IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF COLUMBIA

STENOGRAPHIC TRANSCRIPT

- -x

FRIENDS FOR ALL CHILDREN, INC., as legal guardian and next friend of the named 150 infant individuals, et al.,

Plaintiffs,

- vs -

LOCKHEED AIRCRAFT CORPORATION,

Defendant and Third-Party Plaintiff,

- vs -

THE UNITED STATES OF AMERICA,

Third-Party Defendant.

- -x

Civil Action No. 76-0544

Arlington, Virginia

Friday, January 8, 1982

DEPOSITION OF DR. ROBIN I. WELCH

Mattingly Reporting, Inc.
COURT REPORTERS
4339 Farm House Lane
Fairfax, Va. 22032

BIOGRAPHICAL DATA

ROBIN I. WELCH

EDUCATION

Ph.D. Wildland Resource Science, University of California, Berkeley, 1971
M.S. Forestry, University of California, Berkeley, 1956
B.S. Forestry, University of California, Berkeley, 1955

PROFESSIONAL EXPERIENCE

Research and Management

November 1981 - Present
Operations Research Specialist at Lockheed Missiles and Space Company, Sunnyvale, California. Principal assignment involves technical support and project management in remote sensing applications and research for advanced systems programs with emphasis in computer aided image analysis.

1977 - September 1981
Contractor at National Aeronautics and Space Administration, Ames Research Center, in technology transfer of remote sensing data in Western Regional Applications Program (WRAP). This activity provided technical training in the application of sophisticated remote sensing technology using satellite, aircraft and ground data for 14 western states. Served on Multispectral Resource Sampler (MRS) Workshop Committee, Colorado State University, June 1979.

1975 - 1977
Associate Research Scientist, Remote Sensing Center, Visiting Associate Professor, Range Science Department, Texas A&M University. Staff assignments included managing programs in agricultural remote sensing and Landsat II study of rangeland resource inventory, consulting with NASA scientists on devising methods for inventorying wheat crops on a worldwide basis in the Large Area Crop Inventory Experiment (LACIE) and assisting in obtaining and analyzing remote sensing data for aquatic plant monitoring, agricultural crop assessment and coastal zone management. Taught graduate course in remote sensing of earth resources. Managed Active Microwave Users Workshop, Houston, Texas, August 1976.

PROFESSIONAL EXPERIENCE (Continued)

Research and Management (Cont'd)

1970 - 1975

Assistant to the Director, Earth Satellite Corporation, Berkeley office. Responsible for office management, research planning and management, training programs for both foreign and U.S. remote sensing courses (2-week and 2 - 1/2-month short courses), flight operations, project and office accounting and sales activities. Served as co-investigator on ERTS and Skylab projects for agricultural crop inventory and yield studies, and in forest insect detection on ERTS images. Served as project manager on EPA spill prevention project using multiband remote sensing, kelp inventory for Pacific Gas & Electric thermal outfall monitoring on California coast, project to select sites for underwater parks on California coast by remote sensing for California Department of Parks and Recreation, and on several training courses in remote sensing of earth resources. Served as consultant in Argentina, Greece and Guatemala for remote sensing planning projects. Served as photo pilot.

1966 - 1970

Senior research engineer at Stanford Research Institute, Menlo Park, California. Served as project leader in multispectral research and photo interpretation for long range planning of military reconnaissance, and in the use of remote sensing in water pollution and water resource studies. Provided guidance in defining remote sensing requirements for Alaska natural resource studies and environmental planning. Contributed to projects on urban analysis, transportation planning, coastal zone management, agricultural inventory and economic analysis of the remote sensing industry. Served as research photo pilot.

1963 - 1966

Research engineer at Mark Systems, Inc. of Santa Clara, California. Served as project leader in multispectral research and photo interpretation for military and natural resource studies specializing in agricultural crop inventory and yield estimation. Involved in one of the first space photo interpretation projects for Athena re-entry tests. Developed photo-optical instrumentation specifications and design. Served as research photo pilot.

PROFESSIONAL EXPERIENCE (Continued)

Research and Management (Cont'd)

1956 - Present

President of Airview Specialists Corporation. Assignments include managing projects in applying advanced remote sensing technology; teaching image analysis, data collection and system operation; research and development of advanced aircraft and spacecraft remote sensing systems, image interpretation systems and applications; special projects in inventory and analysis of natural resources with emphasis in vegetation, water, marine, urban and wildland investigations; and extensive experience in service to industrial businesses in agriculture, rangeland, forestry, geologic, urban and utility areas as well as military reconnaissance activities. These activities have been conducted in North, Central and South America, Middle East, Far East, Africa, South East Asia, Australia, Mediterranean, South Pacific, Soviet Union, Europe and Asia. Served as corporate photo pilot.

PUBLICATIONS

See attached list.

MILITARY

1951 - 1953

U.S. Air Force, Jet Flighter Pilot. Honorable discharge (Disability retirement).

PUBLICATIONS OF ROBIN I. WELCH

Contribution to Chapter 2 in Manual of Photo Interpretation. American Society of Photogrammetry. 1960.

Aerial Photography as a Basis for Determining Fruit and Nut Tree Acreages. A paper for the State of California Department of Agriculture. 1962.

Remote Detection of Minefields. Final Report and Manual. U.S. Army Corps of Engineers. 1962.

Photo Interpretation Keys for Classification of Agricultural Crops. Final Report. U.S. Army Corps of Engineers. 1963.

Biochemical Warfare Analysis by Aerial Reconnaissance. Unpublished paper. 1965.

Penetration of Camouflage Materials by Photographic Techniques. Final Report. U.S. Army. 1965.

The Use of Aerial Photography in Agricultural Crop Analysis and Yield Determination. Technical Publication TB-1, Mark Systems, Inc., Santa Clara, California. 1965.

An Evaluation of Agricultural Crops by Remote Sensing. Final Report (Classified). U.S. Government. 1966.

Detecting Chlorosis of Vegetation by Aerial Photography. Final Report. U.S. Army Corps of Engineers. 1967.

Remote Sensing Systems in Water Control Programs. Paper presented at Third Annual Conference on Remote Sensing of Air and Water Pollution, Sacramento, California. 1967.

Development of a Psychophysical Photo Quality Measure. Final Report. U.S. Army Personnel Research Office. 1968.

Remote Sensing Techniques for Planning, Evaluation, and Monitoring Agricultural Crops. Working paper, Stanford Reserach Institute. 1968.

Remote Sensing in California Water Resource Management. Paper presented at the American Society of Photogrammetry Annual Meeting, published proceedings. March 1968.

Remote Sensing. Stanford Research Institute Journal, No. 19. March 1968.

Detecting Oil Slicks on Water by Multiband Aerial Photography. Stanford Research Institute. Final Report to Chevron Research Corp. 1969.

The Use of Remote Sensing in Water Resource Management. Stanford Research Institute R&D project. (Ph.D. Dissertation) 1969.

The Use of Color Aerial Photography in Water Resource Management. Paper presented at Photo Exposition 1969, New York Coliseum, published proceedings. June 11, 1969.

The Use of Remote Sensing in Water Resource Management. Paper presented at Eutrophication and Biostimulation Assessment Workshop, Berkeley, California, published proceedings. June 21, 1969.

The Use of Remote Sensing in Alaska Water Resource Management. Symposium proceedings, Remote Sensing in Alaska. December 1969.

An Environmental Monitoring Program for the Sacramento-San Joaquin Delta and Suisun Bay. State Water Resources Control Board, final report, the Resources Agency, State of California, Sacramento, California, Stanford Research Institute, Menlo Park, California. May 1970.

Use of Aerial Remote Sensing in Water Resource Management. Lecture for Ecology 201C, The Changing Biosphere, University of California, Davis. May 12, 1970.

Remote Sensing in Hydrology. Paper presented at University of California, Riverside. July 27, 1970.

The Use of Remote Sensing in Providing the Environment and Location of Leisure Facilities. Paper presented at Conference on the Economics of Leisure, Denver, Colorado. October 26, 1970.

The Use of Remote Sensing in Hydrology in Argentina. Draft for publication in government sponsored scientific journal in Argentina. November 1970.

Case Studies in Water Pollution Detection by Remote Sensing--Multispectral Approach. Paper presented at Institute on Remote Sensing of Environmental Pollution, University of Wisconsin, Madison, Wisconsin. November 4, 1970.

The Use of Remote Sensing in Natural Resources and Pollution Control. Paper presented to class on Environment and Pollution at York University, Toronto, Canada. November 5, 1970.

Monitoring Earth Resources from Aircraft and Spacecraft, Chapter 7. National Aeronautics and Space Administration. NASA SP-275. 1971.

Evaluating Growing Conditions and Crop Yields in Agriculture by Remote Sensing. Paper given at the Third Biennial Workshop, Color Aerial Photography in the Plant Sciences and Related Fields, University of Florida, Gainesville, Florida. March 2, 3, 4, 1971.

Remote Sensing: Environment, Ecology, Pollution, Conservation, Development and Resources. Town Hall Reporter. May 1971. Proceedings of Environmental Engineering, Mileau Information Service. July 1971.

A Feasibility Demonstration of an Aerial Surveillance Spill Prevention System (with Allan D. Marmelstein and Paul M. Maughan). Published by the Office of Research and Monitoring, Environmental Protection Agency. January 1972.

Remote Sensing: Aerial Aid for the Water Resource Planner. Modern Government. Servicios Publicos. August 1972.

A Demonstration of the Usefulness of Ektachrome Infrared Aerial Photography to Inventory Kelp on the California Coast at Three Selected Locations: Diablo Canyon, Davenport and Mendocino. Final Report to Pacific Gas and Electric Company. Co-author Steven L. Wert. October 1972.

Applications of Remote Sensing in Studying Effects of Engineering Works on the Environment. Institute of Transportation and Traffic Engineering Conference Proceedings, University of California. October 1972.

Aerial Spill Prevention Surveillance During Sub-Optimum Weather. EPA-R2-73-243. U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C. September 1973.

A Comparison of Skylab and ERTS Data for Agricultural Crop and Natural Vegetation Interpretation (with L.R. Pettinger and C.E. Poulton). Paper presented to AIAA/AGU Conference on Scientific Experiments of Skylab, AIAA Paper No. 74-1219, Huntsville, Alabama. October 30-November 1, 1974.

A Scheme for the Uniform Mapping and Monitoring of Earth Resources and Environmental Complexes. An Assessment of Natural Vegetation, Environmental and Crop Analogs. Co-author Charles E. Poulton. Final Report to Goddard Space Flight Center, Greenbelt, Maryland. 1975.

Water Resources Assessment. Co-author, Chapter 19, Manual of Remote Sensing. American Society of Photogrammetry. 1975.

Remote Sensing for Land and Resource Management in the South and Southwest. Author/Editor, Conference Proceedings. Remote Sensing Center, Texas A&M University. September 28-29, 1976.

Analyst Interpreter Keys, Vol. I and Vol. II, Large Area Crop Inventory Experiment (LACIE). Consulting Author/Editor. Johnson Space Center, Houston, Texas. January 1977.

Conference of Remote Sensing Educators (CORSE-78) Proceedings - Author/Editor. NASA Ames Research Center, Western Regional Applications Program, June 1979.

Training Module Series, produced under contract for NASA Ames Research Center, Moffett Field, CA:

Poulton, C. E. and Robin I. Welch. 1979-1981. Digital Analysis of Landsat Data - The Woodside Quadrangle:
Introduction and Background Information
Exercise 1: Familiarization and Use of Line Printer Output
Exercise 2: Clustering and Classification using an Unsupervised Approach (with Dave Morse)
Exercise 4: Verification and Accuracy Check
Simulated Field Trip and Image Familiarization Slide/Tape

Poulton, C. E. and Robin I. Welch. 1979. Ground Data Verification Methods - Laboratory Exercise

Poulton, C. E. and Robin I. Welch. 1980. Visual Interpretation of Remote Sensing Photography/Imagery (A Self-Study Module)

Poulton, C. E. and Robin I. Welch. 1980. Where Remote Sensing Fits in Resource Planning, Development and Management: What the Administrator Needs to Know or Appreciate

Poulton, C. E. and Robin I. Welch. 1980. Remote Sensing; What Is It?

Poulton, C. E. and Robin I. Welch. 1980. Preparing Aerial Photographs for Stereo Interpretation, Measurement and Data Transfer

Poulton, C. E. and Robin I. Welch. 1980. Determination of Information Classes - Legends and Mapping Guidelines

Poulton, C. E. and Robin I. Welch. 1980. Visual Interpretation of Landsat Images, Highflight and Conventional Aerial Photography - Laboratory Exercise

Poulton, C. E. and Robin I. Welch. 1980. Work Flow in Remote Sensing Applications: A Conceptualization Leading to the Design of an Integrated System to Acquire Information

Welch, Robin I. and C. E. Poulton. 1979. The Basic Physics of Remote Sensing, Matter and Energy Relationships

Welch, Robin I. and C. E. Poulton. 1979. Glossary - Common Terms and Acronyms

Welch, Robin I. and C. E. Poulton. 1979. Ground Data Verification Methods

Welch, Robin I. and C. E. Poulton. 1979. Remote Sensing Systems - Photographic and Imaging, Active and Passive

Welch, Robin I. and C. E. Poulton. 1980. Geometry of Aerial Photographs (Measurements, Displacements, Distortions)

Welch, Robin I. and C. E. Poulton. 1980. History of Remote Sensing

Welch, Robin I. and C. E. Poulton. 1981. Image Interpretation Keys and Aids

LECTURES AND PAPERS

Remote Sensing in Alaska Mineral Exploration, testimony presented to Yukon-Taya Commission, Juneau, Alaska, April 1970.

Remote Sensing--A Window Into our Environment, invited lecture to College of Engineering, University of California, Berkeley, January 29, 1971.

Invited testimony on Coastline Preservation in Monterey County, AB 1471, Paul Priolo, Chairman, April 23, 1971.

Remote Sensing, paper presented to Oceanography, Natural Resources, and Systems & Technology Sections, Colonel T. R. Gillenwaters, Vice Chairman, published in Town Hall Reporter, May 1971.

Use of Remote Sensing in Agriculture, invited lecture presented on the occasion of the visit of Dr. Robert Chandler, Director of Rice Institute, Philippines, to the Ames Research Center, May 21, 1971.

Remote Sensing Data Acquisition Systems, lecture given at San Jose State College, August 11, 1971.

Waste Management Planning and Pollution Detection in the Urban Environment, invited paper presented at University of Wisconsin, Madison, Wisconsin, October 1971.

Environmental Considerations in Coastal Zone Planning, lecture presented to the State of California, November 1971.

Sensing Land Pollution, invited paper presented to AIAA Symposium on Sensing of Environmental Pollutants, Palo Alto, California, November 8, 1971.

Photo Interpretation Report on Underwater Park and Recreation Use of Shoreline Area from Partington Cove North to Mouth of Big Sur River, Special Report for Department of Parks and Recreation, State of California, January 1972.

An Aerial Surveillance Spill Prevention System, presented at EPA Conference on Spill Prevention, Houston, Texas, March 1972.

Remote Sensing: Environment, Ecology, Pollution, Conservation, Development, and Resources, lecture presented at MIS, April 1972.

Estimating Rice Crop Production by ERTS-1 Imagery, presented at NASA, Goddard, Greenbelt, Maryland, October 29, 1973.

The Use of Remote Sensing in Water Resource Management, presented at the Conference on Resource Evaluation through Remote Sensing and Satellite Imagery, sponsored by Idaho Department of Water Resources and Idaho Water Resources Research Institute, Boise, Idaho, July 23, 1974.

Remote Sensing in Agricultural Crop Production Analysis, Special Seminar presented at Texas A&M University, College of Agriculture, Department of Soil and Crop Sciences, College Station, Texas, November 1, 1974.

Remote Sensing Short Course, University of Texas, August 18-20, 1976.

Water and Environmental Engineering, Session Chairman, American Society of Photogrammetry Semi-annual Meeting, Seattle, Washington, October 1, 1976.

A Bird's-eye View of a Water-level Problem, Marina Management and Operational Seminar, A Sea Grant Advisory Program, Austin, Texas, October 20, 1976.

Remote Sensing Lecture, National Conference of State Legislators, New Orleans, Louisiana, September 12-13, 1977.

Remote Sensing Lecture, National Conference of State Legislators, Aspen, Colorado, September 23-24, 1977.

Remote Sensing Lectures, State of Hawaii personnel, Honolulu, September 29-30, 1977.

Remote Sensing Lectures, State of Montana personnel, Helena, October 26, 1977.

Remote Sensing Lecture, National Conference of State Legislators, Lake Tahoe, California, November 8-9, 1977.

Remote Sensing Lecture, San Diego State University faculty, November 21, 1977.

Remote Sensing Short Course, State of Hawaii personnel, Hilo and Honolulu, December 12-14, 1977.

Remote Sensing Short Course, State of Montana personnel, Helena, January 24-25, 1978.

Remote Sensing Lecture, Landsat Education Conference, Santa Maria, California, March 3, 1978.

Remote Sensing Lecture, Earth Resources and Remote Sensing, College of San Mateo, March 15, 1978.

Lectures, Remote Sensing Training Course Modules - NASA Western Regional Applications Program, Ames Research Center:

- The Basic Physics of Remote Sensing, Matter and Energy Relationships, March 1979.
- Ground Data Verification Methods, April 1979.
- Image Interpretation Keys and Aids, April 1979.

Water and The People. Paper prepared for Proceedings, Fall Convention, American Society of Photogrammetry, September 1979.

Remote Sensing Lectures - Western Regional Applications Program (WRAP) - Training Courses (Continued)

Helena, Montana Department of Fish and Game, August 21-25, 1978

Humboldt State University Faculty, Arcata, CA September 11-15, 1978

California Department of Forestry, Ames Research Center, October 2-6, 1978

U. S. Forest Service, Ames Research Center, January 29-February 2, 1979

Colorado State University, Fort Collins, January 9-11, 1980

Staff Training at Ames Research Center, January 7, 1980

Association of Bay Area Governments (ABAG) - California Department of Forestry, Ames Research Center, March 3-6, 1980

State and Federal Agencies involved in Eruption of Mt. Saint Helens Survey, Olympia, Washington, July 30-August 1, 1980

Electric Power Research Institute (EPRI), Ames Research Center, October 20, 1980

Pre-VICAR Training Course, Ames Research Center, October 23-24, 1980

Landsat in the National Water Use Program, Ames Research Center, Nov. 4-7, 1980

Staff Training, Ames Research Center, December 8-10, 1980

NASA U-2 and Landsat Coverage of Mount Saint Helens Eruption, Eastern Washington University, Cheney, Washington, May 17-18, 1981

Remote Sensing for Public Utility Industry, Ames Research Center, Sept. 24-25, 1981

Assessment of Saigon C-5A SN 68-218 Crash Site
April 4, 1975

Robin I. Welch, Ph.D.

December 16, 1982 - January 8, 1982

1. Objectives

1.1. Description of Crash Events

The objective of this report is to provide a description of the events of the crash of the U.S. Air Force C-5A, SN 68-218 near Saigon, South Vietnam on April 4, 1975, from initial contact on the east side of the Saigon River to final resting place of the four major aircraft components, flight deck, troop compartment, empennage and wing, and associated parts visible on aerial and ground photographs.

1.2. Assessment of Report of Dr. Stanley Morain

An additional objective is to assess and critique the report by Dr. Stanley Morain on the interpretation of the crash site prepared for this investigation. Particular attention will be given to the alleged occurrence of fire and fuel spill at the site, the period when the troop compartment was allegedly airborne and the alleged abrupt stopping of the troop compartment against an embankment-like structure and the associated evidence for these occurrences.

2. Methodology

2.1. Data Used

The data used for this assessment includes aerial and ground photographs and movie films taken after the accident and collateral charts, diagrams, maps and reports. These data were used to reconstruct the various major events of the touchdown and subsequent destruction of the aircraft.

2.2. Crash Events Analyzed

Available aerial and ground photographs, maps, reference documents and consultation with experts with knowledge of the local terrain and vegetation types have been used to describe the before - and - after conditions, separating naturally occurring anomalies from those caused by the crash of the C-5A. As far as possible, the cause or sources of the visible ground scars and vegetation changes -- both naturally occurring and crash induced -- have been identified and documented with photographic examples.

2.3. Morain's Report Verification

The interpretation, measurement and analyses contained in the report and testimony by Dr. Stanley Morain were tested in an attempt to verify his findings. Where any analysis revealed differing conclusions these were explained and documented.

3. Findings of Interpretation - Physical Description of Data

3.1. Normal Aircraft Configuration

Charts and photographs contained in defendant's Exhibit Nos. D 1216, D 1217, D 1307, D-9 and D 1320 were used for all measurements and descriptions of aircraft components. Collateral information contained in documents prepared by Mr. John Edwards of Lockheed Aircraft Corporation were used for conditions and measurements specific to this C-5A and the crash investigation.

3.2. Local Terrain and Vegetation

Local terrain and vegetation conditions are typical of wet land rice culture in many parts of Southeast Asia. This area is characterized by relatively flat river terrace terrain prepared for rice growing by draining the land, constructing levees 1/2 meter (20") or so in height, transplanting of rice plants grown in nearby nurseries and reflooding during the growing season. The total growing period from planting to harvest is generally 4-5 months in duration. Rice at the time of the crash had been freshly planted in many of the fields around the aircraft parts. In the case of the troop compartment there was no evidence that planting for the season had yet taken place in the field where that structure came to rest. The area was however flooded as evidenced by standing water nearly completely surrounding the troop compartment.

Associated with the rice lands are naturally occurring patches of trees, shrubs and grasses occupying sites either too wet because of low lying terrain, too dry because of slight elevation in terrain or devoted to other land uses -- farm storage, municipal facilities, woodlots, roads, trails, rivers, etc. Generally the terrain is very flat typical of river delta lands covered by alluvial soils of mixed clay, silt, sand and gravel zones (See Figures 1 & 2).

The C-5A crash while ultimately destructive of the aircraft allowed survival of many passengers and crew because of three factors -- the flat terrain allowing relatively uniform deceleration (expending of energy of the moving aircraft) evenly over a distance of nearly a half mile, slick soil surfaces due to rice paddy conditions (flooded, muddy soils of low compaction) providing a lubricated surface for easy sliding and soft, muddy soil to facilitate a retarding of the aircraft as parts of the belly structure dug into the soft surface and were torn away. This tearing caused a cumulative slowing of the aircraft from an initial touchdown speed of 270 knots to a resting point of the troop and flight crew compartments nearly a half mile from initial ground contact.

Several soil structures and drainage features are visible on the photographs such as river levees and the Saigon River that could potentially have altered greatly the course of the crash had the aircraft contacted them in a different fashion, but the skill of the flight crew, and in my opinion the grace of God saved many lives in this accident.

Much of the crash area was devoted to rice culture at the time of the crash and growing rice is visible in fields near the river through which the aircraft parts slid, as it was at the beginning of the rice growing season. Much of the area through which the empennage, troop compartment and flight deck slid had already been planted to rice as seen in the evenly spaced rows of rice plants (grass-like leaves) in the forground of Figure 3. The area where the wing and the two right engines came to rest and burned is occupied by natural grasses, shrubs and a Vietnamese cemetery and as such was for the most part drier soil area. It also was slightly higher -- perhaps a quarter of a meter (10") or so -- than the rice paddys to the east where the other parts of the aircraft came to rest (See Figure 4.).

Evidence for the flatness of the terrain of perhaps an overall rise in elevation from the fields nearest the river to the touchdown point on the east side of the Saigon River of a meter (3') or less over about a half mile horizontal distance, and a lesser rise of perhaps a tenth of a meter (4") on the west side over a similar distance can be seen by the views in Figure 5 taken on the ground on the east bank and Figure 6 taken from the ground on the west bank. Also, the presence of standing water in slight depressions on the west bank verifies the flatness of the terrain.

The east bank of the river where the aircraft first touched down did not have current rice culture as seen in Figure 5 and as such was not flooded. The soil at the point of touchdown was thus somewhat more firm than that in the rice paddy on the west bank allowing the aircraft to "skip" on initial touchdown where tire marks are visible. (See Figure 7) The levees (around the rice paddys) were a signifcant obstacle to the rolling of the landing gear tires and were effective in removing both rear main gear assemblies and one forward gear assembly as the aircraft passed over them. Had these levee structures not been present exactly where they were, the landing gear assemblies may not have failed at that point as the ground appears to be relatively firm and the aircraft did roll some distance before contacting the levees.

As noted the terrain on the east side of the Saigon River is relatively flat and the aircraft touched the upper portion of two levees spaced about 69 meters (225') apart without contacting the ground between them. Thus, the aircraft was flying nearly level at this point -- neither descending or climbing -- which further verifies the flatness of the terrain.

There is a row of palm trees along a permanent levee slightly right or north of the aircraft flight path where one or more trees were contacted by the right wing and sheered off as seen in Figure 8.

3.3. Post Crash Site Ground Conditions

3.3.1. East side of Saigon River

The touchdown point of the aircraft on the east side of the Saigon River shows evidence of the aircraft being in a nearly level aircraft attitude and in a slight descent. The sequence of touchdown marks suggests the following possible events.

First levee contact - The first levee contacted by the aircraft appears to be about 1/2 meter (20") in height and was hit by several of the tires in the landing gear, or other structural members, taking out about half of the levee height or .25 meters (10"). There was no apparent aircraft parts torn off at that point. See Figure 9.

Second levee contact - The second levee which lies approximately 225' from the first appears to have been contacted by tires on all three landing gear (left and right main gear tires and nose gear tires) or by other structural members. It may be assumed that the contact was by both front and rear main gear tires but that cannot be verified from the photographs available and it is possible that not all wheels touched the levee because of the uneven top of the levee and the uncertainty of the attitude and condition of the belly of the aircraft at this point. It is apparent that the sink rate (descent) of the aircraft at this point was minimal because the soil torn out of the second levee was perhaps .4 meters (about 15") or about 5" deeper than the dent in the first levee. If the aircraft forward velocity was 310 mph, that equates to 455 feet per second (fps). Assuming the horizontal distance between levees 1 and 2 to be approximately 225 feet the rate of descent was 5" in 1/2 second or 50' per minute. See Figure 7.

Rice paddy contact - The next contact point was past levee number 2 by about 50' on the level ground in the rice paddy, perhaps another 5" below the past point of contact on the levee. At 455 fps the aircraft traveled 50' in .11 seconds while descending 5", or 227' per minute rate of descent. These figures are of course only estimates but probably bracket the true rate of descent.

At the third point of contact on the east side of the Saigon River, i.e., in the rice paddy it appears possible that the nose gear with four tires across first contacted the ground as evidenced by the slight rolling marks of 3 or 4 tires between the main gear tire marks. These marks could have been made by other structural members hanging below the aircraft.

The next marks in sequence of touchdown were made by the left main landing gear followed by the right main landing gear. These measurements were obtained by using D 1216 tread width of 35' 11" (431") which was measured to be 60 mm on Figure 7. The overall rolling tire marks run for about 50 to 70 feet in a forward direction.

Third levee contact - The fourth contact point on the East side of the Saigon River was at the levee on the west side of that rice paddy. At that point it appears that the nose had raised to a point where the nose gear and any other structures hanging in the center area cleared that levee and did not touch ground again until the west side of the River. The left and right main gear tires contacted the third levee in the line of contact points and in my opinion at that point both left gears (forward and rear) and the right rear gear separated from the aircraft. What was probably the right main gear assembly came to rest near the base and south about

10' of the tenth palm tree in the row of trees to the north of the flight track (See Figure 10).

The two outer (rear) tires and wheels in the rear members of the six wheels of the right rear main gear were torn loose and landed at other locations. Several tires were visible such as one to the northeast of tree #1 about 50'; one to the west of tree #1 about 143', slightly right of the aircraft flight track, and yet another nearly under the flight track. (See Figure 11). Fifteen tires were accounted for definitely and possibly two others as seen in Figure 12.

The two left main gear assemblies broke into several pieces and came to rest in widely scattered locations beneath the flight track of the aircraft on the east side of the Saigon River.

A plotting of the visible locations of tires and gear components from the three main landing gears that came to rest on the East side of the Saigon River are shown in Figure 11 through 17.

As the aircraft progressed forward the broken strut or struts from the left main gear assemblies contacted the ground leaving a scar of about 144' with the western-most segment 76' long. See Figure 18. Measurement of this scar is difficult because no vertical photography has become available and the oblique photos are not optimum for this view.

Over the remaining distance from the last scar of the broken landing gear strut while still attached to the aircraft to the east bank of the River a number of ground indentations and remmant parts are visible indicating that the initial contact of the aircraft damaged the structure and parts began to fall away hitting the ground and remaining on that side. This included one of the landing gear doors as seen in Figure 1i. There is a row of palm trees running along an east-west levee just north of the final flight track of the aircraft. See Figures 13 & 17. It appears that the first tree in the row (the easternmost tree) was sheared off 16' above ground and perhaps the second tree although measuremnts indicate that it is about 113 feet off the centerline of the flight track and thus may not have been impacted. The estimated distances of the trees and their heights were measured from several photos using an aircraft tire given as 4.02' in diameter for calculation. An average of readings taken on several photos was made as shown in table #1. The aircraft wing span is shown to be 222.75 in D 1216 and thus the measurement of trees off centerline can be compared with the distance from the flight track centerline to the wing tip (111.37') to determine whether a tree was within or outside of the area covered by the wing.

As it appears that the first tree was broken off at 16' above the levee top or 17' 8" above the paddy floor (assuming the levee was 20" high), the wing was about 3' higher than its normal ground clearance (about 14.5' parked on the ramp) which indicates the low flying altitude at that point.

In my opinion the "blow-down" effect of the air from the low flying aircraft left a visible path along the ground where dust would have been blown away, grass would have been bent over and general appearance of the ground would have changed to reveal the flight path over the ground. The flight height from that point to touchdown on the west side of the Saigon River was probably not over 50-70' above ground thus providing a relatively low rate of descent on impact on the west side of the River.

Other than the general changes in vegetation and soil surface caused by the blow-down there were numerous ground scars caused by tumbling landing gear parts, tires and pieces of metal such as gear doors and belly covering visible on the east side of the River. (See Figure 11)

3.3.2. <u>West side of Saigon River</u>

The aircraft apparetnly hit the levee on the west bank of the Saigon River and tore out soil nearly to the level of the rice paddy of about 4'. This scar is visible in Figure 19 and 20 and this indicates a slightly nose high attitude at touchdown. From that point westward the belly of the aircraft was in contact with the ground which as noted was very flat, soft and wet which served to dampen any bouncing motion, prevent the sparking of metal which might have caused a fire and lubricated the path of the aircraft. As the aircraft moved forward it was slowed in its progress by parts that dug into the moist, soft soil and were torn loose. (See Figure 21)

Because of the weight of the aricraft (nearly 450,000 lbs.) and the velocity (270 knots at touchdown) the deceleration was, in my opinion, relatively uniform and gradual as no major obstructions were impacted by the airframe --

particularly the troop compartment and the flight deck. The nose remained slightly elevated as evidenced by no depressions in the track centerline.

The forward travel of the troop compartment was in nearly a level, straight line from the point of touchdown on the east and then the west side of the River to its stopping point (See Figures 17 & 21). Because of the soft, wet soil along the path on the west side any heavy object impactig the ground left a very visible scar as seen in numerous Figures, such as 21: Therefore, if the troop compartment had been airborne along this path and come down with any significant vertical force a huge scar or indentation would surely have been visible. As it was the path along which both the troop compartment and the flight deck traveled is devoid of any abrupt indentations and instead a steady trace of the sides of the fuselage are readily visible throughout the sliding path of these components.

The initial impact on the west side was relatively mild as the rate of descent was gradual. The scars in the soil are relatively uniform in depth and width. (See Figure 21.) These scars appear to extend continuously from the initial contact point near the River's edge to the final stopping place, with no major changes in the width or line of travel. As seen in Figure 17 the troop compartment came to rest in nearly perfect alignment from the inital touchdown orientation.

The standing water seen in the tracks in Figure 21 and 22 outlines the location of the fuselage sides as the aircraft slid forward as well as ground indentations from components that bounced along the surface. Following these indentations leads the observer to a final resting place of various aircraft parts such as engines, landing gear and other structures. (See Figure 23, and later 29 and 33)

As the aircraft progressed forward the underside of the fuselage wore away lowering the aircraft compartments, wings, empennage, etc., to the ground. At about 1050' from the touchdown point sufficient structure had torn away, particularly toward the aft end of the aircraft as it was still sliding slightly nose high, to weaken the fuselage structure to the point where a major separation of aircraft sections began to occur.

In Figure 22 it is possible to see several indications of a change in aircraft configuration. It appears that the aircraft fuselage ground away to the point where the engines finally came in contact with the muddy, soft soil surface (at about 733' from the river) which effectively slowed the whole structure sufficiently to permit the flight deck to move foward away from the wing. The pieces of fuselage side and belly were left along the slide path in the mud as the aircraft moved along as seen in Figures 22 and 23. As the flight deck separated from the aircraft at the leading edge of the wing and began a gentle arc to the left (south), further deterioration of structural integrity allowed the wing, which still had flying speed to drag both left and right engines on the soil surface causing both left engines to separate from the engine pylons. The tracks for these two left engines can be seen in Figure 23, as the engines diverged in their travel to their final stopping place -- the outboard (No. 1) engine coming to rest to the left of the flight deck track and the inboard (No. 2) engine stopping to the right and slightly behind the troop compartment.

At this point the wing became lighter in weight as the two left engines were gone, the main part of the aircraft no longer was firmly attached and the wing lifted free of the fuselage taking part of the center section holding the two wings together and with the two right engines still attached flew forward for approximately another 1739 feet and impacted ahead of the place where the troop compartment came to rest. At this point essentially all of the fuel was still in the wing as there is no evidence of fuel spillage, as reported by the eye witnesses, before the wing structure resting place.

In my opinion, had fuel spilled out, there would have been a possibility of fire at that point (as there was in the wing area). Any vegetation damaged or staining caused by fuel spillage would have taken a number of days to become visible and then only in areas where heavy concentration of fuel would have polluted the soil. The green vegetation around the crash site was neither burned by fire nor crushed by the structures; the brown vegetation around the troop compartment, flight deck and in various other locations appears to be a natural occurrence during the growth cycle of these plants caused by flooding of the plants, and is not related to fire or chemical damage from fuel spillage. In my opinion all of the brown areas in the vicinity of the troop compartment and flight deck were brown before the crash as a result of natural growth retardation from flooding. Standing water can be seen around the flight deck and nearly completely around the troop compartment. Using Figures 24-26, which are two stereo pairs, one can see standing water and the relative height of vegetation and terrain in the vicinity of the troop compartment and flight deck.

As the wing separated from the aircraft the troop compartment, which was located immediately aft of the wing continued its forward slide as it was much lighter at this point, having lost the weight of the wing with its load of fuel (See Figure 22). It thus began skimming along the surface leaving even less tracks in the soft mud than before but still in contact with the soil.

The cargo floor was still beneath the troop compartment but soon separted (See Figure 27) as the fuselage sides continued to wear away finally leaving only the sliding troop compartment which by now had "out riggers" formed by the fuselage side walls which had been holding the cargo floor in place only moments before. These outriggers served to float the troop compartment across several levees and clumps of vegetation permitting a slow final deceleration.

It is possible to trace the continuous slide of both the troop compartment and flight deck back to the point of separation from the wing by drawing a line from traces seen on Figure 27 and other photos from the two structures back to the point where the two lines intersect.

The total distance from the River bank to the forward edge of the troop compartment was measured to be about 2161' using Figure 28, scaling from the known length of the troop compartment of 75.67'. This distance corresponds closely with measurements made from other photos of the same line.

Two points indicating that the aircraft slid forward in a slightly nose high attitude are one, the presence of the nose gear coming to rest near the troop compartment, and the relatively intact condition of the gear and tires seen in Figure 29, and also the fact that the nose of the flight deck with the bulkhead supporting the RADOME is seen at the front of the flight deck, Figures 30-32. Had the aircraft been nose low or even level the RADOME would have ruptured and torn away sooner and the nose gear would have been ground up under the aircraft and been deposited at some earlier point. Figure 29 also reveals the stopping place of one of the left jet engines, slightly to the right rear of the troop compartment. The other left side jet engine came to rest to the left of the flight deck ground path as seen in Figure 33.

The close up ground views of the troop compartment as well as the low altitude photos taken out of the movie film reveal standing water all around the troop compartment and also reveal that the front overhang of the floor is not in contact with the ground indicating that the compartment had not yet reached the stand of vegetation located ahead of the stopping point some 10' or so. This can be seen in Figures 24 a & b where one can look under the overhanging floor and see standing grass which shows clearance of a foot or more of open space beneath this point. The troop compartment did not stop abruptly against an abutment but came to rest on flat ground -- standing water shows that to be the case (See Figure 34.) This situation is particularly evident when photographs are viewed stereoscopically (in 3D) which is the method this witness used on Figures 24 a & b for the troop compartment and 25, 26 and 30 and 31 for the flight deck.

Figures 35-36 also shows vegetation with fully formed and undamaged leaves with no evidence of fire. Had there been a fire around the troop compartment this brown vegetation would have burned vigorously.

A similar situation exists around the flight deck where standing water is visible on all sides of this structure and also much undamaged (unburned) vegetation can be seen as there was no fire or fuel spillage near this structure. (See Figures 25, 26, 30 and 31).

The wing structure burned furiously as evidenced by fire, smoke and burned vegetation which appears black and without recognizable leaves and foliage. Photos of the wing area were compared with photos taken of vegetation around the troop compartment to show the absence of fire in the troop compartment and flight deck areas. (See Figures 37 and 38 and compare with Figures 35 and 36.)

The two right engines are visible in the wing area accounting for all four engines. The wing landed upside down facing back from where it came and was heavily damaged by fire from the jet fuel that was in the wings when they impacted well ahead of the troop compartment. The wind blew the fire and flames away from the troop compartment as seen in Figure 23.

The empennage broke loose from the aircraft about the same time the wings separated from the flight deck and troop compartment coming to rest slightly to the North of the slide track of the troop compartment. See Figure 27. No fire was present in the empennage area.

4. Comparison of these findings with those of Dr. Stanley Morain

There are several measurements made by Dr. Morain that were erroneous because he used incorrect dimensions for aircraft components for calibration -- namely tire dimension and length of troop compartment. The tire diameter is actually 4.02' instead of the 3.75' used by Dr. Morain. The troop compartment and part of the fuselage still attached, is actually 75.67' instead of the 65' he used. These errors would influence all calculations in which the incorrect dimensions were used to estimate ground distances.

Dr. Morain indicated the possibility of fire around the troop compartment which was not confirmed by photo evidence, which would have showed burned vegetation or burned paint on the aircraft had fire been present in that location. In my opinion there was no fire at any point along the slide path or final stopping place for the troop compartment, flight deck or empennage. The only fire that existed was at the wing structure. There was also no significant fuel spillage except at the wing. This is confirmed by eye witnesses and by the absence of evidence of fuel burning except in the wing area.

The troop compartment did not become airborne at any time after initial touchdown on the west side of the River but instead was in continuous sliding contact with the ground as evidenced by the continuous skid marks -- even though some were rather faint where the structure became "light" but was still moving in a "planing" fashion over the moist soil of the rice paddy.

The photographs presented in this report verify all of my opinions regarding these points.

TABLE #1

Distance of Trees Off
Center Line - in Feet

Observation	Tree Number 1	2	3	4
1	99	119	124	131
2	89.3	109.5	113.7	119.6
3	91.4	114.6	119.9	128.2
4	96	115.2	118	128
5	88	105.6	114	120.1
Average Distance	92.7	112.8	117.9	125.4

Tree Heights - in Feet

	Tree Number 1	2	3	4
Height	16	27	31	31

Aircraft wing span 222.75'
From centerline to end of wing = 111.37'