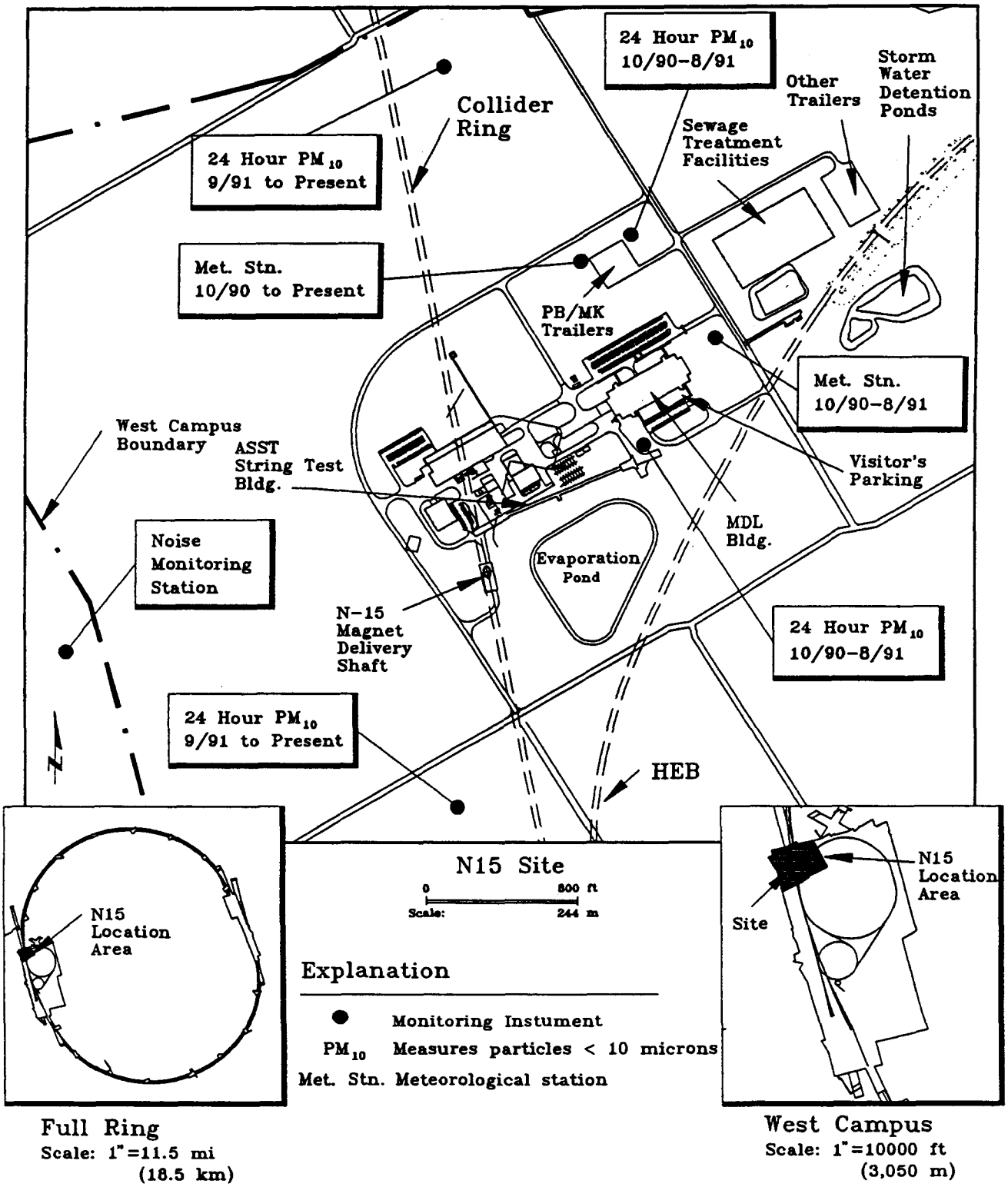

Figure 2-1 Monitoring instruments on the N15 Site

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disposal is the preferred option because of potential negative impacts, such as increased traffic, vehicle exhaust, noise, and fugitive dust associated with removal of these materials from the site. The SSCL will consider other uses of excavated material on an individual basis, provided the overall environmental effect is beneficial. The preferred option at present is placement of spoils near the site, followed by contouring, replacement of topsoil, and landscaping to blend the new material into the existing landscape. The service areas have been increased in size to approximately 20 hectares (50 acres) to accommodate cooling ponds and on-site placement of spoils.

Several small berms at N15 have been treated in this way and will be partially seeded with a variety of different plant species. Services of a consultant will be obtained during 1992 to ascertain the best combinations of plants to use in vegetating the spoils areas. Use of native plants is the preferred solution (PB/MK, 1991).

Some earthen materials have been placed in temporary stockpiles at N15. The TNRLC is currently negotiating the planned purchase of land on which to place this material permanently.

Other material awaiting permanent placement includes broken concrete from foundations and slabs of buildings that have been sold and moved off the West Campus. This concrete has been placed temporarily near the exploratory shaft site (near the intersection of Bearden Road and Old Maypearl Road) and will be relocated to a permanent site during 1992.

2.1.2. Spoils Leachate Studies

One impact considered in the SEIS from placement of earthen and rock materials from underground excavations on the surface was the possibility that rainwater might leach deleterious substances (for example, metals in solution or acids) from this unweathered material. Preliminary considerations of the rock types involved suggested that there would be no such problems, as stated in the SEIS. Chemical testing of spoils materials was performed during 1989 by Earth Technology Corporation to evaluate this supposition (Werner, 1989). The study, although less than ideal because it utilized weathered materials, found no harmful substances associated with the Austin Chalk Formation, the material that will host about 60 percent of the underground facilities, and only minor elevation of some substances in the Eagle Ford Shale. It must be noted that the study results are compared to the National Primary Drinking Water Standards (NPDWS), even though these standards govern water quality "at the tap" and are not meant to be applied to untreated water. Nitrites were not detected in any samples; nitrates did not exceed the NPDWS. The pH of leachate water was similar to that of local ground water and did

not exceed NPDWS. Total dissolved solids initially exceeded NPDWS but decreased over the test period. The final values for the Austin Chalk met NPDWS; slightly higher values for the Taylor Marl and Eagle Ford Shale are thought to result from the high clay content of marl and shale. Samples of leachate were analyzed for the following metals: antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, copper, iron, lead, mercury, nickel, potassium, selenium, silver, sodium, thallium, and zinc. Metals were either absent or below NPDWS for all except selenium, which ranged from twice NPDWS to absent over the test period. The study suggested that there might be some problems concerning the leaching of sulfates from the Taylor Marl, which will host about 30 percent of the underground facilities. It is possible, however, that this observed concentration was due to naturally occurring bacterial activity. Discussions have been held with the United States Geological Survey to resolve any uncertainties by conducting a study of the leachability of underground materials at the SSC in 1992.

The effect of recent design changes that change the tilt of the Collider tunnel have been analyzed, and the total volume of spoils attributable to shaft excavation will not be markedly different from those assessed in the SEIS. Spoil volumes associated with experimental halls on the East and West Campuses likewise will be well within the SEIS envelope. See Appendix A.

For all earth resources discussed above, the responsible parties are:

Requirements Validation - SSCL
Mitigation Development - A-E/CM
Mitigation Implementation - A-E/CM
Mitigation Verification and Monitoring - SSCL
Performance Audit - DOE

2.2 Water Resources

Discussion of water resources in this section is confined to surface water resources. The program of ground-water characterization and monitoring at the SSC site is discussed in Section 4.

2.2.1 Water Use in Cooling Systems

Water will be used throughout the SSC as a cooling medium for various electrical components. In order to remove the heat generated in the underground facilities of the SSC by magnets and electronic equipment, special low conductivity water will be used as a heat exchanging medium in the collider tunnel. The heat absorbed from underground facilities will ultimately be dissipated to the air, primarily by means of cooling ponds, where possible, instead of the more visually obtrusive and noisy cooling towers. It must be stressed that the only cooling media to circulate in the Collider tunnel itself will be the various cryogens (liquid nitrogen, liquid helium) and the low conductivity water. Cooling pond water will not circulate in the Collider tunnel.

Two types of cooling ponds will be used: offstream and onstream ponds. Offstream ponds are generally smaller than onstream ponds and are not part of an existing stream system, hence will have no flow-through water. The ponds must be lined with an impervious material to prevent seepage to ground water, since evaporation of the cooling water will lead to the build-up of salts over time. Present plans call for lining some of these offstream ponds with a 0.6 m-thick (2-foot thick) layer of clay, which meets the permeability requirements of the Texas Water Commission. Clay liners, although extremely effective, must be kept wet at all times, which requires a commitment on the part of the SSCL to buy any water necessary to maintain total dissolved solids within SSC operating limits, to keep the liner under water, and to satisfy National Pollutant Discharge Elimination System (NPDES) requirements.

Onstream ponds are constructed along existing drainages. These are flow-through systems and will not need to be lined. Water quality will be carefully monitored along these flow-through systems to ensure that the quality of the water in the system is the same as that of surrounding streams. In addition, onstream cooling ponds will be designed to detain increased runoff associated with impervious areas constructed for the SSC. During major rainstorms, water levels will be allowed to rise above the normal level for the ponds, and the water will be released gradually, thus alleviating dangers to any areas prone to flooding. It is hoped that onstream ponds will also aid migratory water birds in their passage through the area.

Construction has begun on the offstream cooling tower blowdown evaporation pond that will service the N15 service area. This zero discharge system has been designed to accommodate the 25-year storm (the worst storm expected in the area during a 25 year period). The surface area of the pond will be about 3 hectares (7 acres).

Major Activities for 1992: A system of ponds is being designed for the West Campus to serve the MEB and two Interaction Regions, and construction on these ponds will

begin in 1992. Instream ponds with an expected surface area of about 40 hectares (100 acres) will be impounded along the drainage between Greathouse Branch and Baker Branch. This tributary drains into Chambers Creek. The area of this project is discussed in Section 2.2.5 and shown in Figure 2-5.

Investigation of the effects of SSC redesign has been completed, and there will be no adverse effects on water quality from the new tunnel tilt or elevation (Appendix A).

The primary responsibility matrix for management of water resources is:

Requirements Validation - SSCL
Mitigation Development - A-E/CM
Mitigation Implementation - A-E/CM
Mitigation Verification and Monitoring - SSCL
Performance Audit - DOE

2.2.2 Runoff, Erosion, and Sedimentation Control

Surface water could be adversely affected by SSC construction in several ways. Clearing of vegetation, grading, and movement of heavy equipment would disrupt the existing land surface; in addition, loose material excavated and brought to the land surface from underground construction would constitute an unprotected surface until revegetation was accomplished. Disturbed or unprotected land surfaces are susceptible to erosion by storm runoff, and surface water systems might be damaged by increased sediment burden as a result of such erosion. Both the SEIS and the MAP address this problem by stipulating several mitigation measures to be taken at all construction sites. First, the amount of disturbed land surface exposed to weather effects at any one time is to be minimized by scheduling construction activities so that no more earth is exposed than absolutely necessary to accomplish the work in a reasonably efficient manner. Second, detention ponds, ditches to divert runoff around disturbed areas, silt fences, buffer strips of natural vegetation, and artificial runoff-retarding devices will be used wherever need dictates.

Many of these mitigation measures have been put into effect at construction sites in the West Campus area. Overland stormwater runoff is routed around the construction site. Any water that flows out of a construction area must pass through a combination of erosion control devices, such as a sediment detention basin, silt fence, or haybale checkdam, before entering the off-site surface water system. Silt fences have been

constructed around spoil and topsoil stockpiles. The clarity of water entering drainages has been monitored by visual inspection and has generally been found to be similar to that of the water entering the site (PB/MK 1992).

Contamination of runoff by fuels and other hydrocarbons is prevented by careful storage and refueling procedures. Contractors are required to remove any soil contaminated by fuels and to provide documentation of proper disposal to the SSCL.

Road construction has posed the greatest challenge. The placement of culverts as part of construction of a new road between N15 and FM66 was not complete when more than 25.4 cm (10 inches) of rain fell on the site during a period of a few days. The partially constructed roadway embankment impounded a volume of water that had to be released before culvert placement could continue. This unusual circumstance resulted in the unavoidable discharge of water that was more turbid than that received; however, there was no adverse environmental impact (PB/MK, 1992).

2.2.3 Baseline Surface Water Quality

Surface water quality is a direct reflection of the quality of the surface environment. For this reason it is essential to measure the surface water quality before the construction phase of the SSC begins, in order to protect the environment, demonstrate compliance with environmental regulations, and provide a basis for any mitigative action. In 1991 these baseline surface water studies began with a preliminary analysis of optimum sampling conditions, analysis costs, sampling techniques, and locations for sample collection by the SSCL.

Drainages on the West Campus may be characterized as intermittent or ephemeral; that is, they flow when it rains, with flow rates depending on the intensity and duration of precipitation. After rainstorms, the flow rate declines until the drainages form a series of pools that may dry up completely. As evaporation occurs in the pools, salts that were dissolved in the water precipitate out and remain in place until the next rainstorm causes the stream to flow again. Maximum concentration of dissolved salts occurs at low flow conditions, so it is under these conditions that streams will be sampled.

An environmentally sound sampling and analysis program should include testing for pH, dissolved metals, common nonmetals, nitrates, sulfates, hardness, alkalinity, radiological components and bacterial contamination. Any such sampling program must be carefully designed to be cost effective. The most effective approach is to collect a large number of preliminary samples and subject them to a few simple tests (such as pH, conductivity, temperature, oxygen concentration, alkalinity, chloride content and nitrate concentration)

that can be performed by SSCL personnel in order to determine the conditions under which it is most desirable to perform the rigorous chemical testing. About thirty sampling sites of streams and impoundments have been identified as a starting point (Figure 2-2a, b, and c). Ideally, sampling will take place during late fall/winter and late spring/summer and will involve collection of about four or five liters of water. Selected samples will be analyzed more completely for dissolved and/or total chemical and radioactive constituents by commercial analytical/radiological laboratories. Test results will dictate any further refinements of sampling sites and procedures or other analyses (Goss, 1991).

Drainages that carry rainwater off fee simple lands are obvious choices for analyses. Typical drainages off-site will be analyzed for comparison purposes. The locations of sampling sites will be noted on field maps prior to sampling; geographic description and alphanumeric codes will also be used to facilitate data retrieval. Physical descriptions of the sampled water bodies will be recorded in field notes. Surface water sampling sites on the West and East Campuses are identified in Figures 2-2a, b, and c (Goss, 1991). Preliminary results of surface water and ground-water analyses performed in conjunction with the Texas Proposal in 1988 are reported in Appendix C (TNRLC, March 1988).

Illegal dumping of trash in low areas in or near stream channels contributes to the overall poor surface water quality of many streams in Ellis County, as do certain agricultural practices. Herbicides, pesticides, fuels, oils, septic tank drainage, and runoff from feedlots combine to produce surface and ground-water pollution. Baseline samples will characterize the extent of these problems around the SSC Footprint. Present levels of radioactivity in Ellis County waters are extremely low, based on sampling done in 1991. See Section 3 for a full discussion and Appendix G for a table of results.

2.2.4 Floodplains

In recognition of the value of floodplains as habitat for wildlife and as rich farmland, the SSCL has assumed a commitment to avoid these areas as building sites as much as possible. The S35 (formerly designated E8) service facility is a major case in point. Service areas are required at set intervals around the collider ring in order to provide regular input of electrical service and cryogenic materials (the liquid nitrogen and liquid helium used to cool the magnets to superconducting temperatures). Service area S35 was initially sited in the floodplain of Big Onion and Little Onion Creeks. From the standpoint of Collider design, the optimum location for the service shaft in that area was directly on the 0.4 km (one-quarter-mile) wide floodplain. See Figure 2-3 and satellite image. The disturbed area would have been about 8 hectares (20 acres), accommodating

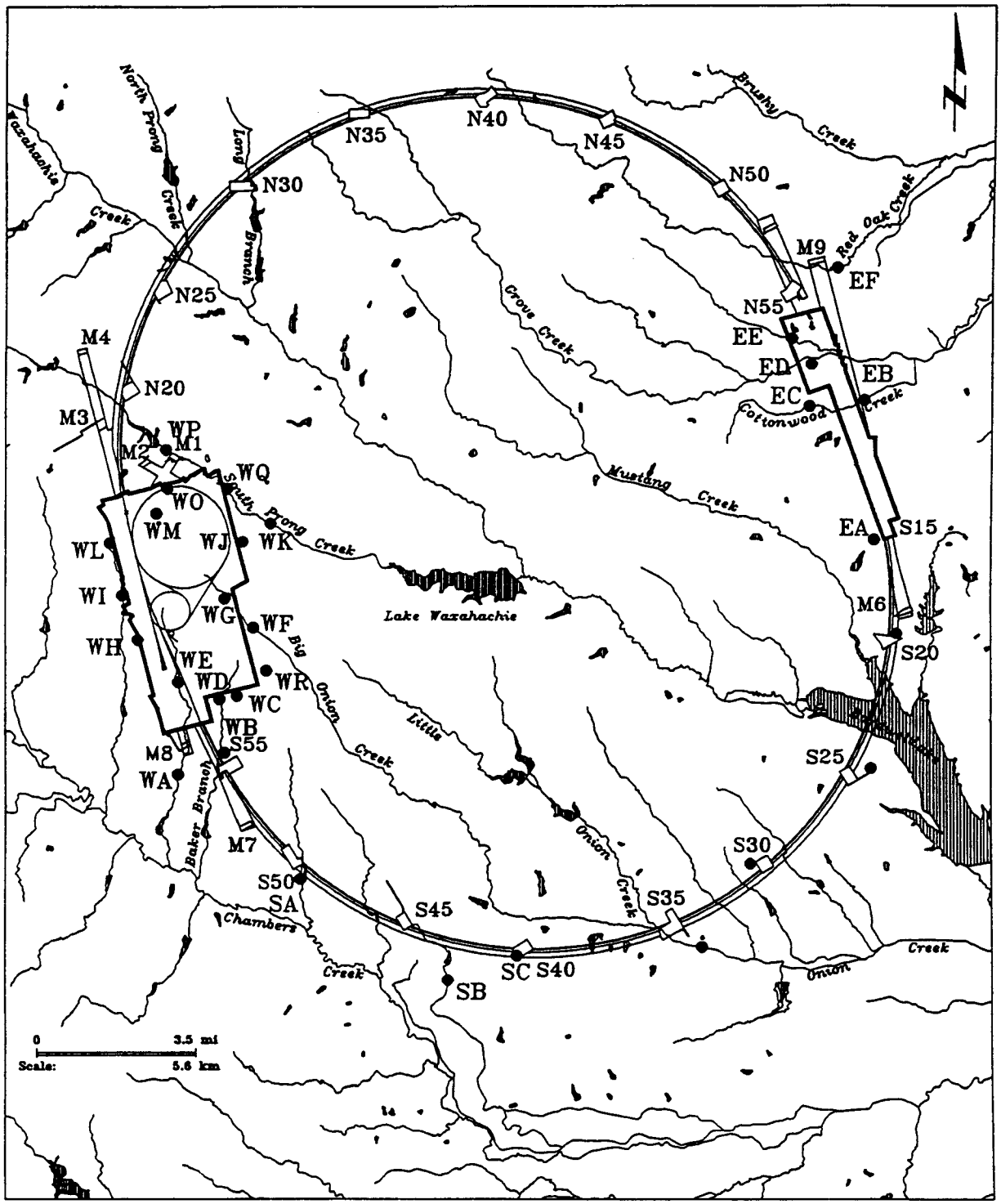

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Figure 2-2a: Surface water sampling sites

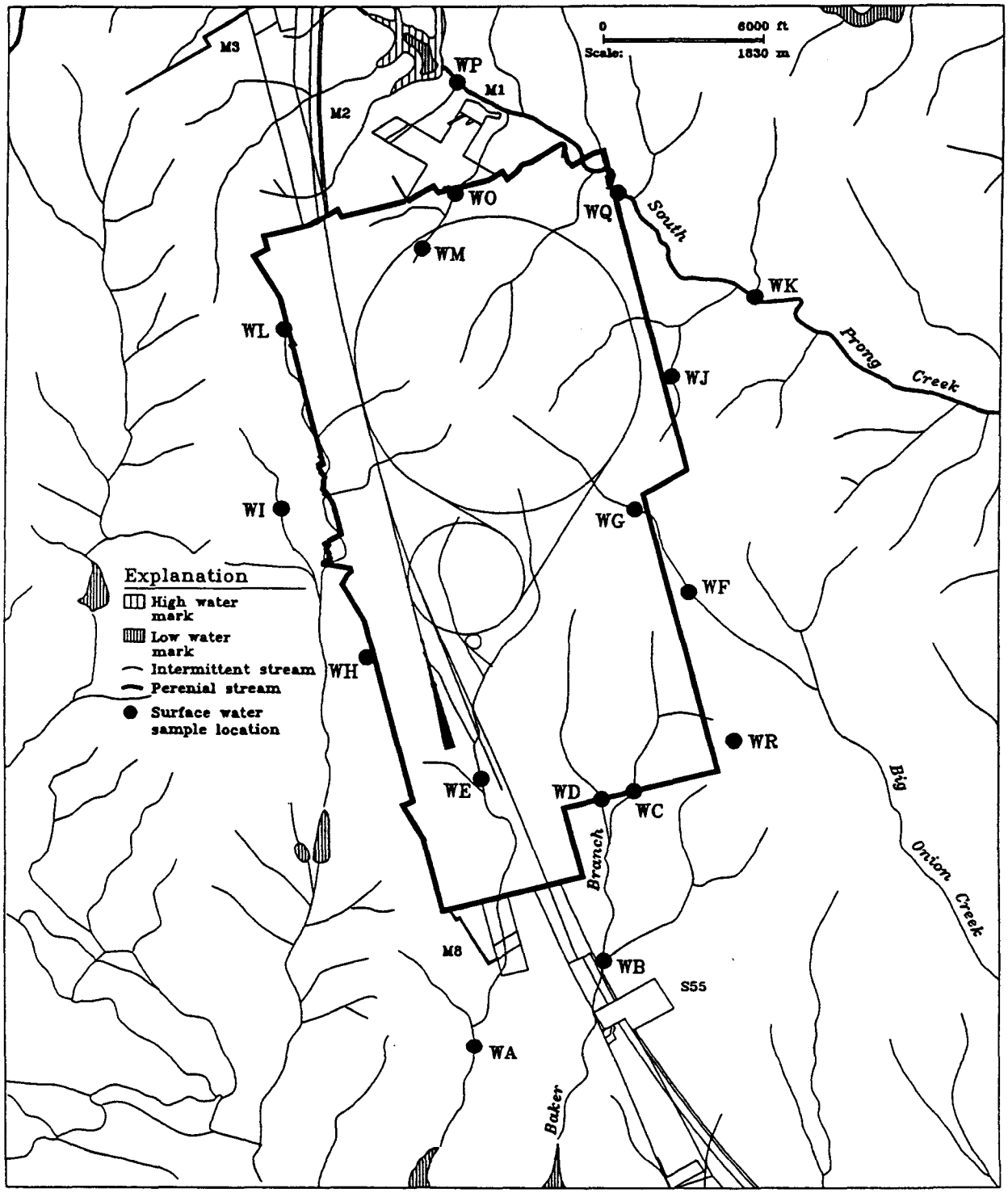

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Figure 2-2b: Surface water sample sites on West campus

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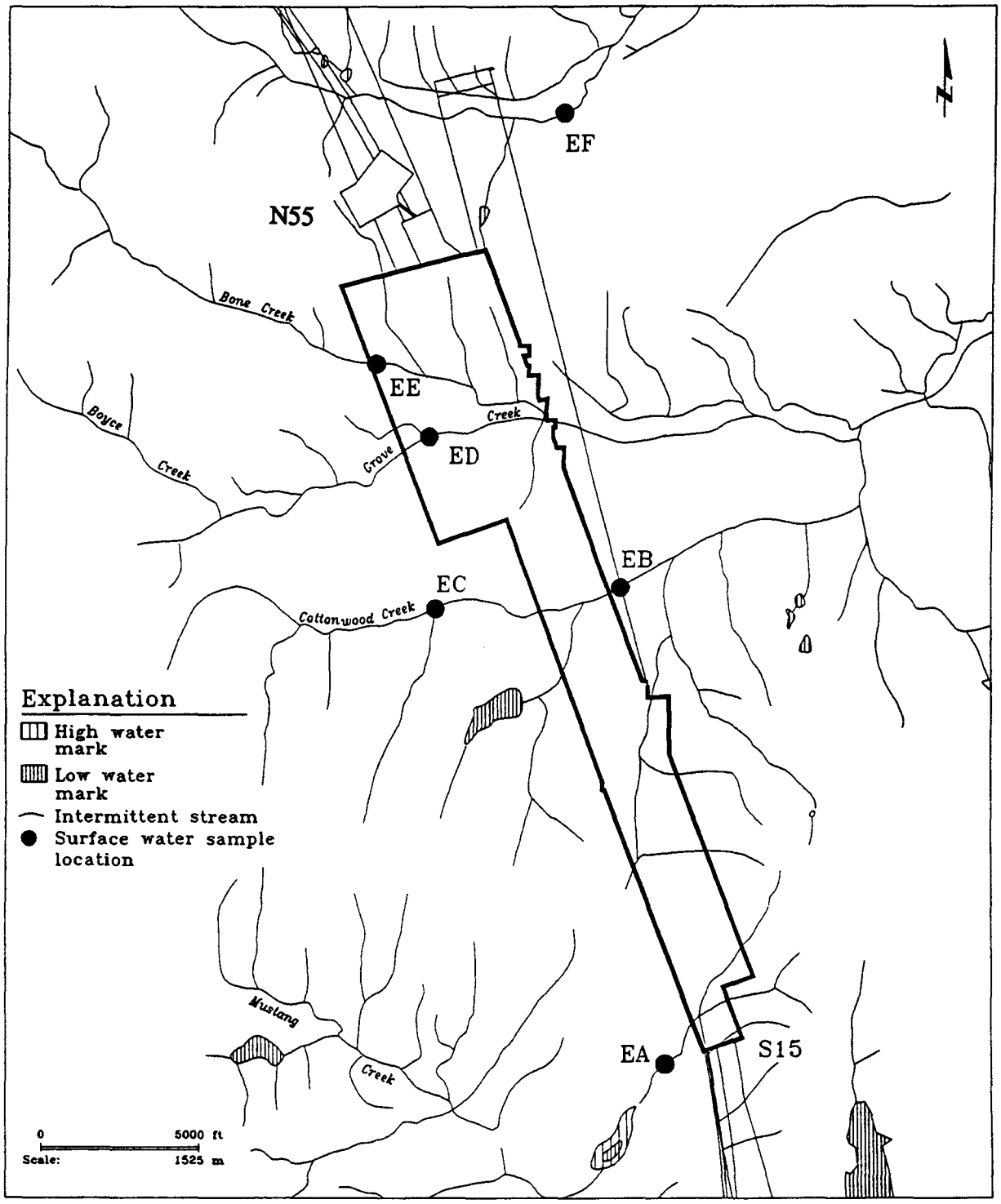

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Figure 2-2c: Surface water sampling sites on East campus

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a cryogenics facility, access road, and cooling ponds. In order to avoid disturbing areas within the floodplain, the SSC investigated the possibility of relocating the service area.

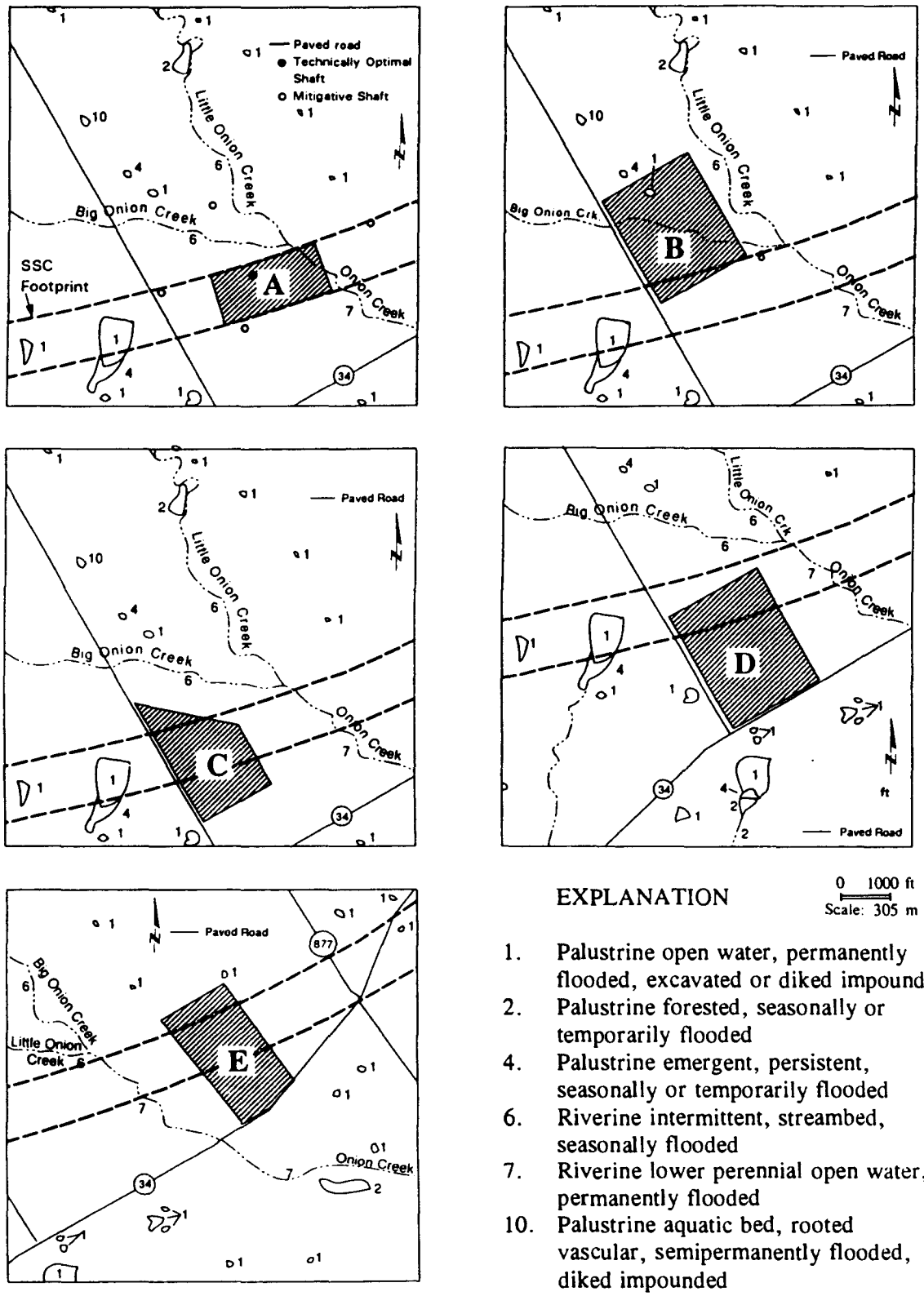
Figure 2-3 shows some of the alternative service shaft locations considered. After reviewing the options, the SSC decided to move the service shaft and facilities to a location removed from the floodplain (Figure 2-4). The new location poses a major problem in the design and location of major electrical components. A major re-design of the ring path was required in order to alter the point of connection for electrical power and cryogenics. The choice to move the service facilities out of the floodplain reflects a strong commitment on the part of the DOE to minimize the impact of the SSC project on the environment. There are other cases, e.g. N30, in which the shaft locations have been moved a short distance from the technically optimal locations in order not to compromise the quality of floodplain and wetland environment. In addition, 9.7 km (6 miles) of power line was re-routed to minimize the impact to riparian habitat.

The location of the LEB ring on the West Campus was another case in which the demands of accelerator design conflicted with the natural configuration of the site. A certain thickness of earth was required to fulfill shielding requirements around the LEB, and the resulting berm would have impinged on the channel of a small intermittent stream. In this case the decision was made to reroute the stream channel around the accelerator (Figure 2-5). The new stream channel has been designed to be as similar as possible to that of the natural stream. The bed will be chalk rather than concrete, since the natural bedrock of the area is Austin Chalk. The banks will be ripped through natural rock, soil and vegetation, in an effort to duplicate the natural stream channel. Side pockets that will retain shallow water have been included as part of the stream relocation project to encourage wetland development. Finally the banks will be seeded with buffalo grass (*Buchloe dactyloides*), a native constituent of shortgrass prairie.

2.2.5 Wetlands

A draft Wetlands Mitigation Plan of Action has been prepared by the PB/MK Team and was submitted to the Environmental Compliance Committee (ECC) in December, 1991. This plan outlines a course of action to be used in case construction projects require filling of wetlands. It also specifies the criteria on which to base the creation of new wetlands: soil type, topography, water sources, construction costs, location of proposed and anticipated facilities, and compatibility with adjacent land use. Means by which to rank alternative locations where new wetlands could be created are listed.

The ECC is coordinating with resource agencies to obtain recommendations on compensating habitats that might be included in appropriate design packages. The

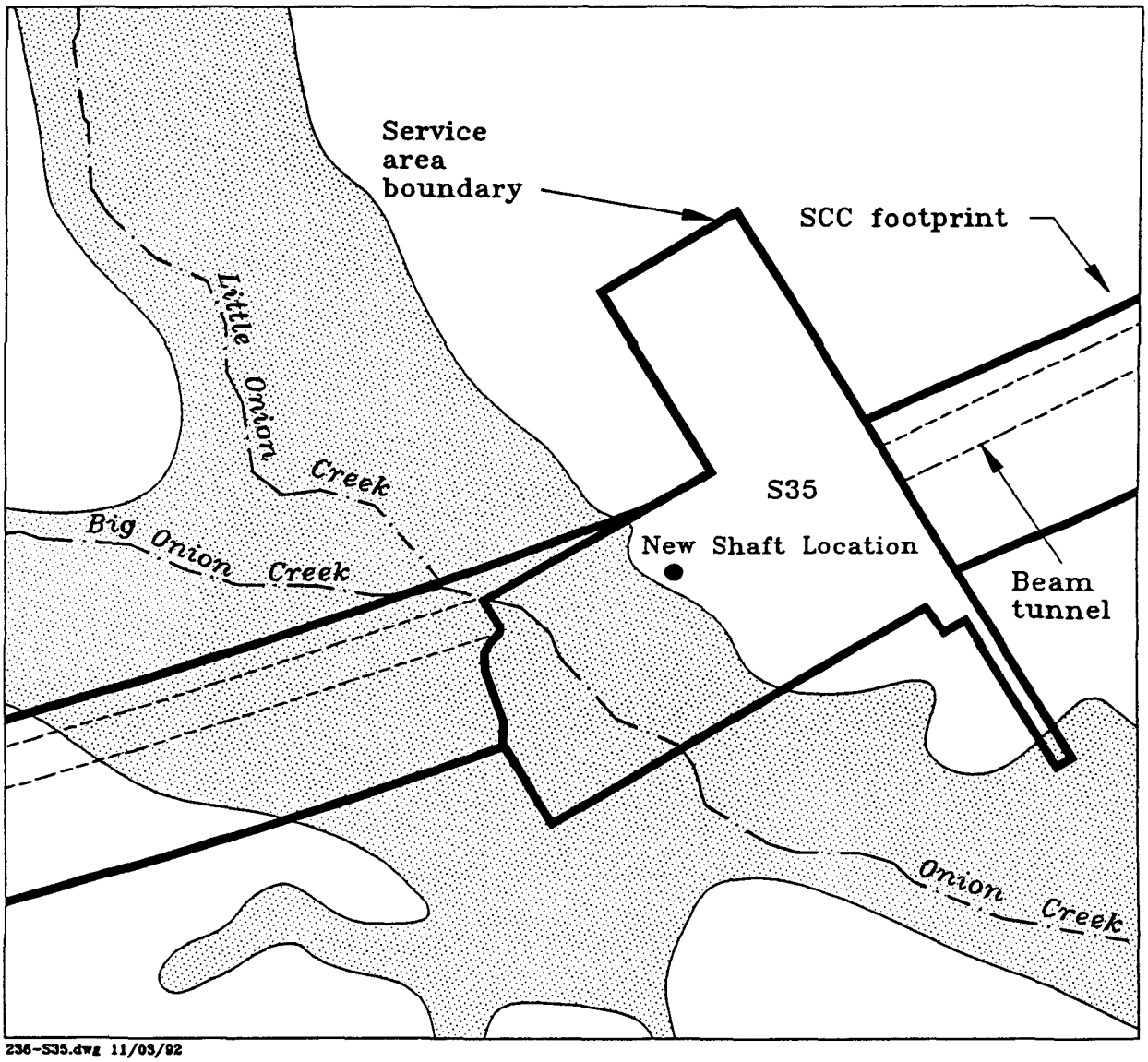


EXPLANATION

0 1000 ft
Scale: 305 m

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 2-3: Sites considered for the S35 service area and possible shaft locations for the technically optimum site (Box A).



Explanation

- Floodplain
- Waterway
- Beam tunnel below

0 1000 ft
Scale: 305 m

Figure 2-4: Final location for the S35 service area

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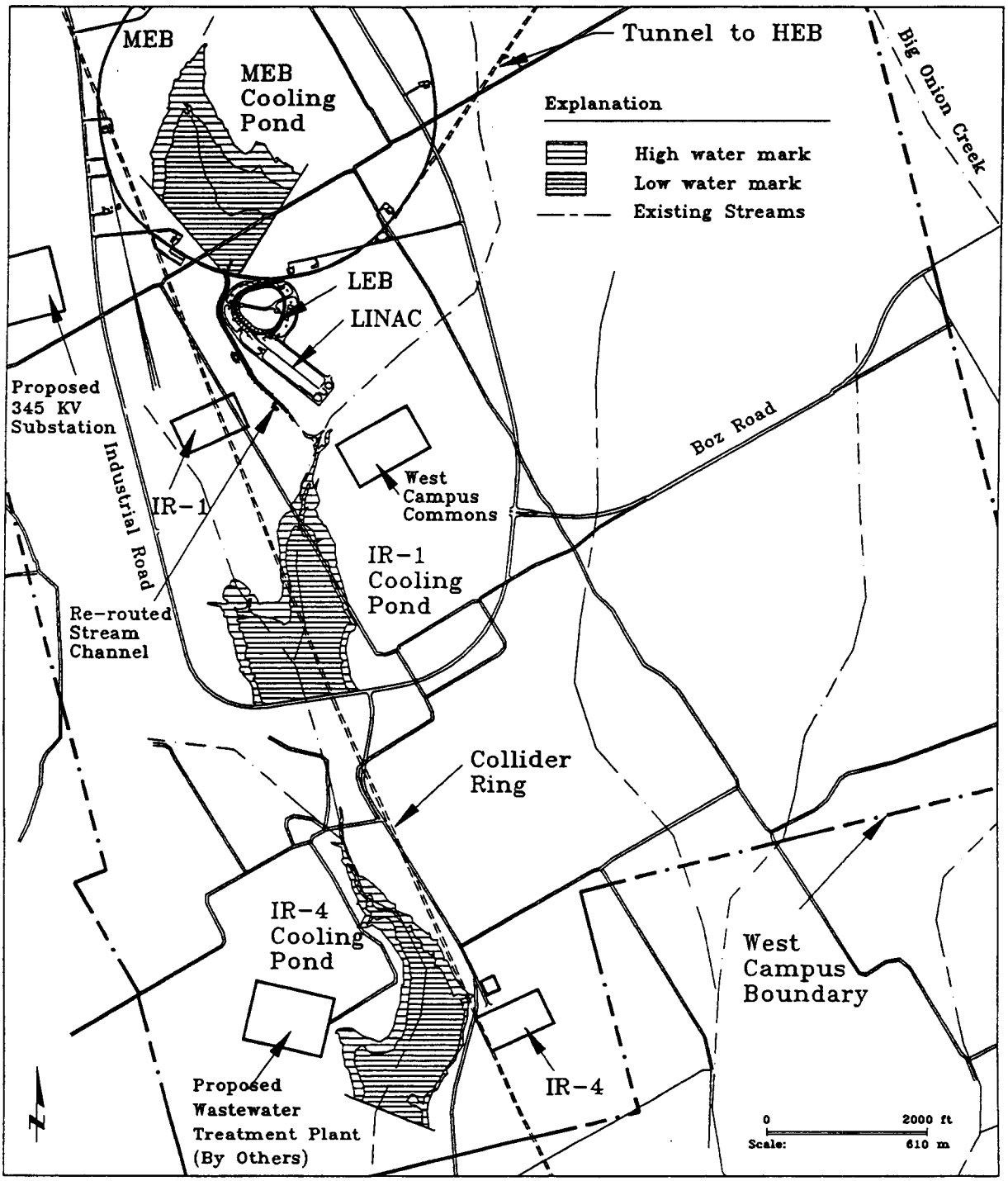

Figure 2-5 Proposed instream ponds near the MEB

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PB/MK Team has also discussed techniques to develop fish and wildlife wetland habitats that can be readily incorporated into the three cooling ponds (MEB, IR-1, and IR-4) scheduled for construction in the West Campus in 1992 (Figure 2-5). Existing trees above the proposed water levels are to be retained. Existing topography will be used to the extent possible to create natural shorelines and shallow areas. Where desirable, soil material will be removed from adjacent areas and used to create islands, irregular shorelines, and shallow water areas for wildlife. These three ponds are onstream ponds constructed in an existing stream course, so there will be no problems with buildup of salts that might interfere with wildlife and migratory bird usage of the ponds.

The ECC has conducted "environmental walkovers" with the PB/MK Team to verify environmental compatibility of specific facilities and reconcile wetlands preservation requirements with construction efforts. One such field reconnaissance served to identify prospective sites for the construction of SSC Project-wide wetlands in the East Campus area between Bone Branch and Grove Creek east of Ebeneser Road. Another walkover was scheduled for early 1992 in the West Campus.

Service Area N25 will require a cooling pond in an existing drainage that also contains a small stock pond. Each acre of existing channel and pond covered by the cooling pond dam and the cooling pond itself will be replaced by 0.6 hectares (1.5 acres) of new wetland having a habitat value as high as or higher than that of the existing channel and stock pond. Topsoil will be left in place; pond sides will be shallow slopes, the pond shape will be as irregular as possible, and woody vegetation will be established along the pond edge and below the dam. The U.S. Fish and Wildlife Service and Texas Department of Parks and Wildlife will be consulted in regard to pond design.

The cooling pond concept for IR8 was modified to avoid wetland impact. An off-channel cooling pond connected to the lower of three existing ponds will avoid impacts on the two upper ponds. Multiple road routings were considered on the East Campus also to avoid wetland impact. Some new wetland pools were created in connection with the stream location in the Linac area (Figure 2-5).

2.3 Biotic Resources

Clearing of the SSC Project land for agriculture, grazing of livestock, lumbering, and the construction of roads and towns have changed both the flora and the fauna of the SSC Project lands profoundly since the first settlers entered the region a century and a half ago. The DOE is committed to preserve, maintain and restore wildlife habitats on properties associated with the SSC project, and to work with various public interest groups to see that the land is used wisely and within its capacity.

2.3.1 Habitat Management Plan (HMP)

A Draft HMP is scheduled for submission to DOE in mid-1992. The purpose of this HMP is to establish the strategy necessary to protect and maintain existing wildlife and restore quality habitat in areas where native habitats have been destroyed. Strategies for habitat management include:

- Management of terrestrial and aquatic ecosystems;
- Perpetuation and restoration of native flora and fauna;
- Establishment of "Wetlands Banks" to ensure replacement of wetlands impacted by construction; and
- Assurance that surface manifestations of the SSC Project are comparable to the natural topographic features of the area.

Most of the land in the SSC project is currently used as cropland or pasture, but it was originally prairie grasslands. Riparian forest lands occurred in strips along streams and rivers, providing a great diversity of plant species and wildlife breeding and feeding areas. Figure 1-8 shows the location of key riparian habitats in the Project area (DOE, 1990). Ephemeral drainages are potential riparian habitat, and these are shown for East and West Campus areas in Figures 2-2b and 2-2c. Over the past century, these native habitats have become increasingly rare, due to agriculture and urbanization. Poor agricultural practices in general and the cultivation of cotton in particular have damaged much of Ellis County's blackland soils. Hunting, fishing, and commercial trapping take place in the County. No wildlife refuges or sanctuaries have been established in the Project area, and no federal or state listed endangered species are known to be present.

Habitat development of SSC property will address the DOE commitments to replace wetlands, restore prairie, and preserve existing habitat to the maximum extent commensurate with the SSC Project mission. Over half of the SSC fee simple land will be developed into prairie, wetland, wooded, or rangeland type habitat. This kind of development will provide good to high quality habitat to replace the marginal habitat currently provided by agricultural land. The habitat development aspect of the Plan specifically addresses three major areas: wetlands, prairie, and Campus areas.

There will be no net loss of wetlands due to construction and operation of the SSC. The SEIS (DOE, 1990) indicated that DOE would construct wetlands in appropriate locations to replace streams and ponds that could not be avoided by construction of surface facilities. For each acre of impacted wetlands, 1.5 acres of new wetlands will be

developed. Wetlands can be created by impoundment to create marshes, by enlarging the size of existing wetlands, or by creating ponds or potholes, small shallow open water retention areas. Offstream cooling ponds to be constructed at service areas would not perform adequately as wetlands, due to their poor water quality, and would not be included as replacement wetlands in a wetlands bank.

Another important facet of the HMP is prairie development. Almost all of the native blacklands prairie has been destroyed by converting the land to agriculture. Isolated small patches of prairie grasses and the Kachina Prairie, a tract of prairie on the east shore of Clark Lake, are all that remain of the presettlement vegetation of Ellis County. One of the environmental enhancements undertaken by the SSCL is the restoration of large tracts of this unique visual and environmental resource. This program is discussed in Section 2.4.1 and Section 2.8.

Development of Campus areas will include some small areas of lawn and trees around the main buildings. Remaining areas will be directed toward re-establishment of native vegetation. It is envisioned that nature trails will be established in these restored Campus areas, particularly along streams and wetlands. Public access to any given area of the SSCL will be decided on a case-by-case basis.

Once established, native habitats require minimum maintenance, but certain steps are necessary to ensure the continued viability of these areas. Wetlands will, for the most part, be left alone to develop naturally. Insecticides or herbicides will not be used. Cooling ponds will require periodic cleaning, and a biodegradable algicide will be used to control undesirable plant growth in the warm water.

Restored prairie needs little maintenance. It is likely that the only special attention these areas will require is a controlled burn in late spring, to mimic the natural conditions in which grasslands flourish. Prairie maintenance is discussed in Section 2.8, Environmental Enhancements and Visual Resources.

Maintenance of campus areas will involve conventional watering, erosion control, fertilizing, trimming, and mowing of lawns and shrubs. Weeds will be controlled by chopping when possible, by applying carefully selected herbicides only when necessary.

DOE will lease out some unoccupied land in the East and West Campus areas for farming or pasture. The lessee will maintain these lands and report anticipated and actual use of the land and any pesticides applied to it for inclusion in the annual SER (TNRLC, 1991). Approval of pesticides will be required before application.

2.3.2 Insecticides and Pesticides

The SSC is committed to operating with as little impact on the environment as possible. To minimize the environmental impact from the use of insecticides and pesticides, a Draft Pesticide Management Plan was submitted to DOE in August, 1991 (DOE, August 1991). This plan provides guidance for the management and use of pesticides during construction and operation of the SSC. Its intent is not to prevent the use of pesticides but to delineate the notification, approval, reporting, and certification for SSCL personnel, pesticide applicators, and farmers who lease Project land for agricultural purposes. This plan will be reviewed periodically for necessary changes in requirements and procedures for the handling and use of pesticides.

The responsibility matrix for biotic resources consideration is:

Requirements Validation - SSCL
Mitigation Development - A-E/CM
Mitigation Implementation - A-E/CM
Mitigation Verification and Monitoring - SSCL
Performance Audit - DOE

2.4 Land Resources

The basic philosophy of land acquisition by TNRLC is to impact as few land owners as possible when acquiring parcels of land for development. The odd shapes of many service and access areas are due directly to the reluctance of TNRLC to split parcels of land, potentially leaving land owners with devalued fragments of land.

Another fundamental commitment on the part of the SSC is to purchase any land for which the worst-case scenario accident would expose an individual land owner to a radiation dosage exceeding 10 mrem/yr. The shielding necessary to fulfill this commitment is less than 9.2 m (30 feet) of earth, but DOE has agreed to purchase in fee simple any land that lies fewer than 13.7 m (45 feet) above the crown of the beam tunnel. The recent realignment of the ring that raised the tunnel elevation along the western half of the ring has necessitated the purchase of additional land in fee simple. These lands are approximately 7 hectares (17 acres) at the Waxahachie Creek crossing, 7 hectares (17 acres) at the crossing of an unnamed tributary to Chambers Creek, and 0.8 hectares (2 acres) at the Mill Branch. The land is held in five parcels and involves

no additional relocations. It is all currently unimproved land and not conducive to development, being confined to the stream channels. These changes in tunnel design are discussed in more detail in the Summary and Appendix A of this report.

Much of the land held in fee simple by the SSCL is situated in one of the most important natural regions in Texas, the Blackland Prairie, which stretches in a crescent-shaped zone from the Red River through Dallas, Waco, and Austin to San Antonio. As the name implies, the soil of this region (Austin-Houston black association) is heavy, productive, and black. Another common soil type is the Eddy-Stephens association (whiterock land), which is generally thinner and less productive than the Austin-Houston black association. These two different soils support two different assemblages of vegetation, which are visible in the satellite image on the cover. Any workable land use plan must be sensitive to the unique characteristics of the soils and topography in the region of the SSC.

2.4.1 Conceptual Land Management Plan

The TNRLC has developed a Conceptual Land Management Plan in order to assure a cost effective utilization of land resources within the extensive land base it holds in Ellis County. This plan integrates the land planning and management goals and objectives of the SSCL, while setting environmentally and economically sound goals (TNRLC, 1991).

DOE requires that all improvements (houses, barns, septic tanks, concrete slabs, etc.) must be removed from the land before it is transferred to DOE. At present, however, TNRLC does not transfer land acquisitions immediately to the SSCL, but holds title to all land until it is actually needed for construction. It is TNRLC's policy to allow interested parties to lease such property for agricultural purposes. Some agricultural usage may require that certain improvements such as fences and outbuildings be left in place. One of the functions of the Conceptual Land Management Plan is to integrate the temporary agricultural use of the land with Project plans. Lease agreements were formerly on a calendar year basis but are now based on crop seasons. Where the current use of the land is geologically and economically sound, that use will be allowed to continue. In the very few instances in which the land is currently mismanaged (crops grown on steep slopes or thin soils or in frequently flooded locations), land use will be converted to activities more compatible with soils and topography. In general, the areas for crop farming will be confined to the Austin-Houston black association, and the Eddy-Stephens whiterock association soils will be devoted to range land.

Figures 2-6a and 2-6b depict 1990 land use patterns for the West and East Campus areas. Figure 2-7 shows the proposed land use pattern for 1992 for West Campus stipulated by

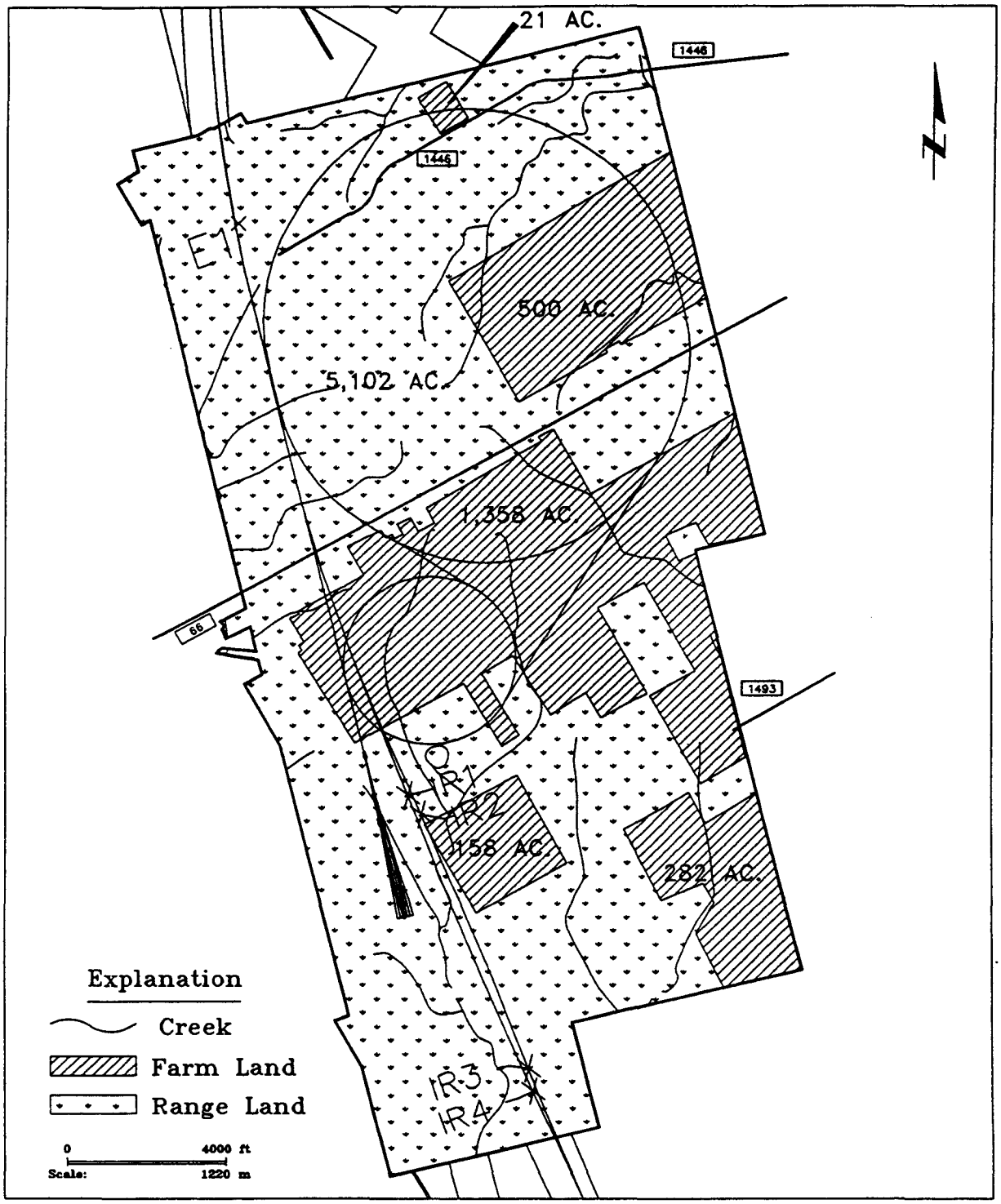

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Figure 2-6a: 1990 land use patterns - West Campus

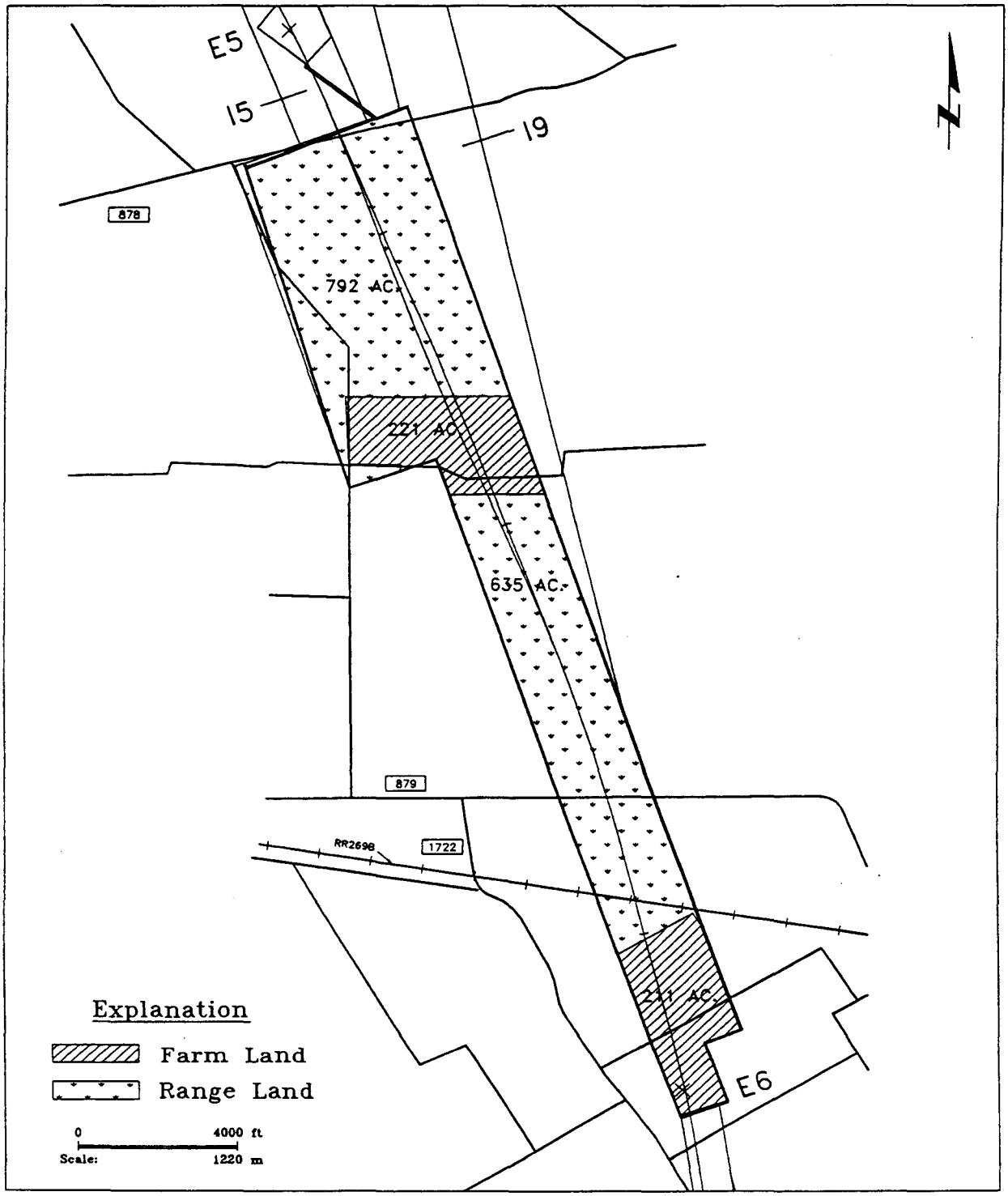

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Figure 2-6b: 1990 & proposed 1992 land use patterns - East Campus

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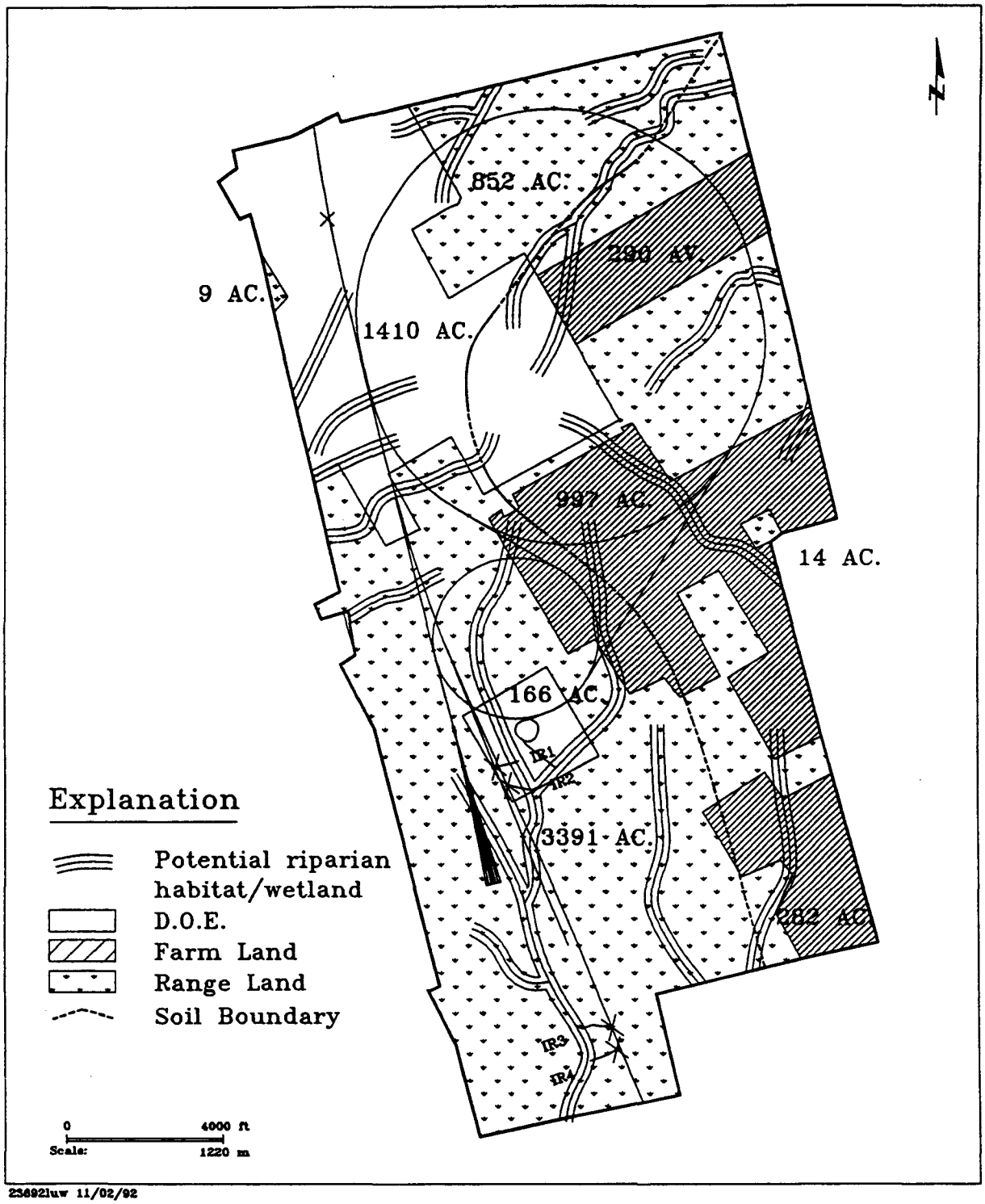

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Figure 2-7: Proposed 1992 land use patterns - West Campus

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the Conceptual Land Management Plan. Land use patterns for East Campus for 1992 do not change from those of 1990.

There are two special interest projects worthy of mention in connection with land use planning. One is a plan to devote over 400 hectares (1,000 acres) on the West Campus to re-establishment of a native blackland prairie in pre-settlement condition. The Texas Nature Conservancy has been contacted to assist the SSCL in identifying appropriate existing prairies from which to collect seed. In addition, a consultant will advise the SSCL as to the most desirable species to use in the rest of the prairie restoration project.

The other project of note is the enhancement of bottomland hardwood growth. Major tributaries crossing the West Campus (Greathouse, Baker, and South Prong Creeks) will have a minimum 46-m (150-foot) buffer zone along each side of the creeks that will not be disturbed by farming or ranching activities. It is planned to enhance the growth of presettlement hardwood trees in these zones by planting appropriate species or by allowing natural succession of plant growth to be the major seeding factor.

2.4.2 Socioeconomic Impacts of Land Use Changes

A project as extensive as the SSC will have far-reaching effects on the economy of the region. Most of these effects are expected to be beneficial in the long run as a result of the creation of thousands of new jobs directly associated with the SSC or indirectly attributable to the increased economic base of the area created by new residents employed by the SSC. Section 5 contains a more complete discussion of these important issues.

The primary responsibility matrix for land resources is:

Requirements Validation - TNRLC
Mitigation Development - TNRLC
Mitigation Implementation - TNRLC
Mitigation Verification and Monitoring - TNRLC
Performance Audit - DOE

2.5 Air Resources

Construction activities will produce minor and temporary air resource impacts due to increased concentration of particulate matter. Particulates would come from construction traffic on unpaved roads and wind erosion from spoil piles prior to revegetation. The PB/MK Team has monitored the concentration of thoracic particulates (PM_{10}, or "dust" particles smaller than 10 microns (μ) in size) at the N15 construction site on West Campus. The monitoring instruments were located within several hundred feet of construction activities and were aligned with the prevailing winds. Figure 2-1 shows the location of various monitoring instruments on the N15 site. Figure 1-4 shows prevailing wind directions recorded at the N15 site by PB/MK monitoring stations, and prevailing wind directions at the Dallas-Fort Worth International Airport recorded by the National Weather Service. These data are broken down into seasons for comparison. Notice that the data sets from the two areas are very comparable, and data from Dallas-Fort Worth International Airport could almost certainly be used to characterize wind conditions at the SSC site. New instruments installed at N15 will enable a better comparison to be made in subsequent years. Voids in the N15 data set resulted from power outages, relocation of the samplers, and instrumental difficulties with the samplers. Records are available for about 80 percent of the total potential time. Monthly calibration checks were performed, as were three audits by outside staff. Appendix E shows the data collected during 1991 by the particulate monitoring stations.

The following paragraphs derive from the PB/MK report "Overview of Environmental Compliance During Construction" (PB/MK, 1992).

In March, 1991, a west Texas dust storm increased observed PM_{10} values for a period of several days compared to data collected before and after the event. Weather records from Dallas-Fort Worth International Airport also recorded this event. The data collected during this period are not reflected in the following discussions.

The average non-work day PM_{10} concentration was 28.7 micrograms per cubic meter ($\mu g/m^3$), compared to an annual mean background level of 22.1 $\mu g/m^3$ estimated in the SEIS. The annual average PM_{10} level observed at N15 (work days and non-work days) was 30.1 $\mu g/m^3$, which is well within the National Ambient Air Quality Standard (NAAQS) of 50 $\mu g/m^3$. The average annual PM_{10} level for construction days was 36.7 $\mu g/m^3$, also within NAAQS. No violations of the 24-hour standard of 150 $\mu g/m^3$ were recorded. Maximum 24-hour values observed at the N15 area during 1991 ranged between 84 and 118 $\mu g/m^3$.

Concentrations of PM_{10} dust within a meter of trenching operations ranged between 75 and 150 $\mu g/m^3$. The relatively short period of time during which these activities

occurred, the application of water as a dust suppressant, and rapid dispersion of the plume avoided violations at the boundaries of the construction site.

The sampling stations were located so that the effect of construction on PM_{10} levels could be determined by comparing the levels from the upwind station to those of the downwind station. As suggested by the wind rose diagrams in Figure 1-4, this configuration is achieved by placing monitoring stations north and south of the construction site. The difference between PM_{10} levels at upwind and downwind stations is about ten percent of the average values at each station (27.6 $\mu g/m^3$ upwind versus 30.2 $\mu g/m^3$ downwind).

The average work day concentration of PM_{10} was 36.7 $\mu g/m^3$, and the average non-work day concentration was 28.7 $\mu g/m^3$.

The data collected at the N15 area during 1991 suggest that construction of the SSC has had little impact on PM_{10} concentrations measured within about 60 m (200 ft) of construction activities. Construction activities have resulted in no measurable change in PM_{10} levels at the boundary of the West Campus, located about 600 m (2,000 feet) away from the construction site. The data therefore indicate that the strategies for controlling PM_{10} levels have been adequate. Appendix E presents tables of PM_{10} data from the N15 monitoring stations.

Changes in SSC design are not anticipated to change the predicted levels for PM_{10}, although the volume of excavated material is expected to be somewhat less. See Appendix A for a more complete discussion.

It should be mentioned that the N15 area is being very heavily monitored so that mitigation measures planned for other sites will be based on actual measurements obtained at an active construction site. In this way better predictions may be made concerning construction effects elsewhere.

Activities for 1992: The 24-hour PM_{10} monitoring stations will be maintained at the N15 site throughout 1992, and additional samplers and stations are planned to monitor PM_{10} levels at the injector area. A new software package to record wind direction is being developed and will be tested early in 1992. Conditions throughout the north arc will be monitored by portable instruments until substantial earthmoving and spoil operations begin in 1993.

The focus of conventional construction in 1992 will shift from the N15 area to the injectors and the north arc. The magnet test laboratory, the last building at N15 in the current program, will be transferred to SSCL for outfitting. The magnet delivery shaft, utility shaft, and personnel shaft will be completed and the first tunnel section started.

The Linac, LEB, and MEB will be under construction by the end of 1992 and work should be in progress all across the north arc. Some activity on the East Campus may also begin in 1992.

2.6 Noise and Vibration

Noise and vibration impacts on the environment are a result of construction activities and are expected to be temporary in nature. Vibration impacts will be primarily impacts upon the SSC operation by factors in the surroundings.

2.6.1 Noise Impacts

Noise levels over Ellis County were monitored in 1989 by consultants (Van Houten and Associates of Los Angeles) to determine baseline conditions with which to compare any noise produced by construction and operation of the SSCL. A portable precision sound level meter is used to record noise at construction site boundaries and at the nearest residences. Sound is reported in dBA (decibels, A scale, which is more attuned to the human hearing range).

Noise data collected before April 1991 by PB/MK have only limited value in documenting unacceptable noise because of limitations in methodology and instruments. All data collected when the wind speed exceeded 16 km (10 miles) per hour are invalid. After carefully examining the data and the site, the acoustical engineer who audited the noise monitoring program concluded that there were no violations of the limits established in the Site-specific EIS (DOE, 1988). Changes suggested by the auditing engineer were fully implemented by July, 1991.

Noise levels at the N15 construction site have generally been substantially less than 85 dBA, and the daytime levels at the nearest residence outside the fee simple boundary have generally been less than 55 dBA during the daytime. Since earthmoving and other heavy equipment operations occurred only during the days, the commitments set forth in the Site-specific EIS have been met.

The highest values measured at off-site residences nearest the N15 and Exploratory Shaft sites (600 m or 2,000 feet and 1,700 m or 5,600 feet away) are 61 and 51 dBA, respectively. At these distances noise levels would have to regularly exceed 85 dBA at the construction site boundary to cause unacceptable levels at these residences. Appendix E presents noise levels recorded by PB/MK monitoring instruments.

2.6.2 Vibration Impacts

No blasting has occurred during 1991, hence there have been no vibrational impacts from that source. Five vibration holes drilled to test conduction of vibrations through the bedrock near highways and railroads in the SSC area have been sealed.

In a reversal of the usual considerations, concern is being expressed that vibrations created by Southern Pacific Railroad trains crossing a trestle in the northwestern quadrant of the ring near North Prong may impact operation of the SSC due to the design changes that led to a rise in tunnel elevation in that part of the ring. Loads have become heavier each year, and heavier trains could create unacceptable vibration levels in the collider tunnel. This scenario will be investigated in the future.

Otherwise, noise and vibration levels due to the design changes in the SSC are not expected to vary significantly from those already measured.

The primary responsibility matrix for air resources and noise and vibrational impacts is:

Requirements Validation - SSCL
Mitigation Development - A-E/CM
Mitigation Implementation - A-E/CM
Mitigation Verification and Monitoring - SSCL
Performance Audit - DOE

2.7 Human Health Effects

2.7.1 Fire Ants

The Red Imported Fire Ant (*Solenopsis invicta*) is prevalent in the region and may need to be controlled during various phases of the SSC project. During SSC operation, fire ants will need to be controlled in the landscaped areas around buildings within Complex areas. Control will be by means of bait formulations recommended by the Texas Department of Agriculture, and this material will be applied by trained SSCL personnel or an approved subcontractor. There is no plan to control fire ants in restored prairie areas. The Pesticide Management Plan (DOE, August 1991) addresses the fire ant problem in more detail.

2.7.2 Hazardous Materials

A hazardous substance and waste compliance reference manual has been prepared in accordance with DOE Order Series 5400.1 (Marple, 1991). It will be used in training and to increase awareness among employees of hazardous substance and waste requirements.

Small quantities of hazardous materials will be used during operation of the SSC, and as such the SSC will be a small quantity generator. Use of these materials will be supplanted as much as possible by use of less hazardous materials. These hazardous materials consist primarily of acids, organic solvents, paint, toner from copy machines, and film developer. In a typical month of 1991, toner from the Calcomp plotter (petroleum distillate) totalled less than 1 gallon; non-halogenated spent solvents such as acetone and alcohols used in the machining of metal parts totalled less than 0.1 kg; lead used in soldering circuit boards totalled about 1 kg; spent acids used in the preparation of metallographic samples totalled less than 0.1 kg; and halogenated spent solvents (1,1,1-trichloroethane and trichlorofluoromethane) totalled less than 1 kg.

Immediately west of Building 4 of the SSCL Temporary Facility (See Figure 1-1) are two temporary buildings in which hazardous waste is accumulated. Volumes are typically 60 to 70 kg each month, and the accumulated quantity currently is about 1,000 kg. The SSC is at present allowed to accumulate 6,000 kg of hazardous material before shipping; hence, none was shipped in 1991. There is no limit on the time for which these materials may be held.

Laidlaw Environmental Services, Inc. of La Porte, Texas, is the contractor to the SSCL for hazardous waste disposal. Infectious wastes generated by the medical office of the SSCL are contracted to Complete Compliance Corporation of Houston, Texas. Pollution Prevention and Waste Minimization Programs are particularly important to hazardous material handling, and these programs are being developed by SSCL personnel.

2.7.3 Nonhazardous Wastes

A recycling program for various kinds of materials is in place at the SSCL. City Industries of Dallas, Texas has the recycling contract for non-hazardous metals, plastics, and used oils. The contract for recycling of white paper is pending.

A Waste Minimization Program and a Pollution Prevention Awareness Program will be developed at the SSCL, but as yet these programs do not exist. The SSCL Environ-

mental Protection Subcommittee will be in charge of these programs, and it is expected that they will be completed during 1992.

The primary responsibility matrix for human health effects (except for construction wastes) is:

Requirements Validation - SSCL
Mitigation Development - SSCL
Mitigation Implementation - SSCL
Mitigation Verification and Monitoring - SSCL
Performance Audit - DOE

For construction wastes, Requirements Validation is handled by the SSCL. Mitigation Development, Implementation, Verification and Monitoring is the responsibility of A-E/CM, and Performance Audit is by DOE.

2.8 Environmental Enhancements and Visual Resources

In a large project such as the SSC, it is sometimes possible to go beyond minimal mitigation of environmental impacts, and actually enhance the environment. Several such opportunities have presented themselves at the SSC project. Among those considered to date are restoration of tracts of the native blackland prairie, restoration of wildlife habitat that has been destroyed by agriculture, development of new wetlands, and improvement of ground-water quality by cleaning and closure of contaminated wells.

A tract on the West Campus having blackland prairie soil is being considered for revegetation using native species. It has recently been used for corn and wheat production. Strips containing different species could be seeded parallel to existing terraces. These species could then be studied to determine the optimum species from which to collect seeds to restore large tracts of land on the East and West Campuses to presettlement prairie growth. Once established, the native prairie will constitute a unique ecological resource for north central Texas.

Restored prairie needs little maintenance; fertilizers or herbicides will not be used. It is likely that pre-settlement prairie remained in that state with the aid of periodic wildfires that killed invading trees or shrubs. Studies have shown that unburned prairies

deteriorate both in grass production and in species composition. On SSC project lands, periodic controlled burns may be used to increase seed yield and reduce competition from unwanted vegetation. Native prairie species include 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*). Seeds for many of these grasses can be obtained locally from surviving remnants of original prairie, such as the Kachina Prairie in Ennis. Some of the seeds are difficult to harvest and process efficiently, but specialized equipment is available to overcome these problems.

Laboratory personnel are planning to help restore the Kachina Prairie by participating in a controlled burn of the area, which has been neglected for the past several years. Unwanted woody growth such as mesquite is establishing itself in the prairie grasses, and burning is the natural way of ridding the grassland of such intruders.

As previously discussed in Section 2.3.1, the SSCL intends to proceed with restoration of various types of wildlife habitat, ranging from the prairie habitat previously discussed, to establishment of bottomland hardwoods, to creation of new wetlands. It is hoped that these high quality wildlife habitats will return some of the land to near pre-settlement conditions in terms of both flora and fauna.

3. RADIOLOGICAL ENVIRONMENTAL PROGRAM

3.1 General

Since the SSC is in the early design and construction phase, all radiological environmental measurements have been preoperational. They could be described as baseline studies done to establish the preoperational radiological characteristics of the SSCL site. There was no generation of radioactive materials and no radioactive waste produced in 1991. It should be stressed at the beginning of this discussion of radiological monitoring that even in the worst case accident, the levels of radiation expected at the boundaries of the SSC land (surface and subsurface) would be comparable to the radiation dosage received by commercial jet passengers in a round trip flight from coast to coast. The most serious conceivable SSC accident is the accidental loss of the full proton beam at a location other than the heavily shielded beam absorbers. The above ground dose in uncontrolled areas from such an accident would be less than 100 microsieverts or 10 mrem, well below the annual public exposure received from naturally occurring background radiation, which averages about 80 mrem/year from cosmic rays and naturally occurring radioactive elements in rocks in Ellis County (EG&G Energy Measurements, Inc. (EG&G/EM)).

Measurement of radioactivity is complex because of the different types of radioactive decay and the various types of instruments used to measure these decays. Exposure is defined by the effects of radiation, and is usually measured in *roentgens* (R). One R is an amount of ionizing radiation sufficient to produce an electric charge of 1 electrostatic unit in one cm^3 of dry air. Perhaps the more appropriate unit of radiation dosage is the *rem*, which stands for "radiation equivalent man". The rem is a measure of the dose equivalent, which depends upon the amount of biological damage caused by the particular type of radiation being measured. One R equals one rem for beta and gamma rays. The SI unit corresponding to the rem is the *Sievert*; one Sievert (Sv) equals 100 rem (100,000 mrem). The activity of a radioactive source is measured in *Curies* (Ci) or *Becquerels* (Bq). The historical unit of activity has been the Ci, defined as 3.7×10^{10} (37 billion) disintegrations per second. Recently, the Bq has been adopted as the SI unit equivalent to the Ci. One Bq is one disintegration per second.

The ion source, a 35 kiloelectron volt (KeV) proton (actually H^-) accelerator, was tested in 1991. This device starts the acceleration process that finally produces 20 TeV protons. It consists of several components, beginning with a hydrogen gas cylinder. Next is a chamber where metallic cesium is heated to temperatures at which it gives up

an electron to the hydrogen atoms from the cylinder, producing H^- ions. Last, the negatively-charged hydrogen ions pass through an evacuated orifice where the ions are accelerated to an energy of 35 KeV using the voltage produced by a high voltage power supply. Protons are the nuclei of hydrogen atoms and can be produced directly in an arc discharge, which strips off the electrons. Some ion sources produce protons in this manner. However, more particles can be injected into circular machines like the LEB if they are negative and therefore are attracted by the positively charged protons already circulating. Consequently, H^- ions will be injected into the LEB and then stripped of their electrons by passage through a very thin carbon foil.

The ion source does not have enough energy to induce radioactivity in other materials. It does emit a few X-rays; hence, a personal radiation dosimetry program was initiated. Any exposure to personnel from operation of the ion source in 1991 was below the detection limit of the dosimeters (about 10 mrem/year). See Section 3.8.

A few small radioactive sources were borrowed and purchased in order to check prototype detector modules. These sources were previously sealed by the vendor before shipment to the SSCL, so that no radioactive material could escape. They were used at the SSCL Interim Facility at Stoneridge Business Park in Dallas, just north of DeSoto (Figure 1-1), and some of them are still located in Building 3.

3.2 Environmental Radiation Monitoring

3.2.1 Radiation Sources

The primary source of radiation at the SSC facility will be interaction of the beams of protons with one another or with the various components of the series of accelerators. The magnitude of the radiation emitted will be, in general, directly proportional to the number of beam protons involved in such an interaction. This radiation will be of several different types, requiring different detection and monitoring techniques. Figure 3-1 shows the location and types of radiation monitors planned for both campuses, as well as service and access areas around the collider ring. Work was begun on a prototype environmental radiation monitoring station in 1991. The different types of radiation and the detection methods required are described in the following sections of this report.

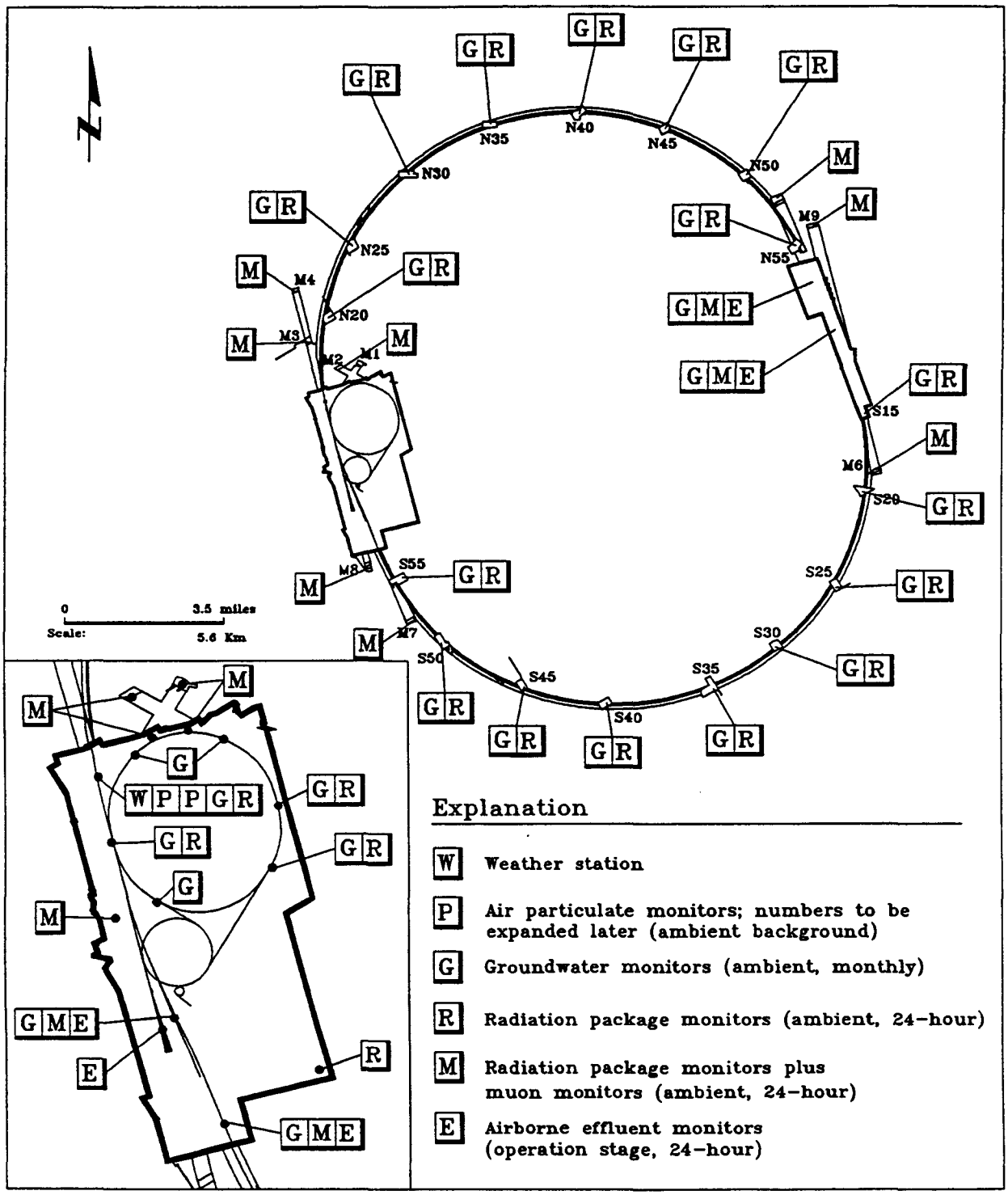


Figure 3-1: Location and types of proposed environmental monitors on the SSC footprint

3.2.2 Penetrating Radiation

Direct radiation given off when high energy protons collide with matter is very penetrating. In addition, secondary particles are emitted in proton interactions, and these produce a cascade of additional particles. Some of these particles interact strongly with matter and others interact weakly. The strongly interacting particles such as pions are stopped much more quickly than the weakly interacting particles such as muons. A similar phenomenon occurs in nature when protons from outer space enter our atmosphere. Most of the particles that reach us at ground level are the muons. In this case the particles are called "cosmic rays", and they add significantly to the natural environmental radiation background. In Ellis County cosmic rays contribute about 31 mrem/year to the natural background radiation (EG&G/EM, 1992). Although the range of the pions from the SSC will be few hundred m in the forward direction, the muons will travel more than a km under the ground before stopping. To monitor these muons, holes will be drilled in the ground and detectors will be placed down to the depth of the accelerator. The M (monitoring) areas shown in Figure 3-1 have been acquired specifically for this purpose. They are near the ends of the muon paths from the beam absorbers.

Gamma rays and neutrons are also produced in the collisions of protons with matter. They travel much shorter distances than muons. Gamma rays are also emitted later when the radioactive materials produced in the high energy proton interactions decay. Levels of residual radiation are typically one thousandth to one ten thousandth (10^{-3} to 10^{-4}) of the prompt radiation near the source. Low energy gamma rays are usually detected by a scintillator such as thallium-activated sodium iodide, which is dense and relatively high in atomic number and emits light in the visible part of the spectrum when penetrated by a gamma ray. The emitted light is converted to an electronic signal by a photomultiplier. Different detectors are required for neutrons. These detectors typically use a hydrogen-containing material as a moderator to slow the neutrons down to "thermal" energies where they are more easily detected.

Ion chambers will be used as environmental radiation monitors for ionizing radiation near the site boundaries. They have the advantage of being able to measure the pulse of radiation that might be emitted in the rare case of accidental beam loss.

Most surface areas of the site will be accessible to the public except for small areas near access shafts and interaction halls, because there will be no detectable radiation at the land surface in any other part of the collider ring during normal operations of the SSC.

3.3 Baseline Radiological Studies

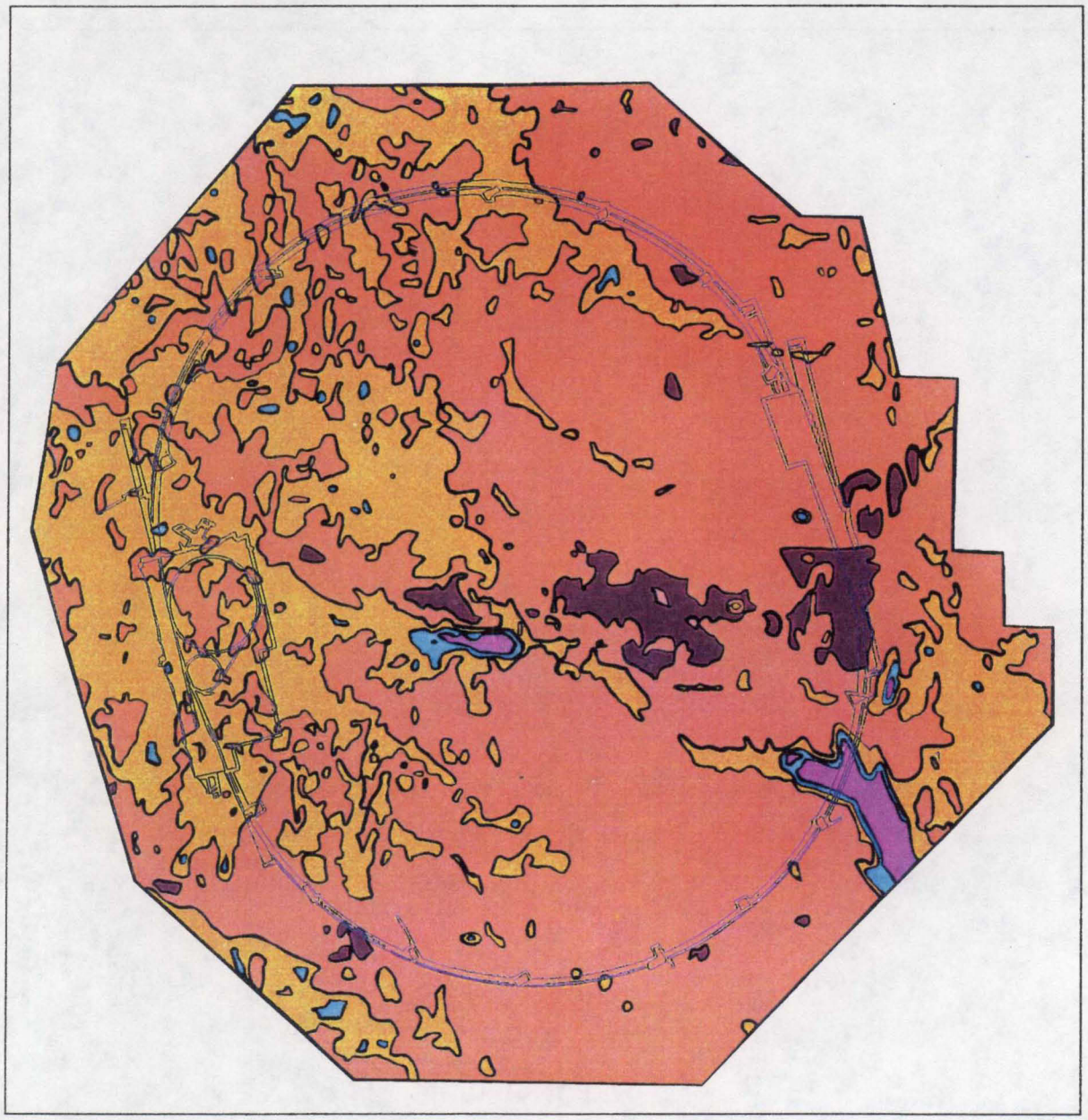
3.3.1 Baseline Radiological Survey of Site

An aerial radiological gamma-ray survey was conducted over the SSCL site from July 22 through August 20, 1991. The survey was performed by EG&G/EM of Las Vegas, Nevada, and sponsored by DOE. EG&G/EM, a prime contractor to DOE, has conducted radiologic surveys for the DOE, the Nuclear Regulatory Commission, and other U.S. government agencies for more than thirty years.

The purpose of the survey was to map the background terrestrial gamma-ray exposure rates in the 1,036-square km (400-square miles) of the site. The survey included the interior of the accelerator ring, which is 87 km in circumference (54 miles), and the area extending at least 3 km (2 miles) beyond the ring. A uniform set of parallel lines was flown at 305 m intervals (1,000 feet) to achieve coverage of the area. About 70,000 gamma-ray spectra were recorded on these flight lines. The data from these spectra were reduced to an exposure rate contour map overlaid on a United States Geological Survey map of the area.

This map, shown in Figure 3-2, is an indicator of the terrestrial gamma ray exposure rate at one m above the ground. The mean exposure rate was 5.4 microroentgen per hour (μR/hour). The data were searched for evidence of man-made gamma emitters, but none were found. Note the low rates for Bardwell Lake and Lake Waxahachie (less than 1 μR/hour). The radiation shielding provided by the water in the lakes is responsible for the low values. Similar low values can be found over other small lakes in the western part of the survey area. The irregular pattern of exposure rates in the western half of the survey area reflects the irregular hilly topography and variable soil depths in that area. The generally lower exposure rate values over the western half of the map area correspond to the Austin Chalk bedrock area. The generally higher exposure rates in the eastern half are developed over Taylor Marl bedrock. Naturally-occurring radionuclides are often associated with clays, and the higher exposure rates over the Taylor Marl bedrock reflect its higher clay content. Linear trends of lower exposure rates extending into the eastern half of the area coincide with alluvial fill in stream valleys, where bedrock gamma emissions may be shielded by clay-poor sediments or by saturation with water. Exposure rates of 5 to 7 μR/hr occur where thick soils or terrace gravels blanket the Taylor Marl bedrock, whereas rates of 7 to 9 μR/hr are found where Taylor Marl is exposed at the surface or is covered by only a very thin layer of weathered material.

Exposure rates and soil samples were acquired at 14 locations on the SSCL site. These ground-based data have been compared to the aerial data and good agreement observed.



0 6 mi

Scale: 9.8 km

Explanation

7-9 μR/h	μR/h Terrestrial Exposure Rate
5-7 μR/h	Exposure rates are extrapolated from the 91 meter flight altitude to 1 meter above the ground. The cosmic contribution, 3.6 μR/h is not included.
3-5 μR/h	
1-3 μR/h	
0-1 μR/h	

Figure 3-2: Map of aerial gamma-ray survey results

Figure adapted from: EG & G/EM, 1992.

Walsh & Associates, Inc.

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The soil samples were assayed using a germanium semiconductor detector. The aerial terrestrial measurements were made using thallium-activated sodium iodide scintillators. Appendix F shows the data from the EG&G/EM radiological survey of the SSC site.

3.3.2 Radioactivation of Ellis County Rocks

Proper protection of the ground water from radioactivity produced by the SSC depends on how the soil materials react to the high energy protons and secondary particles produced by the SSC. For the conceptual design of the SSC, radioactivation of soil materials of Ellis County was simulated by measurements made on soils from Fermilab (Illinois). To refine the design of the shielding for the SSC, Ellis County rock samples were irradiated at the Fermilab Tevatron. A computer program, CASIM, was used to determine the number of nuclear interactions produced in the soil samples by secondary particles. The actual radioactivity produced by bombardment of the samples was measured, as was the fraction of the activity that appeared in water percolating through the material. These measurements made it possible to predict how much radioactivity would be leached from soil material at the SSC site with different doses of irradiation.

To make these predictions, samples of Ellis County rock were obtained from cores of the Austin Chalk, the Taylor Marl, and the Eagle Ford Shale, drilled as part of the geotechnical program carried out by the Earth Technology Corporation, 100 W. Broadway, Suite 5000, Long Beach, CA 90802. Quality assurance procedures for sampling were followed, which included chain-of-custody forms and sample preparation. Samples were irradiated at Fermilab under conditions that simulated the irradiation that soil might receive from an accidental loss of beam occurrence at the SSC. Scientech, Inc., 2105 Luna Avenue, Suite 390, Carrollton, Texas 75006, performed the analyses. Approximately 10 percent of the samples sent for analysis contained known concentrations of the radionuclides of interest. These "spiked" samples were prepared by the Fermilab E S & H Section.

The amount of leaching from the Ellis County samples was determined as follows: the rock sample was placed in a beaker with an equal amount of distilled water and stirred for one hour with a magnetic stirrer. This technique had previously been shown to yield the same results as percolation for materials similar to typical Taylor or Eagle Ford samples. For unfractured Austin Chalk there is less penetration of moisture because of the nature of the rock. Preliminary experiments suggest that most of the leaching of the Austin Chalk occurs in the first few hours of exposure to water (D. Goss, personal communication). Some samples have been stored with the leach water and will be analyzed after one year to verify these results.

The Taylor and Austin Formations have more aluminum and silicon than the Eagle Ford Shale, thus more ^{22}Na is produced by irradiation of these formations. The radionuclide ^{22}Na is of concern because it may be leached from rocks, as may tritium. Due to chemical and physical properties of the three formations, the general conclusion is that radioactivation and leaching of Ellis County rock is less than that of Fermilab soil (Samuel Baker, unpublished results). Shielding calculations done for the SEIS were based on results with Fermilab soil. Now the new results will be used in the determination of the shielding requirements for the SSC. When the study is completed, the results will be published.

3.4 Airborne Radioactivity

3.4.1 General Discussion

A comprehensive discussion of the expected radiation exposure associated with the release of airborne radioactivity from SSC operations was provided in the SEIS (DOE, 1990). The principal radionuclides released during normal SSC operation from 10 m (30 feet) above the access shafts are extremely minute quantities of ^{11}C, ^{13}N, and ^{41}Ar. These radionuclides have half-lives of 20.4 minutes, 10 minutes, and 1.82 hours, respectively, and emit positive and negative beta particles.

The air exhausted from the Collider tunnel at the shafts near points where protons interact will be monitored using detectors that are sensitive to the beta particles. A computer model will be used to calculate the site boundary and nearest off-site individual exposure rates, because those rates will be too low to measure directly. The maximum annual exposure is calculated to be 0.03 mrem compared to the 10 mrem EPA dose limit (DOE, February 1990).

3.4.2 Effect of Design Changes and Land Acquisition

The realignment of the Collider tunnel has raised the tunnel a maximum of 5.4 m (18 feet) on the west side of the ring and lowered it as much as 6.6 m (22.5 feet) on the east side. Since the release point for airborne radionuclides remains 10 m (30 feet) above the ground surface, the only change in conditions caused by the realignment of the tunnel is in the time it takes for the radionuclides to reach the release point. That time difference is less than one minute, which changes the dose rate less than 10 percent. Doses will be greater or less, depending on whether the distance to the surface increased or decreased with the change in the tilt of the tunnel.

On the east and west campuses where the interaction halls will be located, care was taken to maintain the distances to the site boundaries near release points for radionuclides. These strict safety standards caused some concern when a landowner whose house was located less than 30 m inside the boundary had to move, but his neighbor's house, 30 m outside the boundary, was not purchased.

3.5 Waterborne Radioactivity

3.5.1 Surface Discharges

Conventional (resistive) magnets will be used in the LEB and MEB. The resistance of the copper wire used to generate the magnetic field dissipates energy. The resulting heat is carried away by low conductivity cooling water passing through the center of the magnet wire. The magnet cooling water system is a closed loop which circulates very high purity water through a heat exchanger. Heat -- but not water -- is transferred from the closed loop to cooler water from a pond (or at N15, a cooling tower). The water in the closed loop will become radioactive through interactions of protons and secondary particles produced in the magnets. Since the closed loop cooling water is never mixed with exterior water, there is no transfer of radioactivity to the exterior surface water system.

Lower volume closed loop cooling systems are used to cool beam absorbers and beam scrapers (apertures in the beam path that remove unwanted beam particles that could interact with the magnets). These low volume systems have a low potential for leakage. If some water should leak out, it will be contained rather than being released to the environment.

The floor drains and sumps in the underground enclosures (interaction halls and tunnels) collect water and conduct it to tanks or lined containment basins. There the water will be tested to verify that it meets drinking water standards for radioactivity before it is allowed to be discharged to surface waters. The primary radionuclide of concern here is tritium, a low energy beta emitter with a half-life of 12.3 years. The 53 day half-life ^{7}Be is readily removed from the high purity cooling water systems by the resins used to purify the water. As the closed loop cooling systems age, radionuclides from copper appear in the system. Eventually ^{60}Co (5.27 year half-life) will appear. These radionuclides, like the ^{7}Be, are easily removed from the cooling water by the purification resins. Tritium alone is not removed by the resins because it behaves chemically like the hydrogen in water and remains an integral part of the water. The radionuclides absorbed by the resins will add to the radioactive waste the Laboratory must dispose of. Water

containing high concentrations of tritium (much greater than drinking water limits) will be drained, solidified (by mixing with cement to make concrete), and disposed of properly as radioactive waste.

3.5.2 Surface Water Sampling Program

Surface water samples on and around the SSCL site will be collected and tested for radionuclides at the same time they are tested for other impurities. This sampling and testing program has been described in Section 2.2.3 and Figure 2-2a, b, and c.

3.5.3 Radiological Effects on Ground Water

The design criteria for underground facilities of the SSC stipulate that radionuclide concentrations in ground water shall not exceed drinking water concentrations that would result in annual exposures in excess of 4 mrem for persons using that water as a sole source. The primary pathway for radionuclides to enter the ground water is through leaching of radioactivated soil and rock by passage of ground water through that material. This activated material is found primarily adjacent to the beam absorbers and beam scrapers. A secondary pathway is through accidental release of radioactivated cooling water that leaks from closed loop systems and escapes from containment--an unlikely possibility. These cooling systems will be designed to ensure that no water with radionuclide concentrations exceeding drinking water concentrations can reach the ground water.

Calculations have been done to estimate the effect of the worst possible accident on the radionuclide content of ground water. In this scenario, the full beam is lost at a single point, and the collider tunnel is surrounded by ground water in a porous medium, conditions far worse than the actual situation in Ellis County rocks. These calculations indicate that there would still be no excess radiation in a well 150 feet from the tunnel. In the plans for the stratified fee there will be no wells penetrating the stratified fee land within 150 feet of the beam tunnel, so actual effects of accidental beam loss on ground water would be negligible.

3.6 Other Pathways

Although the primary pathway for radiation exposure to the public would be via a dose received externally, consideration must be given to ingestion or inhalation of radionuclides. For airborne radioactivity from ^{11}C, ^{13}N, and ^{41}Ar, the principal

radionuclides released by the SSC, inhalation would deliver a far lower dose than the external exposure due to radioactive decay in the air surrounding the person.

There will be some deposition of radionuclides on the collider-owned land surface adjacent to the release points (the shafts leading up from the tunnels) in normal operation of the SSC. The longer half-life radionuclides such as ^{7}Be (53 day half-life) and ^{22}Na (2.6 year half life) will persist at very low concentrations. However, the possibility for delivering a measurable dose to the off-site population is extremely remote. These surface radionuclides will be monitored for verification that the pathway is not a dose contributor.

The other pathway deserving consideration is drinking water consumption. Some radio-activation of the rock and soil will occur normally outside the proton beam loss points. The accelerator will be designed to keep such concentrations below the drinking water limit of 4 mrem per year by means of appropriate shielding. Monitoring wells on the site will be routinely checked to verify that the concentrations remain negligible. The principal radionuclides leachable by water percolating through the Ellis County materials (Austin Chalk, Taylor Marl, and Eagle Ford Shale) are tritium and ^{22}Na. An experiment conducted to determine the leachability of these materials was discussed in Section 3.3.2.

3.7 Non-ionizing Radiation

The biological effects of electromagnetic fields have become a topic of public concern. The non-ionizing radiation impacts of the SSC project were discussed in the EIS and SEIS (DOE, 1988 and 1990). Although no permanent power lines have been installed to date, a new 25 KeV electric transmission line has been strung along the western boundary of the West Campus by the Hill County Electric Cooperative. This line is supplying power to the N15 area on the West Campus. An environmental walkover was made before the line was installed to determine the path with the lowest environmental impact. Since the landowners are being relocated from the West Campus, the distances to the nearest homes are much greater than for typical installations elsewhere. Off the site, the transmission line follows existing corridors except for a short distance at the south end of the West Campus, where it goes overland to reach the utility corridor on the West Campus. At the low voltage of 25 KeV no impact is anticipated.

Magnetic fields from the steering and focusing magnets of the main Collider ring are another potential source of non-ionizing radiation. Because of the need to prevent magnetic fields from one ring of magnets in the Collider tunnel from interfering with those from the other ring, the steering and focusing magnets in the tunnel are designed

to produce very uniform magnetic fields over a short distance. They will produce no measurable magnetic fields outside the collider tunnel itself.

3.8 Employee Dosimetry Program and Training Program

In 1991 the ion source was tested (see Section 3.1). Low level X-rays were produced, but no one received a measurable exposure from the ion source. An employee dosimetry program was initiated, and radiation survey meters were used in addition to the personal dosimeters to monitor the radiation. Radiation safety training was provided to the workers and to the few employees who used radioactive sources to check prototype detector modules for the large detectors in the interaction halls. Personal exposures were monitored using thermoluminescent dosimeters obtained from R.S. Landauer, Inc. of Glenwood, Illinois. The detection limit of these devices was approximately 10 mrem (100 μSv). There was no recorded whole body exposure and only one employee received a shallow dose to the skin from a radioactive source. That exposure was 20 mrem.

3.9 Radioactive Sources and Waste

A number of radioactive sources were borrowed or purchased for the SSC project during 1991. The only shipments of radioactive material made involved these sealed sources in quantities of a few millicuries (approximately 0.1 gigaBq) or less. No radioactive waste was generated by the SSC project in 1991. Production of radioactive waste is not expected for many years, until some time after high energy collisions occur. It is possible that some waste could be produced during the commissioning of the Injector (linear and booster accelerators), but this is unlikely because the number of protons will initially be kept low to avoid residual radioactivity. Just as for previous high-energy accelerators, protons will not be accelerated unless their use at high energies can be justified. Radioactive waste should be minimized or eliminated and ways to accomplish this goal will be addressed in the Pollution Prevention and Waste Minimization Programs.

4. GROUND-WATER PROTECTION AND MONITORING

4.1 Ground-water Characterization Program

4.1.1 Study of Shallow Alluvial Aquifer

A major study of ground water in shallow aquifers within Pleistocene alluvial terrace deposits in the northeastern part of the SSC Collider ring was conducted by Matthew K. Wickham and Alan R. Dutton of the Bureau of Economic Geology (BEG) at the University of Texas at Austin during 1990 and 1991 (Wickham and Dutton, 1991). All data and conclusions in Section 4.1 are derived from this report. Similar terrace deposits cover bedrock in other areas along the Collider ring: for about 1.5 kilometer (1 mile) in the southeast part of the ring along the south shore of Bardwell Lake, and for about 10 kilometers (six miles) in the south to southwestern part of the ring (Figure 1-6). All these alluvial terraces have similar geologic histories and materials, and are therefore expected to have similar hydrologic properties. Since shallow aquifers in these terrace deposits constitute limited local sources of ground water for domestic and livestock use, it is important to characterize them fully. The SSCL does not plan to utilize these aquifers as a water source for its operations, but wishes to address public concerns about possible ground-water impacts of SSCL construction and operation.

The area selected for the study of the shallow alluvial aquifer was between Red Oak and Brushy Creeks northwest of Palmer (see Figures 1-6 and 4-1). Here the Pleistocene terrace deposit consists primarily of unconsolidated stratified clay, sand, and gravel, overlain by a calcareous clay and a thick clayey soil. This alluvium is deposited over the Cretaceous bedrock of impermeable Austin Chalk and lower Taylor Marl, which dip very gently (less than 0.5 degrees) to the southeast. The thickness of the terrace deposit averages about 9 meters (30 feet); saturated thickness averages 6 meters (20 feet). The field work for this study included a water well inventory, geophysical surveys (primarily seismic refraction profiles and resistivity measurements), stream gaging, drilling of monitor wells, logging of subsurface materials in exploratory boreholes, various pump tests, and a ground-water chemical sampling program. The data collected were used to calibrate a numerical flow model (MODFLOW) of the aquifer. This model was then used to characterize the flow of ground water in the aquifer and to predict the response of the aquifer to changes in discharge and recharge.

Water level elevations appeared to follow the ground surface fairly closely, a common attribute of shallow aquifers. Discharge from the aquifer is predominantly from

numerous springs and seeps along the periphery of the aquifer, where Modern streams have incised into the Cretaceous bedrock. A cross-section of the terrace with geologic contacts and water level elevations is shown in Figure 4-2. Although there were approximately 40 working wells in the shallow aquifer within the study area, well discharge constitutes less than one percent of the total discharge of the aquifer. Ground-water yield is mainly from the lower unit of the terrace alluvium, which is generally coarser-grained and therefore more permeable than the upper unit. The flow direction of the ground water is along the regional topographic gradient from northwest to southeast. Simulated flow lines and locations of wells are shown in Figure 4-1. Studies based on the ambient tritium content of ground water on the average suggest that its residence time in the aquifer is about 40 years, and that water moves from recharge to discharge points in a few decades. Recharge of the aquifer is predominantly from precipitation onto the surface.

The water level of the aquifer in this alluvial deposit fluctuates rapidly with rainfall and evaporation, and even shows daily fluctuations of approximately 5 to 12 cm (2 to 5 inches) in response to evapotranspiration by crops and native vegetation. The water level does not vary with barometric pressure, however, suggesting that the aquifer is largely unconfined, probably due to the uncompacted nature of the upper unit of the alluvium.

One objective of this study was to characterize the flow of ground water between the shallow alluvial terrace aquifer and the underlying bedrock. Any such cross-formational flow is of concern because of the possibility of downward flow from the shallow aquifer into subsurface SSC facilities. Conversely, upward flow might carry materials from the Collider tunnel into the surficial aquifer. While there is little direct evidence on the direction or rate of cross-formational flow, computer simulations combined with field evidence suggest that cross-formational flow is insignificant, constituting less than 0.04 percent of the outflow from the surface aquifer. Another scenario addressed by the study was the effect of a single production well in the surficial aquifer to supply water for a Collider ring service area. MODFLOW was used to simulate this scenario; it was found that areas adjacent to the well would experience only small drawdowns at large discharges. Also it was found that the surficial aquifer could not continuously supply the specified 38,000 liters (10,000 gallons) per day where the aquifer is thin, such as the E4 area, without local dewatering.

Chemically, ground water in the surficial aquifer is very hard, with calcium and bicarbonate ions making up over 50 percent of the dissolved species. As a result of the relatively short travel times of ground water within the aquifer and the rapid response of the water level to precipitation, the aquifer is very vulnerable to contamination by improper disposal of wastes and over-application of agricultural chemicals. There were almost 60 unused or abandoned dug wells in the study area, many of them with broken

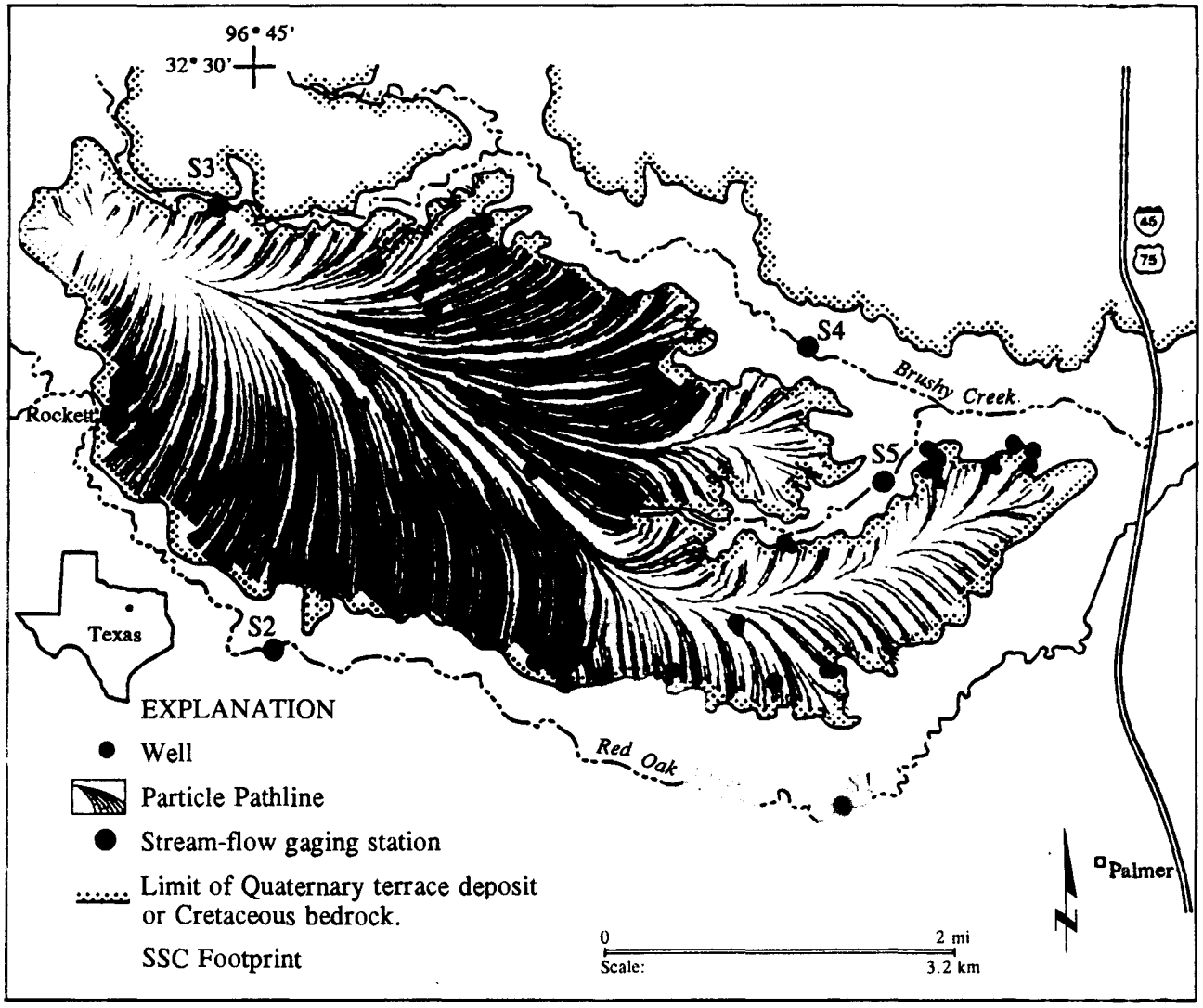

Figure 4-1: Study area for shallow alluvial aquifer, with simulated flow lines of ground water in shallow aquifer calculated by MODFLOW on the basis of March 1991 water table.

Figure adapted from: Wickham and Dutton, "Hydrogeologic case Study" Sept. 1991, Bureau of Economic Geology, University of Texas at Austin, prepared for TNRLC.

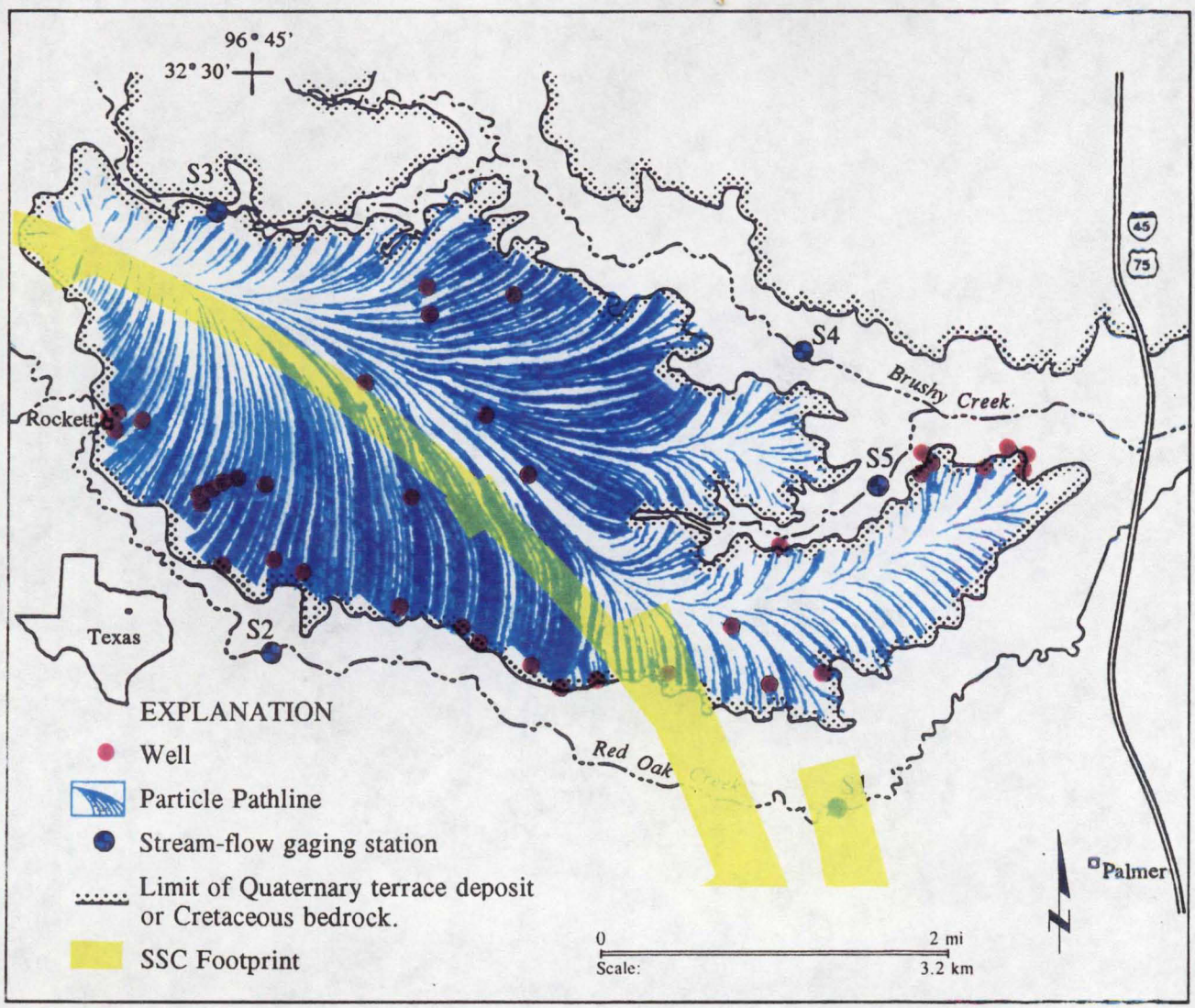

Figure 4-1: Study area for shallow alluvial aquifer, with simulated flow lines of ground water in shallow aquifer calculated by MODFLOW on the basis of March 1991 water table.

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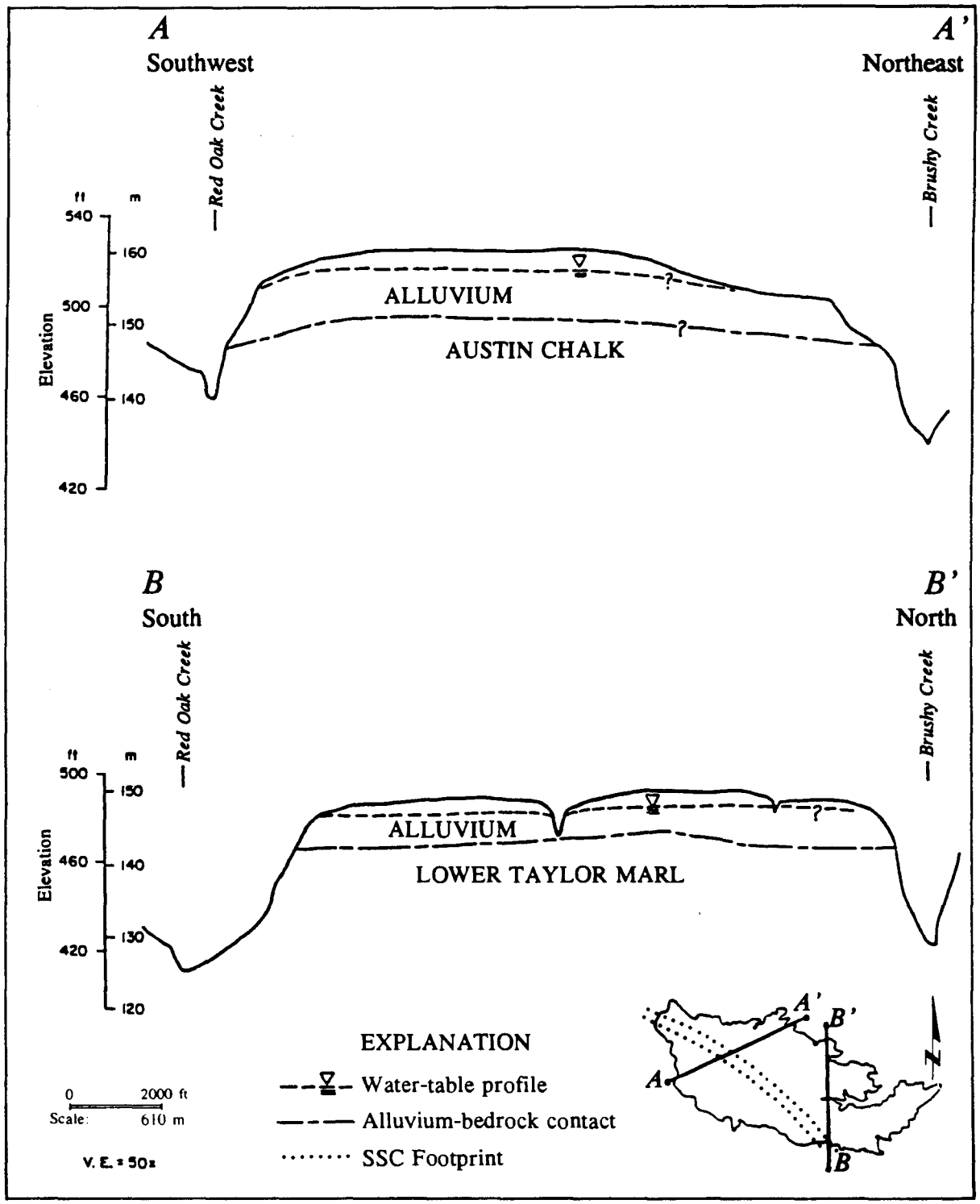

Figure 4-2: Cross sectional view of alluvial terrace.

Figure adapted from: Wickham and Dutton, "Hydrogeologic case Study" Sept. 1991, Bureau of Economic Geology, University of Texas at Austin, prepared for TNRLC.

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or missing well casings or covers. Some of these wells were filled with trash, constituting a potential source of ground-water contamination. Chemical analyses of ground water in the aquifer show widespread contamination by nitrates and bacteria within the study area. As a result of this contamination, the BEG has concluded that the ground water of the surficial aquifer is potentially unsafe as drinking water.

4.1.2 Further Studies

Additional studies by the BEG of the University of Texas at Austin are under way, with one goal being the establishment of a regional hydrological data base. It is especially important to establish the baseline conditions before the SSC facilities are constructed. Further studies are divided into the Phase II study, scheduled for completion in March 1993, and the Phase III study, scheduled for completion in June, 1994.

The Phase II study underway will lead to a comprehensive ground-water monitoring system for the area impacted by the SSC. It includes field studies of the Austin Chalk, Taylor Marl, and Eagle Ford Shale in order to characterize the subsurface stratigraphy and fracture systems, plus hydrologic studies of fluid flow in the Austin and Eagle Ford units, and interpretative and monitoring activities. At the end of 1991 the major geologic studies planned for Phase II were progressing on schedule; hydrologic studies were slightly behind schedule, and the interpretive, modeling, and monitoring tasks were on schedule.

Preliminary recorrelations of the Austin Chalk suggest that the unit is 15 meters (50 feet) thicker than originally reported, placing the base of the Chalk 15 meters (50 feet) deeper in the northeastern quadrant of the Collider ring. Fracture studies in the field and in cores show that the upper and lower units of the Austin Chalk are more fractured than the middle unit. Weathered zones in the Chalk near the land surface generally have greater than average fracture density, and weathered bedding planes there help connect the fractures, forming potential paths for fluid flow. It is not yet known whether these zones of enhanced porosity will affect fluid flow between the surface and the underground collider ring. An article, entitled "Fracture Systems of the Austin Chalk, North-Central Texas" (Collins, E.W., Hovorka, S.D., and Lauback, S.E., in prep.) describes the relationship between the chalk stratigraphy, fracture distribution, and location, including the influence of local faulting on fracture systems in the Chalk.

In March, 1991, the BEG began an inventory of public and private water wells around the SSC ring. A total of 591 wells inside and outside the footprint, almost all of them shallow dug wells, have been inventoried. Their location, condition, depth, depth to water, diameter, land elevation at the wellhead, and distance of the well from the beam

line have been put into a computerized data base, which will be revised and updated as the survey proceeds. The BEG performed pump tests and began water level monitoring on many of these wells during 1991.

Detailed logging of water levels in SSCL monitoring wells on the ring has been conducted since November, 1991, in order to establish baseline characteristics of water level fluctuations. These data are included in an interim report, "Record of Water Levels Measured at SSCL Monitor Wells" (Herrington, K. and Dutton, A.R., 1991b).

In addition, chemical analyses were performed on water samples from monitor wells to study water quality. Twelve of the 23 samples so far collected show high pH levels, for reasons at present unknown, but thought to be related to cement used to grout the well casings. Some pump tests have been conducted at monitor wells and some private wells throughout the area. Data from these tests will be available in August 1992.

The proposed Phase III study, to be completed in June 1994, will focus on deep ground-water resources associated with the Woodbine, Paluxy, and Twin Mountains Formations. These aquifers are of major regional importance, being the most important sources of water for small communities and unincorporated rural areas (Figure 1-10). Although many major cities have converted to surface water use, their historical reliance on these deep regional aquifers has resulted in a reversal in their flow direction. Rather than flowing southeast along the regional dip of the water-bearing strata, ground water in these aquifers in Ellis County now flows to the northwest as a result of over-pumping of the aquifers by users in the Dallas-Fort Worth metropolitan area (DOE, 1990). This study will be directed toward characterization of baseline conditions in the deep aquifers before the SSC becomes operational, followed by prediction of the response of the system as direct or indirect results of the Project.

4.2 Ground-water Monitoring Programs

Several ground-water monitoring programs will be implemented to verify that the quality of local sources of ground water remains unaffected by construction and operation of the SSC.

4.2.1 Ground-water Protection Management Program

Since the initial characterization of Ellis County ground-water resources, the SSCL has conducted an extensive program of geological sampling to verify and supplement the TNRLC information. Some monitoring wells have been installed in the formations in

which the Collider tunnel will be located (Austin Chalk, Taylor Marl, Eagle Ford Shale). Data from these wells verify that these formations are not aquifers. The water-bearing Quaternary gravels discussed in detail in Section 4.1 lie above the tunnel, and the water-bearing Woodbine Formation lies below it.

One concern is the possible leaching of radionuclides from the geologic materials in which the tunnel and interaction regions are constructed. Tests have been conducted on these materials to establish the degree of leaching expected. These results have been discussed in Section 3.3.2.

Ground-water monitoring programs and monitoring for radionuclides will be in accord with government mandates. The plans for ground-water monitoring will be proposed by the University of Texas at Austin BEG upon conclusion of their study, and with input from SSCL, TNRLC, and DOE, will form the basis for the ground-water monitoring program.

4.2.2 Pollution Prevention Awareness Program Plan

Other measures are being undertaken to protect ground-water resources. The Environmental Subcommittee and Panel will develop a Pollution Prevention Awareness Program Plan with the intent of training employees in pollution prevention awareness. The elements of this training will be:

- A Spill Prevention, Control, and Countermeasures Plan prepared by the Environmental Safety and Health (ES&H) Department to train personnel annually in spill control, including awareness of new pollutants and how to prevent their release into the environment. The final form of this plan is expected in May, 1992.

- Implementation of SARA (1986) began in 1991. Training in hazardous substance and waste compliance has been made available to the entire SSCL staff, and most have completed the training. Information on hazardous materials has been provided in the work place, including appropriate MSDSs.

- The list of hazardous chemicals to be used by the SSCL has been prepared and is being updated monthly as required by SARA. Required training of employees is already in progress. The ES&H Department is coordinating these efforts.

4.2.3 Soil and Water Resource Protection Plan

To satisfy a commitment made in the MAP, a Draft Soil and Water Resource Protection Plan has been prepared to provide guidance for the protection of the local soil, water, and earth resources. Facets of this plan have been discussed in the appropriate sections elsewhere in this report, since the impacts and mitigations for soil, water, and earth are so broad. The report discusses the soil, water, and earth resources that exist in the Project area, evaluates the impacts on these resources from both the construction and the operation phases of the SSC, enumerates the federal and state regulations and standards pertaining to these impacts, and finally discusses mitigation and monitoring programs to be applied to specific impacts.

4.3 Well Closures

The study of the shallow alluvial aquifer conducted by the BEG has identified several previously contaminated wells developed in this shallow aquifer. It has been recommended by BEG that these contaminated wells be cleaned and sealed to protect the ground water in this aquifer from further contamination.

In addition, any wells along the beam line that penetrate stratified fee land and are 150 feet to either side of the center line of the tunnel will be closed. One or two wells may be closed under this program.

5. SOCIOECONOMICS

5.1 Baseline Characterization Studies and Project Impacts

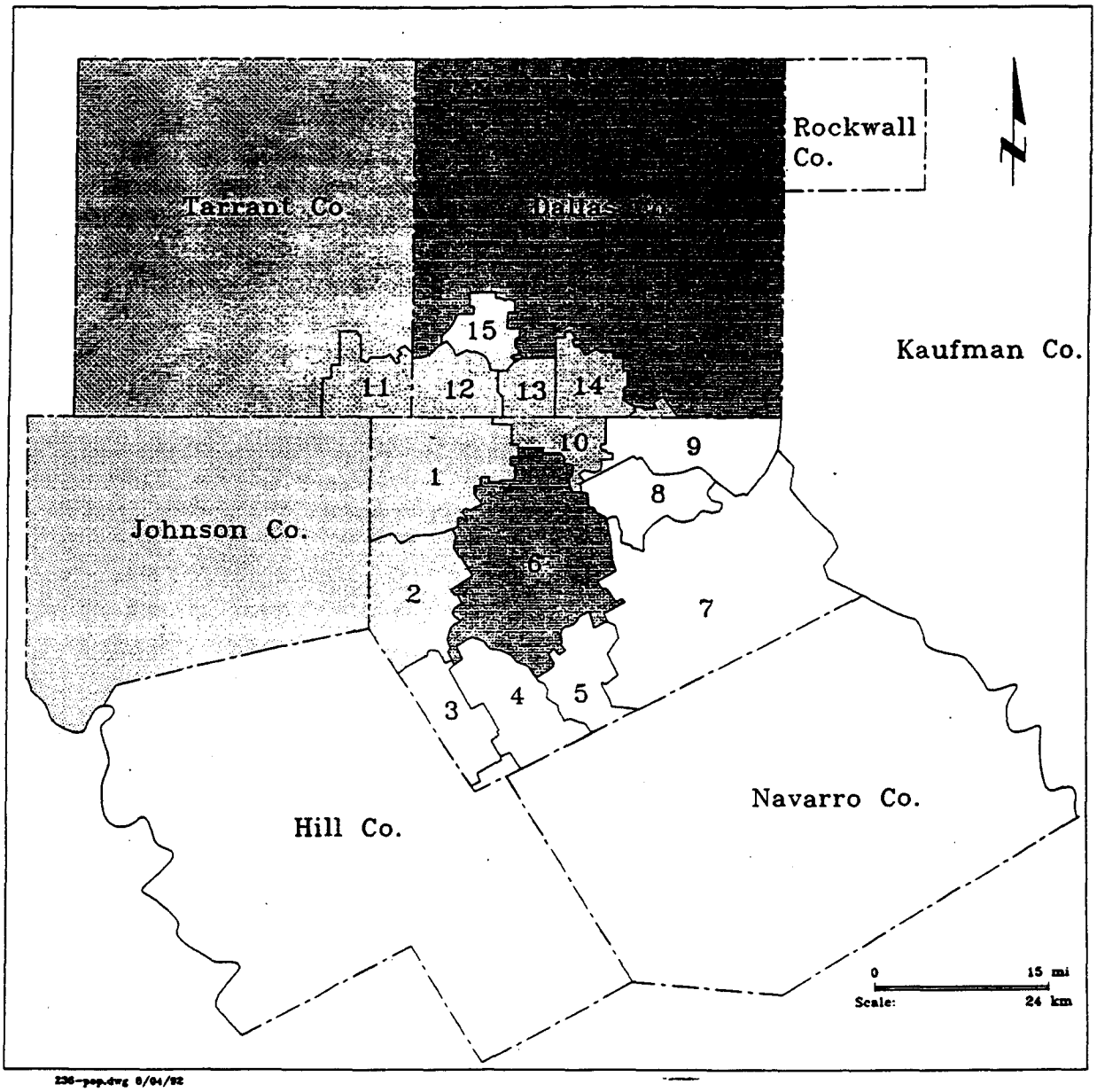
Socioeconomic impacts in the region of influence of the SSC Project depend on several factors: the eventual work force employed at the SSCL, the characteristics of workers who move into the area, the location preference of the incoming workers, and the number of local residents that can be employed. Predictions based on various combinations of these factors have been prepared to guide the decision-making process. However, until migration of substantial numbers of incoming workers occurs, the socioeconomic effects will be impossible to assess accurately.

An assessment of the effects of the SSCL on socioeconomics and infrastructure of the eight counties in the region of influence (ROI) has been prepared by Robert D. Niehaus, Inc., Santa Barbara, California (Robert D. Niehaus, Inc., 1990).

5.1.1 Assessment Methodology

The methodology for projecting SSC-related and secondary economic effects was provided in the EIS and is based on two extreme scenarios. In the model that assumes a high influx of new workers, half of all construction jobs, half of clerical and operations staff, half of all jobs created by secondary economic effects, and three-fourths of all professional and technical jobs would be filled by workers migrating into the region around the SSC. In the low-influx model, only one-fifth of the construction jobs, none of the secondary jobs or non-technical operations staff, and only half of the professional and technical operations jobs would be filled by workers from other areas. All visiting scientists would come from outside the area under both scenarios.

Effects of the SSC were considered in all sectors: demographics and housing, public services, public finance, transportation, utilities, economic activity, and quality of life. Effects were also broken down by region and municipality. A map referring to these sectors is presented in Figure 5-1. Changes in overall population (adults and school age children) are broken down by county and, in areas most affected by the SSCL, by school district. A brief summary of findings follows.



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School Districts

1	Midlothian	8	Palmer
2	Maypearl	9	Ferris
3	Milford	10	Red Oak
4	Italy	11	Mansfield
5	Avalon	12	Cedar Hill
6	Waxahachie	13	DeSoto
7	Ennis	14	Lancaster
		15	Duncanville

Increase in overall population (peak year)

- Fewer than 100
- 100 to 475
- 476 to 1000
- More than 1000

Figure 5-1: Region of influence of the SCCL: counties, school districts, and predicted distribution of population impacts

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Figure adapted from: Robert D. Niehaus, Inc., 1990. Socioeconomic and Infrastructure Impact for the Superconducting Super Collider in Texas: An Analysis in the Support of the Supplemental Environmental Impact Statement. Santa Barbara, Calif., draft report

5.1.2 Predicted Impacts

Demographics and Housing: The ROI of the SSC (including Dallas and Tarrant Counties, where the cities of Dallas and Fort Worth are located) contains over 3.9 million people, nearly one-fifth the population of Texas. Population has been growing in the eight ROI counties by rates that vary from 2.7 percent per year to 5.9 percent per year. Almost half of the total SSC-related housing requirements are estimated to occur in Dallas County, where the peak impact would amount to about 0.1 percent of the total housing units in the county. It is estimated that new housing requirements in other counties and cities would range from that figure up to 1.7 percent of total housing units.

Public Services: The key public services examined are public education, police and fire protection, and health care. The greatest impacts by far would be in Dallas, Tarrant, and Ellis Counties. To accommodate projected enrollment increases in the public schools, it is estimated that an additional 107 teachers would be required throughout the ROI by the peak year, 1993, to maintain existing levels of public education services. An additional 18 police officers and nine firefighters would be required. A total of 15 additional physicians and 50 registered nurses would be required by the year 2001 to serve the additional population associated with the SSC.

Public Finance: Revenue and expenditure levels for affected cities, counties, and school districts were examined. Only Ellis County and southern Dallas County were expected to see measurable project-related fiscal effects in the public sector. Increases in both revenues and expenditures are expected for local jurisdictions, as both population and tax base rise. The State of Texas is directly impacted due to the financial incentive package offered to the Federal government during the site selection process. This package included the spending of up to $1 billion to support infrastructure improvements and other project requirements. General obligation bonds and revenue bonds were issued to fund these expenditures. It is estimated that an average of $5 each year per household in the state would be required to retire a $500 million general obligation bond issue, assuming a 30-year amortization schedule.

Transportation: Roads, air and rail service, and public transportation are the focus of this section. There are no anticipated impacts on the existing system of air, rail, and public transportation in the ROI (Figure 1-1). Increased traffic on local roads due to construction of the SSC is expected, and steps to mitigate this problem have already been taken.

As far as possible, excavated earth materials will not be transported off the sites where they are produced, but will be used in place to minimize the transport of these materials off the site, as discussed in Section 2.1.1. Trucks bringing supplies to construction sites

are now guided by a series of signs directing them from the Interstate highways to the construction sites by the most suitable routes in order to minimize impacts on local traffic patterns.

Several road construction projects have been undertaken specifically to upgrade or replace local roads to accommodate the new traffic flow. A new access road was constructed around the N15 service area while Hoyt Road was being upgraded in anticipation of increased traffic. Problems arose with mitigation of impacts to North Arrowhead Road because of a very unusual series of rainstorms. A new road was planned because Arrowhead Road could not handle the increase in traffic associated with construction activities at the N15 site. However, over 76 cm (30 inches) of rain fell over a period of several months (normal rainfall is about 76 cm (30 inches per year), which delayed completion of the new road and caused the old roadbed to fail before the new one could be completed.

Activities for 1992: Plans for 1992 include facilitation by the TNRLC for the Texas State Highway Department to perform upgrading on local County roads for other construction traffic needs, because Ellis County does not have the financial resources to devote to the project.

Utilities: The present capacities and growth potentials of providers of electricity, natural gas, and telecommunications were examined. As the economy of the Dallas-Fort Worth region continues to improve after decline of the 1980s, both large and small scale developments are planned throughout the region in addition to the SSC, and it is expected that the capacity of local utilities will easily meet the increase in load. The Texas Utilities Electric Company has proposed several improvements to its system, including new overhead transmission lines and several new substations, and it is anticipated that this future Texas Utilities Electric System, planned prior to the SSC Project, would be able to absorb the SSC electrical demand easily.

Economic Activity: Employment, income, sales, and tax revenues would all increase as a result of the SSCL. By 1992 and 1993, the survey estimates that as many as 9,600 new jobs, both direct SSC employment and secondary jobs, would be created. In this sense the regional economy would benefit from construction and operation of the SSC beginning in the early 1990s.

Quality of Life: Impacts in this sector are concentrated directly in Ellis County, particularly among those whose homes and livelihoods would be relocated. This is a very broad and emotional issue, affecting primarily those who reside directly on property required for the project. Factors that might degrade the quality of life such as increased

traffic, fugitive dust, and noise associated with construction are being addressed by mitigative measures, which were discussed in Section 2 of this report.

People who move to the region as a result of SSC-related employment will almost certainly find the region hospitable. Ellis County communities pride themselves on their friendliness and welcome to newcomers. In addition, the generally favorable attitude that most residents have toward the SSC is also extended to "SSC families". No relocation problems are expected for this group.

5.2 Socioeconomic Monitoring and Mitigation Plan (SMMP)

The MAP specifies the need for a SMMP in order to address the impacts to the Project area that were highlighted in the Niehaus Report. This plan has been prepared (Thompson, J.G., et al., 1991) and its stipulations are at present being implemented.

5.2.1 Socioeconomic Monitoring Program

A SMMP is required in order to satisfy NEPA requirements that project development proceeds in a way that minimizes any significant adverse environmental impacts. Since the socioeconomic effects of the SSC cannot be characterized accurately in advance, a process to develop mitigation must be in place before the need arises, so that any problems may receive timely attention.

The monitoring program specified by the SMMP will be three-fold. First, surveys will be conducted of direct employees to establish housing preferences, number of persons in the household, mode of transportation and routes to and from work, number of school age children, and other questions that may become pertinent as settlement patterns become more obvious. These surveys will be completed by Project workers upon initial hiring, which will provide a baseline pattern. In the early phases of the Project, these surveys will also be completed by workers on a semi-annual basis in order to detect any changes in settlement patterns that develop as the Project proceeds. The follow-up monitoring will also establish employees' utilization of and satisfaction with local services.

The second part of the monitoring program is a quarterly survey of direct SSC employers, including the SSC Laboratory, TNRLC, and DOE, as well as DOE regional contractors and their subcontractors. This survey will document the number of employees, total payroll expenditures, local materials and services expenditures, and various taxes paid.

The third part of the monitoring effort consists of a semi-annual survey of potentially affected local jurisdictions such as counties, cities, and school districts. The information requested in this survey will vary according to the jurisdiction being surveyed, but will certainly address the number of employees, payroll, current budget, and degree of services currently provided by the jurisdiction.

Because there has been a buildup of the workforce already, an Employee Survey has been developed and administered (Appendix H). In addition a traffic survey has been conducted among employees to establish transportation patterns to and from the various SSCL facilities.

5.2.2 Mitigation Strategies

The DOE, in coordination with the TNRLC, will seek to monitor impacts (probably related to population change) that could trigger mitigation. Once an impact has been identified, two types of mitigation are possible. The first type of mitigation involves changing project-controlled factors that impact local jurisdictions. The second type involves local jurisdiction claims of impacts, which can be handled through a claims procedure on a case-by-case basis. Once a claim is approved, the TNRLC will recommend to the SMMP group as set forth in the SMMP that some payment, activity, or technical support take place. Mitigation Program Guidelines are being developed by the various agencies to handle these claims.

Most of the effects of the SSCL are expected to be beneficial in the long run as a result of the creation of thousands of new jobs either directly associated with the SSC or indirectly attributable to the increased economic base of the area created by new residents employed by the SSC. However, there have been two recent claims for reimbursement as a result of a decreased tax base attributed to the SSC. A large pharmaceutical distribution warehouse north of Waxahachie on Route 77, previously owned by Revco, was recently purchased by the State of Texas and now serves as the Central Facility for the SSCL (Figure 1-1). By the end of 1992 it will provide office and laboratory space for about 1,500 employees. State and Federal government agencies do not pay taxes, whereas the previous owner of the building did. Hence, the Waxahachie Independent School District has submitted a request for reimbursement of lost tax revenues as a result of government occupation of the building. The claim is still pending. Appendix A discusses these and other effects of the Central Facility purchase.

Ellis County has recently requested financial assistance from DOE for the adoption, implementation, and administration of new planning and zoning activities. The Texas State Legislature has empowered Ellis County with planning and zoning powers to

manage the growth that is expected to result from the construction of the SSC, but there are no appropriate sources of funding available to implement the program. Ellis County proposes to add three new positions: a Director for County Development, a County Planner, and a Secretary. Since this is the first county in Texas to have such planning and zoning authority, a state precedent does not exist.

The SMMP calls for the establishment of a committee to receive any claims and make recommendations on their disposition. This committee was formed in 1991 and includes members from DOE, SSCL, and TNRLC.

5.3 Emergency Preparedness Plan (EPP)

Federal, state, and DOE orders demand a site-wide EPP whose scope is defined by the type and degree of hazards present on the site, as well as the potential consequences of accidents. The Emergency Management Office of the SSCL is dedicated to preservation of life, property, and the environment both within the boundaries of the SSCL site itself and throughout the surrounding area. The EPP will be the organizational vehicle through which the SSCL addresses various possible emergency situations. These emergencies need not be confined to the site itself. With reciprocal agreements between SSCL and local jurisdictions in place, project personnel trained in various facets of emergency work would be available to assist local authorities in dealing with natural disasters or major accidents. The EPP will be completed by January, 1993, and will address such functions as emergency action levels, protective actions during emergencies, medical support, public information, activation and coordination of trained specialized response teams, communications, integration of SSCL personnel with local community response agencies, emergency equipment, and coordination of emergency drills and exercises.

5.4 Land Acquisition

The acquisition of land for the SSCL is occurring on a scale unprecedented in previous scientific endeavors. These land requirements alone constitute a major impact on the people of surrounding communities. The TNRLC, DOE, and SSCL have worked to define parcel boundaries that meet the technical and safety needs while minimizing impacts on individual property owners. The process has attempted to define takings along existing parcel lines, thus affecting the fewest number of land owners. Where alternatives existed, adjustments were made to avoid relocations. This policy accounts for the irregular shapes of some of the service and access areas. It is also the policy of DOE that radiation levels will not exceed 10 mrem/year outside the subsurface (stratified fee) volume. Rock and soil of the stratified fee volume will absorb any radiation, and

the radiation to humans at the surface will be negligible. The minimum depth of cover above the accelerator tunnel in privately owned surface areas will be 13.7 m (45 feet). Where the depth of cover is less than 13.7 m (45 feet), the land will be acquired by the Project.

The DOE stipulation that all land delivered to the project be cleared of all improvements has resulted in a mutually beneficial arrangement between TNRLC and local citizens. Rather than simply demolish the houses, TNRLC sold them to people who agreed to have the houses moved off the site. These measures were discussed previously in Section 2.4.

In other examples of attempting to minimize the impact of the SSC on individual land holdings, the N25 site was adjusted in order to avoid relocation of a family and to achieve greater separation from existing residences. The access route to N25 was relocated to avoid impacting the community of Sardis. The N30 site was adjusted to eliminate a relocation and to minimize noise and visual impacts to other properties. Boundaries of the S55 site were adjusted to avoid a historic structure.

6. CULTURAL RESOURCES

6.1 Historic Structures and Artifacts

6.1.1 General Information

The architectural firm of Hardy-Heck-Moore of Austin, Texas, conducted a survey of the historic resources of Ellis County from October 1989 to April 1990 in support of the SSCL (Hardy-Heck-Moore, 1990). The survey included all of Ellis County, both on and off the "Footprint" of the SSC, with the exception of the cities of Waxahachie and Ennis. Historic resources of Waxahachie and Ennis had been identified in earlier work. The "Footprint" of the SSC is considered to be the land owned in fee simple by the SSCL, and the land surface above the holdings in stratified fee. For the purposes of impacts on historical resources, the Area of Potential Effect of the SSC is currently defined by the Programmatic Agreement as the whole of Ellis County outside the SSC Footprint. It is expected that the Area of Potential Effect Management Plan (APEMP) will narrow the area of potential effects significantly.

As a result of the historic resources study, 3,714 previously unrecorded historic resources were identified within Ellis County, 41 of which were likely to be impacted directly by laboratory campus and service area construction. Included in the survey were domestic, commercial, and farm buildings, and bridges.

Following the completion of the historic resources survey by Hardy-Heck-Moore, Delara Almond Architects and the Southern Methodist University Archaeology Research Program devised a Historic Structures Management Plan (HSMP) (Almond, Killis P. et al., 1992). This plan provides general recommendations and procedures to assist the DOE and other participants in the SSC project in complying with their duties and responsibilities specified in Sections 106 and 110 of the NHPA of 1966. The HSMP is primarily concerned with historic structures located in the SSC footprint that are considered eligible for the National Register of Historic Places (NRHP). An APEMP to address historic properties in the rest of Ellis County is currently in preparation by DOE.

6.1.2 Historic Resources Survey Overview

The historic resources study conducted by Hardy-Heck-Moore involved two major aspects: field investigations and research investigations. The major thrusts of the field investigations were documentation of historical properties by survey forms and photographs and the assignment of preliminary priority ratings, which rated each property as high, medium, or low priority for further study. Research investigations consisted of archival research to provide an overview of the historical development of Ellis County, and site research to document the current legal status of each identified resource.

6.1.3 Survey Methods

Survey crews conducted their field research from the public right-of-way, without crossing private property. Thus a small percentage of historic structures were inadvertently omitted. The field crews documented properties according to age, architectural integrity, style, and historical associations. All properties were photographed with black and white film, the potentially significant structures with color film in addition. The crews also completed a survey field form, based on the Texas Historic Sites Inventory form used by the Texas Historical Commission (THC). Appendix I shows the form used. Each site received a permanent site number based on its location and a preliminary priority rating reflecting the property's relative significance, the known historical data, and the present condition of the property.

Preliminary research investigations were conducted to help characterize the major historical and developmental influences of the project area. This research helped to define the historical context used to organize and interpret the survey results.

6.1.4 Survey Results

Approximately 1.5 million hectares (600,000 acres) of land in Ellis County were included in the historic resources survey. The total number of potentially important historic sites identified was 3,714. Of these sites, 1,559 were classified as low priority (common example of architecture, engineering, or crafted design, but with severely diminished integrity due to alteration or deterioration, no known historical associations), and 1,563 were classified as medium priority (good or typical example, diminished integrity from alteration or deterioration, marginally significant historically). Five hundred ninety-two sites were identified as high priority; they are outstanding, unique, or good examples of architecture, engineering or crafted design, with no or minor alterations. Further, they retain a significant portion of their original character and contextual integrity, and are

significant modern or recent landmarks. High priority structures are potentially eligible for the NRHP. Appendix J lists criteria for inclusion in the NRHP. Figure 6-1 shows the locations of historic resources on the SSC Footprint. Appendix K lists those properties by site number and brief description.

The management of the SSCL is consulting with local agencies such as the Ellis County Historical Society and with the Advisory Council on Historic Preservation and the Texas State Historic Preservation Office (SHPO) in order to determine eligibility of sites in the SSCL area for placement on the NRHP. If disagreement on eligibility does occur, the final decision is made by the Keeper of the NRHP.

6.1.5 Historic Structures Management Plan (HSMP)

The TNRLC, in cooperation with other state agencies such as SHPO and the DOE agreed (in the Programmatic Agreement) that an HSMP was needed to assure compliance with Sections 106 and 110 of the NHPA of 1966. The Draft HSMP was prepared by Delara Almond Architects and Southern Methodist University Archaeology Research Program and submitted to TNRLC on December 2, 1991 (Almond 1991). Areas of responsibility for preservation of historic sites were clearly delineated in this document. TNRLC is the lead agency in the acquisition of land for the SSCL, and holds title to the land until it is actually needed for SSCL construction. In the original state site proposal from Texas, the state agreed to remove any improvements from properties if DOE did not wish to accept these structures. Therefore, TNRLC has the responsibility to mitigate most of the structures in the Footprint. While TNRLC has the responsibility to document the significance of and manage most structures within the Footprint, the preservation of historic structures is the responsibility of the Federal government.

One of the most important steps in any characterization of historic resources is to define the historic context of the properties to be evaluated. This is a particularly important assessment, inasmuch as the historical context provides a framework within which to discuss a group of related structures in terms of shared themes and common historical development. The historic context most relevant to the historic resources in Ellis County was perceived to be primarily agricultural and rural in focus. The formal context statement developed for the HSMP by Delara Almond and Southern Methodist University was "Agricultural Settlement, Farming and Building Traditions in Rural Ellis County, Texas: 1850 to 1945 A.D."

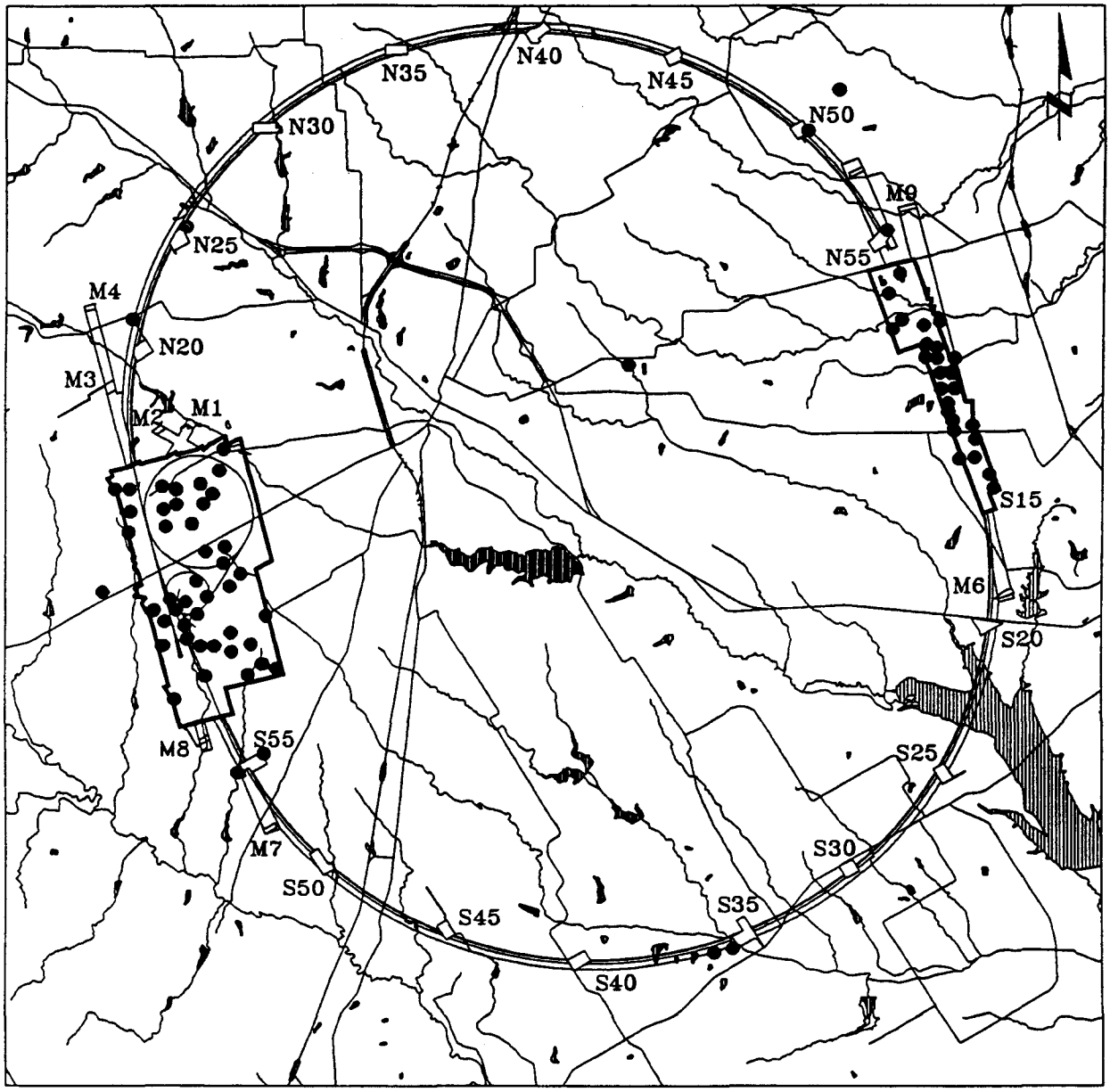
The contribution of disparate sites to the historic context of the SSCL area of impact is perhaps best illustrated by a brief discussion of several specific examples. A high priority property in good condition is the Dunaway House, Site 41EL75, near the small

community of Boz. This whole area is within the lands purchased in fee simple for the West Complex of the SSC. The Dunaway family has had significant land holdings in Ellis County since shortly after the region was first settled in the mid-1840s. The site has in the past comprised as many as nine farm structures in addition to the original residence, but the only ones that remain are a garage and the residence. These structures date from 1855 to 1925, a period that saw the transition from the traditional farming methods of the original settlers to the tenant farming and concentration on cotton typical of the early twentieth century. The residence itself has been modified several times, reflecting the evolution of building styles and family usage. These modifications will be the subject of further study. The site has been purchased by the TNRLC, as have all the other structures in the area. Most of the modern structures have been sold and removed from the West Campus area, and those that remain have been boarded up to prevent vandalism. However, the THC has expressed interest in having the historic properties remain in place. According to the Programmatic Agreement, all structures eligible for the NRHP will be included in a marketing plan developed to solicit proposals from organizations and individuals interested in preservation projects.

Another property of note is the Cunningham property, which was unoccupied previous to its purchase by the TNRLC and is in poor condition. The site of the house, a hill overlooking the surrounding countryside, was selected by an early surveyor of the area. Typical of many historic properties, the house has been modified and enlarged several times, the workmanship ranging from hand planed boards fitted precisely and joined with wooden pegs down to a quality best described as crude. This range of construction practices reflects not only the evolution of building practices in the area, but very likely the changing economic circumstances of the owners as well.

The old cotton gins that dot Ellis County are unique agricultural and industrial sites potentially eligible for the NRHP because of their associations with the emerging cotton-based culture that came to dominate Ellis County following the Civil War. Gins and their ancillary facilities such as cotton compresses, cottonseed oil mills, and textile mills were the basis of the local economic boom of the early twentieth century. In addition, the need to transport cotton products to markets was the major impetus for construction of roads and historic bridges in Ellis County. The old cotton gin at Five Points is close to the West Complex and has been identified as a high priority historical site. The prosperity generated by cotton led to construction of the large beautiful nineteenth century houses in Waxahachie, Ennis, and elsewhere in the County, many of which are already on the NRHP.

Other high priority historic sites on the SSC Footprint are the Mitchell, Welch, and Elliott properties. These sites will be subjects of further study and documentation. The



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Explanation

0 3.5 mi
Scale:
5.6 km

- Sites identified by Hardy, Heck and Moore

Figure 6-1: Location of historic resources in SSCL area

Figure adapted from: Hardy, Heck, and Moore, Inc., 1990, Historic Resources Survey of Ellis County, Texas. 1989-90, Austin, Texas.

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DOE will then make decisions concerning demolition, relocation, or preservation in place for the structures on these sites.

Activities for 1992: Representatives from DOE will meet with the THC to further refine the list of eligible historic structures in the SSC Footprint and the Area of Potential Impact. Sites may be added to or deleted from the current list. In addition, DOE will seek concurrence on the level of documentation (floor plan, photographic record only, etc.) required for structures on the list, establish firm priority levels, and initiate mitigation procedures for those structures that cannot be preserved in place. Possible mitigation procedures for historic structures within the SSC Footprint include maintenance in place by the SSCL, relocation (followed by stabilization, and reuse of the structure), or documentation according to various Historic American Building Sites/Historic American Engineering Record standards before removal.

An APEMP is in preparation. This plan will emphasize monitoring rather than mitigation of historic sites outside the area of direct impact of the SSC. The DOE, as lead agency, will periodically conduct reviews of historic sites in Ellis County to determine any indirect effects of SSC construction and operation.

6.1.6 Historic Artifacts

A number of historic artifacts that reflect the early days of prairie farming and ranching in Ellis County have been donated to the SSCL by Mr. Robert L. Mitchell of Ennis. These include a working tractor, a wagon from the early 1920s, plows, hay balers, harnesses, various handmade tools, and other farm implements.

6.2 Archaeological Resources

Every effort is being made by the SSCL to respect and preserve the archaeological resources of the Project area. Each construction or drilling site is surveyed by qualified archaeological personnel to obtain archaeological clearance (from SHPO) before construction begins. Surveys include historical as well prehistorical review, to assure that no traces of the history of early settlers or aboriginal inhabitants are obliterated by construction of the SSC. The Archaeology Research Program of Southern Methodist University has prepared a lengthy document, "An Archaeological Survey of the Proposed Superconducting Super Collider, Ellis County, Texas" (Jurney, et. al. 1990), which discusses in great detail the surveys of historic and prehistoric sites in the parts of Ellis County directly impacted by construction of the SSC. This survey, its methods, and the results are the subjects of the next four sub-sections of this report.

6.2.1 Survey Overview

The Archaeology Research Program of Southern Methodist University, under contract with the URA, has performed a first phase field archaeological survey of proposed fee simple purchase areas and impact areas associated with the SSC. Approximately 90 percent of the fee simple lands had been visually surveyed through mid-September 1990, when the Draft Interim report was issued. Thirteen prehistoric and two prehistoric/historic sites had been identified and recorded and may require further investigations to determine significance.

Of necessity, archaeology must incorporate into its framework geology, climate, and biology, for it is these fundamental attributes of a locale that define the course of human habitation. For this reason, short sections on these topics are included in the Draft Interim Report and some effort has been made to establish a correlation between them and the course of human prehistory in north central Texas. The Research Design will place more emphasis on these correlations. The draft Research Design is currently being reviewed by SSCL, DOE, and SHPO.

6.2.2 Survey Methods

The survey represents an initial assessment of cultural resources within the SSC Project area. The initial archaeological visual reconnaissance was designed to identify all cultural properties, determine their boundaries, and evaluate the material cultural content based on field observations of artifacts. In order to leave potential resources undisturbed, pending a more detailed study phase, temporally diagnostic artifacts were documented in field notes and photographs. Assessments of archaeological site significance are based primarily on the criteria of the NRHP.

The field survey was conducted by a crew consisting of a supervisor and at least three assistants. Every effort was made to conduct surveys under optimal conditions such as plowed fields immediately after a rain, and to avoid fields with standing crops. Field crews walked each survey tract at a 20-m spacing. All creek banks were walked, and some banks were cut back to provide fresh soil horizons. Limited numbers of shovel tests were conducted with the landowner's permission when circumstances warranted. Boundaries, ground cover, and field conditions of surveyed tracts were recorded on project maps and field notes. Crews filled out a Texas Archaeology Research Laboratory site form for each site discovered (Appendix L).

The same methods were applied to advance clearing of areas selected for geotechnical borings. If cultural resources were encountered, all ground disturbing activities were

halted and a new location for the geotechnical work was established and clearly flagged in order to avoid disturbing the cultural resources. In this way archaeological clearance was obtained for each drilling site. In addition, two samples of material recovered from the geotechnical boring at the S35 site, located in the floodplain of Big Onion Creek, were submitted for radiocarbon dating.

Finally, team members conducted archival research to review pertinent archaeological reports from earlier projects such as Bardwell Lake, Richland Creek Reservoir, and Joe Pool Lake, as well as several smaller projects in the region. General Land Office surveys provided information on native vegetation and landscape from the first settlers.

Collections of archaeological artifacts by local individuals have provided a wealth of comparative data from areas adjacent to the project although not directly from the SSC site itself.

6.2.3 Survey Results

Several possible statements of context were developed for the archaeology program, similar in intent to the historic context statement developed for the survey of historical resources of Ellis County. At present, a single context has been published for the archaeological survey: "The Emergence of Sedentism in Northeast Texas." Two additional contexts are being reviewed: "Cultural Implications of Late Quaternary Environmental Change in Northeast Texas" and "The Evolution of Agricultural Societies in Northeast Texas." These statements of context are intended to serve as organizational frameworks within which to identify, evaluate, and treat archaeological resources. Based on this and previous studies, more specific research questions have been developed for the SSC area in order to guide future investigations.

In general, prehistoric artifacts in this area have been found adjacent to creeks in the deep undisturbed sediments, and there is some question about how much material actually exists. Some has been washed away; other material has almost certainly been covered by alluvium in flooding events. To date, the prehistorical finds show no evidence that villages or large encampments occupied the SSC area; most evidence suggests transient occupation, perhaps the campsites or retooling areas of hunting parties.

Currently, some 15 prehistoric sites have been identified on land that is or will be owned outright by the SSC. An interesting pattern is revealed when the sites are grouped by location. Twelve sites are on or near the East Campus land, although that land constitutes less than 10 percent of the surveyed area. This density of sites is probably due to a combination of geologic circumstances. A deposit of water worn lag gravels

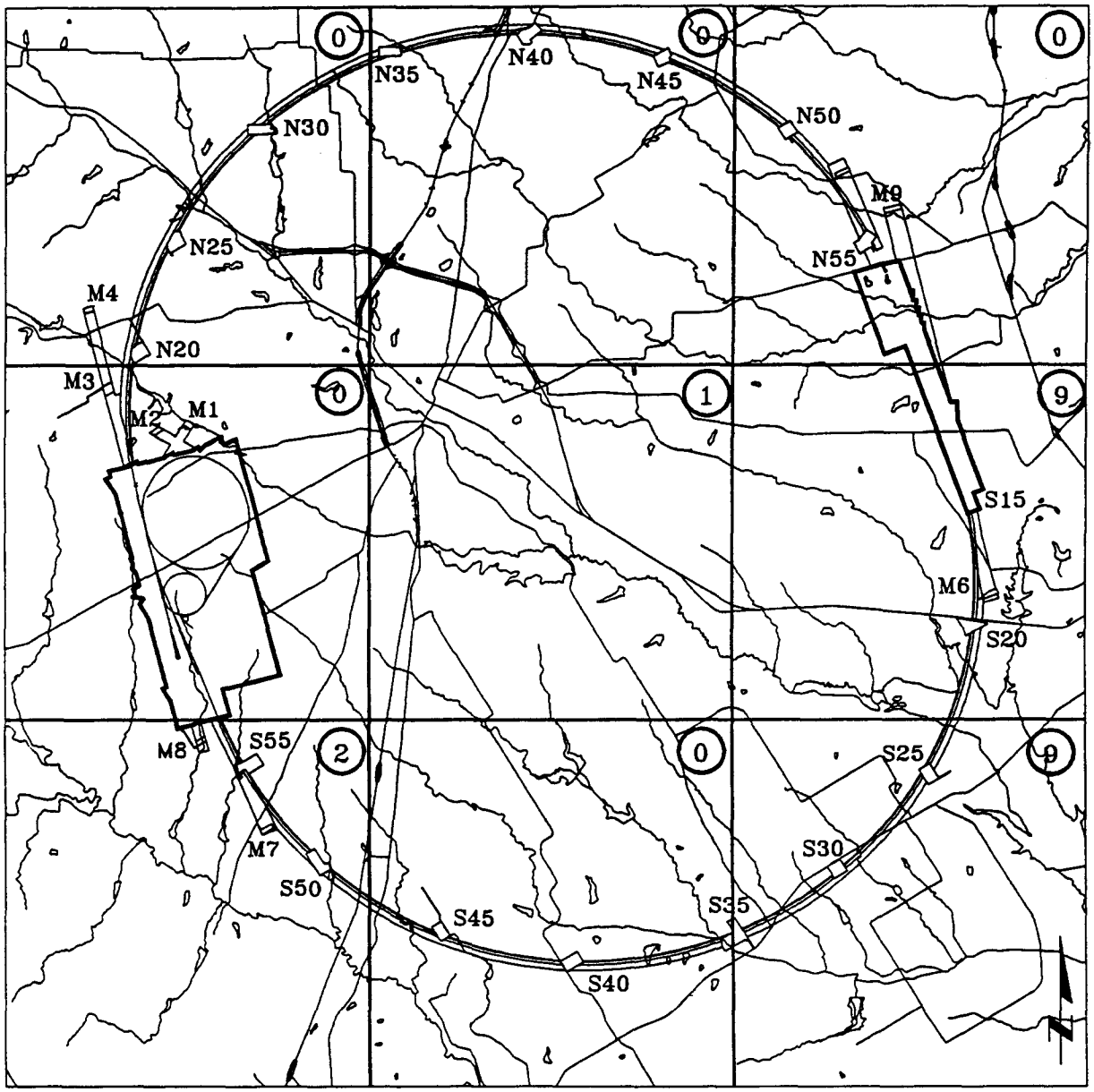
(Uvalde gravels) from long abandoned stream channels blankets large parts of the East Campus land surface, and although geologically insignificant these gravels are culturally vital. The single most distinctive trait of the Paleo-Indian culture is the crafting of stone projectile points, and the Uvalde gravels provide the only local source of suitable material for the manufacture of these stone tools. In addition, the eastern half of Ellis County hosts many natural springs, which could have provided reliable water sources to both prehistoric and historic peoples.

Most of the prehistoric sites consisted of lithic scatters with quartzite and/or chert flakes, cobbles, and broken pieces. Some of the material has been worked into sharp edges, some has been broken by impact, and some has apparently been tested for suitability as tools. Some stones are unmodified but consist of material not native to the region, suggesting that they were carried from their source area by tool-makers, indicating either trade or a high degree of travel. In rare cases, blades or projectile points have been found. Figure 6-2 shows the general locations of prehistoric properties.

6.2.4 Future Research

One of the primary research directions of the archaeology program concerns the interaction between the natural environment and human ecology, only one facet of which is illustrated by the geological theme discussed above. Soils, climate, vegetation, and fauna have each played important roles. The SSC project area falls into a broad transitional belt between deciduous forests to the east and shortgrass prairie to the west. The area is also an upland site, as contrasted with the more heavily watered and vegetated lowland sites. The influence of these factors on migration routes or habitation patterns of aboriginal populations is an important topic for research.

The patterns of previous archaeology studies in this region of Texas have been dictated largely by reservoir projects; hence studies have concentrated on lowland settings, which are more conducive to human habitation than uplands such as the SSC region. In many cases, however, these lowland sites are "artifact mines" that represent extensive overlap of multiple generations and cultural groups. In these cases, although many artifacts are unearthed, it is sometimes difficult to separate the contributions of different groups and generations. In contrast to these artifact mines, the SSC sites are marginal sites; that is, they are peripheral to the mainstream of sociocultural development as seen in adjacent regions of Texas. They are apparently ephemeral sites, utilized for short periods of time by highly mobile groups. Precisely because marginal sites such as these are widely scattered in both time and space, they are a unique archaeological resource. The assemblages of artifacts found at the upland sites are relatively pure and unmixed by subsequent occupations, so they represent, to a far greater degree than the heavily used



Explanation

(4) Number of prehistoric sites in grid

Scale: 0 — 3.5 mi / 5.6 km

Figure 6-2: Number of archeaological sites in regional grid

Figure adapted from: Jurney, D. H. et al., Inc.,1990, An Archeaological Survey of the Proposed Superconducting Super Collider, Ellis County Texas. Southern Methodist University, Dallas, Texas, draft interim report.

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lowland sites, an "instant" in archaeological time. As such, these sites demand a carefully planned research program.

To date, the archaeological work has consisted of walkover surveys, limited test excavations and archival research. No artifacts have been removed from the sites pending the design of an appropriate site-by-site research program. The level of effort will range from one crew day per site to several crew days at each site. Detailed surface mapping and artifact recovery will be required at 13 sites. Five additional sites do not appear to merit surface collections. If the results of surface investigations are promising, testing at depth will be carried out. Portable resistivity meters will be used to probe for subsurface cultural remains. If these results warrant further investigation, large scale subsurface methods such as augering, backhoe trenching, and block or trench excavations will be utilized. All excavation of culture-bearing strata will be by hand. Artifact surfaces will be mapped and photographed *in situ*. Samples will be taken from each site and subjected to further laboratory work.

Some of the options for research techniques include analysis of the stone artifacts to establish source areas for the raw materials, and methods of working the material. Any ceramic material recovered from sites should be similarly analyzed to determine sources of temper and clay material. Vertebrate, invertebrate, flora, and human remains all yield invaluable clues as to the nature of society in the site area and should be thoroughly studied. In order to reconstruct the study area's environmental setting during the period of aboriginal occupation, the Recent regional geology should be carefully analyzed for climate changes and other culturally significant features.

6.3 Worker Education Program

One of the ongoing efforts of the SSCL is to inform workers in the construction and monitoring programs of relevant laws and regulations related to archaeological sites and historical properties, in order to eliminate accidental or intentional destruction of possibly significant archaeological artifacts encountered in the field. This information is contained in a pamphlet that is printed in both English and Spanish and provided to each worker. If any unusual material is discovered at any site, work must be stopped immediately and the discovery reported to the SSCL. Disturbance of the site will not continue until clearance is obtained from an archaeologist. One of the authors of the Archaeology Survey is a local resident of Ellis County and is available often at a moment's notice to investigate any site upon request. In this way, DOE intends to avoid any loss of significant archaeological material in construction or operation of the SSC.

The primary responsibility matrix for cultural and paleontological resources is

	Requirements Validation	Mitigation Development	Mitigation Implementation	Mitigation Verification
Paleontological and archaeological resources	SSCL	A-E/CM	A-E/CM	A-E/CM
Historic structures transferred to DOE	SSCL	SSCL	SSCL	SSCL
Historic structures not transferred	TNRLC	TNRLC	TNRLC	TNRLC
Worker education program	SSCL	DOE	A-E/CM	SSCL

All Performance Audits are conducted by DOE.

7. QUALITY ASSURANCE

Although the primary mission of the SSC is research, Laboratory Management has committed the program to

> "...protecting our environment and conserving our natural resource heritage both for ourselves and future generations. To assure fulfillment of our commitment, the project has adopted the following environmental quality goals:
>
> - Demonstrate leadership in environmental protection and improvement
> - Minimize adverse environmental and health impacts while accomplishing the scientific research for which the machine is designed.
> - Initiate aggressive action to comply with all Federal, State, and local environmental quality laws.
> - Restore, augment and enhance wetlands and other environmental features during project development and operation.
> - Support programs for the recycle and reuse of materials to conserve natural resources, prevent pollution, and minimize the generation of waste.
> - Pursue an active role in addressing environmental quality issues in our relations with neighboring communities.
> - Assure through a Pollution Prevention Awareness Program, that project plans recognize a requirement for pollution prevention.
>
> To these environmental quality goals the SSC project remains irrevocably committed."

The primary objectives of quality assurance programs are to ensure that data generated by the SSCL is of the highest possible quality. In addition, the idea of quality assurance pertains to many other parts of the SSC construction and operation program, as well, from land issues to decontamination and decommissioning activities.

7.1 Data Quality Objectives

In discussing laboratory results the following individual components of overall data quality must be considered:

Precision: A measure of the analytical agreement between multiple measurements of the same property for an individual sample.

Accuracy: A measure of the degree to which an analytically determined value approaches an accepted reference value.

Representativeness: A qualitative expression of the degree to which data represent the actual concentrations of the target compounds in the environmental matrix of interest.

Comparability: An expression of the confidence with which one data set may be compared to another. Data subjected to strict quality assurance procedures will be more reliable and therefore more comparable than data obtained from less controlled environments.

It is SSCL policy to achieve the highest precision, accuracy, representativeness, and comparability possible while still keeping costs within reasonable bounds.

Several program plans are being developed or are to be developed in conjunction with the Environmental Protection Implementation Plan for the SSCL. Most of these plans have been discussed in more detail elsewhere in this report, but they are listed here for completeness:

Long Range Environmental Protection Plan
Ground-water Protection Management Program Plan
Waste Minimization Program Plan
Pollution Prevention Awareness Program Plan
Environmental Monitoring Program Plan
Environmental Quality Assurance Program Plan
Spill Prevention Control and Countermeasure Plan
Emergency Preparedness Plan

Safety Analysis Report
Operational Readiness Review

These last two documents act as final quality checks on the design and construction processes of the SSC. The Safety Analysis Report stipulates the safety measures that must be implemented, and the Operational Readiness Review serves as a final check that all facilities are safe for workers and members of the public before the SSC goes into operation.

7.2 Environmental, Safety, and Health (ES&H) Quality Assurance Program

The Quality Assurance Program will address each element of the SSCL environmental monitoring and surveillance program and assure consistency with DOE Order 5700.6C, as well as meeting the elements of Chapter IV 1.0 of DOE Order 5400.1. It addresses quality standards and procedures to be followed in all aspects of Laboratory operation.

Adequate documentation (e.g., field logbooks, chain-of-custody records) will be required to ensure that all sample collection criteria are met. Samples collected for the purposes of monitoring must be traceable from the time of collection through analytical determination and archiving if required.

The SSCL will participate in the Independent Data Verification Program, which will be integrated into the ongoing environmental monitoring program. The ES&H Oversight Office will coordinate the SSCL participation in the program.

7.2.1 Analytical Laboratories

Only laboratories with clear documented management system records and records of certification will be contracted for analytical work. Sample analyses will be performed by applicable standard methods and covered by an adequate quality assurance program.

To preclude bias, third-party laboratories were deemed necessary, rather than an internal laboratory or a University laboratory that might be connected with the URA. To select an analytical laboratory several criteria were used. The credentials of laboratory staff and the quality of laboratory equipment were reviewed, as were existing laboratory certifications by government agencies. Previous contract performance for the SSC was considered. The final selection of the analytical laboratory included required consideration of small business status and whether it was minority-owned. Armstrong

Forensic Laboratory, Inc. of Arlington, Texas was selected as the primary analytical laboratory, and Scientech, Inc. of Carrollton, Texas was chosen for radiological analyses.

7.2.2 Analytical Procedures

The methods to be used in analyzing environmental samples will be approved standard U.S. Environmental Protection Agency methods. The method for each analysis will be recorded and reported to SSCL along with the analytical results. In addition, the laboratory must specify the detection limit for each component analyzed, so that if a quantity is reported as "not detectable", the maximum possible quantity present is known.

SSCL laboratory personnel will personally inspect and audit both analytical laboratories and recycling/disposal contractors to assure that proper procedures, chain-of-custody, handling, cataloging, and accounting methods are followed, as well as assuring proper permitting and compliance, plus adequate training and qualifications of personnel.

7.3 Additional Quality Assurance Plans

Several other quality assurances are planned for SSCL, as well as outside laboratory personnel. One audit program planned is to check job descriptions against actual work performed to ensure that SSCL personnel are properly matched to the work they perform. In the case of outside laboratories, the job task analysis will be reviewed, along with the personnel records to ascertain qualifications and training. Audits will be used to verify continuing compliance with SSCL procedures and contracts. For example hazardous waste treatment, storage, and disposal facilities will be audited periodically, because the hazardous waste generator retains liability.

SSCL and the vendors responsible for the analyses of SSCL samples in support of the environmental radiological programs will participate in the DOE interlaboratory quality assurance program (coordinated by the DOE Environmental Measurements Laboratory in New York). The ES&H Department will be responsible for ensuring participation of SSCL and its vendors. Other vendors/suppliers of environmental services will be required to meet stringent quality standards, and quality assurance plans will be implemented in those cases as well.

7.3.1 Land Issues

A major concern is that any problems associated with land owned by the SSCL are remediated promptly. Problems include (but are not limited to) removal of septic tanks, closure of wells within the specified distance of the collider tunnel, and removal of abandoned fuel storage tanks. A large part of the land was previously of rural agricultural usage, posing the possibility of high pesticide residuals as well as fuel tanks for operation of farm equipment. The solutions to these problems will be considered on a case-by-case basis.

7.3.2 Decontamination and Decommissioning

At some time in the future, the SSC must be decontaminated before it is decommissioned. The decontamination and decommissioning requirements are being addressed during the design phase, and current information will be maintained during the operational phase to assure safe and correct decontamination and decommissioning. To avoid costly duplication of effort, the SSCL will document all mitigation measures taken as they are completed, so that adequate records exist when it is time to retire the SSC from use.

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APPENDIX A

NEPA Evaluations of Collider Design Changes in 1991

APPENDIX A:

NEPA Evaluations of Collider Design Changes in 1991

1. ORIENTATION OF COLLIDER RING TUNNEL AND HEB

Design changes to the Collider ring tunnel and HEB ring are the following:

- The long axis of the Collider tunnel oval has been rotated approximately 8 degrees counter-clockwise.
- The dip of the plane of the Collider ring has been changed from 0.179 degrees to 0.198 degrees to the southeast.
- The elevation of the HEB ring has been raised to match the new elevation of the main ring.

The environmental impacts of these changes to Collider ring orientation have been reviewed and are discussed in the following paragraphs.

Earth Resources: The shafts on the western side of the ring will be as much as 6 m (20 feet) shallower, and those on the eastern side of the ring will be up to 7.6 m (25 feet) deeper, measured from the crown of the tunnel to the land surface. Calculations suggest that the net effect on spoil volume is a decrease of approximately 230 m^3 (300 cubic yards), which is negligible compared to the total spoil volume. The worst case is at the S25 (formerly E-7) site, where the increase in depth is projected to be 7 m (23 feet), and three major shafts are planned. Spoil volume at S25 is estimated to increase by just under 2,600 m^2 (3,400 cubic yards). According to the analysis in the SEIS, however, this site could easily accommodate over 9,180 m^2 (12,000 cubic yards) of additional spoils. Since S25 is the worst case site, all other sites will fall well within the assessment discussed in the SEIS, and no additional mitigation actions beyond those already planned will be required.

Water Resources: The SEIS noted that all wells penetrating the stratified fee volume within 46 m (150 feet) of the beam tunnel would be closed. The change in tunnel elevation does not increase the number of wells to be closed, which remains at ten.

Land Resources: The requirement that 13.7 m (45 feet) of earth cover the beam tunnel on land not owned by DOE dictates that small additional parcels of land be acquired in

Visual Impacts: Since the volume of spoil is essentially unchanged from that originally anticipated, there should be no visual impact that is not assessed in the SEIS.

Other Impacts: The finished inside tunnel diameter has no effect on water resources, biological resources, soils, cultural resources, radiation hazards, or the use of hazardous materials.

4. ACQUISITION OF CENTRAL FACILITY

The TNRLC has purchased and is remodelling the Revco Building in Waxahachie, Texas, and is using this site as the Central Facility for the SSCL. The environmental impacts associated with use of this building by the SSCL have been evaluated and are discussed in the following paragraphs.

Biological Resources: The whole area surrounding the Central Facility is already zoned and developed for heavy industry. There is virtually no natural vegetation and no wildlife habitat, therefore no impact.

Air Resources: There will be little to no disturbance of the land surface, hence no dust. There is no change in the number or transport of SSCL workers from those addressed in the SEIS, and no mitigation measures were predicted to be needed in that document.

Cultural Resources: Due to the disturbed nature of the site as it currently exists, within an area zoned and developed for heavy industry, no impact on cultural resources as a result of SSCL use will occur.

Socioeconomics: The water supply to the Central Facility is provided by the City of Waxahachie, and no change is anticipated in that service. One additional sewer line will be added to serve the full complement of employees at the site, and the city's publicly-owned treatment works has more than available capacity to accommodate the proposed action. Only a modest upgrade to the telephone and natural gas service is anticipated.

The additional employees at the site will result in an increase in vehicular traffic in the area. Should any traffic congestion develop as a result of occupation of the Central Facility by the SSCL, the mitigation measures discussed in the SEIS will be implemented. These include staggering of working hours, encouraging ride-sharing among employees, using shuttle vans for transportation between SSC sites, and using traffic control guards at the main intersection of the site with public roads.

The Waxahachie Independent School District has filed a request for compensation for tax revenues lost as a result of government ownership of the building, and its consequent removal from the public tax rolls. This claim is still pending, and is discussed more fully in Section 5.2.2.

Other Impacts: No impacts due to SSCL use of the Central Facility are expected in the areas of earth resources, visual resources, noise and vibration, soils, radiation hazards, or use of hazardous materials.

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APPENDIX B1

Part of the Environmental Compliance Plan (ECP) for Linear Accelerator (Linac), N15 Site

Table 1

DOE ENVIRONMENTAL COMMITMENTS FOR THE FACILITIES AT THE INJECTOR AREA

TOPIC/CONCERN	REFERENCE	STANDARD/COMMITMENT	COMMENT
1. Excavation and Spoil	FSEIS Sec 4.1.6 (p 4-5)	• Sample Eagle Ford Shale runoff for toxic leachate.	
		• Use in project features and landscaping.	• Material excavated during construction will be used in the formation of shielding berms.
		• Blend spoil that is excess to project needs into the existing and surrounding topography.	
2. Water Quality			
a. Erosion and Sediment Control	FSEIS Sec 4.2.2.1 (p 4-7) FSEIS Sec 4.2.2.4 (p 4-17) FSEIS Sec 4.2.2.5 (p 4-18)	• Schedule construction to reduce size of disturbed area at any one time.	• These items are addressed in specifications and plan sheets.
		• Temporarily divert surface runoff around construction areas.	• Appendix II to the General Conditions of all construction subcontracts requires the subcontractor to submit a plan for implementing the environmental requirements contained in the contract documents
		• Timely topographic and locally-adapted vegetative restoration of disturbed areas.	
		• Stormwater detention to maintain stream flow and flood peaks to preconstruction levels	
		• Adequate number of properly sized sediment control basins and grade-stabilizing structures in temporary channels.	
	FSEIS Sec 4.2.2.4 (p. 4-17)	• Maintain natural buffer strips along water courses.	
		• Use runoff-retarding devices (e.g., straw bale).	

Table 1 (Continued)

DOE ENVIRONMENTAL COMMITMENTS FOR THE FACILITIES AT THE INJECTOR AREA

TOPIC/CONCERN	REFERENCE	STANDARD/COMMITMENT	COMMENT
	FSEIS Sec 4.2.6 (p. 4-29)	• Protect temporary soil stockpiles from erosion; trap sediment (e.g. straw bale, silt fence).	
		• Locate features outside of stream courses and 100-year floodplains.	• About 2,000 ft. (1.38 ac) of streambed may have to be permanently relocated due to construction of the Linac and LEB.
		• Properly maintain erosion and sediment-control devices during construction and operation.	• FEMA maps show the Linac to be out of the 100-year floodplain while PB/MK calculations show it to be in this floodplain. Appropriate design features and coordination with FEMA and Ellis Co. need to be implemented to resolve this issue.
b. Fuels and Lubricants	FSEIS Sec 4.2.2.5 (p 4-18)	• Trap pollutants from roads and parking areas in runoff detention basins.	• Detention basin serving the Injector Area will trap sediments and oil from the first flush (about 1/2-inch) of rainwater runoff.
c. Sanitary Wastes	FSEIS Sec 4.2.2.5 (p 4-18)	• Treat with package treatment system during construction. On-site treatment plant during operation.	• Combination of chemical toilets and on-site treatment plant.
	FSEIS Sec 4.2.3.4 (p4-24)	• No septic system with drainage fields. Verify that leachate is not a concern.	
d. Industrial Wastes	FSEIS Sec 4.2.2.5 (p4-18)	• Industrial wastewater is to be handled by the West Campus wastewater treatment plant.	

Table 1 (Continued)

DOE ENVIRONMENTAL COMMITMENTS FOR THE FACILITIES AT THE INJECTOR AREA

TOPIC/CONCERN	REFERENCE	STANDARD/COMMITMENT	COMMENT
e. Hazardous Wastes	FSEIS Sec. 4.7.1.3 (p4-87)	• The Texas Low Level Waste Disposal Authority was confirmed its willingness and ability to accept the LLW produced by the SSC	
3. Water Level and Overdraft			
a. Shallow Aquifer	FSEIS Sec 4.2.3.1 (p. 4-23)	• Inflows controlled by pressure grouting.	
b. Deep Aquifer		• Minimize withdrawals by relying on surface water for cooling pond make-up.	
4. Biotic Resources	FSEIS Sec 4.3.8 (p 4-42)	• Site the facilities at the Injector Area and their associated construction support areas to minimize clearing.	
		• Visual reconnaissance of riparian areas during construction to prevent unauthorized intrusion into sensitive habitats or areas.	
		• Implement effective and timely erosion and sediment control measures.	• Specific requirements discussed in Item 2a.
		• Conduct activities during low- or no-flow conditions.	
		• Segregate and store topsoil for use in revegetating disturbed areas.	
		• Remove excess construction materials from work site and practice good housekeeping.	

Table 1 (Continued)

DOE ENVIRONMENTAL COMMITMENTS FOR THE FACILITIES AT THE INJECTOR AREA

TOPIC/CONCERN	REFERENCE	STANDARD/COMMITMENT	COMMENT
		• Minimize damage to vegetation during construction of buildings and infrastructure (e.g., roads, utilities). • Use existing access and stream crossings, when possible. • Temporarily fence wooded areas that are within the construction limits to prevent unauthorized construction activities, where appropraite.	
5. Wetlands	FSEIS Sec. 4.2.2.3 (p 4-15) and Sec. 4.2.6.2 (p. 4-30)	• Where avoidance is not practicable, some form of wetland compensation will be required. (150% replacement of lost area.)	• U.S. Fish and Wildlife Service and Texas Parks & Wildlife Department will be consulted during the design phase of any additional ponds.
6. Air Quality (dust)	FSEIS Sec 4.5 and 4.5.1 (p 4-50), Sec 4.5.3 (p 4-53)	• Satisfy NAAQS for thoracic particle (PM_{10}) emission: 50 $\mu g/m^3$ annual average 150 $\mu g/m^3$ 24-hour average.	• These values are totals for all sources. The FSEIS estimated the 24-hour average background concentration to be about 41.2 $\mu g/m$.
	FSEIS Sec 4.5.5 (p 4-59)	• Petroleum resin on unpaved roads and haul roads. • Watering unimproved unpaved haul roads. • Vacuum sweeping paved roads in fee-simple area. • Minimize wind erosion from topsoil and spoil storage piles by watering or other means to control dust leaving the site.	• These measures are predicted to be effective if dust-generated sources are at least 50 meters from a receptor.

Table 1 (Continued)

DOE ENVIRONMENTAL COMMITMENTS FOR THE FACILITIES AT THE INJECTOR AREA

TOPIC/CONCERN	REFERENCE	STANDARD/COMMITMENT	COMMENT
		• Coordinate with Texas Air Control Board for enforceability.	
7. Noise and Vibration			
a. Noise	FSEIS Sec 4.6.2 (p 4-64)	• Operational noise levels: - 55 dBA or less during the day at receptor - 47 dBA or less during night at receptor	
	FSEIS Sec 4.6.3 (p 4-66) FSEIS Sec 4.6.5 (p 4-77)	• Reduce noise levels during construction if the levels at the receptor exceed guidelines. • Conduct routine noise monitoring at critical locations and implement corrective action to comply with applicable guidelines as necessary.	
b. Blasting	FSEIS 4.6.3.4 (p 4-71)	• Limit peak particle velocity to 2.0 in/sec. or less at any occupied structure not related to construction. • Limit air blast over pressure to 0.01 lb/in.^{2}. • Survey potential noise and vibration receptors to establish pre-blast conditions. • Monitor vibration and noise during all blasting phases. • Assess damage at receptors during and after blasting.	

Table 1 (Continued)

DOE ENVIRONMENTAL COMMITMENTS FOR THE FACILITIES AT THE INJECTOR AREA

TOPIC/CONCERN	REFERENCE	STANDARD/COMMITMENT	COMMENT
8. Solid Waste	FSEIS Sec 4.7.6.2 (p 4-102) and FSEIS Sec 4.7.6.3 (p 4-102)	• Solid wastes transported and disposed by contract in accordance with Texas Water Commission and Texas Department of Health Regulations. • Small quantities of hazardous waste (e.g., residue epoxsy resins and hardeners, solvents, diluted acids, paint, mold releases) will be transported and disposed in accordance with applicable regulations by a licensed contractor. • Exposures reduced through construction subcontractor training and hazards communication program.	• Requirements contained in Appendix I to General Conditions of each construction subcontract.
9. Socioeconomic and Infrastructure	FSEIS Sec 4.8.11 (p 4-11)	• Stagger work force if construction-related traffic becomes a problem. • SDH & PT will improve roads outside fee simple area.	• Potable water and commercial electric will be provided by franchised utility companies using existing rights-of-way.
10. Cultural Resources	FSEIS Sec 4.9.4 (p 4-126)	• Avoid significant resources • Worker Education Program • Protect resources discovered during construction.	• Mitigation accomplished in accordance with the Programmatic Agreement.

Table 2

INVENTORY OF SOURCES AND PERMIT ASSESSMENT FOR THE LINEAR ACCELERATOR

Activity	Agency	EXPECTED REQUIREMENT Permit	Notification Or Review	Comment
1. Wastewater Treatment & Disposal				
a. Sanitary	• Texas Water Commission • Texas Dept. of Health • Ellis County			• Chemical toilets serviced by a contractor will be used during construction. • Sanitary waste generated at the Linac will be accommodated under a permit application for the West Campus wastewater treatment plant.
b. Industrial	• Texas Water Commission			• Industrial wastewater may be generated by floor drains. The West Campus wastewater treatment plant is envisioned to handle industrial wastewater.
c. Point Discharge	• U.S. Env. Protection Agency (Region VI)	X		• No regulated discharges under current regulations are expected. • A stormwater discharge permit for construction will be required from EPA.
2. Potable Water Supply	• Texas Dept. of Health • Texas Water Commission			• From the Buena Vista-Bethel Water Supply Corporation. No TDH or TWC reviews or approvals required.
3. Solid Waste (Nonhazardous)	• Texas Dept. of Health • Texas Water Commission			• All solid waste to be transported by contractor for disposal in licensed landfill; therefore, no permit required. • Waste storage containers must not create a nuisance condition. • The TWC-0060 (solid waste registration) will include the surface galleries, source area, and tunnel.

Table 2

INVENTORY OF SOURCES AND PERMIT ASSESSMENT FOR THE LINEAR ACCELERATOR

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a. Sanitary	• Texas Water Commission • Texas Dept. of Health • Ellis County			• Chemical toilets serviced by a contractor will be used during construction. • Sanitary waste generated at the Linac will be accommodated under a permit application for the West Campus wastewater treatment plant.
b. Industrial	• Texas Water Commission			• Industrial wastewater may be generated by floor drains. The West Campus wastewater treatment plant is envisioned to handle industrial wastewater.
c. Point Discharge	• U.S. Env. Protection Agency (Region VI)	X		• No regulated discharges under current regulations are expected. • A stormwater discharge permit for construction will be required from EPA.
2. Potable Water Supply	• Texas Dept. of Health • Texas Water Commission			• From the Buena Vista-Bethel Water Supply Corporation. No TDH or TWC reviews or approvals required.
3. Solid Waste (Nonhazardous)	• Texas Dept. of Health • Texas Water Commission			• All solid waste to be transported by contractor for disposal in licensed landfill; therefore, no permit required. • Waste storage containers must not create a nuisance condition. • The TWC-0060 (solid waste registration) will include the surface galleries, source area, and tunnel.

Table 2 (Continued)

INVENTORY OF SOURCES AND PERMIT ASSESSMENT FOR THE LINEAR ACCELERATOR

Activity	Agency	EXPECTED REQUIREMENT Permit	Notification Or Review	Comment
4. Hazardous Waste	• Texas Water Commission • U. S. EPA			• No hazardous wastes are anticipated.
5. Air Emissions	• Texas Air Control Board			• Exhaust air will not involve regulated air emissions under normal operating conditions. EPA has concurred that potential hazardous air emissions are less than threshold levels and does not require a permit.
6. Underground Storage Tanks	• Texas Water Commission • U.S. EPA			• No underground storage tanks will be required.
7. Fill In Wetland	• U. S. Army Corps of Engineers	X		• About 1.38 acres of streambed may be rerouted around the Linac and the LEB. The existing streambed at this location may be filled.
8. Subsurface Excavation	• Texas Water Commission			• As indicated at page 3-40 of the Regulatory Compliance Plan for the SSC, Dallas-Fort Worth Site, the TWC has ruled that the drilled/ mined shaft permit program does not apply to the SSC Project. • Spoil will be used to construct a berm to provide radiation shielding for the Linac. Up to 30 ft. of shielding will be required. The Linac berm will have a side slope of 2:1 to 3:1 and a maximum height above ground of about 20 ft. if the floor elevation is at 640 MSL. • Excess spoil to be blended into existing topography and disposed in piles that average no higher than 10 feet compared to existing ground with slopes no greater than 5 horizontal to 1 vertical.

Table 2 (Continued)

INVENTORY OF SOURCES AND PERMIT ASSESSMENT FOR THE LINEAR ACCELERATOR

Activity	Agency	EXPECTED REQUIREMENT Permit	Notification Or Review	Comment
				• Revegetate spoil piles with native grasses.
9. Utility Facilities	• Public Utilities Commission • Texas Railroad Commission			• Less than 60 kV, therefore no PUC involvement.
10. Navigable Airspace	• Federal Aviation Administration			• No aerial structures over 200 feet above ground level.
11. Noise Control	• U. S. EPA • U. S. DOE			• Noise levels at the construction site boundary will be monitored during construction.
12. Cultural Resources	• State Historic Pres. Office • TX Antiquities Commission • Natl. Park Serice • Adv. Council on Historic Preservation		X	• A clearance grant from the State Historic Preservation Officer is required prior to starting work. Approval will be obtained from DOE prior to archaeological field work (see discussion in section 4.1).
13. Endangered Species	• TX Parks & Wildlife Dept.			• No listed species or habitats will be affected.
14. Farmland Protection	• U. S. Dept. of Agriculture, Soil Conservation Service		USDA has issued an exception	• No prime or unique soils • No highly erodible soils
15. Emergency Planning/Right to Know	• Texas Dept. of Health • Ellis County		X	• TBD if threshold quantities exceed the levels indicated on MSDS. PB/MK hazards program is based on 29CFR1926.59.

Table 2 (Continued)

INVENTORY OF SOURCES AND PERMIT ASSESSMENT FOR THE LINEAR ACCELERATOR

Activity	Agency	EXPECTED REQUIREMENT Permit	Notification Or Review	Comment
16. Driveway Permit	• Texas Dept. of Highways & Public Transportation • Ellis County			• Access into the Linac area has not yet been determined.
17. Road Relocation	• Texas Dept. of Highways & Public Transportation • Ellis County			• None Required
18. County Ordinances	• Ellis County	X		• County development permit (flood plain review)

Report: STATS
Project: LINAC
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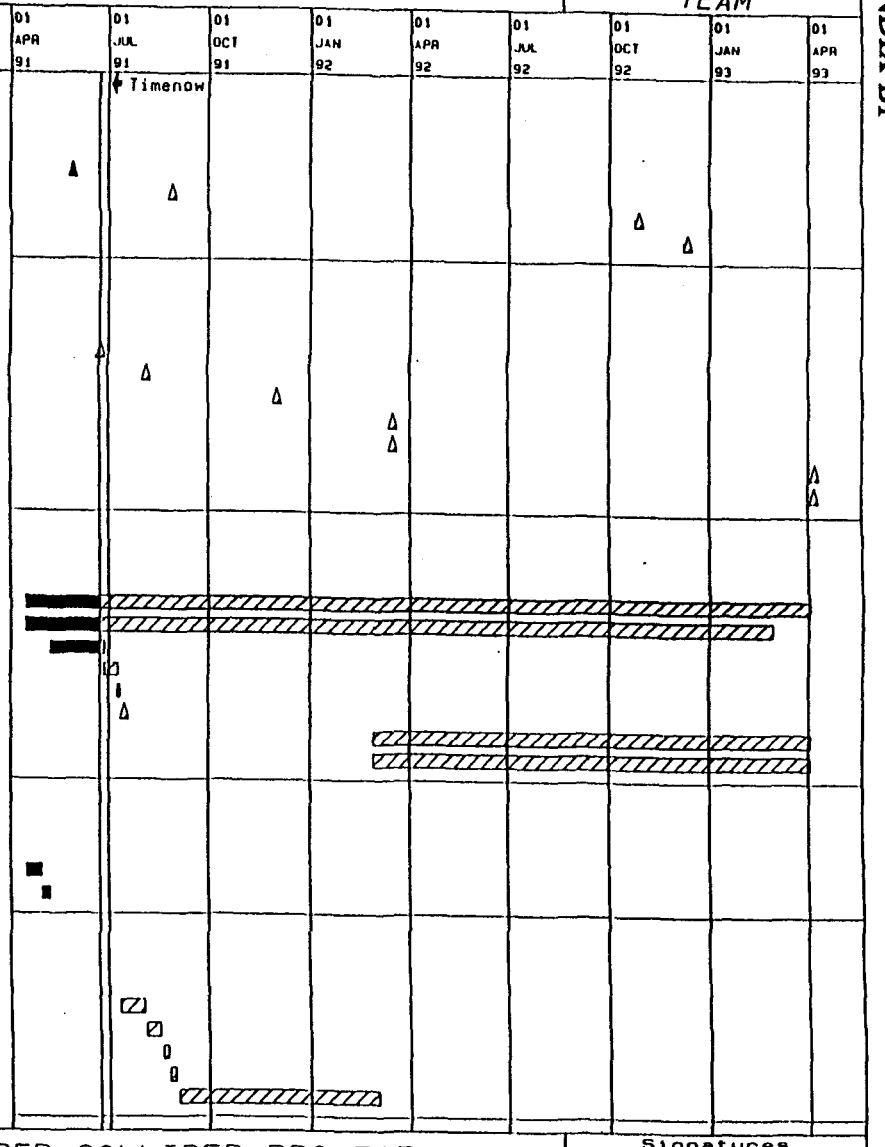
LINEAR ACCELERATOR (LINAC)
ENVIRONMENTAL COMPLIANCE PLAN
LINEAR ACCELERATOR PERMITTING/REQUIREMENTS SCHEDULE

THE PB/MK TEAM

ACTIVITY	DESCRIPTION		ADUR	START	FINISH
	SSC MILESTONES				
.IM100	COMPLETE TITLE II DESIGN		0	29-MAY-91A	29-MAY-91A
.IM105	CONSTRUCTION START		0	29-AUG-91	28-AUG-91
.IM120	FACILITY PARTIAL COMPLETE		0	27-OCT-92	26-OCT-92
.IM125	FACILITY COMPLETE		0	11-DEC-92	10-DEC-92
	PROJECT MILESTONES				
.IM001	PRE-TITLE I DESIGN COMPLETE		0	24-JUN-91	21-JUN-91
.IM010	TITLE I DESIGN COMPLETE		0	06-AUG-91	05-AUG-91
.IM020	TITLE II DESIGN COMPLETE		0	02-DEC-91	29-NOV-91
.IM025	AWARD CONTRACT		0	16-MAR-92	13-MAR-92
.IM040	NTP ISSUED		0	16-MAR-92	13-MAR-92
.IM060	FACILITY COMPLETE		0	07-APR-93	06-APR-93
.IM070	TITLE III COMPLETE		0	07-APR-93	06-APR-93
	DOE ENVIRONMENTAL COMPLIANCE				
.IE015	DOE	PERFORMANCE AUDIT	494	15-APR-91A	01-APR-93
.IE020	PB/MK	MITIGATION DEVELOPMENT	469	15-APR-91A	26-FEB-93
.IE025	PB/MK	PREPARE DRAFT ECP	3	08-MAY-91A	26-JUN-91
.IE030	ALL	REVIEW DRAFT ECP	8	27-JUN-91	08-JUL-91
.IE035	PB/MK	REVISE ECP	3	09-JUL-91	11-JUL-91
.IE040	DOE/SSCL	APPROVE ECP	0	15-JUL-91	12-JUL-91
.IE045	PB/MK	MITIGATION IMPLEMENTATION	286	28-FEB-92	02-APR-93
.IE050	SSCL	MITIGATION MONITORING	286	28-FEB-92	02-APR-93
	ENVIRONMENTAL PERMIT REQUIREMENTS				
.IE005	PB/MK	PREPARE DRAFT INVENTORY	0	15-APR-91A	29-APR-91A
.IE010	ALL	VERIFY ENV./PERMIT INVENTORY	0	30-APR-91A	07-MAY-91A
	PERMITS - FEDERAL				
.IE055	PB/MK	PREPARE SEC. 404 DOCUMENTS	16	12-JUL-91	02-AUG-91
.IE060	ALL	REVIEW SEC. 404 DOCUMENTS	10	05-AUG-91	16-AUG-91
.IE065	PB/MK	REVISE SEC. 404 DOCUMENTS	5	19-AUG-91	23-AUG-91
.IE070	DOE	SUBMIT SEC. 404 DOCUMENTS	5	26-AUG-91	30-AUG-91
.IE075	USCEO	USCEO REVIEW AND CONCUR	130	03-SEP-91	02-MAR-92



Legend
-In progress
-Planned

SUPERCONDUCTING SUPER COLLIDER PROJECT

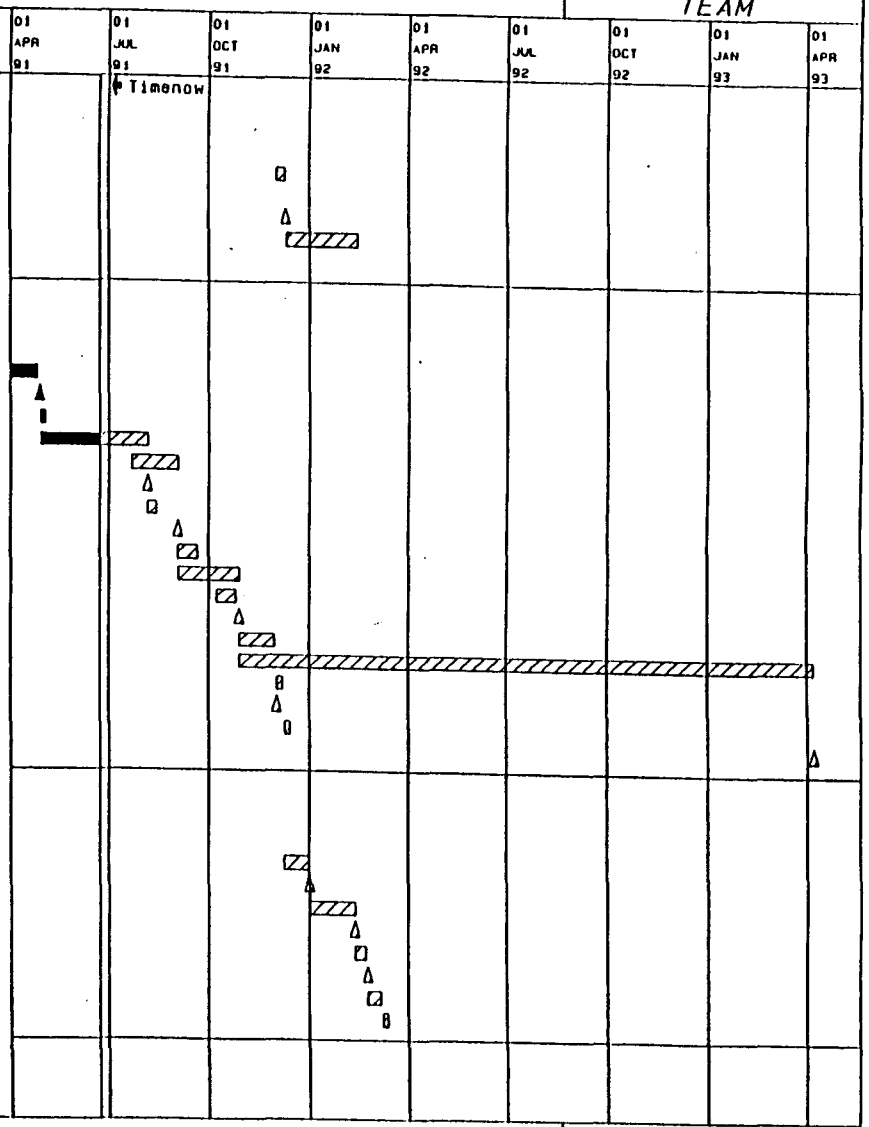
Signatures
DES
PRO
CM:
DRAFT

Report: STAT8
Project: LINAC
Time Now: 23-JUN-91
Date: 18-JUL-91
Page: 2

LINEAR ACCELERATOR (LINAC)
ENVIRONMENTAL COMPLIANCE PLAN
LINEAR ACCELERATOR PERMITTING/REQUIREMENTS SCHEDULE

THE PB/MK TEAM

ACTIVITY	DESCRIPTION	DUR	START	FINISH
	PERMITS - COUNTY			
.IE080	PB/MK PREPARE DEVELOPMENT APPLICATION	6	02-DEC-91	09-DEC-91
.IE085	DOE/TNALC SUBMIT DEVELOPMENT APPLICATION	0	11-DEC-91	10-DEC-91
.IE090	ELLIS CO. PROCESS APPLICATION AND ISSUE PERMIT	47	11-DEC-91	13-FEB-92
	DESIGN			
.ID001	PRE-TITLE I DESIGN	0	01-APR-91A	26-APR-91A
.ID005	PRE-TITLE I DESIGN SUBMISSION	0	29-APR-91A	26-APR-91A
.ID010	PRE-TITLE DESIGN REVIEW - SSCL	0	29-APR-91A	03-MAY-91A
.ID015	TITLE I DESIGN	31	29-APR-91A	05-AUG-91
.ID030	TITLE II 60% DESIGN	31	22-JUL-91	02-SEP-91
.ID020	TITLE I DESIGN SUBMISSION	0	06-AUG-91	05-AUG-91
.ID025	TITLE I DESIGN REVIEW - SSCL	6	06-AUG-91	13-AUG-91
.ID035	TITLE II 60% DESIGN SUBMISSION	0	03-SEP-91	02-SEP-91
.ID040	TITLE II 60% PB/MK/SSCL DESIGN REVIEW	14	03-SEP-91	20-SEP-91
.ID044	TITLE II 90% DESIGN	40	03-SEP-91	28-OCT-91
.ID050	TITLE II 90% PB/MK/SSCL DESIGN REVIEW	14	08-OCT-91	25-OCT-91
.ID054	TITLE II 90% DESIGN SUBMISSION	0	29-OCT-91	28-OCT-91
.ID055	TITLE II 100% DESIGN	24	29-OCT-91	29-NOV-91
.1H001	TITLE III DESIGN	376	29-OCT-91	06-APR-93
.ID059	TITLE II 100% DESIGN REVIEW - PB/MK	5	02-DEC-91	06-DEC-91
.ID060	TITLE II 100% DESIGN SUBMISSION	0	02-DEC-91	29-NOV-91
.ID063	TITLE II 100% BOARD DESIGN REVIEW & APPR	5	09-DEC-91	13-DEC-91
.ID070	TITLE III DESIGN SUBMISSION	0	07-APR-93	06-APR-93
	PROCUREMENT			
.IP001	PREPARE BID PACKAGE	17	09-DEC-91	31-DEC-91
.IP008	BID PERIOD BEGINS	0	01-JAN-92	31-DEC-91
.IP010	BID PERIOD	30	01-JAN-92	11-FEB-92
.IP012	BIDS IN	0	12-FEB-92	11-FEB-92
.IP015	REVIEW/EVALUATE BIDS PB/MK	8	12-FEB-92	21-FEB-92
.IP017	RECOMMENDATIONS TO SSCL	0	24-FEB-92	21-FEB-92
.IP022	SSCL CONSENT TO AWARD	10	24-FEB-92	06-MAR-92
.IP025	AWARD CONTRACT	5	09-MAR-92	13-MAR-92



Legend
-In progress
-Planned

SUPERCONDUCTING SUPER COLLIDER PROJECT

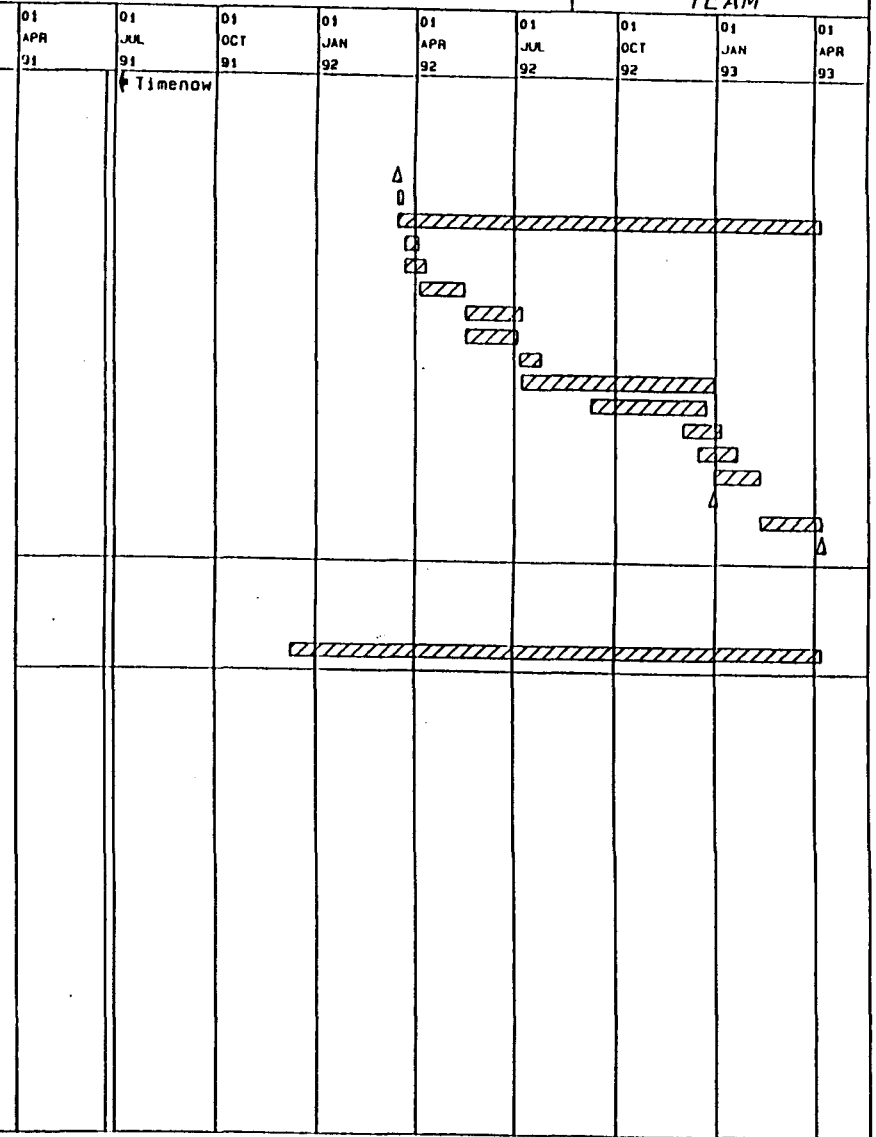
Signatures
DES
PRO
CM:
DRAFT

Report: STATS
Project: LINAC
Time Now: 23-JUN-91
Date: 18-JUL-91
Page: 3

LINEAR ACCELERATOR (LINAC)
ENVIRONMENTAL COMPLIANCE PLAN
LINEAR ACCELERATOR PERMITTING/REQUIREMENTS SCHEDULE

THE PB/MK TEAM

ACTIVITY	DESCRIPTION	RDUR	START	FINISH
	CONSTRUCTION			
.IC001	NTP - GENERAL CONTRACTOR	0	16-MAR-92	13-MAR-92
.IC003	MOBILIZATION	5	16-MAR-92	20-MAR-92
.IH002	CONSTRUCTION	277	16-MAR-92	06-APR-93
.IC006	CLEAR AREA & REMOVE TOPSOIL	10	23-MAR-92	03-APR-92
.IC010	ROUTE CREEK - (NIC)	15	23-MAR-92	10-APR-92
.IC015	TRENCH TOP 10FT.	30	06-APR-92	15-MAY-92
.IC020	TRENCH REMAINING AREA	37	18-MAY-92	07-JUL-92
.IC035	ERECT BUNCHER & GALLERY BLDG.	35	18-MAY-92	03-JUL-92
.IC040	INSTALL UTILITIES IN BLDGS.	15	06-JUL-92	24-JUL-92
.IC025	FORM & POUR TUNNEL	125	08-JUL-92	29-DEC-92
.IC030	INSTALL CONDUIT & WAVE GUIDE TUBE	75	09-SEP-92	22-DEC-92
.IC050	BACKFILL & COMPACT TO GROUND LEVEL	25	02-DEC-92	05-JAN-93
.IC045	INSTALL ELECTRICAL RACEWAY IN TUNNEL	25	16-DEC-92	19-JAN-93
.IC055	BACKFILL & COMPACT BERM.	30	30-DEC-92	09-FEB-93
.IH126	INTERIOR COMPLETE	0	30-DEC-92	29-DEC-92
.IC060	CLEAN-UP AREA	40	10-FEB-93	06-APR-93
.IM130	LINAC FACILITY COMPLETE	0	07-APR-93	06-APR-93
	CONSTRUCTION MANAGEMENT			
.IH003	CONSTRUCTION MANAGEMENT	347	09-DEC-91	06-APR-93



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SUPERCONDUCTING SUPER COLLIDER PROJECT

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APPENDIX B2

Environmental Compliance Plan (ECP) Status

ENVIRONMENTAL COMPLIANCE PLAN (ECP) STATUS
A. Completed or Approved in 1991

ECP Title	Area[1]	Start Date of Title I	Finish Date of Title I	Submission Date of First ECP Draft		Date Approved	Scheduled Start of Construction
				Planned	*Actual*		
MDL	N15	17 August 1990	24 August 1990	22 August 1990	22 August 1990	October 1990	3 October 1990
ASST	N15	5 October 1990	11 December 1990	16 November 1990	16 November 1990	22 March 1991	25 April 1991
MTL	N15	2 February 1991	8 March 1991	30 January 1991	30 January 1991	22 March 1991	4 February 1992
N15 Site and Infrastructure	N15	2 January 1991	7 June 1991	30 January 1991	30 January 1991	22 March 1991	7 November 1991
N15 Shafts and N15 to N20 Tunnel	N15	7 January 1991	30 June 1991	20 May 1991	22 May 1991	25 July 1991	18 September 1991
Exploratory Shaft	Exper Area (North)	14 January 1991	28 February 1991	12 April 1991	12 April 1991	25 July 1991	25 June 1991
Linac	Injector	15 April 1991	5 August 1991	28 June 1991	2 July 1991	25 July 1991	19 May 1992
LEB	Injector	25 July 1991	24 January 1992	13 August 1991	19 August 1991	1 October 1991	18 August 1992
MEB	Injector	12 November 1991	5 April 1992	15 November 1991	11 December 1991		9 February 1993
West Complex Site and Infrastructure	NA	1 July 1991	5 December 1991	22 August 1991	16 September 1991	9 January 1992	9 January 1992
N20 and N25 Shafts and N20 to N30 Tunnel	NA	8 July 1991	9 September 1991	16 August 1991	9 September 1991	9 January 1992	1 April 1992
N30, 35, 40, and 45 Shafts and N30 to 45 Tunnel	NA	8 July 1991	9 September 1991	16 August 1991	6 September 1991	9 January 1992	17 June 1992
N15 Low Conductivity Water	N15	31 May 1991	7 June 1991	7 August 1991	5 August 1991	1 October 1991	6 January 1992
N40 to N55 Shafts and Tunnel	NA	24 September 1991	21 January 1992	22 November 1991	12 December 1991		5 August 1992
Sight Pipe Installation	NA	18 August 1991	5 November 1991	22 November 1991	5 December 1991		to be determined

[1] ECPs for facilities in the same area will be combined in a single document.

ENVIRONMENTAL COMPLIANCE PLAN (ECP) STATUS
B. To Be Submitted in 1992

ECP Title	Area[1]	Start Date of Title I	Finish Date of Title I	Submission Date of First ECP Draft		Date Approved	Scheduled Start of Construction
				Planned	*Actual*		
East Complex Site and Infrastructure	NA	1 March 1992	1 May 1992	17 April 1992			1 December 1992
1R5 and 8 Exper Hall	NA	to be determined	to be determined	to be determined			to be determined
Finishout of N15 and N20 Shafts and N15 to N25 Tunnel	NA	27 November 1991	10 April 1992	13 March 1992	24 March 1992		22 April 1993
S25 to N55 Shafts and Tunnel	NA	to be determined	to be determined	to be determined			to be determined
S60 Shafts and S60 to N15 Tunnel	NA	1 September 1992	13 January 1993	15 October 1992			to be determined
S40 to S50 Shafts and Tunnel	NA	20 November 1991	7 February 1992	10 February 1992	19 February 1992		9 September 1992
Test Beams	Injector	6 April 1992	24 July 1992	4 May 1992			26 May 1993
Finishout of N25, N30, and N35 Shafts and N25 to N40 Tunnel	NA	28 February 1992	25 June 1992	13 April 1992			20 August 1993
S30 Shaft	NA	23 March 1992	27 March 1992	3 April 1992	3 April 1992		17 June 1992

[1] ECPs for facilities in the same area will be combined in a single document.

APPENDIX B3

Permits and Approvals Status

APPENDIX B3

PERMITS AND APPROVALS STATUS
A. Permit Status at the End of 1991

AGENCY	PERMIT	ACTIVITY	ACTION BY	SCHEDULED COMPLETION	ACTUAL COMPLETION	STATUS/COMMENT
U.S. Army Corps of Engineers (USCOE)	Section 404 (Sec 404), Clean Water Act (Discharge of dredged or fill material in wetland)	LINAC/LEB Stream Reroute and MEB Pond a. Prepare Sec 404 documents b. Review Sec 404 documents c. Finalize Sec 404 documents d. Submit letter and documents e. Review and concur	 PB/MK All PB/MK DOE USCOE	 2 September 1991 16 September 1991 23 September 1991 30 September 1991 NLT* 1 November 1991	 9 September 1991 20 September 1991 3 October 1991 11 October 1991 17 December 1991	Nationwide Permit Number 26 which authorizes up to 10 acres of fill above stream headwater (average annual flow less than 5 cubic feet per second)
U.S. Environmental Protection Agency (EPA)	NESHAPS	1. Submit letter 2. Exemption	SSCL & DOE US EPA	October 1990 December 1990	October 1990 December 1990	
	NPDES (Stormwater during construction)	1. Prepare draft application 2. Review draft application 3. Finalize draft application 4. Submit	PB/MK All PB/MK DOE	28 June 1991 12 July 1991 26 July 1991 16 August 1991	9 September 1991 18 September 1991 7 October 1991 18 October 1991	
Texas Air Control Board	Exemption a. MDL b. ASST	1. Emission inventory and project description 2. Meet with TACB 3. Confirm exemption by letter 4. TACB acknowledges exemptions apply	SSCL & PB/MK TNRLC et al. DOE & TNRLC TACB	14 August 1990 13 September 1990 24 September 1990 3 October 1990	21 August 1990 13 September 1990 26 November 1990 6 January 1991	Included in exemption for N15 site.

AGENCY	PERMIT	ACTIVITY	ACTION BY	SCHEDULED COMPLETION	ACTUAL COMPLETION	STATUS/COMMENT
Texas Water Commission	Sanitary System (N15) a. Phase I (MDL)	Pre-submission Meeting	TNRLC et al.	21 September 1990	21 September 1990	Approval of no-discharge concept. Include request for authorization to construct.
		1. Submit final plans and specifications and application	DOE & TNRLC	8 October 1990	16 November 1990	
		2. Draft permit received	TWC	22 January 1991	22 January 1991	
		3. Authorization to construct	TWC	13 March 1991	13 March 1991	
		4. Confirm status upon close of public comment period	TNRLC	26 March 1991	26 March 1991	At regular commission meeting. Action by Ellis County is required before plant operation.
		5. Verify permit approval is on TWC agenda	TNRLC	NLT* 1 May 1991	28 March 1991	
		6. Operating permit	TWC	NLT* 15 June 1991	17 April 1991	Permit # 03422
	b. Phase II (MDL and N15)	1. 90 percent plan review complete	SSCL et al.	14 June 1991	11 June 1991	The permit for both phases was reissued along with the operating permit for the cooling tower blowdown pond.
		2. Final plans complete	PB/MK	1 July 1991	15 July 1991	
		3. Submit for TWC review	DOE & TNRLC	8 July 1991	26 August 1991	
		4. TWC approval	TWC	8 August 1991	13 December 1991	
	Solid Waste Registration	1. Registration for (N15)				Submit 90 days before waste generation. Dates to be provided by SSCL-ES&H and TNRLC.
		a. Prepare	SSCL	NLT* 30 April 1991		
		b. Submit to TWC	DOE & TNRLC	NLT* 17 May 1991		
		c. TWC confirm registration	TWC	NLT* 1 September 1991		
	Industrial Wastewater	N15 Cooling Tower Evaporation Blowdown Pond				
		a. Prepare draft plans and draft application	PB/MK	22 May 1991	22 May 1991	
		b. Finish review of draft documents	All	6 June 1991	11 June 1991	
		c. Revise and finalize	PB/MK	14 June 1991	21 June 1991	
		d. Submit permit application documents	TNRLC	28 June 1991	28 June 1991	
		e. Construction authorization approved	TWC	13 September 1991	13 November 1991	Construction authorization enables early start at risk of DOE.
		f. Operating permit issued	TWC	28 January 1992	19 February 1992	Permit # 03422

AGENCY	PERMIT	ACTIVITY	ACTION BY	SCHEDULED COMPLETION	ACTUAL COMPLETION	STATUS/COMMENT
Texas Historical Commission, State Historic Preservation Officer	Archaeological Site Clearance (unless otherwise stated)	1. N15 MDL Site				
		a. Maps depicting potentially disturbed areas	SSCL, PB/MK	7 September 1990	7 September 1990	Accomplished through EG&G
		b. Letter report to THC	SSCL	14 September 1990	18 September 1990	
		c. Letter confirming MDL is clear	THC	28 September 1990	27 September 1990	
		2. Hoyt Road Culvert				
		a. Report to THC	SSCL	28 May 1991	28 May 1991	
		b. SHPO grant	THC	28 June 1991	7 June 1991	
		3. Exploratory Shaft				
		a. Report to THC	SSCL	28 May 1991	28 May 1991	
		b. SHPO grant	THC	28 June 1991	7 June 1991	
		4. 25kV Interim Power Line				
		a. Report to THC	SSCL	14 August 1991	28 August 1991	
		b. Verbal clearance	SSCL	14 August 1991	26 August 1991	
		c. SHPO grant	THC	13 September 1991	29 August 1991	
		5. Hoyt Road Widening				
		a. Report to THC	SSCL	31 July 1991	28 August 1991	
		b. SHPO grant	THC	31 August 1991	29 August 1991	
		6. N15 Loop Road				
		a. Report to THC	SSCL	31 August 1991	28 August 1991	
		b. Verbal clearance	SSCL	31 August 1991	26 August 1991	
		c. SHPO grant	THC	31 September 1991	29 August 1991	
		7. Arrowhead Road Relocation				
		a. Report to THC	SSCL	31 August 1991	17 September 1991	
		b. SHPO grant	THC	31 September 1991	3 October 1991	
		8. Parcel 86C (Stream Reroute, Linac, LEB)				
		a. Report to THC	SSCL	31 August 1991	28 August 1991	Some limitations apply to construction.
		b. SHPO grant	THC	31 September 1991	29 August 1991	
		9. N15 Site north and west of MDL				
		a. Report to THC	SSCL	27 September 1991	17 September 1991	Avoid site 41EC101 during construction.
		b. SHPO grant	THC	11 October 1991	3 October 1991	
State Department of Highways and Public Transportation	Driveway Permit	Arrowhead Road at FM 66				
		a. Prepare and review application	PB/MK & All	6 September 1991	26 August 1991	
		b. Submit	DOE/TNRLC	10 September 1991	28 August 1991	
		c. SDHPT process and issue	SDHPT	25 September 1991	19 September 1991	Permit # 265-91

AGENCY	PERMIT	ACTIVITY	ACTION BY	SCHEDULED COMPLETION	ACTUAL COMPLETION	STATUS/COMMENT
Ellis County	Development Permit (100-year floodplain)	1. MDL Building (N15)				
		a. Submit application	TNRLC & DOE	14 September 1990	14 September 1990	
		b. Permit issued	Ellis County (Dept. of Public Works)	NLT* 3 September 1990	21 September 1990	Permit # 6283
		2. Construction field office				
		a. Submit application	PB/MK & TNRLC	6 February 1991	11 February 1991	
		b. Permit issued	Ellis County	15 February 1991	15 February 1991	
		3. Wastewater Treatment Plant and Stormwater Ponds (N15)				
		a. Submit application	TNRLC	NLT* 26 February 1991	27 February 1991	
		b. Permit issued	Ellis County	8 March 1991	28 February 1991	Permit # 6396
		4. ASST				
		a. Submit application	DOE & TNRLC	NLT* 15 April 1991	8 April 1991	
		b. Permit issued	Ellis County	NLT* 29 April 1991	16 April 1991	Permit # 6449
		5. MTL				
		a. Submit application	DOE & TNRLC	6 September 1991	13 August 1991	
		b. Permit issued	Ellis County	20 September 1991	11 September 1991	Permit #6589
		6. Exploratory Shaft				
		a. Submit application	TNRLC	27 May 1991	28 May 1991	
		b. Permit issued	Ellis County	12 June 1991	18 June 1991	Permit #6508
		7. N15 Cooling Tower Blowdown Pond				
		a. Submit application	DOE & TNRLC	16 September 1991	16 September 1991	
		b. Permit issued	Ellis County	23 September 1991	25 September 1991	Permit # 6602
		8. N15 Magnet Delivery Shaft				
		a. Submit application	TNRLC	NLT* 4 September 1991	27 August 1991	
		b. Permit issued	Ellis County	19 September 1991	10 September 1991	Permit # 6590
		9. N15 Personnel and Utility Shafts				
		a. Submit application	TNRLC	20 December 1991	23 December 1991	
		b. Permit issued	Ellis County	8 January 1992	2 January 1992	Permit # 6662
		10. Site Access Control Center				
		a. Submit application	PB/MK & TNRLC	11 October 1991	14 October 1991	
		b. Permit issued	Ellis County	25 October 1991	16 October 1991	Permit # 6621
		11. Linac/LEB Stream Reroute				
		a. Submit application	PB/MK & TNRLC	2 December 1991	4 December 1991	
		b. Permit issued	Ellis County	17 December 1991	5 December 1991	Permit # 6655
		12. N15 Low Conductivity Water				
		a. Submit application	DOE & TNRLC	17 October 1991	5 November 1991	
		b. Permit issued	Ellis County	NLT* 4 December 1991	11 November 1991	Permit # 6636

AGENCY	PERMIT	ACTIVITY	ACTION BY	SCHEDULED COMPLETION	ACTUAL COMPLETION	STATUS/COMMENT
Ellis County (cont.)	Sanitary System	1. Submit plans and specifications	TNRLC	NLT* 15 April 1991	9 April 1991	
		2. Submit TWC permit and Ellis County private sewer system application	DOE & TNRLC	18 June 1991	4 June 1991	
		3. Issue permit	Ellis County	1 July 1991	17 June 1991	Permit # 06129101
		4. Expanded plant				
		a. Submit plans and specifications	TNRLC	8 July 1991	28 August 1991	
		b. Submit application	TNRLC	9 August 1991		County stated this is unnecessary.
		c. Issue Permit	Ellis County	NLT* 15 August 1991		

NLT = Not later than

PERMITS AND APPROVALS STATUS
B. Permits to be Applied for in 1992

AGENCY	PERMIT	ACTIVITY	ACTION BY	SCHEDULED COMPLETION	ACTUAL COMPLETION	STATUS/COMMENT
U.S. Army Corps of Engineers (USCOE)	Section 404 (Sec 404), Clean Water Act (Discharge of dredged or fill material in wetland)	1. Cooling Pond at IR1 and IR4				Title 1 will be complete not later than 15 March 1992. After Title I, design will be on hold.
		a. Prepare Sec 404 documents	PB/MK	3 April 1992		
		b. Review Sec 404 documents	All	17 April 1992		
		c. Finalize Sec 404 documents	PB/MK	24 April 1992		
		d. Submit letter and documents	DOE	1 May 1992		
		e. Review and concur	USCOE	5 November 1992		
		2. Cooling Pond at N25				
		a. Prepare Sec 404 documents	PB/MK	28 July 1992		
		b. Review Sec 404 documents	All	11 August 1992		
		c. Finalize Sec 404 documents	PB/MK	14 August 1992		
		d. Submit letter and documents	DOE	21 August 1992		
		e. Review and concur	USCOE	6 August 1992		
		3. Experimental Connector Road (East Complex)				
		a. Prepare Sec 404 documents	PB/MK	15 May 1992		
		b. Review Sec 404 documents	All	29 May 1992		
		c. Finalize Sec 404 documents	PB/MK	5 June 1992		
		d. Submit letter and documents	DOE	12 June 1992		
		e. Review and concur	USCOE	16 September 1992		
		4. IR5 Site Preparation				
		a. Prepare Sec 404 documents	PB/MK	14 September 1992		
		b. Review Sec 404 documents	All	29 September 1992		
		c. Finalize Sec 404 documents	PB/MK	9 October 1992		
		d. Submit letter and documents	DOE	16 October 1992		
		e. Review and concur	USCOE	19 March 1993		
		5. IR8 Site Preparation				
		a. Prepare Sec 404 documents	PB/MK	29 May 1992		
		b. Review Sec 404 documents	All	15 June 1992		
		c. Finalize Sec 404 documents	PB/MK	22 June 1992		
		d. Submit letter and documents	DOE	30 June 1992		
		e. Review and concur	USCOE	1 October 1992		
		6. IR8 Hall (includes Cooling Ponds)				
		a. Prepare Sec 404 documents	PB/MK	30 July 1992		
		b. Review Sec 404 documents	All	14 August 1992		
		c. Finalize Sec 404 documents	PB/MK	21 August 1992		
		d. Submit letter and documents	DOE	28 August 1992		
		e. Review and concur	USCOE	30 October 1992		

AGENCY	PERMIT	ACTIVITY	ACTION BY	SCHEDULED COMPLETION	ACTUAL COMPLETION	STATUS/COMMENT
U.S. Army corps of Engineers (USCOE) - continued	Section 404 (Sec 404), Clean Water Act (Discharge of dredged or fill material in wetland)	7. S20 Service Area				
		a. Prepare Sec 404 documents	PB/MK	14 September 1992		
		b. Review Sec 404 documents	All	28 September 1992		
		c. Finalize Sec 404 documents	PB/MK	6 October 1992		
		d. Submit letter and documents	DOE	14 October 1992		
		e. Review and concur	USCOE	6 August 1992		
U.S. Environmental Protection Agency (EPA)	NDPES (Cooling Pond Discharge)	1. West Complex				
		a. Prepare application	PB/MK	31 March 1992		
		b. Review application	All	17 April 1992		
		c. Finalize draft application	PB/MK	1 May 1992		
		d. Submit application	DOE	8 May 1992		
		e. Process and issue	US EPA	24 November 1993		
		2. Cooling Pond at N25				
		a. Prepare application	PB/MK	17 July 1992		This schedule is tied to the Texas Water Commission Industrial Waste Water Application.
		b. Review application	All	3 August 1992		
		c. Finalize draft application	PB/MK	10 August 1992		
		d. Submit application	DOE	17 August 1992		
		e. Process and issue	US EPA	16 July 1994		
		3. Cooling Pond at S25				
		a. Prepare application	PB/MK	9 December 1992		This schedule is tied to the Texas Water Commission Industrial Waste Water Application.
		b. Review application	All	28 December 1992		
		4. Cooling Pond at N35				
		a. Prepare application	PB/MK	25 August 1992		
		b. Review application	All	9 September 1992		
		c. Finalize draft application	PB/MK	17 September 1992		
		d. Submit application	DOE	25 September 1992		
		e. Process and issue	US EPA	19 May 1995		
		5. Cooling Pond at S15				
		a. Prepare application	PB/MK	9 December 1992		
		b. Review application	All	29 December 1992		
		6. Cooling Pond at IR5				
		a. Prepare application	PB/MK	31 July 1992		
		b. Review application	All	17 August 1992		
		c. Finalize draft application	PB/MK	25 August 1992		
		d. Submit application	DOE	1 September 1992		
		7. Cooling Pond at IR8				
		a. Prepare application	PB/MK	31 July 1992		
		b. Review application	All	17 August 1992		
		c. Finalize draft application	PB/MK	25 August 1992		
		d. Submit application	DOE	1 September 1992		

AGENCY	PERMIT	ACTIVITY	ACTION BY	SCHEDULED COMPLETION	ACTUAL COMPLETION	STATUS/COMMENT
FEMA	Floodplain Coordination	1. IR4 Pond				
		a. Prepare FEMA documents	PB/MK	13 November 1992		
		b. Submit FEMA documents	DOE	4 December 1992		
		c. FEMA review and concur	FEMA	15 January 1992		
		2. IR5				
		a. Prepare FEMA documents	PB/MK	18 December 1992		
Texas Water Commission	Industrial Wastewater	1. West Complex				
		a. Prepare draft plans and draft application	PB/MK	31 March 1992		
		b. Finish review of draft documents	All	17 April 1992		
		c. Revise and finalize	PB/MK	1 May 1992		
		d. Submit permit application documents	TNRLC	8 May 1992		
		e. Construction authorization approved	TWC	14 October 1992		
		2. Cooling Pond at N25				
		a. Prepare draft plans and draft application	PB/MK	17 July 1992		NPDES permit application is prepared concurrently.
		b. Finish review of draft documents	All	3 August 1992		
		c. Revise and finalize	PB/MK	10 August 1992		
		d. Submit permit application documents	TNRLC	17 August 1992		
		3. Cooling Pond at S25				
		a. Prepare draft plans and draft application	PB/MK	9 December 1992		NPDES permit application is prepared concurrently.
		b. Finish review of draft documents	All	28 December 1992		
		4. Cooling Pond for N35				
		a. Prepare draft plans and draft application	PB/MK	25 August 1992		
		b. Finish review of draft documents	All	9 September 1992		
		c. Revise and finalize	PB/MK	17 September 1992		
		d. Submit permit application documents	TNRLC	25 September 1992		
		5. Cooling Pond for S15				
		a. Prepare draft plans and draft application	PB/MK	9 December 1992		
		b. Finish review of draft documents	All	28 December 1992		
		6. IR5				
		a. Prepare draft plans and draft application	PB/MK	30 June 1992		
		b. Finish review of draft documents	All	6 July 1992		
		c. Revise and finalize	PB/MK	13 July 1992		
		d. Submit permit application documents	TNRLC	20 July 1992		
		7. IR8				
		a. Prepare draft plans and draft application	PB/MK	30 June 1992		
		b. Finish review of draft documents	All	6 July 1992		
		c. Revise and finalize	PB/MK	13 July 1992		
		d. Submit permit application documents	TNRLC	20 July 1992		

AGENCY	PERMIT	ACTIVITY	ACTION BY	SCHEDULED COMPLETION	ACTUAL COMPLETION	STATUS/COMMENT
Texas Water Commission (cont.)	31 TAC 299 Dams and Reservoirs	1. Cooling Pond for MEB				
		a. Prepare documents	PB/MK	10 September 1992		
		b. Review documents	All	25 September 1992		
		c. Finalize documents	PB/MK	2 October 1992		
		d. Submit documents	DOE/TNRLC	8 October 1992		
		e. Review and concurrence	TWC	18 November 1992		
		2. Cooling Pond for IR1				
		a. Prepare documents	PB/MK	25 June 1992		
		b. Review documents	All	10 July 1992		
		c. Finalize documents	PB/MK	17 July 1992		
		d. Submit documents	DOE/TNRLC	23 July 1992		
		e. Review and concurrence	TWC	31 August 1992		
	Water Use Permit	1. West Complex				
		a. Prepare documents	PB/MK	17 April 1992		
		b. Review documents	All	1 May 1992		
		c. Finalize documents	PB/MK	8 May 1992		
		d. Submit documents	DOE/TNRLC	15 May 1992		
		e. Construction authorization approved	TWC	14 October 1992		
		f. Water Use Permit issued	TWC	19 October 1992		
Texas Historical Commission, State Historic Preservation Officer	Archaeological Site Clearance (unless otherwise stated)	1. Arrowhead Road Extension				
		a. Report to THC	SSCL	14 February 1992		
		b. SHPO grant	THC	14 March 1992		
		2. MEB				
		a. Report to THC	SSCL	14 February 1992		
		b. SHPO grant	THC	14 March 1992		
State Department of Highways and Public Transportation	Driveway Permit	1. N20: Entry at FM 875				
		a. Prepare and review application	PB/MK & All	7 February 1992		Land has not been acquired by TNRLC.
		b. Submit	DOE/TNRLC	14 February 1992		
		c. SDHPT process and issue	SDHPT	5 March 1992		
		2. N40: Entry at FM 342				
		a. Prepare and review application	PB/MK & All	11 May 1992		
		b. Submit	DOE/TNRLC	15 May 1992		
		c. SDHPT process and issue	SDHPT	5 June 1992		
		3. N55: Entry at FM 878				
		a. Prepare and review application	PB/MK & All	11 May 1992		
		b. Submit	DOE/TNRLC	15 May 1992		
		c. SDHPT process and issue	SDHPT	5 June 1992		

AGENCY	PERMIT	ACTIVITY	ACTION BY	SCHEDULED COMPLETION	ACTUAL COMPLETION	STATUS/COMMENT
State Department of Highways and Public Transportation (cont.)	Driveway Permit	4. S40: Entry at FM 55				
		a. Prepare and review application	PB/MK & All	17 June 1992		
		b. Submit	DOE/TNRLC	22 June 1992		
		c. SDHPT process and issue	SDHPT	10 July 1992		
		5. Industrial Access from 66				
		a. Prepare and review application	PB/MK & All	13 May 1992		
		b. Submit	DOE/TNRLC	22 May 1992		
		c. SDHPT process and issue	SDHPT	12 June 1992		
		6. S30: Entry at State Highway 34				
		a. Prepare and review application	PB/MK & All	4 May 1992		
		b. Submit	DOE/TNRLC	11 May 1992		
		c. SDHPT process and issue	SDHPT	4 June 1992		
	Utility Crossings	Utility Ducts Crossing FM 1446				
		a. Prepare and review application	PB/MK and All	6 March 1992		
		b. Submit	DOE/TNRLC	11 March 1992		
		c. SDHPT process and issue	SDHPT	31 March 1992		
Ellis County	Development Permit (100-year Floodplain)	1. MEB Cooling Pond				
		a. Submit application	DOE & TNRLC	14 August 1992		
		b. Permit issued	Ellis County	28 August 1992		
		2. IR1 Cooling Pond				
		a. Submit application	DOE & TNRLC	6 November 1992		
		b. Permit issued	Ellis County	20 November 1992		
		3. Linac				
		a. Submit application	DOE & TNRLC	16 April 1992		
		b. Permit issued	Ellis County	4 May 1992		
		4. LEB				
		a. Submit application	DOE & TNRLC	15 July 1992		
		b. Permit issued	Ellis County	30 July 1992		
		5. MEB				
		a. Submit application	DOE & TNRLC	20 November 1992		
		b. Permit issued	Ellis County	7 December 1992		
		6. N20 Service Area - Shafts & Basic Tunnel				
		a. Submit application	DOE & TNRLC	22 January 1992		Land has not been acquired by TNRLC.
		b. Permit issued	Ellis County	6 February 1992		
		7. N25 Service Area - Shafts & Basic Tunnel				
		a. Submit application	DOE & TNRLC	1 June 1992		
		b. Permit issued	Ellis County	16 June 1992		
		8. N30 Service Area - Shafts & Basic Tunnel				
		a. Submit application	DOE & TNRLC	1 June 1992		
		b. Permit issued	Ellis County	16 June 1992		

AGENCY	PERMIT	ACTIVITY	ACTION BY	SCHEDULED COMPLETION	ACTUAL COMPLETION	STATUS/COMMENT
Ellis County (cont.)	Development Permit (100-year Floodplain)	9. N35 Service Area - Shafts & Basic Tunnel				
		a. Submit application	DOE & TNRLC	1 June 1992		
		b. Permit issued	Ellis County	16 June 1992		
		10. N40 Service Area - Shafts & Basic Tunnel				
		a. Submit application	DOE & TNRLC	17 June 1992		
		b. Permit issued	Ellis County	30 June 1992		
		11. N50 Service Area - Shafts & Basic Tunnel				
		a. Submit application	DOE & TNRLC	17 June 1992		
		b. Permit issued	Ellis County	30 June 1992		
		12. N55 Service Area - Shafts & Basic Tunnel				
		a. Submit application	DOE & TNRLC	17 June 1992		
		b. Permit issued	Ellis County	30 June 1992		
		13. S40 Service Area - Shafts & Basic Tunnel				
		a. Submit application	DOE & TNRLC	23 July 1992		
		b. Permit issued	Ellis County	7 August 1992		
		14. S45 Service Area - Shafts & Basic Tunnel				
		a. Submit application	DOE & TNRLC	23 July 1992		
		b. Permit issued	Ellis County	7 August 1992		
		15. S50 Service Area - Shafts & Basic Tunnel				
		a. Submit application	DOE & TNRLC	23 July 1992		
		b. Permit issued	Ellis County	7 August 1992		

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APPENDIX C

Results of Surface Water Analyses

APPENDIX C

TEMPERATURE AND pH RESULTS

LOCATION	TEMPERATURE (°C)	pH
Red Oak Creek	5	7.6
Grove Creek	5	8.2
Onion Creek	4	8.2
Chambers Creek	6	7.6

WATER QUALITY TEST RESULTS
(Results in mg/L)

Constituent	Red Oak Creek	Grove Creek	Onion Creek	Chambers Creek
Alkalinity as $CaCO_3$	211	178	162	186
Chloride	26	22	15	17
Total Hardness as $CaCO_3$	222	218	185	247
Nitrate/Nitrite as N	0.89	6.4	5.6	1.4
Sulfate	60	50	32	74
Total Dissolved Solids	390	330	280	350
Total Kjeldahl Nitrogen as N	0.26	0.65	0.25	0.19

APPENDIX C

RESULTS OF TOTAL METALS ANALYSIS
(Total Metals in mg/L)

Constituent	Red Oak Creek	Grove Creek	Onion Creek	Chambers Creek
Aluminum (Al)	< 0.2	< 0.2	2.1	0.3
Arsenic (As)	< 0.3	< 0.3	< 0.3	< 0.3
Barium (Ba)	0.057	0.067	0.056	0.048
Beryllium (Be)	0.002	< 0.001	< 0.001	< 0.001
Boron (B)	< 0.6	< 0.6	< 0.6	< 0.6
Calcium (Ca)	76	73	60	82
Cadmium (Cd)	< 0.003	< 0.003	< 0.003	< 0.003
Cobalt (Co)	< 0.01	< 0.01	< 0.01	< 0.01
Chromium (Cr)	0.032	0.015	0.017	0.023
Copper (Cu)	< 0.01	< 0.01	< 0.01	< 0.01
Iron (Fe)	< 0.03	0.06	1.4	0.29
Magnesium (Mg)	2.3	2.9	2.7	3.1
Manganese (Mn)	0.025	0.008	0.026	0.035
Molybdenum (Mo)	< 0.05	< 0.05	< 0.05	< 0.05
Potassium (K)	3.0	1.2	1.4	3.7
Sodium (Na)	38	24	19	24
Nickel (Ni)	< 0.02	< 0.02	< 0.02	< 0.02
Lead (Pb)	< 0.05	< 0.05	0.06	< 0.05
Antimony (Sb)	< 0.06	< 0.06	< 0.06	< 0.06
Selenium (Se)	< 0.03	< 0.03	< 0.03	< 0.03
Thallium (Ti)	< 0.09	< 0.09	< 0.09	< 0.09
Vanadium (V)	< 0.02	0.06	< 0.02	0.04
Zinc (Zn)	< 0.006	0.008	< 0.006	< 0.006

TWC WATER QUALITY STANDARDS
TRINITY RIVER BASIN - SEGMENT 0814[1]

PARAMETER	LAKE WAXAHACHIE	CHAMBERS CREEK FROM CONFLUENCE WITH RICHLAND CREEK TO CONFLUENCE OF NORTH CHAMBERS CREEK AND SOUTH CHAMBERS CREEK
Chloride (mg/L)	Not to exceed 50	Not to exceed 65
Sulfate (mg/L)	Not to exceed 50	Not to exceed 110
Total Dissolved Solids (mg/L)	Not to exceed 300	Not to exceed 500
Dissolved Oxygen (mg/L)	Not less than 5.0	Not less than 5.0
pH (at 25 °C)	6.5 to 9.0	6.5 to 9.0
Fecal Coliform (#/100 ml)	Geometric mean not to exceed 200	Geometric mean not to exceed 200
Temperature (°F)	Not to exceed 91	Not to exceed 90

[1] Source: TWC, 1986

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APPENDIX D

Texas Air Control Board - Registration Form for Standard Exemptions, Form PI-7

TEXAS AIR CONTROL BOARD
REGISTRATION FORM FOR STANDARD EXEMPTIONS
FORM PI - 7

APPENDIX D

I. Company Name _____
(Corporation, Company, Government Agency, Firm, etc.)

Mailing Address _____

Individual Authorized to Act for Applicant: Name _____ Title _____

Address _____ Telephone _____

II. LOCATION OF EXEMPT FACILITY (Latitude and Longitude must be to the nearest second):

Name of Plant or Site _____ Street Address (If Available) _____

Nearest City _____ County _____ Latitude _____ Longitude _____

SITE REQUIREMENTS:

A. Submit a plot plan to scale of the property showing the location of plant boundaries, plant equipment, and surrounding area.
B. Furnish an area map showing the facility location relative to highways and towns.

III. TYPE OF FACILITY:

A. Applicable Standard Exemption Number from TACB List _____
B. Name of Facility and Company's Facility Number _____
C. TACB Account Identification Number _____
D. Previous Exemption or Permit Number _____
E. Operating Schedule: Hours/day _____ Days/week _____ Weeks/year _____
F. Proposed Start of Construction _____ (Date) Operation _____ (Date)
G. Permanent ☐ Portable ☐

IV. PROCESS INFORMATION

Description of Process:

Prepare and attach a written description of the exempt process. The description must be in sufficient detail to indicate that the facility will conform to the specified exemption.

V. EMISSIONS DATA

Furnish a description of the basis for emission rates including fugitives. (Calculations, emission factors, measurement, NSPS, etc.)

Emission Point Number	Name of Source	Name of Air Contaminant	Emission Rate of Each Air Contaminant			
			lb/hr		tons/yr	
			Gaseous	Particulate	Gaseous	Particulate

VI. A copy of the application is being sent to the Regional Office of the Texas Air Control Board - ☐ Yes ☐ No

VII. I, _____
(Name) (Title)

state that I have knowledge of the facts herein set forth and that the same are true and correct to the best of my knowledge and belief. I further state that to the best of my knowledge and belief, the project will satisfy the conditions and limitations of the indicated exemption. The facility will operate in compliance with all Regulations of the Texas Air Control Board and with Federal Environmental Protection Agency Regulations governing air pollution.

DATE _____ SIGNATURE _____

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APPENDIX E

Temperature, Rainfall, Noise, and Air Quality Data from the PB/MK Monitoring Stations on the N15 Site

Table 1

Comparison of Temperature
Data Collected at N15 During 1991 to the Long-term Record

Temperature (°F)	January	February	March	April	May	June	July	August	September	October	November	December	Average
Long Term Max	54	59	67	76	84	93	97	97	89	79	66	58	77
N15 Max	67	77	77	82	88	96	99	100	87	92	77	68	84
Long Term Min	33	37	44	55	62	70	74	73	67	56	44	37	54
N15 Min	25	32	37	41	43	64	68	68	51	44	29	32	45

Table 2

Comparison of Rainfall
Data Collected at N15 During 1991 to the Long-term Record

Rainfall (inches)	January	February	March	April	May	June	July	August	September	October	November	December	Total
Long Term Average	1.65	1.93	2.42	3.63	4.27	2.59	2.59	1.76	3.31	2.47	1.76	1.67	30.05
N15	3.3	3.9	1.5	3.5	4.2	3.8	3.3	5.5	3.5	16.5	3.1	12.2	64.3

APPENDIX E

Table 3

Comparison of Noise Data
Data Collected at N15 During 1991, Residential Versus Construction

Noise Levels (dBA)	July	August	September	October	November	December
Residential	58	55	55	52	57	61
Construction	79	71	73	71	71	79

Table 4

Comparison of Noise Data
Collected at Exploratory Shaft During 1991, Residential Versus Construction

Noise Levels (dBA)	October	November	December
Residential	50	51	51
Construction	78	79	78

APPENDIX E

PM10 VALUES GROUPED BY AIR MONITORING STATION AND WIND SPEED (expressed as $\mu g/m_3$)

DOWNWIND WORKDAY			DOWNWIND NON-WORKDAY			UPWIND WORKDAY		
0-7 mph	8-15 mph	16-23 mph	0-7 mph	8-15 mph	16-23 mph	0-7 mph	8-15 mph	16-23 mph
11.8	21.6	**13.4**	28.1	25.4	**25.8**	15.1	17.5	**16.6**
29.1	24.9	25.5	24.9	18.1		29.5	22.3	27.7
38.5	41.2	**215.1**	15.1	39.7		31.0	25.9	18.8
20.9	25.2	37.1	26.3	21.4		37.0	43.7	**656.3**
24.1	47.2	63.6	24.1	15.1		21.0	52.0	45.3
36.6	31.2		29.1	31.6		23.8	72.7	54.2
66.8	30.2		**58.5**	24.0		25.2	62.8	
23.6	41.9		28.0	19.6		47.5	42.1	
48.5	26.9		**6.7**	28.7		21.3	28.9	
96.7	15.4		11.8	48.4		**59.5**	15.1	
36.7	30.5		14.1	19.1		55.2	42.0	
39.5	69.4		7.2	51.3		48.6	33.5	
32.6	55.2		11.9	52.4		26.6	40.4	
26.5	16.2			21.4		22.7	46.5	
26.9	28.5			30.7		17.4	18.5	
15.2	21.1			39.6		20.2	9.6	
21.2	36.6			19.8		21.2	45.8	
22.4	45.9			39.3		**11.4**	106.3	
10.7	36.3			**57.4**		14.1	45.5	
12.6	54.3			9.9			39.3	
106.2	58.9			21.1			62.1	
	101.8			**8.5**			47.4	
	88.7						58.1	
	67.7						**110.0**	
	56.1						67.3	
	22.6						62.6	

APPENDIX E

0-7 mph	8-15 mph	16-23 mph	0-7 mph	8-15 mph	16-23 mph	0-7 mph	8-15 mph	16-23 mph
	33.4						67.2	
	38.9						53.1	
	19.1						47.5	
	28.2						41.9	
	84.1						14.4	
	52.6						26.2	
	55.8						30.3	
	35.9						28.4	
	73.0						24.6	
	69.8						15.1	
	51.4						11.4	
	48.7						**5.6**	
	10.9						9.6	
	3.7						14.1	
	8.1							
	15.8							
A. 35.58	40.56	34.90[1]	21.98	29.20	25.80	28.86	40.04	32.52[2]
B. 24.97	22.38	18.57[1]	13.17	13.74	——	13.80	23.69	14.82[2]

BOLD VALUES indicate the highest and lowest PM10 reading in each group
[1] = The reading of 215.1 $\mu g/M^3$ was removed from statistical analyses
[2] = The reading of 656.3 $\mu g/M^3$ was removed from statistical analyses
A. = Average - arithmetic mean of the column
B. = Standard deviation of the PM10 concentrations in the column

APPENDIX F

Comparison of Aerial and Ground-Based Radiological Surveys of the SSCL Region

APPENDIX F

AERIAL AND GROUND-BASED EXPOSURE RATE COMPARISON

Location No.	Estimate from Soil Analysis (μR/h)	Estimate from Aerial Data (μR/h)
1	8.3 ± 0.7	-----
2	8.1 ± 1.0	8.5
3	7.8 ± 0.6	8.0
4	10.6 ± 0.8	9.1
5	9.1 ± 0.8	9.8
6	10.9 ± 0.8	11.1
7	7.9 ± 1.0	8.8
8	8.7 ± 0.8	8.9
9	9.9 ± 0.6	9.4
10	9.1 ± 1.4	8.2
11	-----	6.7
12	9.6 ± 1.3	9.9
13	7.4 ± 1.2	8.6
14	8.8 ± 1.3	7.1

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APPENDIX G

Results of Chemical Analyses of Groundwater

APPENDIX G

RESULTS OF CHEMICAL ANALYSES OF GROUND WATER

Well Sample*	1	1	2	2	3	4	4	33	37
Date	8/8/90	12/13/90	7/19/90	12/12/90	8/8/90	11/17/90	11/29/90	12/6/90	12/5/90
Temp (°C)	22.5	19.7	21.0	19.5	21.3	20.6	19.6	19.8	19.4
pH	6.8	6.9	6.7	6.9	7.1	7.1	7.1	6.8	6.9
Eh (mV)	350	90	n.a.	100	310	140	n.a.	340	370
Ca	134	138	120	112	101	101	96.3	153	127
Na	37.1	28.7	73.6	72.3	36.7	34.2	38.3	27.9	12.4
Mg	2.7	2.64	4.3	4.05	2.5	2.46	2.53	2.96	2.26
K	1.4	0.94	1.2	0.73	1.5	0.91	0.92	0.58	2.62
Sr	0.57	0.58	1.07	0.98	0.67	0.68	0.69	0.91	0.64
HCO_3	410	357	429	450	273	276	280	338	322
Cl	43.6	36.6	29.1	26.1	13.2	10.5	11.1	42.7	13.3
NO_3	29.0	33.0	17.9	19.0	86.2	88.0	89.7	63.7	55.6
SO_4	26.7	20.3	53.2	51.8	9.7	8.35	8.17	56.5	9.54
F	0.6	0.32	0.8	0.7	0.3	0.34	0.4	0.32	0.33
SiO_2	18.5	20.9	18.8	20.1	16.7	19.4	18.1	18.0	18.6
Mn	0.14	0.11	0.11	0.08	0.07	0.03	0.02	0.01	< 0.01
Fe	0.12	0.05	< 0.05	< 0.01	0.12	0.12	< 0.01	< 0.01	< 0.01
Ag	< 0.05	< 0.025	< 0.05	< 0.025	< 0.05	< 0.025	< 0.025	< 0.025	< 0.025
As	< 0.1	< 0.06	< 0.1	< 0.06	< 0.1	< 0.06	< 0.06	< 0.06	< 0.06
B	0.06	0.04	0.08	0.07	0.06	0.07	0.08	0.06	0.04
Ba	0.12	0.11	0.06	0.05	0.10	0.08	0.09	0.07	0.08
Be	< 0.1	< 0.02	< 0.1	< 0.02	< 0.1	< 0.02	< 0.02	< 0.02	< 0.02
Br	< 1	0.35	< 1	0.28	< 1	< 0.1	< 0.1	< 0.1	< 0.1
Cd	< 0.1	< 0.02	< 0.1	< 0.02	< 0.1	< 0.02	< 0.02	< 0.02	< 0.02
Co	< 0.1	< 0.02	< 0.1	< 0.02	< 0.1	< 0.02	< 0.02	< 0.02	< 0.02
Cr	< 0.1	< 0.02	< 0.1	< 0.02	< 0.1	< 0.02	< 0.02	< 0.02	< 0.02
Cu	< 0.1	< 0.02	< 0.1	< 0.02	< 0.1	< 0.02	< 0.02	< 0.02	< 0.02
Hg	0.015	< 0.5	< 0.01	< 0.5	0.014	< 0.5	< 0.5	< 0.5	< 0.5
Ni	< 0.25	< 0.5	< 0.25	< 0.5	< 0.25	< 0.5	< 0.5	< 0.5	< 0.5
Pb	< 1	< 0.2	< 1	< 0.2	< 1	< 0.2	< 0.2	< 0.2	< 0.2
Sb	< 0.25	< 0.16	< 0.25	< 0.16	< 0.25	< 0.16	< 0.16	< 0.16	< 0.16
Se	< 0.25	n.a.	< 0.25	n.a.	< 0.25	n.a.	n.a.	n.a.	n.a.

APPENDIX G

RESULTS OF CHEMICAL ANALYSES OF GROUND WATER

Well Sample*	1	1	2	2	3	4	4	33	37
Date	8/8/90	12/13/90	7/19/90	12/12/90	8/8/90	11/17/90	11/29/90	12/6/90	12/5/90
V	< 0.1	< 0.02	< 0.1	< 0.02	< 0.1	< 0.02	< 0.02	< 0.02	< 0.02
Zn	< 0.1	< 0.02	0.1	0.02	< 0.1	< 0.02	< 0.02	0.02	0.03
TDS	705	640	749	758	542	542	546	705	564
Hardness **	345	355	317	296	262	262	251	394	326
Bacteria ‖	n.a.	TNTC	n.a.	YNYC	n.a.	n.a.	n.a.	14	n.a.
Tritium (pCi/ml)	n.a.	0.020	n.a.	0.036	n.a.	n.a.	0.011	0.030	0.018
Atrazine	n.a.	< 0.02	n.a.	< 0.02	n.a.	n.a.	< 0.02	< 0.02	< 0.02‡
Fusilade	n.a.	< 0.02	n.a.	< 0.02	n.a.	n.a.	< 0.02	< 0.02	< 0.02
Treflan	n.a.	< 0.02	n.a.	< 0.02	n.a.	n.a.	< 0.02	< 0.02	< 0.02
Poast	na.a	< 0.1	n.a.	< 0.1	n.a.	n.a.	< 0.1	< 0.1	< 0.1
Roundup	n.a.	1.06	n.a.	0.26	n.a.	n.a.	n.a.	0.10	0.69
Charge balance (%)	2.3	3.4	1.7	2.1	3.4	2.8	1.4	1.0	2.9

* Alluvial Well (Figure 4-1)
Concentrations in mg/L unless noted otherwise
n.a. = not analyzed
** as $CaCo_3$
‖ Coliform organisms in colonies per 100 mL
‡ Trace detected below quantifiable limits
TNTC = Coliform organisms too numerous to count

All data obtained from results of chemical analyses performed by the University of Texas, Bureau of Economic Geology.

APPENDIX H

Employee Survey Form

Department of Energy
SSC Project Office
2550 Beckleymeade, Mail Stop 1020
Dallas, Texas 75237-3946

Dear Employee:

The Department of Energy, the Superconducting Super Collider Laboratory (SSCL) and the State of Texas (through the Texas National Research Laboratory Commission) are cooperating in a Socioeconomic Monitoring program to determine the impacts of the SSC on local communities. The attached questionnaire forms the core of the monitoring program. We are requesting your participation by providing the information called for in the questionnaire. Participation is wholly voluntary. However, the participation of everyone that works on the SSC project is critical to the success of this endeavor.

As new employees move to the area, the number of school age children may increase. In addition, new residents may require other services. Local school districts, communities and the counties need certain information to help plan for growth. This questionnaire ask questions about where you work, where you live, whether your move here was directly related to your SSC job, and so forth. Your participation in filling out this questionnaire is requested whether you are a new employee or have been with the project for sometime. Your name will not be associated with the information that is collected from the survey.

It will be necessary to conduct this survey periodically in order to monitor impacts resulting from changes in the workforce and you may be asked to repeat this exercise. Your cooperation in helping to make the SSC a success is greatly appreciated. If you have any questions you may contact Nat Brown, Department of Energy, SSC Project Office, Telephone (214) 708-2589.

Please take a few minutes to fill out this questionnaire and return it. Thank you.

Sincerely,

Joseph R. Cipriano
Associate Director
Office of Energy Research
Superconducting Super Collider
SSC Project Director

SUPERCONDUCTING SUPER COLLIDER
PROJECT EMPLOYEE SURVEY FORM

1. Who do you work for? (Full Time _____ Part Time _____ Temporary _____)

   URA _____ Lockheed _____
   EG&G _____ Consultant _____
   Sverdrup _____ Other _____ (specify) _____

2. What is your work location?

   Beckleymeade/Desoto _____
   Central Facility/Waxahachie _____
   Magnet Design Laboratory _____
   Other _____ (specify) _____

3. What is your job category? (scientist, mathematician, engineer, secretary, administrator, manager, etc.) _____

4. How long do you expect to work at/on the SSC project?

   _____ years OR _____ months
   (number) (number)

5. How far do you travel daily (one way) to get to your job? _____ miles

6. Where did you work before this job? (If you were in school, write the location.)

   Town/City _____ State _____ Zip Code _____

7. Marital status: Single _____ Divorced _____ Widowed _____ Married _____

8. If married, is your spouse currently residing (or expecting to reside) with you at your local address?

   Yes ___ No ___

   If yes, is your spouse employed or expecting to be employed? Yes ___ No ___

   If yes, is the job in the same town/city where you live or another town? (specify) _____

9. If your children under the age of 18 will be going to school in Ellis or Dallas counties, please list their birth dates and the schools they will attend and indicate if the schools are private. If you do not know the name of the school, list the name of the school district.

CHILD	BIRTH DATE (month/year)	SCHOOL YOUR CHILD WILL ATTEND	PRIVATE SCHOOL? (yes or no)
#1			
#2			
#3			
#4			
#5			

(List additional children on the back of this page)

SSC PROJECT EMPLOYEE SURVEY FORM
Cont'd

10. Please check the type of local residence in which you live:

House _____ Mobile Home _____ Motel _____
Condo _____ Boarding or Sleeping Room _____ Other _____
Apartment _____ Townhouse _____

11. Do you own or rent this residence? Own _____ Rent _____

What is your current monthly rent or the value of your home?

Rent:		Home Value:		
$0-200/month	____	$0-25,000	____	$125,001-150,000 ____
$201-400	____	$25,001-50,000	____	$150,001-175,000 ____
$401-600	____	$50,001-75,000	____	$175,001-200,000 ____
$601-800	____	$75,001-100,000	____	$200,001 or more ____
$801-1,000	____	$100,001-125,000	____	
$1,001 or more	____			

12. Is your local address different from your permanent address? Yes _____ No _____

If yes, please list your permanent address:

Town/City _____ State _____ Zip Code _____

If yes, how often do you visit your permanent residence if it is out of the Dallas/Fort Worth metropolitan area?

Every weekend _____ Twice a month _____ Monthly _____ Once every two months or less _____

13. What is your local address (from which you travel daily to work)?

Town/City _____ Zip Code _____

14. Did you live in the above location before working on this project?

Yes _____ No _____

If yes, how long? _____ years
(number)

15. Do you intend to build a new house within the next year?

Yes _____ No _____ Don't know _____

In which city/town and county? _____

What is the anticipated value of the residence, excluding the land? $_____

SSC PROJECT EMPLOYEE SURVEY FORM
Cont'd

16. Please evaluate your local community on each of these characteristics (circle the number corresponding to your degree of satisfaction), then rank the characteristics in order of their importance to you in selecting a community.

Rank of Importance in Selecting a Community (1,2,3,etc.)	Community Characteristic	Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied
	Closeness to project work	1	2	3	4	5
	Shopping	1	2	3	4	5
	Recreation	1	2	3	4	5
	Housing	1	2	3	4	5
	School system	1	2	3	4	5
	Housing costs	1	2	3	4	5
	Community services	1	2	3	4	5
	Nightlife	1	2	3	4	5
	Cultural amenities	1	2	3	4	5
	Overall community satisfaction	1	2	3	4	5
	Other (specify) _____	1	2	3	4	5

17. Age _____ (years) Sex: Male _____ Female _____

18. What is your yearly household income (the combined income of both you and your spouse)?

$0-25,000 _____
$25,001-50,000 _____
$50,001-75,000 _____
$75,001-100,000 _____
$100,001 or more _____

SSC PROJECT EMPLOYEE SURVEY FORM
Cont'd

19. What is your race or ethnic background? (optional)

White _____
Black/Afro-American _____
American Indian _____
Mexican American _____
Asian _____
Other _____

20. Any additional comments, problems with community services, or problems with relocation can be written below.

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APPENDIX I

Texas Historic Sites Inventory - Survey Field Form

TEXAS HISTORIC SITES INVENTORY
HARDY-HECK-MOORE

SITE NO. _____ USGS NO. _____
ID NO. _____ UTM SECTOR _____

LOCATION

County Name _____ City/Town _____ Vicinity of _____

THC County Code _____ NPS Code _____ THC City Code _____

Street/Road Name _____ Dir _____ Street Number _____

(rural) _____

PRESERVATION PRIORITY

____ Potential NR
____ High
____ Medium
____ Low

CONTRIBUTES TO A GROUP

____ Potential District
____ Thematic
____ _____

PHOTOGRAPHIC REFERENCES

Roll	Frame	Camera Facing	View	No. of Slides
			__ Elevation __ Oblique __ View	

FUNCTION OR USE

HISTORIC FUNCTION ____ Domestic ____ Commerce/Trade ____ Government ____ Education ____ Religious _____
CURRENT FUNCTION ____ Domestic ____ Commerce/Trade ____ Government ____ Education ____ Religious _____

MAJOR PHYSICAL FEATURES

DATE OF CONSTRUCTION
Estimated _____
Factual _____

NO. OF STORIES
____ 1
____ 1 1/2
____ 2
____ 2 1/2
____ _____

CONDITION
____ Good
____ Fair
____ Poor
____ Ruins
____ Site

ALTERATIONS
____ siding
____ porch
____ windows
____ doors
____ additions
____ _____

AUXILLARY STRUCTURES
____ Garage
____ Barn
____ Shed
____ _____

WALL CLADDING
____ Wood
____ Brick
____ Stucco
____ Synthetic Siding
____ Stone
____ _____

PROPERTY TYPE
____ Residential
____ Commercial
____ Governmental
____ Educational
____ Religious
____ _____

STYLISTIC INFLUENCE
____ Bungalow
____ Queen Anne
____ Romanesque
____ Classical Revival
____ Tudor Revival
____ Mission/Spanish
____ Prairie/Four Square
____ Gothic Revival
____ No Style
____ _____

PLAN/ TYPE FOR RESIDENTIAL
____ L-plan
____ 2-room
____ shotgun
____ center-passage (I house)
____ modified L-plan
____ asymmetrical
____ rectangular
____ _____

PLAN/ TYPE FOR COMMERCIAL
____ 1-part commercial
____ 2-part commercial
____ enframed wall
____ _____

PLAN/TYPE FOR OTHERS
_____
_____ _____
_____

OWNER INFORMATION

NAME _____
_____
_____

RECORDER

Surveyor Name _____

LEGAL DESCRIPTION

Addition/Survey _____
Block _____
Lot/Acres _____

TAX ACCT NO. _____
Date _____

SITE NO. _____ USGS NO. _____
ID NO. _____ UTM SECTOR _____

ORIENTATION
___ Bay(s)
___ Front faces

FOUNDATION
TYPE
___ pier & beam
___ slab
___ basement
___ _____

MATERIALS
___ wooden blocks
___ brick
___ concrete blocks
___ _____

DETAILS
___ skirt wall
___ watertable
___ _____

STRUCTURAL SYSTEM
TYPE
___ wood frame
___ load-bearing masonry
___ steel frame
___ _____

ROOF
TYPE
___ front gabled
___ side gabled
___ cross gabled
___ hipped w/gables
___ steeply pitched hipped
___ low-pitched hipped
___ pyramidal
___ flat
___ shed
___ _____

ROOF, continued
MATERIALS
___ composition shingle
___ wooden shingles
___ ceramic tiles
___ standing-seam metal
___ lock-seam metal
___ corrugated metal
___ built-up tar-&-gravel
___ roll roofing
___ V-groove
___ _____

DETAILS
___ box eaves
___ extended box eaves
___ exposed rafter ends
___ triangular knee brace
___ bargeboards in gable ends
___ fascia board
___ gabled dormers
___ hipped dormers
___ metal cornice
___ brick parapet
___ _____

CHIMNEYS
TYPE
___ interior
___ exterior

MATERIALS
___ brick
___ stone

LOCATION
___ ridge
___ slope

DETAILS
_____
_____
_____
_____

PORCH/CANOPY
BAYS
___ No. of bays

TYPE
___ integral
___ full width
___ partial width
___ wrap around
___ balcony
___ wood canopy
___ metal canopy
___ _____

ROOF
___ shep
___ hipped
___ gabled
___ _____

SUPPORTS
___ square posts
___ turned wood
___ tapered box
___ box columns
___ classical columns
___ brick pedestals
___ wooden pedestals
___ brackets
___ _____

DETAILS
___ jigsawn brackets
___ spindled frieze
___ concrete floor
___ wooden floor
___ turned-wood balustrade
___ squared-wood balustrade
___ _____

WINDOWS
TYPE
___ double hung
___ casement
___ fixed
___ _____

MATERIALS
___ wood sash
___ metal sash
___ _____

LIGHTS
___ 1/1
___ 2/2
___ 4/4
___ 6/6
___ _____

DETAILS
___ architraves
___ hood molds
___ arched openings
___ lintels
___ voussoirs
___ _____

DOORS
TYPE
___ single
___ double
___ 2 singles
___ recessed single
___ recessed double
___ _____

MATERIALS
___ wooden
___ aluminum

DETAILS
___ transom
___ sidelights
___ architraves
___ paneled
___ glazing
___ arched opening

SIGNIFICANCE _____

LEVEL
___ Nationally
___ State
___ Locally

NR CRITERIA
___ A (events, trends)
___ B (individual)
___ C (architectural)
___ D (research potential)

AREA OF SIGNIFICANCE
___ A (events, trends)
___ B (individual)
___ C (architecture)
___ D (research potential)

AREA OF SIGNIFICANCE
___ Architecture
___ Transportation
___ Agriculture
___ Industry
___ Commerce
___ _____

APPENDIX J

The National Register of Historic Places (NRHP) Criteria for Significance

THE NATIONAL REGISTER CRITERIA FOR SIGNIFICANCE

Defining Criteria for Significance

The quality of significance in American history, architecture, archeology, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

A. that are associated with events that have made a significant contribution to the broad patterns of our history; or

B. that are associated with the lives or persons significant to our past; or

C. that embody the distinctive characteristics of a type, period, or method of construction or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D. that have yielded, or may be likely to yield, information important in prehistory or history.

Criteria Considerations and Exceptions

Ordinarily cemeteries, birthplaces, or graves of historical figures, properties owned by religious institutions or used for religious purposes, structures that have been moved from their original locations, reconstructed historic buildings, properties primarily commemorative in nature, and properties that have achieved significance within the past 50 years shall not be considered eligible for the National Register. However, such properties will qualify if they are integral parts of districts that do meet the criteria or if they fall within the following categories:

1. a religious property deriving primary significance from architectural or artistic distinction or historical importance; or

2. a building or structure removed from its original location but which is significant primarily for architectural value, or which is the only surviving structure most importantly associated with an historic person or event; or

3. a birthplace or grave of an historical figure of outstanding importance if there is no other appropriate site or building directly associated with his or her productive life; or

4. a cemetery which derives its primary significance from graves of persons of transcendent importance, from distinctive design features, or from association with historic events; or

5. a reconstructed building when accurately executed in a suitable environment and present in a dignified manner as part of a restoration master plan, and when no other building or structure with the same association has survived; or

6. a property primarily commemorative in intent if design, age, tradition, or symbolic value has invested it with its own historical significance; or

7. a property achieving significance within the past 50 years if it is of exceptional importance.

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APPENDIX K

Inventoried Historical Properties on Fee Simple Land and Over Stratified Fee Land that are Eligible for the National Register

APPENDIX K

LIST OF INVENTORIED PROPERTIES AND NATIONAL REGISTER ELIGIBILITY RECOMMENDATIONS*

TARL No.	Parcel No.	Assessment of Standing Architecture	Prop. Type	Approx. Date	Description	Owner	Arch. Mitigation Proposed
EL57	220	A C D	F	1925-35	Residence	SF	(HABS I)
					Garage/Shed		(HABS III)
				1950's	Pole Barn		(HABS III)
				1920-30	Barn		(HABS III)
EL67	46a	A D	F	1920-30	Residence	FS	HABS III
				1920-30	Garage		HABS III
				1920-30	Barn		HABS III
EL75	37	C	FC	1855/76/1940	Residence	FS	HABS I
					Well/Cistern		
				1920-30	Garage		
EL77	392b	A B D	F	1880-90	Residence	FS	HABS I
					Well/Cistern		
				1880-90	Barn		HABS I
EL80	28	A B C D	F	1855-1920	2 Residences	FS	HABS I
				1855-1905	Barn		HABS I
					Shed, Well		HABS III
					Coop/Garage		HABS III
					Storm Cellar		HABS III
					Pump House		HABS III
EL81	514	A C D	F	1920-30	Residence	FS	HABS I
				1905-15	Barn		HABS I
				1885-95	2 Tenant Residences		HABS I
					Trough, Shed		HABS III
				1950-60	Pole Barn		HABS III
EL119	304	A C D	F	1890/1915/	Residence	FS	HABS I
				/25/50	6 Outbuildings		HABS I
					Well		Plus all Equipment
EL124	8a	A D	F	1915/20's	Residence	O	(HABS I)
					Barn		(HABS I)
EL129	106a	A D	F	1920-30	Residence	FS	HABS III
					2 Barns		HABS III
					Shed		HABS III
EL130	398	C	FC	1094	Residence	FS	HABS I
					Well		

TARL No.	Parcel No.	Assessment of Standing Architecture	Prop. Type	Approx. Date	Description	Owner	Arch. Mitigation Proposed
EL139	556a	A C D	F	1900-50	Residence	FS	HABS I
					2 Barns		HABS I
					2 Sheds		HABS III
					Windmill		HABS III
					Well		
EL140	343	A	HC	1900/30	Residence	FS	HABS III
EL145	21a	A D	FC	1890-	Barn	FS	HABS III
				1940	Cellar		
					(cut out of Rock)		
EL146	245	C	FC	1910/50	Residence	SF	(HABS I)
				1950's	2 Outbuildings		(HABS III)
EL149	324A	A	FC	1900/70	Residence	SF	(HABS I)
					Garage		
					Shack		
EL152	227	A C	FC	1910	Residence	SF	(HABS I)
EL160	160	A C	F	1920-30	Resdience	O	(HABS III)
				1920-35	Garage		
EL163		C	T	1900-30	Town	SF	(HABS I)
				various	4 Buildings		
EL167	712	A D	F	1927-35	Residence	FS	HABS I
					Silo		HABS I
					Granary		HABS I
					2 Barns		HABS I
					2 Sheds		HABS I
					Well		
EL169	441	C	HC	1925	Residence	FS	HABS III
				1930-40	Garage		HABS III
EL174	211	D	NA	1920-40	Bridge	FS	HABS III
EL184	8a	A D	F	1900/30	Residence	FS	HABS III
					Well		
					Barn		

Ownership:
SF = Stratified Fee
FS = Fee Simple
O = Other

Property Type:
F = Farm and Farmstead
FC = Farmstead Component
H = Hamlet
HC = Hamlet Component
T = Town
S = Service Center

(HABS) = These resources are located on properties which are not being purchased Fee Simple by the Department of Energy. Based on information supplied to the consultants at the time of this report, there will be no adverse effect on the National Register eligibility on these resources. If adverse effect is later determined for any of these resources, recommended mitigation is shown within these parentheses.
* NOTE: This survey contains recommendations on Standing Architecture. The primary emphasis refers to the Architectural Resources. The use of Criterion D refers to data collection on Architectural resources and does not refer to Archaeology.

APPENDIX L

Texas Archaeological Site Data Form

State of Texas

ARCHEOLOGICAL SITE DATA FORM

Instructions: Answer all questions. Be specific in distinguishing between "none" and "none observed" or "unknown"; if in doubt, enter "unknown." Where question is followed by (Yes)(No), simply circle answer. Enter measurements in metric. Attachments may be used to complete any question: at question, write "See Attachment ____" and number attachments consecutively. List all attachments at end of this form.

GENERAL INFORMATION

Temporary Site No. _____

Permanent Site No. _____

Site Name _____

Project Name _____

Project Funding Source(s) _____

Owner and Address _____

Informant and Address _____

Additional Sources of Information _____

Previous Investigations

Who _____

What _____

When _____

Why _____

Name of Original Recorder of Site _____

RECORDING INFORMATION

Name of Recorder _____

Institutional Affiliation, if any _____

Date _____

LOCATIONAL INFORMATION

County _____

USGS Map Name & No. _____

Elevation _____

UTM: Zone _____

Easting ___ ___ ___ ___ ___ ___

Northing ___ ___ ___ ___ ___ ___ ___

Latitude ___ ___/___ ___/___ ___ . _____

Longitude ___ ___/___ ___/___ ___ . _____

Description of Location (include nearby USGS topographic landmarks as well as on-site references; note mileages, distances, etc.)

Permanent Site No. _____

WORK PERFORMED BY FIELD PERSONNEL

Survey (Yes) (No)

Testing (Yes) (No)

Method _____

Excavation (Yes) (No)

Method _____

Notes (Yes) (No)

Where Housed _____

Photographs

Slides—Color (Yes) (No)

Black & White (Yes) (No)

Prints—Color (Yes) (No)

Black & White (Yes) (No)

Where Housed _____

Collections (Yes) (No)

Where Housed _____

Collection Techniques (e.g., controlled, noncontrolled, select, random, arbitrary; describe)

_____

Kinds of Materials Collected _____

Special Samples (e.g., carbon, archeomagnetic, plant; list and describe)

_____

How Collected _____

ENVIRONMENTAL LOCATION

Nearest Natural Water Source _____

Distance _____

Drainage Basin _____

Drainage Type (e.g., riverine, playa, marine) _____

Soil Origins (may be multiple)

Colluvial (Yes) (No) Alluvial (Yes) (No)

Eolian (Yes) (No) Marine (Yes) (No)

Soil Type (e.g., clay loam, sand) _____

Vegetation (list dominant, others if known) _____

Ground Surface Visibility _____

Environmental Setting of Site (include pertinent landforms, slope, visible landmarks, etc.)

_____

Additional Comments _____

Permanent Site No. _____

CULTURAL MANIFESTATIONS

Site Size (estimate if necessary)

At Present _____

At Original Occupation _____

Basis for Determination _____

Circumstances of Observation _____

Depth of Cultural Deposit _____

Basis for Determination _____

Time Periods of Occupation (e.g., Prehistoric-Early Archaic; may be multiple)

Components (refers to discreet occupations)

Single (Yes) (No) Multiple (Yes) (No)

Unknown (Yes) (No)

Basis for Determination _____

Site Type (e.g., open campsite, military post, rockshelter)

Cultural Features (If present, describe; e.g., burned rock midden, hearth, structural remains; how do they relate to components, time periods, physiography; how many are there, spatial distribution, size, contents, etc.)

Artifactual Materials Present (kinds of materials, distribution across site, relationship to features, etc.)

Discussion of Site (comments, observations, impressions)

Additional Comments _____

Permanent Site No. _____

SITE CONDITION AND RECOMMENDATIONS

Approximate percentage of site remaining intact _____

Natural Impacts (include erosion, spalling, sloughing, etc.)

_____

Artificial Impacts (include construction, plowing, etc.)

_____

Known or Perceived Future Impacts _____

_____

Potential for State Archeological Landmark

(Yes) (No)

Potential for National Register of Historic Places

(Yes) (No)

Submitted? _____

Uncertain/Unknown? _____

Current Registration

State Archeological Landmark (Yes) (No)

National Register of Historic Places (Yes) (No)

Other _____

Recommended Actions (regional and project specific research, management, preservation)

_____

LIST ALL ATTACHMENTS (Where applicable, refer to question that is being supplemented)

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____

Other (give numbers) _____