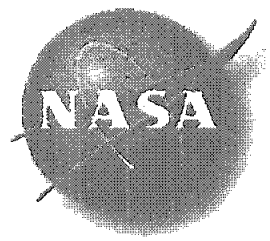
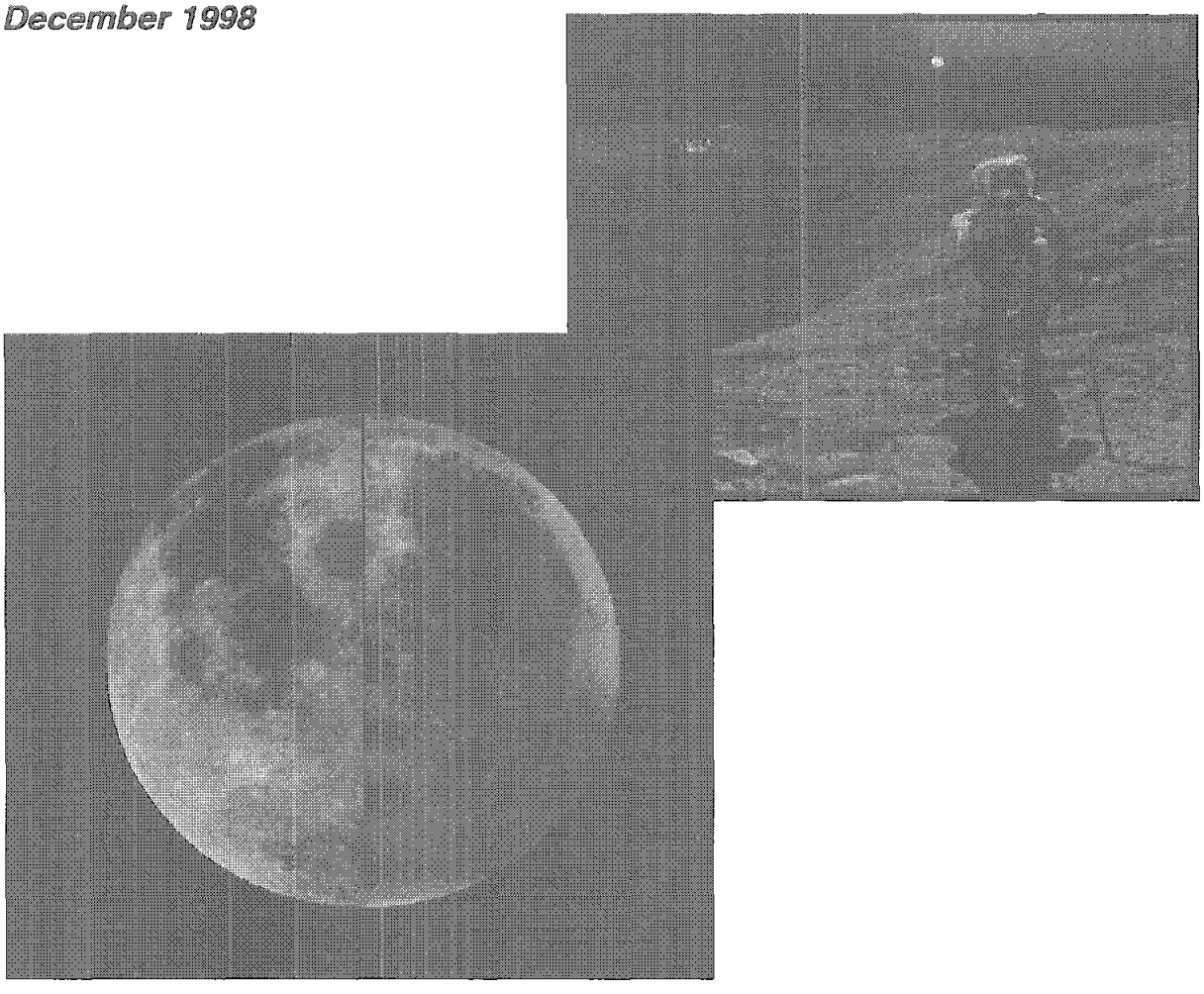


NASA JOHNSON SPACE CENTER
Houston, Texas

ENVIRONMENTAL ASSESSMENT LUNAR/MARS SURFACE SIMULATOR FIELD SITE PROJECT

Final Submittal

December 1998



THOMPSON PROFESSIONAL GROUP, INC.

REQUEST FOR ENVIRONMENTAL IMPACT ANALYSIS

Report Control Symbol
RCS:

INSTRUCTIONS: *Section I to be completed by Proponent; Sections II and III to be completed by Environmental Planning Function. Continue on separate sheets as necessary. Reference appropriate item number(s).*

SECTION I - PROPONENT INFORMATION

1. TO *(Environmental Planning Function)*	2. FROM *(Proponent organization and functional address symbol)*	2a. TELEPHONE NO.

3. TITLE OF PROPOSED ACTION

Lunar/Mars Surface Simulator Field Site Project

4. PURPOSE AND NEED FOR ACTION *(Identify decision to be made and need date)*

To provide the Johnson Space Center with simulated Mars and Lunar landscapes in order to train flight personnel and to test equipment and procedures developed for use in these environments.

5. DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES *(DOPAA) (Provide sufficient details for evaluation of the total action.)*

(Reference Environmental Assessment for the Lunar/Mars Surface Simulator Field Site Project)

6. PROPONENT APPROVAL *(Name and Grade)*	6a. SIGNATURE	6b. DATE

SECTION II - PRELIMINARY ENVIRONMENTAL SURVEY.

(Check appropriate box and describe potential environmental effects including cumulative effects.) (+ = positive effect; 0 = no effect; - = adverse effect; U = unknown effect)

	+	0	-	U
7. AIR INSTALLATION COMPATIBLE USE ZONE/LAND USE *(Noise, accident potential, encroachment, etc.)*		✓		
8. AIR QUALITY *(Emissions, attainment status, state implementation plan, etc.)*		✓		
9. WATER RESOURCES *(Quality, quantity, source, etc.)*		✓		
10. SAFETY AND OCCUPATIONAL HEALTH *(Asbestos/radiation/chemical exposure, explosives safety quantity-distance, etc.)*		✓		
11. HAZARDOUS MATERIALS/WASTE *(Use/storage/generation, solid waste, etc.)*		✓		
12. BIOLOGICAL RESOURCES *(Wetlands/floodplains, flora, fauna, etc.)*		✓		
13. CULTURAL RESOURCES *(Native American burial sites, archaeological, historical, etc.)*		✓		
14. GEOLOGY AND SOILS *(Topography, minerals, geothermal, Installation Restoration Program, seismicity, etc.)*		✓		
15. SOCIOECONOMIC *(Employment/population projections, school and local fiscal impacts, etc.)*	✓			
16. OTHER *(Potential impacts not addressed above.)*				

SECTION III - ENVIRONMENTAL ANALYSIS DETERMINATION

No significant impact.

17. ☐ PROPOSED ACTION QUALIFIES FOR CATEGORICAL EXCLUSION (CATEX) # _____ ; OR
☐ PROPOSED ACTION DOES NOT QUALIFY FOR A CATEX; FURTHER ENVIRONMENTAL ANALYSIS IS REQUIRED.

18. REMARKS

19. ENVIRONMENTAL PLANNING FUNCTION CERTIFICATION *(Name and Grade)*	19a. SIGNATURE	19b. DATE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NOTICE

National Environmental Policy Act; finding of no significant impact

AGENCY: Johnson Space Center, Houston, Texas.

ACTION: The proposed action will provide the Johnson Space Center with simulated Mars and Lunar landscapes in order to train mission personnel and to test equipment and procedures developed for future use in these environments

SUMMARY:

DATE:

RESPONSIBLE OFFICIAL:

ADDRESS:

FOR FURTHER INFORMATION CONTACT:

SUPPLEMENTAL INFORMATION:

An Environmental Assessment (EA) was conducted to examine the proposed design of the Lunar/Mars Surface Simulator Field Site Project with regard to the environmental consequences of constructing the facility on the proposed site. This EA also assessed and evaluated the potential environmental consequences of constructing a simulator facility on two alternative sites at the Johnson Space Center, and of not constructing a simulator facility. The assessment included an analysis of the potential impacts of the proposed facility on the cultural, biological, ecological, water, physical, chemical, and socio-economic environment of the Johnson Space Center and the surrounding community. The impacts of facility construction on these environmental factors were also considered. Based on the information reviewed and the evaluation of the environmental consequences of the proposed action, the EA resulted in a finding of no significant impact (FONSI) on the environment from implementing this project.

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Engineering
Architecture
Environmental Sciences
Surveying & Mapping

December 1, 1998

Mr. Steve Campbell, P.E.
Project Engineer
NASA Johnson Space Center
2101 NASA Road 1
Houston, Texas 77058

Re: Environmental Assessment: Lunar/Mars Surface Simulator Field Site Project
Contract Number NAS 9-19507; Delivery Order Number 7-1

Dear Mr. Campbell:

We are pleased to submit five (5) copies of the Final Environmental Assessment for the Lunar/Mars Surface Simulator Field Site Project. Per your instructions, no changes have been made to the AF Form 813 and FONSI that were previously submitted with the Draft Environmental Assessment.

Please do not hesitate to contact me if you require anything further regarding the Environmental Assessment. We look forward to the next step in the development of this project.

Very truly yours,

JOHN A. LASER
Project Manager

JAL:ss
pc: F884-07.01
JAL File

ENVIRONMENTAL ASSESSMENT
FOR THE LUNAR/MARS SURFACE SIMULATOR FIELD SITE PROJECT
JOHNSON SPACE CENTER, HOUSTON, TEXAS

Lead Agency: NASA/Johnson Space Center

Proposed Action:

The purpose of the proposed project is to provide the Johnson Space Center (NASA/JSC) with simulated Mars and Lunar landscapes in order to train flight personnel and to test equipment and procedures developed for use in these environments. A 9.3 hectare (23-acre) tract of vacant, grassy land located immediately south of Avenue B and west of the 8.1 hectare (20-acre) Exxon Company drilling easement has been designated as the proposed site for the simulator facility. Construction of the facility would occur in three major phases beginning in the year 2000.

For Further Information:

Mr. Steve Campbell, P.E.
Project Engineer
NASA Johnson Space Center
2101 NASA Road 1
Houston, Texas 77058

Date:

Abstract:

This Environmental Assessment (EA) examined the proposed design of the Lunar/Mars Surface Simulator Field Site Project with regard to the environmental consequences of constructing the facility on the proposed site. This EA also assessed and evaluated the potential environmental consequences of constructing a simulator facility on two alternative sites at the Johnson Space Center, and of not constructing a simulator facility. Based on the information reviewed and the evaluation of the environmental consequences of the proposed action, the EA resulted in a finding of no significant impact (FONSI) on the environment from implementing this project.

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF ACRONYMS

CAA	Clean Air Act
CFR	Code of Federal Regulations
COE	Corp of Engineers
EA	Environmental Assessment
EIS	Environmental Impact Statement
EMI	Electromagnetic interference
EPA	Environmental Protection Agency
EVA	Extravehicular Activity
FONSI	Finding of No Significant Impact
HL&P	Houston Light and Power
JSC	Johnson Space Center
LLSS	Lunar Landscape Simulator Site
LMSSF	Lunar Mars Surface Simulator Field
NASA	National Aeronautical Space Administration
NBL	Neutral Buoyancy Lab
NEPA	National Environment Policy Act
NO_x	Nitrous Oxides
NRCS	Natural Resource Conservation Service
OSHA	Occupational Safety and Health Administration
PER	Preliminary Engineering Report
SCH	Space Center Houston
TAC	Texas Administrative Code
TNRCC	Texas Natural Resource Conservation Commission
UCS	Utility Control System
VOC	Volatile Organic Constituents

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This Environmental Assessment (EA) for the proposed Lunar/Mars Surface Simulator Field Site at the Johnson Space Center, Houston, Texas, is performed under Contract Modification DO 7-1 to Contract NAS 9-19507 by Thompson Professional Group, Inc. (Thompson) of Houston, Texas.

The Lunar/Mars Surface Simulator Field Site Project was proposed by NASA/JSC to fulfill a need for simulated environments of certain Lunar and Martian surface terrain features in order to provide a realistic setting for training exercises for mission personnel who will participate in future manned space flights to the Moon and to Mars. The simulated terrain will also permit NASA/JSC personnel to test equipment and procedures to be employed on those missions in a realistic environment.

The purpose of this EA is to examine and evaluate the potential environmental consequences of the proposed simulator project to determine whether or not an Environmental Impact Statement (EIS) needs to be prepared. Should the evaluation and assessment determine that no significant environmental impacts would result from implementing the proposed action, then a finding of no significant impact (FONSI) will be prepared and the proposed action may proceed. Should a need for an EIS result from this EA, this document may serve as the basis for preparing the EIS. This process is explained in detail in, and this EA was developed under, NASA Procedures and Guidelines for Implementing the National Environmental Policy Act and Executive Order 12114[1].

The proposed project action is described in detail in the Preliminary Engineering Report, Lunar/Mars Surface Simulator Field Site Project prepared for NASA by Thompson[2]. Briefly, implementation of the proposed action would result in the phased construction of an 8.1-hectare (20-acre) facility consisting of simulated Lunar and Martian terrain surrounding a central support structure. A 9.3 hectare (23-acre) tract of vacant, grassy land located immediately south of Avenue B and west of the 8.1 hectare (20-acre) Exxon Company drilling easement has been designated as the proposed site for the simulator facility in the NASA/JSC

Master Plan. Construction of the facility would occur in three major phases beginning in the year 2000.

Three alternatives to the proposed action have been evaluated. Two of these alternatives involve locating the facility at different sites, while the third alternative is a no action alternative. Neither of the two alternate sites is large enough to contain the simulator facility as currently envisioned. The no action alternative is not realistic given the objective of the simulator facility, but may be interpreted as suggesting that the existing facility design should be re-evaluated and/or that additional locations should be considered.

The potential cultural, biological and ecological, water resources, physical and chemical, and socio-economic impacts of the proposed action and the alternative actions were assessed and evaluated. The impacts of facility construction activities were also evaluated and assessed with regard to the same environmental factors. The evaluation and assessment of these factors failed to detect any potentially significant adverse impacts on the environment resulting from the implementation of the proposed action. Several minor issues were developed with regard to wetlands, groundwater, storm water, air quality and noise. Recommendations for mitigating these potential minor consequences of project implementation are discussed briefly in Section 5 of this report.

Therefore, based on the information reviewed and the evaluations discussed in this document, a finding of no significant impact (FONSI) is justified for the proposed action.

PURPOSE AND NEED

1. PURPOSE AND NEED

The purpose of the proposed project is to provide the Johnson Space Center (NASA/JSC) with simulated Mars and Lunar landscapes in order to train flight personnel and to test equipment and procedures developed for use in these environments. As proposed, the project would be constructed in three phases with construction of the initial phase planned to begin in the year 2000. When all phases are complete, the proposed Lunar/Mars Surface Simulator Field (LMSSF) will consist of approximately 8.1 hectares (20 acres) of Lunar and Martian terrain features surrounding a central support building. Specifically, the objectives of the proposed LMSSF are as follows:

- To test the range of motion of advanced space suits in a relevant terrain.
- To test the utility of Extravehicular Activity (EVA) tool complement.
- To provide habitat development, placement, leveling, and operation.
- To test pressurized and non-pressurized rover mobility and operation in a relevant environment.
- To test robotic rover mobility and operation in a relevant environment.
- To test operational deployment of surface experiments and surface drilling/coring concepts.
- To test deployment of power generation and thermal radiator systems in relevant terrain and surface characteristics.
- To provide simulation of the Lunar/Mars terrain for crewmember and flight controller training, and to provide real time support for tests during Lunar/Mars missions.

In order to meet these objectives, the proposed LMSSF will need to incorporate the following features:

- A reasonable range of estimated rock populations for Lunar and Martian environments and shall include crater rims (Lunar, Mars), flood plains (Mars), Maria (Lunar), plains (Mars), and highlands (Lunar, possibly Mars).

- A variation in surface texture and bearing capacity (e.g., the Lunar surface showed different degrees of compaction and tractability. Mars will most likely show similar variability).

- A reasonable range of estimated slopes associated with surface features such as crater rims with interior and exterior slopes (Lunar, Mars), slopes associated with various mountain features, up to 20 degrees for Lunar and Martian surfaces.

- Rocks of differing hardness and surface morphology to test hammering and drilling tools, such as rocks embedded by lava flows, impact-shocked rocks, sedimentary/volcanic rocks (tuffs, sandstones), and rocks with a variety of angularity and surface pitting.

- A range of soil and rock mixes to test digging, scooping, raking, and drilling/coring tools and drive tube emplacement.

- A range of degrees of soil compaction to test digging, scooping, raking, and drilling/coring tools and drive tube emplacement.

- A reasonable range of rock populations and estimated slopes to test habitat placement, leveling, and operation. The rock populations shall be consistent with both Apollo and Mars experiences.

- An adequate area to test forward, rearward, turning radius, and "K" turn operations of rovers.

- An adequate capability to view, on a non-interference basis, all operations of the landscape area such as overview points with sufficient space for media utilization.

- Adequate access to the tram system for Space Center Houston (SCH), as well as perimeter roadway for viewing of the entire site.

- Adequate access to the outer perimeter roadway for crane track and for viewing of the entire site by LMSSF personnel.

Given the stated project objectives and requirements, alternative sites within NASA/JSC would be evaluated for suitability on the basis of seven criteria: location, existing land use designation as described in the NASA/JSC Master Plan, functionality, accessibility, utilities, logistics, and constructability.

DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

2. DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

Based on the objectives and requirements discussed in Section 1, the Preliminary Engineering Report (PER) prepared by Thompson Professional Group, Inc. for NASA/JSC identified three potential sites for the LMSSF facility. Drawings illustrating the relative locations of these three sites within the NASA/JSC complex and the individual site plan views are included in the Appendix to this report.

2.1. Proposed Action

NASA/JSC proposes to construct the LMSSF as described in the PER at the site of the abandoned Lunar Landscape Simulator Site (LLSS). The 9.3-hectare (23-acre) site, identified as Site I on the drawings, is located on the south side of Avenue B, west of the Exxon Company 8.1-hectare (20-acre) drilling easement, east of the General Supply Warehouse (Facility No. 421), and north of the potential westward extension of Avenue C. The suitability of this site for development of the LMSSF, regarding the evaluation criteria mentioned in Section 1 of this report, is described in detail in the PER.

The proposed LMSSF is visualized as a large circular complex that is approximately 244 meters (800 feet) in diameter encompassing a ground area of about 4.0 hectares (10 acres). Reference should be made to the drawings in the Appendix. Lunar/Mars surface features will be developed within the entire outer circle that is approximately 75 meters (246 feet) wide surrounding a support core situated in the center of the test complex. A paved access road will penetrate the site and encircle the central core area. An improved working road adjacent to the paved access road will also circumscribe the central core area and define the inner edge of the area provided for the Lunar/Mars surface features. Another improved road will encircle the entire perimeter of the complex. Electrical power, data/phone and communications terminals, survey markers, and other special items can be situated at strategic locations along both roads to support operations for testing activities. A significantly large and contiguous area containing the various surface features is located within a maximum distance of 38 meters (125 feet) from the working roads around the outer perimeter and around the central area.

Preliminary planning of the site has also included some attention to facilitate future incremental development along with the support facilities for expanded operations and viewing. It is anticipated that certain segments of the overall plan can be expanded into the western portion of site as future programs for Lunar/Mars exploration are defined and funding becomes available.

Lunar/Mars surface features are to be arranged within the large peripheral area of the site. Typical surface features will be provided separately for Lunar and Mars environments because of their unique differences.

Lunar surface features will consist of the following:

- Undulating, level, and sloped surfaces with varied distributions of small to large sized rocks.

- Craters of different sizes and types to provide for exterior and interior slopes at the rims. There may be some differences in craters due to the composition of materials and the angle of the impact. Additionally, the A-E has noted variations within craters. These variations result from the differences between relatively new impacts, which have conical interior slopes, and older impacts where the outer rim has eroded to form a generally level area inside the crater.

- Maria, or lunar sea, is identified as a relatively flat undulating area without significant features. It does not include craters.

- Highlands to provide for mountain type slopes, escarpments, and certain rock surfaces that are almost vertical for testing suit mobility and the uses of tools in standing positions; this feature could possibly be combined with the one for Mars.

Surface features for Mars will consist of the following:

- Several rock fields of various population densities, physical sizes, and types that are distributed on level and sloped surfaces, and including ranges of rock and soil mixtures.

- Highlands to provide for mountain-type slopes, escarpments, and certain rock surfaces that are almost vertical for testing suit mobility and the uses of tools in standing positions.

- Flood plains to include alluvial deposits, rills, and erosion;

- Plains that are generally level but have an undulating characteristic and are not the same as flood plains;

- Craters of different sizes and types to provide for exterior and interior slopes at the rims. There may be some differences in craters due to the composition of materials and the angle of the impact.

2.2. Alternative 1

NASA/JSC would locate the LMSSF facility on a 3.4-hectare (8.5-acre) site located at the northeast corner of the intersection of Avenue B and Second Street, just west of Building 220 and south of Building 210, the Child Care Facility. The site, identified as Site II on the drawings included in Appendix 1, currently exists as a flat, grass-covered lot. As discussed in the PER, the area of this site is insufficient to contain the proposed LMSSF as currently envisioned.

2.3. Alternative 2

NASA/JSC would locate the LMSSF facility on a 5.7-hectare (14-acre) site located at the southeast corner of the intersection of Avenue A and Fifth Street, immediately west of the Houston Lighting & Power Company Cooling Water Discharge Canal Easement. The southern extent of this site is adjacent to a right-of-way set aside for the extension of Avenue C from Fourth Street, east to the HL&P canal easement. The site, identified as Site III on the drawings in Appendix 1, currently exists as a relatively flat, grassy area. Although this site is sufficiently large to contain a 4.0-hectare (10-acre) simulator facility, the dimensions of the site cannot accommodate the facility as developed in the PER.

2.4. No Action

Assuming that a LMSSF facility must be developed at the JSC, this alternative is not truly a No Action alternative. In this sense, a conceptual redesign of the LMSSF might need to be considered in addition to identifying other appropriate sites for the facility.

EXISTING ENVIRONMENT

3. EXISTING ENVIRONMENT

The existing environment of the NASA/JSC complex is explored in the report titled "Environmental Resources of Lyndon B. Johnson Space Center, Houston, Texas."[3] The description of the JSC in this 1993 report applies, in general, to all three alternative sites. Only those characteristics particular to the three alternative sites are explored in this Section. The following comments are based on conversations with relevant NASA/JSC personnel, information contained in the PER document, and a field reconnaissance of the three sites by Thompson personnel on October 9, 1998. Photographs of the three sites taken during the field trip are included as Appendix 2 to this report.

3.1. Proposed Alternative

The site currently exists as a relatively flat, grassy field. The northeast portion of this site includes the former site of the abandoned Lunar Landscape Simulator Site (LLSS). The LLSS previously occupied approximately 0.8 hectares (2 acres) at this location. Subsequent to being abandoned, the former LLSS was graded and currently exists as a grassy area that is about 0.6 to 0.9 meters (2 to 3 feet) higher in elevation than the surrounding site surface (refer to Drawing Sheet No. 2, Appendix 1). The site averages 5.0 meters (16.5 feet) in elevation above sea level with a maximum elevation of 6.0 meters (19.8 feet) at the site of the abandoned LLSS.

The current NASA/JSC Master Plan use designation for this site is for the proposed LMSSF facility. Previously, the use designation for this tract of land was S-15A and R-10D. The portion of the site previously designated as S-15A is semi-restricted land set aside for expansion of general logistical support, storage, and warehousing. The section previously included in R-10D was designated for restricted use. Any development in this sector must be carefully planned and controlled so as not to produce electromagnetic interference (EMI) sources or cause multi-path radiation fading that would affect operations of the Antenna Test Range and Radar Boresight Range.

During the site visit, approximately fifteen head of white-tailed deer were observed in the general vicinity of the site. Depressed areas at the site contained up to three inches of standing water, possibly due to recent heavy rains. It has been noted in the PER that the clayey soils in this area are poorly drained. Other than these small areas of ponding, there were no surface waters in evidence at the site. Although grasses in the northern portion of the site had recently been mowed and bailed, grasses in the unmowed portion ranged upward to waist height. It is reported that the bailed grasses are currently used by a local farmer/rancher for animal feed. In addition to grasses, the site is populated by a single, 90-centimeter (36-inch) circumference Chinese tallow tree. No historical artifacts or structures were noted during the site visit.

The groundwater table is reported at an average depth of 2.3 meters (7.5 feet) below natural grade (see PER, Geotechnical Report); although lens of perched groundwater may be encountered at shallower depths, depending on location. There are no reports of groundwater contamination at this site. Exxon Company USA was contacted regarding the history of any oil exploration activities that may have occurred at their drilling easement that lies immediately to the east of this site. Exxon reported that no drilling activities have occurred in the past and that none are planned for the future at this location.

Various utilities are located adjacent to the site in the Avenue B right-of-way. These utilities include a 20-centimeter (8-inch) sanitary sewer line, a 30-centimeter (12-inch) water line, and a 15-centimeter (6-inch) fuel gas line. Record drawings show an 8-duct bank and a 12-duct bank containing primary and secondary electrical power, fire alarm, telephone, TV, and UCS (Utility Control System). One additional electrical line is shown serving the existing streetlights. Also, separate lines are shown for direct-bury telephone, CATV cable, and fiber optic cable. Existing ditches along Avenue B and on the western boundary of the site provide for storm water drainage.

3.2. Alternative 1

This 3.4-hectare (8.5-acre) site, identified as Site II on the drawings, currently exists as a flat, grassy field populated by several trees. This site was once considered as a potential location

for the Neutral Buoyancy Laboratory (NBL), and groundwater piezometers installed to evaluate the suitability of this site for the NBL remain in place, as apparent during a field visit to the site.

The proposed use designation for this tract of land under the NASA Master Plan is GU-1 and S-12A. The section included in GU-1 can be used for general or multipurpose. The section included in S-12A is designated for semi-restricted use. It is set aside for development of semi-permanent type facilities that relate to or support the Vibration and Acoustic Test Facility in Building 49. The site is intended for relatively quiet, semi-industrial use.

This tract of land does not have adequate space for the construction of the initial 4.0-hectare (10-acre) LMSSF, as envisioned in the PER. Furthermore, there is no space for future expansion of the site. Existing utilities in the vicinity of this site include treatable wastewater lines, water distribution lines, fuel gas distribution lines, communication distribution lines and overhead electrical distribution lines. A 38-centimeter (15-inch) gravity sanitary sewer and an overhead power line bisect the site from east to west. Storm water drainage ditches run along Avenue B at the southern boundary and along Second Street at the western boundary of the site.

3.3. Alternative 2

This 5.7-hectare (14-acre) site, identified as Site III on the drawings, also currently exists as a flat, grassy field populated with trees. During the field visit to this site, ponded water was observed in isolated, depressed areas similar to those encountered at Site I. Grasses at this site are reported to be mowed periodically; however, unlike the grasses at Site I, the mowed grasses are not bailed and used for animal feed.

The current land use designation for this site is S-5A in the NASA Master Plan. It is set aside for expansion of facilities for sciences activities, particularly life sciences. NASA/JSC reports that this site is currently being considered for a Space and Life Sciences Medical Research facility.

Although this tract of land is larger than the initial 4-hectare (10-acre) planned development, it does not allow for construction of the proposed schematic as described in the PER. The dimensions of this site will not accommodate the planned LMSSF configuration. Further, it is doubtful that usable space would be available for future expansion of the proposed facilities on this site.

Existing utilities at the site include treatable wastewater lines, water distribution lines, fuel gas distribution lines, communication distribution lines and electrical distribution lines. A direct-bury telecommunication line and a 25-centimeter (10-inch) PVC gravity sanitary sewer line bisect the site from north to south. Site drainage is currently provided by a combination of perimeter open ditches and a storm sewer on Fifth Street. A portion of this site falls within the 500-year Flood Plain and is subject to 4.3 meters (14 feet) of tidal surge from bayous and 4.6 meters (15 feet) of tidal surge from Clear Lake during such an event.

ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

4. ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

With the exception of certain environmental issues that are discussed on a site-specific basis, the impacts of establishing the proposed LMSSF at the proposed action site or at either of the two alternative sites are similar and are evaluated generically. Where the environmental impacts are particular to a specific site, the discussion differentiates the impacts on a site-specific basis. The consequences of the No Action Alternative are discussed separately.

4.1. Consequences of Action Alternatives

4.1.1. Cultural Impacts

The National Register of Historic Places, authorized under the National Historic Preservation Act of 1966, was created under the National Park Service to identify, evaluate and protect sites of historic and archeological significance. Two sites located at the JSC are currently listed on the National Register. The Space Environmental Simulation Laboratory and the Mission Control Center were both placed on the Register in 1985. Three other historic sites located in the general vicinity of the JSC are currently listed on the Register along with their date of registration: the James and Jessie West Mansion (1994), the Armand Bayou Archeological District (1978), and the Harris County Boy's School Site (1979).

It should be noted that a formal study for the purpose of identifying potential sites of historic, archaeological, architectural or paleonthological merit has not been conducted at the JSC. The Environmental Resources document prepared for NASA/JSC in 1993 did not suggest the presence of any such sites within the JSC beyond the two sites previously mentioned. In addition, no indicators of the presence of any culturally significant items were noted during the field reconnaissance. Based on the existing information concerning the JSC, the likelihood that there are unknown sites of cultural significance located on, or adjacent to, the three potential sites for the LMSSF is extremely remote.

There are no natural landmarks listed on the National Registry of Natural Landmarks in the immediate vicinity of the proposed LMSSF site or the two alternative sites. There are no officially designated Wild and Scenic Rivers on, or in the immediate vicinity of, these sites.

The current land uses and the NASA/JSC Master Plan designated land uses for the proposed and alternative sites are discussed in Section 3, Existing Environment. As discussed in the PER, a section of the proposed action location, Site I, was designated as R-10D, restricted use. It was desired that this section of the tract remain undeveloped and open to assure that electromagnetic interference and multipath radiation fading related to radar and antenna testing were minimized. However, a review of the conceptual design for the LMSSF at this site by NASA personnel resulted in a judgment that the proposed facilities should not interfere with these testing operations. As such, the NASA/JSC Master Plan currently designates this site for development of the proposed LMSSF.

4.1.2. Biological and Ecological Impacts

4.1.2.1. Biological Resources

Development of the LMSSF at the proposed action site or at either of the alternative sites would result in the removal of existing plants and displacement of mobile animal species. However, based on a review of the Environmental Resources document and the field reconnaissance, there does not appear to be any unique plant or animal species present at the three sites, nor is there any unique habitat present. Additionally, there is a substantial area to the south of the proposed action location that is in nature to Site I. Thus, there appears to be adequate habitat to absorb animal species displaced from this site by the proposed LMSSF facilities.

It has been reported that the local white-tailed deer population migrates in a north/south direction across Avenue B in the vicinity of the proposed facilities. Further, it is possible that one, or more, of their preferred migration routes may be through the area where the LMSSF would be constructed. However, should the LMSSF facilities prove to obstruct any existing migration routes, there appears to be more than a sufficient amount of area to the west and east of the proposed site to accommodate north/south migration. Additionally, since a final design for the facility has yet to be developed, the degree to which any existing migration routes through this area might be obstructed cannot be fully assessed. It is possible that the deer may be able to migrate through portions of the LMSSF site even after it is fully constructed.

4.1.2.2. Endangered Species

It has been reported in the Environmental Resources document that no critical habitat for threatened or endangered species exists at the JSC complex, according to the U.S. Fish and Wildlife Service and The Texas Parks and Wildlife Department. Although several threatened and endangered species of birds have been reported to potentially visit the JSC complex, including the bald eagle, peregrine falcon, arctic peregrine falcon, reddish egret, and brown pelican, these species range widely throughout the region and none of the proposed LMSSF activities should affect them.

4.1.2.3. Wetlands

Wetlands are jointly defined by the U.S. Army Corps of Engineers (COE) (Federal Register 1982) and the Environmental Protection Agency (EPA) (Federal Register 1980) as those areas inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. According to the Corps of Engineers

Wetlands Delineation Manual[4], a jurisdictional wetland must have all of the following three criteria:

1. Hydrophytic Vegetation;
2. Hydric Soils; and
3. Wetland Hydrology, in that the area is periodically inundated with water or has soils saturated to the surface at some time during the growing season.

Based on aerial photographs and a site visit, there are no obvious wetlands on the selected site. A review of the Soil Conservation Service Soil Survey for Harris County indicated that the soil for the area of the selected site is a Bernard Series soil. This soil was also located at Alternative 1 (Site II). At Alternative 2 (Site III) there is a Midland Series soil. According to the current Natural Resource Conservation Service (NRCS) list of Hydric Soils of the United States, the Bernard Series in not listed as a hydric soil. The Midland Series, on the other hand, is listed as a hydric soil. However, according to the local NRCS Soil Conservationist, Delwin Cannon, the Bernard Series type soil can be considered hydric under certain circumstances. These circumstances would include frequent ponding, and/or ponding for a long duration, such that reducing and anaerobic conditions might develop that are typical for hydric soils and wetlands.

Small seasonal wetlands may occur in depressions and drainage ditches where water stands for a long duration. The difficulty is in determining if the soils are saturated for a long duration at some time during the growing season to create anaerobic conditions near the surface of the soil. During two site visits, there were at least two small areas where there was standing water or saturated soil, and hydrophytic vegetation (*Eleocharis spp.*). One area was along a narrow ditch south of the selected site running parallel, and just to the

south of a water line. The other was near or adjacent to the southeast end of the selected site, in a slight depression in the surrounding field. It was small, approximately 10 feet in diameter; however, the boundaries were not distinct.

There may be other very small depressional wetlands of a seasonal nature scattered over the site where there are depressions that do not drain. These were either created naturally or were manmade, although there were none observed other than those already mentioned. In addition, there are no obvious or large significant jurisdictional wetlands on the selected field site.

Any mitigation for a small wetland, if necessary, can easily be accomplished by creating a compensatory wetland of the same nature in the adjacent areas to the site.

4.1.3. Water Resources

4.1.3.1. Groundwater

The groundwater table at the NASA/JSC complex is typically encountered at a depth of 2 to 3 meters (8 to 11 feet) beneath the ground surface. This depth will vary depending on the amount of precipitation received in the area. The water table may reach the ground surface during periods of particularly heavy rains. Variations in soil strata from stiff heavy clays to silty clay with sand results in zones of perched groundwater, depending on location.

As previously mentioned in Section 3.1., the groundwater table was encountered at a depth of 2.3 meters (7.5 feet) below the ground surface at Site I, the Proposed Alternative, during the geotechnical exploration conducted in support of the PER on February 19, 1998. The groundwater conditions at the other two alternative sites may be expected to be similar to those encountered at Site I. There is no reported contamination of the groundwater at any of the three sites.

One particular activity planned for the proposed LMSSF that could potentially have impact on groundwater is the testing of drilling equipment under simulated conditions. The PER discusses the designation of three areas at the proposed alternative site that would serve as test drilling areas. At these areas, 3-meter (10-foot) diameter, 3-meter (10-foot) long sections of asphaltic coated corrugated metal pipes would be installed vertically into the ground and filled with a variety of materials to simulate Lunar and Martian drilling conditions. The PER suggests that these pipes should be installed in elevated areas to avoid contact with the water table. In addition, when not in use, the pipes would be capped with protective steel domes to prevent rainwater from passing through the pipes to the groundwater table.

Regardless of the site selected for the proposed LMSSF, the potential exists for the water table to rise to ground level. Therefore, the installation design for these pipes should assure that the groundwater is isolated from infiltration from the interior of the pipes and from interface conduits along the exterior of the pipes regardless of the depth of the water table.

Most of the area at the proposed LMSSF will be covered with a variety of rock materials that will not prevent infiltration of precipitation from the surface. It is not anticipated that any of these materials will provide a source of toxic constituents that could infiltrate to the water table.

4.1.3.2. Wastewater

It is intended that the LMSSF facility be utilized intermittently by existing NASA/JSC personnel. In addition, the proposed training activities should not result in the creation of wastewater, other than amounts used for showering of personnel following training exercises. As such, there should only be a very minor net increase in wastewater generated at NASA/JSC as a result of this

project. Wastewater conduits are available for tie-in the immediate vicinity of all three sites.

4.1.3.3. Surface Waters

There are no permanent surface waters present at, or in the immediate vicinity of, any of the three sites.

4.1.3.4. Storm Water

Although most surfaces at the fully-developed LMSSF facility will allow for some infiltration of precipitation, the site will be graded such that runoff from both impermeable and permeable surfaces will be directed by swales and ditches to existing storm water drainage channels. It is estimated in the PER that implementation of the full LMSSF plan could result in a net increase in runoff of 0.06 cubic meters/second (2 cubic feet/second). Thus, the construction of on-site storm water detention facilities may not be necessary. The issue of storm water run-off and the potential need for run-off detention facilities will be fully analyzed and addressed in the final engineering design.

The potential for siltation and erosion will be minimized by careful selection of materials to simulate the Lunar and Martian surfaces. The presence of fines in the materials that could provide a siltation source will be limited by specification. As discussed in the PER, adequate compaction of subsurface backfill materials and the simulated surface materials will limit the potential for siltation and erosion. In certain areas of the simulator surface where the slope of the terrain might encourage erosion, stabilization materials such as gunite would be employed to prevent potential erosion. Thus, by carefully preparing the simulator surface by sufficiently compacting select materials while employing stabilization techniques where needed, the potential for siltation and erosion will be greatly reduced.

4.1.4. Air Quality

According to the Texas Natural Resource Conservation Commission (TNRCC), air quality in the vicinity of the JSC (Houston-Galveston-Brazoria area) does not meet the federal standard for ozone. The Clean Air Act (CAA) Amendments of 1990 established new nonattainment area classifications for ozone ranked according to the severity of air pollution problem. The Houston-Galveston-Brazoria area ozone problem is classified as severe by the TNRCC. The nonattainment area classification is significant as it establishes emissions thresholds for the purpose of permitting new stationary sources of ozone-forming air pollutants. The TNRCC New Source Review Permits Division regulates new stationary sources of air pollutants that contribute to the formation of ozone through the permitting process.

Both the federal government, under the EPA, and the State of Texas, under the TNRCC, have developed plans implementing the requirements of the CAA Amendments of 1990. Under 40 CFR §93.150, actions by federal agencies, such as NASA/JSC, must conform to the requirements of the applicable implementation plan (federal or state). The conformity provisions of an EPA-approved state implementation plans (SIP) must be at least as stringent as those contained in the federal implementation plan. Thus, NASA/JSC must address any potential impacts to the ambient air quality resulting from this proposed action to conform to the requirements of the CAA Amendments of 1990.

The only impact to air quality that should result from development of this project is related to the use of the self-erecting crawler crane. The primary use for this crane is in simulating the effects of Lunar and Martian gravity. The PER includes a proposed crane design that would require a 480V, 3 phase, 60 Hertz, 135Kva, diesel-powered generator. The TNRCC was contacted to determine whether a typical 200 horsepower diesel engine, used as a power source in a crane of this type, would require their regulatory approval regarding emission standards. The TNRCC responded that they

would need to review plans for the crane to determine whether such a device would be classified as a mobile or stationary source of emissions. If the TNRCC determines that the crane is a mobile source of emissions, then they have no further regulatory interest in the proposed action. If the crane is considered to be a stationary source of emissions regulated under 30 TAC §106.512, then the engine would need to be registered with the TNRCC by filing Form PI-1. Technical data on the diesel engine and proposed usage of the engine and crane would be submitted to the TNRCC along with Form PI-1 This information will enable the TNRCC to estimate the annual emissions load of the engine. The annual emissions load is then compared to the major source limit for the particular nonattainment area to determine whether further permitting action is required. Since the JSC lies within a severe nonattainment area for ozone, the major source emissions limit for a stationary source is 25 tons/year. Small engines of the type envisioned for use as part of the crawler crane typically only require registration with the TNRCC.

In order to evaluate the potential regulatory requirements of the TNRCC should the crawler crane be incorporated into the final design for this project, a manufacturer of a diesel engine that would be suitable for use in the crane design was contacted to obtain technical data on such an engine. Based on a maximum possible usage of 24 hours per day, 365 days per year, this typical diesel engine would produce approximately 10 tons/year of ozone precursor emissions (VOCs and NO_x). Based on this level of emissions, the TNRCC would only require that the engine be registered on Form PI-1 if the crane design is considered to be a stationary source of emissions.

If the diesel engine is not regulated by the TNRCC, it must still conform to the federal EPA emission standards. The EPA requires that manufacturers of new nonroad engines obtain a certificate of conformity that the type of engine being produced complies with federal emissions standards. The engine that is discussed in the preceding paragraph is specified as EPA-certified. Copies of the EPA certification may be obtained from the manufacturer when a particular engine is selected for the crane.

Prior to the construction of electrical utilities during Phase II, power at the site would be provided by portable generators. The use of these generators on an as-needed basis should have minimal impact on air quality. Typically, the engines used in these generators all carry EPA certification that the engine family is in compliance with federal emission standards.

4.1.5. Noise

Noise generated at the proposed action site during training activities should not pose a problem for other personnel at the JSC since this site is fairly well removed from other structures. Noise generation at either of the alternative sites could potentially present a problem since both of these sites are designated for quiet activities. However, the only sources of noise related to the planned training activities would involve the electrical power generators and test drilling equipment. The typical diesel-powered generator discussed in the preceding section produces noise levels of 97 decibels, A-weighted, (dBA) measured at a distance of 0.9 meters (3 feet) without exhaust muffling. With an exhaust noise-silencing device, noise levels may be reduced to 10 dBA. OSHA requires a hearing conservation program for employees if noise levels equal or exceed an eight-hour time-weighted average of 85 dBA (29 CFR 1910.959(c)(1)). Noise levels generated by test drilling equipment should be measured for comparison to this standard and protective measures should be taken as necessary.

4.1.6. Hazardous and Toxic Materials

The proposed LMSSF project does not require the use of potentially hazardous or toxic materials for training exercises. Herbicides would need to be employed periodically on the simulated Lunar and Martian surfaces to control plant growth; however, biodegradable herbicides are available that eliminate the potential for harmful effects to the environment.

4.1.7. Flood Plains

Neither the Proposed Action site or the Alternative 1 site lie within an area designated as a flood plain. As noted in Section 3, a portion of the Alternative 2 site falls within the 500-year Flood Plain. Development at Site III would require a redesign of the proposed LMSSF since this site is not sufficiently large to encompass the facility. Such a redesign would also require consideration of the 500-year Flood Plain encroachment onto the site.

4.1.8. Socio-Economic Impacts

4.1.8.1. Economic

Development of the LMSSF facility will allow future Lunar and Mars mission personnel to test equipment and procedures in realistic environments. An assessment of the impact of such a factor as this is beyond the scope of this report.

Assuming that the proposed LMSSF is fully developed as described in the PER, the total cost of the facility is estimated to approach $13 million. The time period during which these dollars would be expended is uncertain at this time since development of the facility is phased and the scheduling of phase construction will depend on the availability of federal funds. Regardless, construction of this facility should have a positive impact on the local economy.

4.1.8.2. Population

The proposed LMSSF will be utilized by personnel who are currently employed, or would otherwise be employed in the future, at NASA/JSC. Therefore, operation of this facility will not result in any substantive change in population within NASA/JSC or the surrounding area.

4.1.8.3. Traffic

Since the proposed LMSSF will not result in an increase in personnel at the JSC complex, the facility will have no impact on traffic in the community surrounding the complex. When the facility is being used for training and testing activities, there should be a minor increase in traffic on the complex, but the magnitude of the increase should not result in traffic problems and the impact may be reduced by use of the tram, wherever feasible.

4.1.8.4. Environmental Justice

Executive Order 12898 was issued in February of 1994 with the intent of ensuring "that all programs or activities receiving Federal financial participation that affect human health or the environment...do not discriminate on the basis of race, color , or national origin."[5] The Order mandates that Federal agencies evaluate the environmental effects of their actions on minority and low-income communities whenever an environmental impact assessment of those actions is required by NEPA.

NASA has formulated written policies and procedures for implementation of the Executive Order.[6] Based on an assessment of NASA/JSC activities conducted in 1995 in response to the Order and NASA implementation policy, very few of the activities and actions performed at the JSC were judged to have the potential for affecting the surrounding community regardless of the racial or economic characteristics of that community.[7]

The potential environmental impacts of this project have been evaluated and assessed with regard to the intent of the Executive Order and NASA/JSC policies. Based on the PER, the actions associated with this project in both the construction and operational phases should not have a disproportional impact on any minority or low-income population within the vicinity of the JSC. In

fact, implementation of the proposed project should not have any adverse impact on the surrounding community, and thus, no adverse impact with regard to Environmental Justice concerns.

4.1.9. Construction Impacts

Construction of the proposed LMSSF, as described in the PER, is designed to occur in phases with initial construction scheduled for the year 2000. The following table provides summary information on the duration of construction activity by phase and the average construction manpower to be employed on-site during each phase. Consult the PER document for a detailed description of the particulars of each phase of construction. Depending of the availability of funding and the demands of the space program, design and construction schedules for each phase will be developed at a later time.

NASA/JSC LUNAR/MARS SURFACE SIMULATOR FIELD SITE PROJECT
Construtution Summary

Project Phase	Phase Description	Area (approx.)		Construction	
		Incremental (hectares)	Total (hectares)	Time (months)	Average Manpower
Phase I	Martian Rock Field (Mars I)	1.27	1.27	4	10
Phase II					
a.) Sector II	Lunar Surface (Moon I), Access Road	1.27	2.55	3	15
b.) Utilities	Water, Wastewater, Electrical, Communications			4	20
c.) Support Crane	Self-erecting crawler crane for gravity simulation			6	6
d.) Sector III	Mars Highlands (Mars II)	1.17	3.72	(1)	15
e.) Sector IV	Lunar Surface (Moon II)	1.17	4.90	(2)	15
Phase III	Support Structure	0.24	5.14	10	60

(1) Construction to occur simultaneously with the first three months of Crane construction.
(2) Construction to occur simultaneously with the last three months of Crane construction.

Regardless of when each phase of the facility is constructed, the impacts of the construction activity on the JSC and surrounding community should be minimal. The increase in traffic related to construction personnel would be marginal. Increases in noise and emissions related to construction equipment would be minimal and of short duration. Increased noise levels may be a more important factor should a LMSSF facility be constructed at either of the sites identified as Alternatives 2 or 3 since these areas are reserved for quiet activities. However, the increased noise levels would be temporary.

Regardless of the site Alternative selected, approximately 15 centimeters (6 inches) of topsoil and vegetation will need to be removed to prepare the site for further construction activity. The soil and vegetation that is to be removed will be separated into two groups: soil that is satisfactory for future construction use at the JSC; and, material that is unsuitable for future use at the JSC. Satisfactory soil will be removed from the LMSSF site and stockpiled at a location designated by NASA/JSC. The designated stockpile location will provide sufficient erosion and sedimentation controls. The material that is not satisfactory for further use at the JSC will be removed from the LMSSF and transported to a location where it may be legally disposed.

Storm water run-off, erosion and siltation pose potential problems during construction activities. The final design for this project will include a Storm Water Pollution and Prevention Plan to address these issues. Engineering controls, such as filter fabric barriers to retain silt and drainage channels and swales to control run-off, will be evaluated as a part of the construction process to minimize erosion, siltation and run-off.

4.2. No Action Alternative

It is not possible to assess the impact of a No Action Alternative for this type of project. Should a realistic site simulator not be available for testing equipment and procedures, it is conceivable that manned missions to the Moon and/or Mars would not be practicable. Should such missions be attempted without the proper pre-flight training and testing afforded by a simulator, it is imaginable, if not likely, that such missions could end in partial or complete failure. Such failure could be in terms of wasted dollars, the loss of human life, or both. Viewed in this light, a No Action Alternative is not a realistic alternative if NASA is to pursue manned space flight to the Moon and/or Mars. In view of this, the No Action Alternative might be better interpreted as a decision to redesign the facility and/or consider additional sites.

MITIGATION AND MONITORING

5. MITIGATION AND MONITORING

5.1. Wetlands

Although no definitive wetlands were identified at the proposed action site, should any small, depressed, seasonal wetland areas be eliminated from this site as a result of facilities construction, the loss of these areas may be offset by creating similar depressed areas in the unused grassy area to the south of Site I. Additionally, or alternatively, storm water drainage channels and detentions basins can be incorporated into the final design for this facility in a manner that promotes the formation of wetlands conditions in the channels and basins.

5.2. Groundwater

It is recommended that the final design for the LMSSF facility incorporate methods for groundwater protection for the installation of coated metal pipes to be used for testing drilling equipment. Such methods would include sufficient bottom grouting of the borehole into which the pipe is to be set and of the annular space between the borehole wall and the pipe. The upper end of the pipe should be encased with a concrete pad of sufficient height above the surrounding terrain to assure that storm water ponding and/or runoff is isolated from the top of the pipe.

5.3. Storm Water

It is recommended that the final design for the LMSSF facility include a hydrologic analysis to determine if on-site detention facilities will need to be constructed to mitigate the effects of any material increase in storm water runoff related to presence of the facility at the selected site. Two types of detention devices that would be appropriate for consideration at this site are drainage channel restrictors and detention ponds (or basins). The use of restrictors has already been considered in the PER. These devices reduce the rate of surface water run-off to off-site drainage facilities by restricting the flow and causing run-off to accumulate in the upstream drainage channel. Detention ponds may reduce or eliminate run-off from the site to off-site

drainage facilities. A possible site plan design including detention ponds for the proposed plan of action is included in Appendix 1 as Drawing Sheet 6.

A secondary benefit to be realized by using storm water run-off engineering controls such as retrictors and detention ponds is that they create the same type of marginal wetlands conditions that currently exist in, and a the vicinity of the proposed site. Therefore, any loss of these small, localized depressed areas may be mitigated, or offset, by the formation of new marginal wetlands formed in the drainage channels and/or detention ponds.

5.4. Air Quality

It is recommended that final design drawings and specifications for the self-erecting crawler crane be submitted to the TNRCC Office of Air Quality, New Source Review Permits Division, should the crane be included in the final design for the facility. Should the TNRCC determine that the crane is considered to be a stationary source of air pollutants, contractor specifications for the crane should include a requirement that documentation be furnished, in a manner acceptable to the TNRCC, that demonstrates that the diesel engine included with the crane will not produce ozone precursor emissions equal to or greater than 25 tons/year under maximum load and maximum usage conditions. This documentation will then be available for NASA/JSC to submit to the TNRCC on Form PI-1 to register the engine prior to deployment at the site.

Should the TNRCC determine that the crane is a mobile source of emissions, then the contractor bid specifications should require that a copy of the engine manufacturer's EPA certification be furnished with the contractor's bid submittal.

5.5. Noise

It is recommended that the final design for the Self-Erecting Crawler Crane incorporate a diesel engine equipped with an exhaust silencer system to minimize noise levels during utilization of this device. Test drilling activities should be monitored for noise generation to determine if the sound levels require employee protective measures.

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6. AGENCIES AND INDIVIDUALS CONSULTED

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REFERENCES

8. REFERENCES

1 NASA Procedures and Guidelines for Implementing the National Environmental Policy Act and Executive Order 12114, JE/Environmental Management Division, Washington, D.C.

2 Preliminary Engineering Report, Lunar/Mars Surface Simulator Field Site Project, NASA Johnson Space Center, Houston, Texas, 100% Final Submittal, Thompson Professional Group, Inc., Houston, Texas, June, 1998.

3 Environmental Resources of Lyndon B. Johnson Space Center, Houston, Texas, National Aeronautics & Space Administration, Brown & Root, Houston, Texas, February 1993.

4 Corps of Engineers Wetlands Delineation Manual, U.S. Department of Commerce, National Technical Information Service, Springfield, Virginia, January 1987.

5 Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," Federal Register, Vol. 59, No. 32, February 16, 1994.

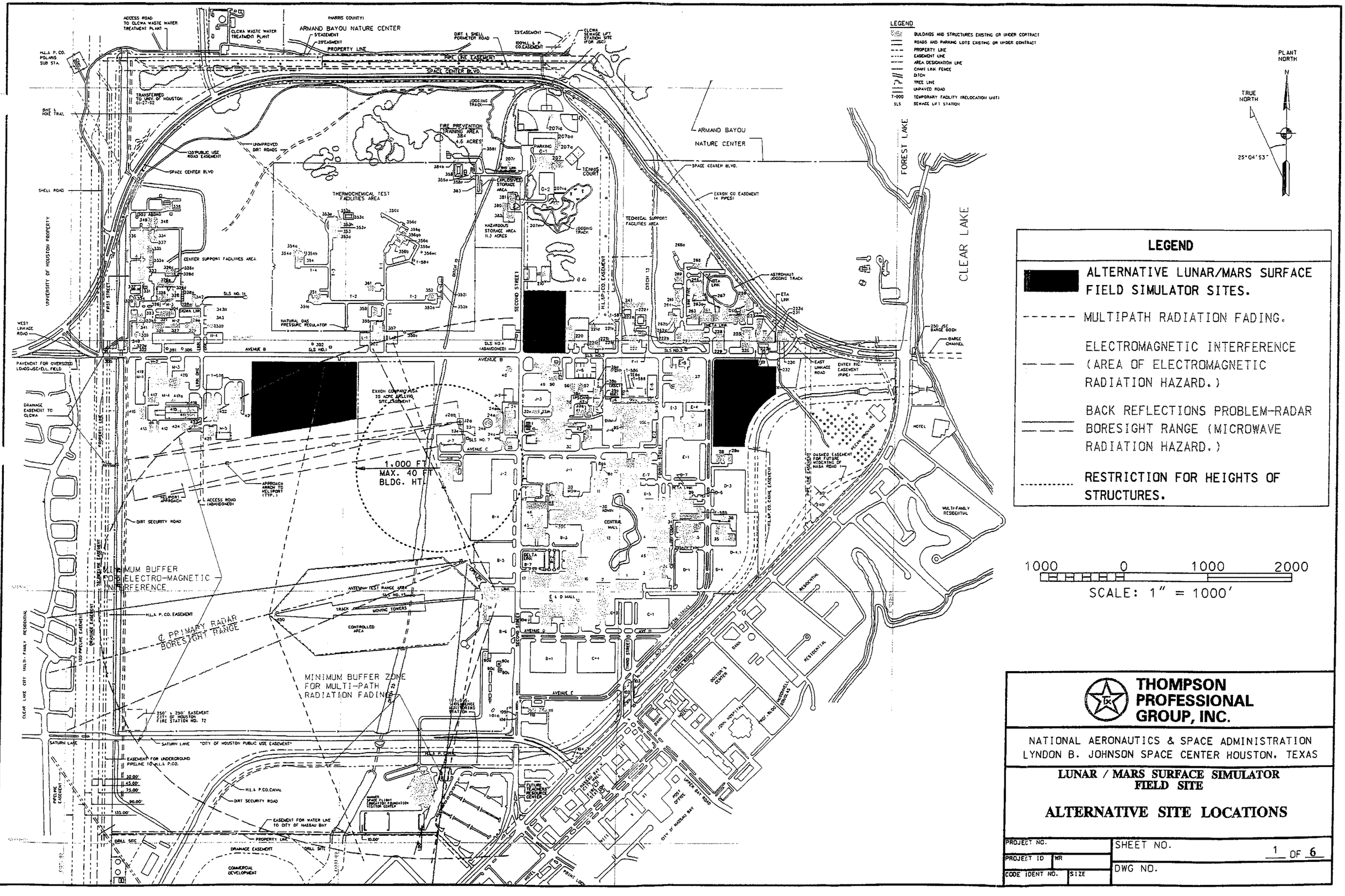
6 "Environmental Justice Strategy," National Aeronautics and Space Administration, Washington, D.C. 1995.

7 Johnson Space Center Draft Environmental Justice Assessment & Implementation Plan, Foothill Engineering Consultants, Inc., Golden, Colorado, 1996.

APPENDICES

APPENDIX 1:

DRAWINGS



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NATIONAL AERONAUTICS & SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS

LUNAR / MARS SURFACE SIMULATOR FIELD SITE

ALTERNATIVE SITE LOCATIONS

PROJECT NO.	SHEET NO. 1 OF 6
PROJECT ID WR	
CODE IDENT NO. SIZE	DWG NO.

Plotted On: 30APR97
FILENAME: 6FILES
ITEMS

SITE I
(23 ACRES)

EXXON COMPANY, USA
20 ACRE DRILLING
SITE EASEMENT

N-4
L-1
L-2
350
350e
302
SLS NO.1
AVENUE B
LINK ONE
T-578
422
421
425
M-5
24" SD
12 DUCT BANK
8 DUCT BANK
4 DUCT BANK
ELEC
6" FG
8" SS
12" SS
8" W
12" W
6" W
1½" FG
15" SD
PLANT NORTH
TRUE NORTH
25°04'53"

200 0 200 400
SCALE: 1" = 200'

APPROACH ARROW TO HELIPORT (TYP.)

LEGEND – EXISTING UTILITIES

ELECTRICAL LINE	ELECTRICAL BOX
SANITARY SEW LINE	SANITARY SEWER MH
STORM DRAIN LINE (GRAVITY FLOW)	STORM SEWER SEW MH
WATERLINE	AREA INLET
UNDERGROUND TEL. LINE	FIRE HYDRANT
FUEL GAS LINE	VALVE

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LUNAR / MARS SURFACE SIMULATOR FIELD SITE

SITE I – EXISTING CONDITIONS

PROJECT NO.
PROJECT ID | MR
CODE IDENT NO. | SIZE
SHEET NO. 2 OF 6
DWG NO.

TNES
Plotted On: 8DATE5
FILENAME: 8FILE5

SITE II
(8.5 ACRES)

DITCH 19

DITCH 13

H.L.&P. CO. EASEMENT

SECOND STREET

AVENUE B

SLS NO.2

EXXON COMPANY, USA

PLANT NORTH

TRUE NORTH

25°04'53"

200 0 200 400

SCALE: 1" = 200'

LEGEND - EXISTING UTILITIES

- ELECTRICAL LINE
- ELECTRICAL BOX
- SANITARY SEW LINE
- SANITARY SEWER MH
- STORM DRAIN LINE (GRAVITY FLOW)
- STORM SEWER SEW MH
- WATERLINE
- AREA INLET
- UNDERGROUND TEL. LINE
- FIRE HYDRANT
- FUEL GAS LINE
- VALVE

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LUNAR / MARS SURFACE SIMULATOR FIELD SITE

SITE II – EXISTING CONDITIONS

PROJECT NO.	SHEET NO. 3 OF 6
PROJECT ID MR	DWG NO.
CODE IDENT NO. SIZE	

SITE III
(14 ACRES)

THETA LINK
AVENUE B
SIXTH STREET
FIFTH STREET
FOURTH STREET
SLS NO. 3
SLS NO. 6
SLS NO. 8
ENTEX INC. EASEMENT (PIPE)
H.L.&P. CO. CANAL EASEMENT
PIPE LINE EASEMENT
PECAN ORCHARD
PLANT NORTH
TRUE NORTH
25°04'53"
222b
262a
228
225
227
F-1
222
229
226
223a
232
230
204
T-586
T-588
TE6a
9N
9C
9SE
37
31
28
28a
8
29
200 0 200 400
SCALE: 1" = 200'

LEGEND – EXISTING UTILITIES

- ELECTRICAL LINE
- SANITARY SEW LINE
- STORM DRAIN LINE (GRAVITY FLOW)
- WATERLINE
- UNDERGROUND TEL. LINE
- FUEL GAS LINE
- ELECTRICAL BOX
- SANITARY SEWER MH
- STORM SEWER SEW MH
- AREA INLET
- FIRE HYDRANT
- VALVE

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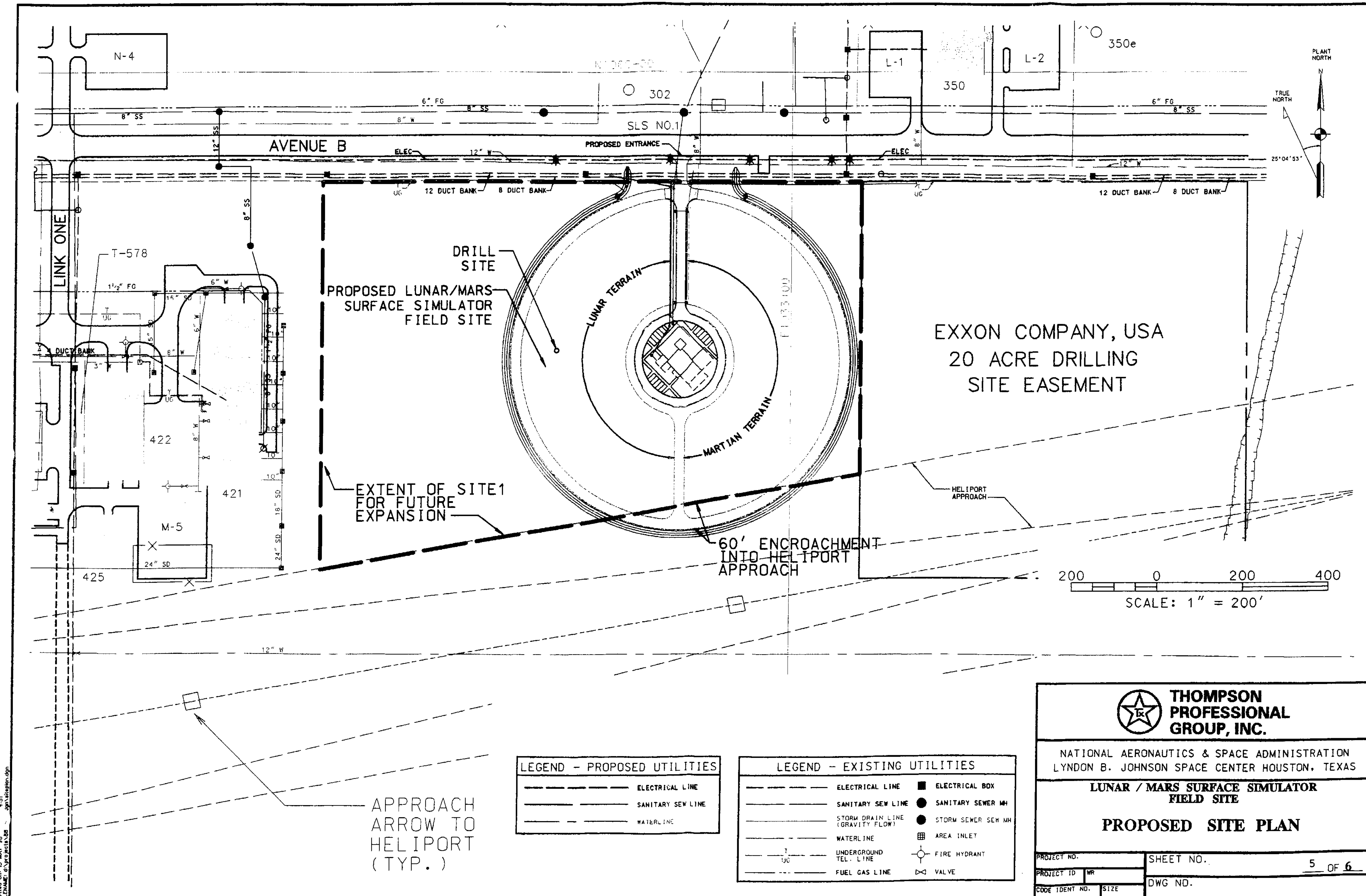
LUNAR / MARS SURFACE SIMULATOR FIELD SITE

SITE III – EXISTING CONDITIONS

PROJECT NO.
PROJECT ID | WR
CODE IDENT NO. | SIZE
SHEET NO. 4 OF 6
DWG NO.

Plotted On: &DATE1
FILENAME: &FILE1


N-4
302
350
350e
L-1
L-2
SLS NO.1
AVENUE B
LINK ONE
PROPOSED ENTRANCE
ELEC
12" W
6" FG
8" SS
8" W
12" SS
12 DUCT BANK
8 DUCT BANK
UG
T-578
422
421
M-5
425
24" SD
DUCT BANK
DRILL SITE
PROPOSED LUNAR/MARS SURFACE SIMULATOR FIELD SITE
LUNAR TERRAIN
MARTIAN TERRAIN
EXTENT OF SITE1 FOR FUTURE EXPANSION
60' ENCROACHMENT INTO HELIPORT APPROACH
HELIPORT APPROACH
EXXON COMPANY, USA 20 ACRE DRILLING SITE EASEMENT
PLANT NORTH
TRUE NORTH
25°04'53"
200 0 200 400
SCALE: 1" = 200'
APPROACH ARROW TO HELIPORT (TYP.)
LEGEND - PROPOSED UTILITIES
ELECTRICAL LINE
SANITARY SEW LINE
WATERLINE
LEGEND - EXISTING UTILITIES
ELECTRICAL LINE
SANITARY SEW LINE
STORM DRAIN LINE (GRAVITY FLOW)
WATERLINE
UNDERGROUND TEL. LINE
FUEL GAS LINE
ELECTRICAL BOX
SANITARY SEWER MH
STORM SEWER SEW MH
AREA INLET
FIRE HYDRANT
VALVE
THOMPSON PROFESSIONAL GROUP, INC.
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
LUNAR / MARS SURFACE SIMULATOR FIELD SITE
PROPOSED SITE PLAN
PROJECT NO.
PROJECT ID WR
CODE IDENT NO.
SIZE
SHEET NO. 5 OF 6
DWG NO.

AVENUE B

PROPOSED ENTRANCE

ELECT. CONDUIT

ELECT. DUCT

ELECT. MOTOR

HI AP.

L.T. STD.

SWBT.

EXIST.D/W

HI-AP. MH.

DETENTION POND (APPX. 1.75 AC-FT)

18"DIA STORM WATER RESTRICTOR (TYP)

24' INTERIOR ASCCESS ROAD

COMPLETED IN PHASE 1

TYP.DRIVE FOR TERRAIN ACCESS

20' INTERIOR WORKING ROAD

260'

DETENTION POND (APPX. 1.75 AC-FT)

400'

COMMUNICATION DUCT EXTENDS 2032 LF TO TUNNEL SYSTEM

DRILL SITE

400'

30'

24' PERIMETER WORKING ROAD

20' INTERIOR DRIVE

ESCARPMENT

24' MULLION SURFACE

24' WORKING ROAD

LARGE CRATER RIM

HELIPORT APPROACH

60' ENCROACHMENT INTO HELIPORT APPROACH

EXXON COMPANY, USA
20 ACRE DRILLING
SITE EASEMENT

100 0 100 200

SCALE: 1" = 100'

LEGEND - PROPOSED UTILITIES

- ELECTRICAL LINE
- SANITARY SEW LINE
- WATERLINE

LEGEND - EXISTING UTILITIES

ELECTRICAL LINE	ELECTRICAL BOX
SANITARY SEW LINE	SANITARY SEWER MH
STORM DRAIN LINE (GRAVITY FLOW)	STORM SEWER SEW MH
WATERLINE	AREA INLET
T / UG UNDERGROUND TEL. LINE	FIRE HYDRANT
FUEL GAS LINE	VALVE

LUNAR / MARS SURFACE SIMULATOR FIELD SITE

PHASE II - SITE PLAN

PROPOSED PLAN WITH DETENTION BASINS

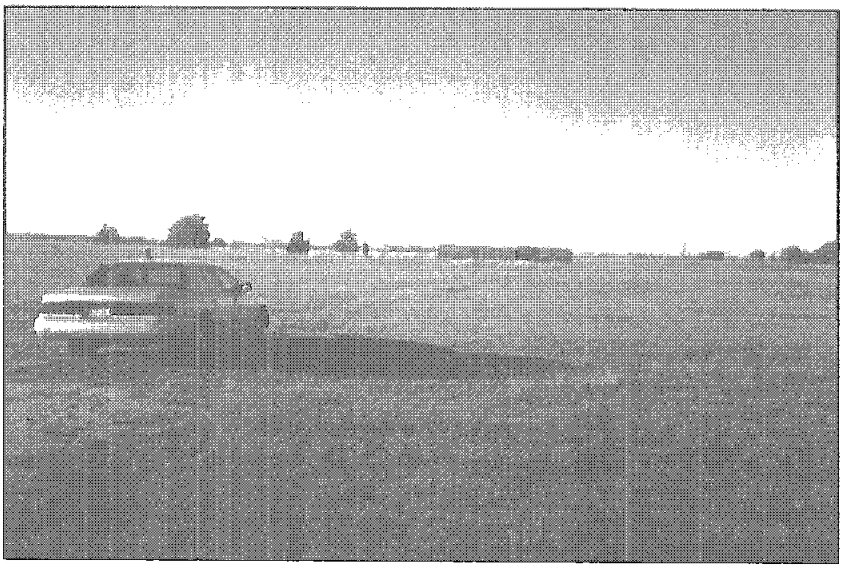
APPENDIX 2:

PHOTOGRAPHS

ENVIRONMENTAL ASSESSMENT
LUNAR/MARS SURFACE SIMULATOR
FIELD SITE PROJECT

Photograph #1

Proposed Alternative, Site I, looking west along Avenue B from the site entry drive. Building 421 appears in left background.



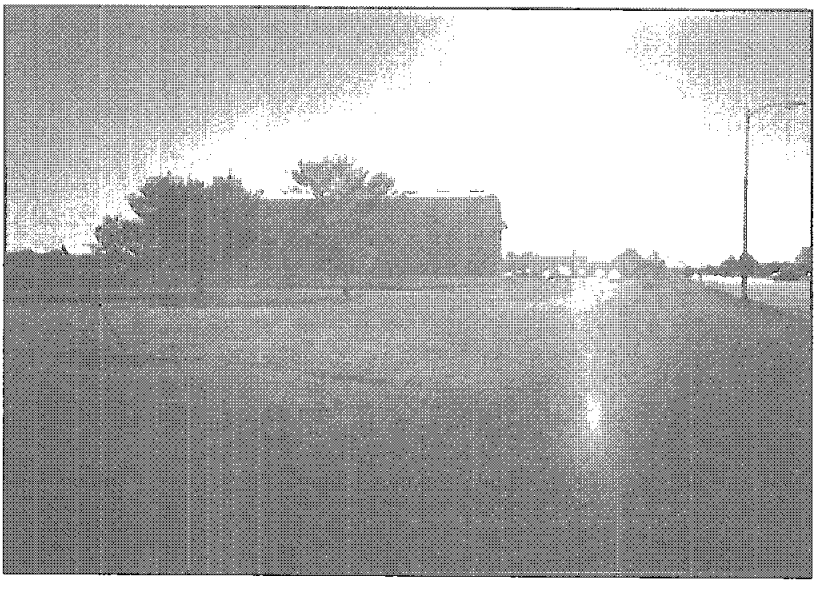
Photograph #2

Proposed Alternative, Site I, looking south from Avenue B. Site entry drive appears in far left foreground.

ENVIRONMENTAL ASSESSMENT
LUNAR/MARS SURFACE SIMULATOR
FIELD SITE PROJECT

Photograph #3

Alternative 1, Site II, looking north along Second Street from the southwest corner of the site.



Photograph #4

Alternative 1, Site II, looking east along Avenue B from the southwest corner of the site. Building 220 appears in background.

ENVIRONMENTAL ASSESSMENT
LUNAR/MARS SURFACE SIMULATOR
FIELD SITE PROJECT

Photograph #5

Alternative 2, Site III, looking southeast from the intersection of Avenue B and Fifth Street.

Photograph #6

Alternative 2, Site III, looking northeast across the site from Fifth Street.