STUDY BY THE STAFF OF THE U.S. GENERAL ACCOUNTING OFFICE

Seasat Project

National Aeronautics and Space Administration Departments of Defense and Commerce

SEASAT-A is a $75-million satellite scheduled for launch in 1978 to measure winds, waves, currents, sea temperatures, and the shape of the earth.

This report provides the Congress with information on the satellite's justification, cost, schedule, and capabilities. It also discusses low project cost estimates, and the need for firm commitments by users to participate in the project during its planning and development.

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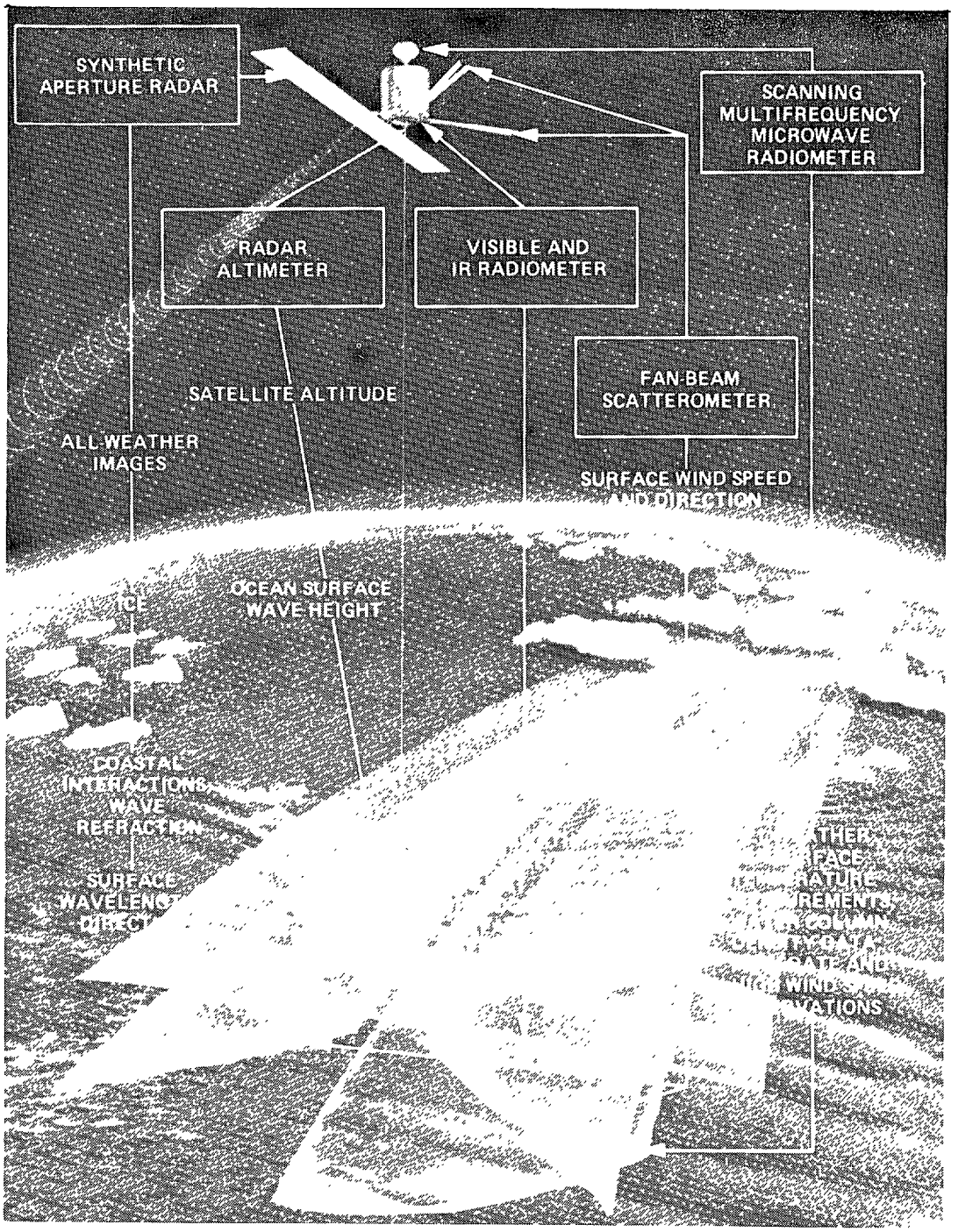

ARTIST'S CONCEPT OF SEASAT
Source: Jet Propulsion Laboratory

UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

PROCUREMENT AND SYSTEMS
ACQUISITION DIVISION

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The General Accounting Office has performed a study of the National Aeronautics and Space Administration's (NASA) SEASAT project. The study was concerned with the project's origin and need; cost, schedule and performance status; and with participation in the project by the oceanographic community.

This staff study is our first review of the SEASAT, and its purpose is to provide information that will assist the Congress in performing its legislative and review functions. A draft of this study was reviewed by agency officials associated with the management of this project and their comments are incorporated as appropriate.

Copies of this study are being sent to the Chairman of the Subcommittee on HUD-Independent Agencies, Senate Committee on Appropriations, at whose request we performed this review. Copies are also being sent to the Chairmen of the Senate Committees on Appropriations, Armed Services, Aeronautical and Space Sciences, Government Operations, Budget, Commerce, and Permanent Subcommittee on Investigations, Senate Committee on Government Operations; and the House Committees on Appropriations, Armed Services, Government Operations, Science and Technology, Budget, Interstate and Foreign Commerce; the Chairman of the Joint Committee on Reduction of Federal Expenditures; members of Congress from the State of California; and other members of the Congress who have requested copies of staff studies.

We are also sending copies to the Administrator, National Aeronautics and Space Administration; to cognizant officials in the Departments of Defense and Commerce; and to the Director, Office of Management and Budget.

R. W. Gutmann
Director

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ABBREVIATIONS

APL	Applied Physics Laboratory
DOD	Department of Defense
EOPAP	NASA Earth and Ocean Physics Applications Program
FNWC	Fleet Numerical Weather Central
GAO	General Accounting Office
HUD	Department of Housing and Urban Development
JPL	Jet Propulsion Laboratory
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
OMB	Office of Management and Budget
SAR	Synthetic Aperture Radar
SMMR	Scanning Multifrequency Microwave Radiometer
WFC	Wallops Flight Center

SUMMARY

SEASAT PROJECT

The SEASAT project is an element of the National Aeronautics and Space Administration's (NASA) Earth and Ocean Physics Applications Program (EOPAP). The project mission is to place into orbit in 1978 a spacecraft containing sensors to make measurements of winds, waves, currents, sea temperatures, atmospheric water vapor and the shape of the earth. NASA justified the project to the Congress on the basis that user organizations would provide scientific and technical manpower and money to make use of the satellite data.

OBSERVATIONS

Our observations on the project issues relating to justification, cost, schedule and performance include:

--Congress was informed that an operational SEASAT system had the potential of providing annual benefits amounting to $350 million. This information was based on a preliminary economic assessment which did not consider system costs. We were informed by NASA officials that system costs are currently being considered. (See page 12.)

--In December 1973, a SEASAT-A project target cost of $58.2 million was established by NASA. This amount, which was confirmed as a cost ceiling when NASA

Headquarters approved the project in November 1974, was low in that it did not provide sufficiently for (1) inflation and (2) a payload that would satisfy the needs of all users of the project data--primarily the need for all-weather sea surface temperature measurements. (See page 15.)

--In July 1975, the project cost ceiling was raised by $16.5 million to $74.7 million to provide an additional amount for inflation and to increase the performance capabilities of the satellite. (See page 17.)

--The project estimate does not include costs of the approximately 109 man-years of in-house civil service effort dedicated to the project. Neither does it include provision for a surface truth program (measurements to determine accuracy of satellite instruments) or for data analysis and dissemination. (See page 19.)

--There is clear interest in and active planning with NASA and internally by the user community toward the use of SEASAT-A data. However, top-level agreements with firm commitments of resources between NASA and the user organizations remain to be developed to assure effective use of the data. (See page 22.)

--The Congress has not provided line item authority for participation in the project by the National Oceanic and Atmospheric Administration (NOAA), one of the principal user organizations. (See page 23.)

--No agency has taken a leadership role concerning possible future operational SEASAT-type systems. (See page 26.)

MATTERS FOR CONSIDERATION

In exercising its legislative and review functions, the Congress should consider requiring that NASA:

--Provide specific information as to how capabilities envisioned in an operational SEASAT are linked to potential annual benefits of $350 million. Further, information on total costs envisioned for such a system should be provided.

--Inform the Congress why NASA, rather than the users, should fund SEASAT improvements which were added to satisfy the users.

--Identify and quantify to the extent possible SEASAT-A related costs which are not charged directly to the project.

--Explore means to accelerate the obtaining of SEASAT-A participatory agreements with firm commitments of resources from NOAA and the Department of Defense (DOD).

--Take the lead in addressing the question of agency responsibilities in possible future operational SEASAT-type systems.

In addition, the Congress should assure itself that user agency participation in the SEASAT-A project is properly defined and, if justified, properly funded.

QUESTIONS

The following questions relate to matters identified but not fully developed during our review. The Congress may want to pursue these matters further with NASA and other potential users as appropriate during the authorization and appropriations deliberations.

1. The Senate Appropriations Subcommittee on HUD-Independent Agencies was informed by NASA that an economic assessment showed that an operational SEASAT system had the potential of returning, in the form of benefits, approximately $350 million per year. With regard to the assessment:

a. What impact did the assessment have on decisions related to the SEASAT project?

b. With regard to current economic studies, what have been the results concerning estimated system costs and benefits?

2. Why did NASA not inform the Congress during fiscal year 1976 hearings that the $58.2 million project cost ceiling did not provide a payload that would satisfy the needs of all users of

the project--primarily the need for all-weather sea surface temperature measurements?

3. If there is no increase in NASA's fiscal year 1977 and future budgets, what existing projects will be cut to fund the increase of $16.5 million in SEASAT-A project costs?

4. What is the estimated total project cost, including the surface truth program, data analysis and dissemination, the 109 man-years of in-house project effort and any other project-associated activities?

5. Why did NASA, NOAA and DOD not enter into agreements at the Administrator level prior to start of the project?

6. What is the status of agreements between NASA, NOAA and DOD with respect to SEASAT participation?

7. What are the estimated costs to be borne by NOAA, DOD and other user organizations participating in the SEASAT-A project?

8. Does NASA intend to take the lead in studying the question of agency and institutional responsibilities in possible future operational SEASAT-type systems?

AGENCY COMMENTS

A draft of this report was reviewed by NASA, NOAA and DOD officials associated with the management of this project. Their comments and opinions are reflected as appropriate. As far as we know, there are no residual differences in fact.

CHAPTER 1

INTRODUCTION

This report contains the results of our study of NASA's SEASAT project.

PROJECT DESCRIPTION

SEASAT-A is an ocean dynamics satellite scheduled for launch in 1978 to measure winds, waves, currents, sea temperatures, ice coverage, atmospheric water vapor and the geoid (shape of the earth). The SEASAT-A project has been characterized by NASA as a key element of the NASA Earth and Ocean Physics Applications Program which is expected to make major contributions to ocean science and lead to advances in the study of the atmosphere and the solid earth as well.

NASA contemplates that scientific and applications investigations using SEASAT-A data will be conducted and funded by the users, such as the National Oceanic and Atmospheric Administration and the Department of Defense. The "user" community--agencies and institutions that are the intended users of SEASAT-A data--became involved in planning the project in early 1973. NASA established an Ocean Dynamics Advisory Subcommittee in September 1975 to advise NASA on the SEASAT-A project and to become involved with user agency activities in the surface truth data analysis and investigations involving science and applications. A listing of the organizations that participated in the development of SEASAT is shown in appendix I.

PROJECT MANAGEMENT

NASA's Office of Applications is responsible for overall management of the project, and the Jet Propulsion Laboratory (JPL), Pasadena, California, is responsible for day-to-day project management and implementation. JPL is being assisted by Wallops Flight Center (WFC), Langley Research Center and Goddard Space Flight Center in the acquisition of the satellite's sensor instruments. Tracking support and data acquisition are to be provided by the Office of Tracking and Data Acquisition and by Goddard Space Flight Center. The launch vehicle office of the Office of Space Flight will be responsible for launch vehicle support.

SCOPE OF STUDY

Our study was performed primarily at NASA Headquarters, Washington, D.C., and at JPL. The information presented herein was obtained by reviewing project plans, reports, correspondence and other documents and by discussions with NASA and JPL personnel. We also made contacts with the user community to learn of its plans for and commitments to SEASAT. An artist's concept of SEASAT is shown inside the front cover.

CHAPTER 2

SEASAT MISSION

SEASAT-A is the first spacecraft dedicated to meeting the early goals of NASA's Earth and Ocean Physics Applications Program (discussed below).

OBJECTIVES AND SYSTEM DESCRIPTION

NASA has characterized SEASAT-A as an experimental and feasibility mission whose objectives include:

--demonstration of techniques for global monitoring of oceanographic phenomena and features;

--provision of oceanographic data for both application and scientific users; and

--demonstration of key features of an operational ocean dynamics monitoring system.

It is planned that these objectives will be reached by operating a set of five sensors in a spacecraft in an 800-kilometer orbit. The sensors and the measurements they will perform are:

Sensor	Measurements
Radar altimeter	Wave height Sea surface topography Geoid
Radar scatterometer	Near ocean surface wind speed and direction
Synthetic aperture radar (SAR)	Surface wave and current patterns Ice fields Coastline and ocean interaction

Sensor	Measurements
Visible and infrared radiometer	Ocean surface patterns Ocean surface temperature
Scanning multifrequency microwave radiometer (SMMR)	Surface wind velocity All-weather sea surface temperature Atmospheric water content Ice coverage

The spacecraft will complete 14-1/2 orbits a day from 72 degrees North latitude to 72 degrees South latitude, spanning almost all of the unfrozen oceans of the world. The sensors on board will cover different swath widths up to about 1,000 kilometers wide, achieving 95 percent coverage of the earth's ocean surface every thirty-six hours with three of the five sensors.

It is intended that the data gathered by the sensors will be assembled through a command and control center at Goddard Space Flight Center. The data will then be converted into geophysical quantities (wind speed, wave height, etc.) and disseminated to research scientists. We were informed by NASA officials that this data will be provided to NOAA for its use and subsequent archiving and distribution.

There is also envisioned a quasi-operational experiment in which data will be provided in near real time to the Navy's Fleet Numerical Weather Central (FNWC) where it will be processed and used in its twice daily global weather and sea state predictions. FNWC output products will be provided to NOAA for use and further distribution to other users.

Plans for satellite systems to follow-SEASAT-A are only at a conceptual stage. One NASA study envisions a three-satellite interim operational demonstration SEASAT to come into being in the 1980-1983 period to be followed by an expanded full-capability operational system at a later date. We were informed by NASA officials that any proposal for an operational system will await the results of SEASAT-A.

ORIGIN AND JUSTIFICATION OF PROJECT

SEASAT-A is the first ocean dynamics satellite in NASA's EOPAP. The origins of EOPAP are to be found in the NASA-managed National Geodetic Satellite Program which started in 1964. A catalyst for EOPAP as such was a 1969 study on solid earth and ocean physics sponsored by NASA and the Massachusetts Institute of Technology. NASA's EOPAP program plan which was drafted in September 1972 is to be updated in the near future. In early 1973, NASA sought the involvement of the oceanographic community in the SEASAT-A project. This involvement is discussed in chapter 4.

In early 1974, NASA requested fiscal year 1975 budget authority to start the SEASAT project which was to be dedicated to the acquisition of data for the oceanographic user community. During NASA's authorization hearings, the following summary of benefits expected from SEASAT-A data was presented by the Chairman of the SEASAT-A User Working Group.

EXPECTED BENEFITS TO BE DERIVED FROM SEASAT-A DATA

A. Advancement of knowledge	Oceanographic, Meteorological, Geodetic and Engineering Science
B. Protection of life and property	
1. Navigation and safety at sea	Prediction of high seas, adverse currents Navigation through ice fields More precise iceberg warnings Decreased loss of men and ships
2. Warning of natural hazards	More accurate, longer-term weather forecasts Improved warnings of storms and surges Decreased Tsunami (tidal wave) false alarm rate
C. Economic benefits to the Nation	
1. Maritime operations	Optimum ship routing and scheduling Reduced loss of oil drilling rigs Improved design of offshore structures Improved ship design Improved mapping, charting and geodesy
2. Utilization of ocean resources	Assessment of biological productivity Location of potential fisheries Enhanced extraction of oil, sand, minerals
3. Environmental impact	Dispersal of pollutants and foreign substances Improvement in shoreline protection
D. National defense posture	Improved environmental forecasts More precise geoidal model Enhancement of other DOD missions

NASA officials informed us that the above benefits are more properly associated with an operational SEASAT system rather than SEASAT-A. A further review of congressional testimony showed that NASA summarized the benefits expected from SEASAT-A data as follows: SEASAT-A will permit systematic steps leading toward the measurement of deep sea tides and the major surface currents and circulations, including their variations in space and time. Meteorology and climatology should also benefit from the SEASAT-A mission through its provision of the first global scale data on surface wind fields. Measurements of the temperature of the portions of the ocean surface lying under persistent cloud cover will fill significant gaps in knowledge of factors affecting the atmosphere on time scales ranging from days to months and longer. Solid earth sciences will also benefit in several ways from SEASAT-A data. The detailed knowledge of both the ocean geoid and the combined solid earth and ocean tides will shed new light on the gravity field and the structure and dynamics of the earth's crust.

SEASAT ECONOMIC ASSESSMENT

In response to a question during March 1975 hearings, NASA informed the Senate Appropriations Subcommittee on HUD-Independent Agencies that an economic assessment showed that an operational SEASAT system had the potential of returning, in the form of benefits, approximately $350 million per year.

As a part of the SEASAT-A project, NASA contracted with ECON, Incorporated, to prepare an assessment with the purpose of identifying, rationalizing, quantifying and validating the economic benefits evolving from SEASAT. The assessment, characterized as preliminary in nature by ECON, was published in October 1974. It estimated benefits from selected case studies and extended the benefits into the populations of which the case studies were examples. The assumption was made that operations of a SEASAT-type system would begin no later than 1985 and the benefits were extended to the year 2000. We were informed by NASA officials that a three-satellite operational system was modeled for the purposes of the benefit analyses. Lower bound and upper bound benefit estimates were made and the benefits were projected using discount rates from zero to 15 percent. Aggregate benefit projections ranged from $352 million (lower bound at a 15 percent discount rate) to $6,325 million (upper bound at zero percent).

Benefit Area	1974 dollars	
	Upper bound	Lower bound
	(millions)	
Ship routing	$ 110	$110
Iceberg reconnaissance	36	11
Canadian Arctic operations	435	270
Alaska pipeline	13	13
Off shore oil production	660	264
Military	28	28
Aggregate benefits	$1,282	$696

The assessment did not estimate research, investment or operating costs of SEASAT-A or of an operational SEASAT system. NASA officials said that economic benefit studies are continuing and a draft study report currently under review considers system costs.

OBSERVATIONS ON THE ASSESSMENT

We believe the assessment would have been of more benefit to decision makers in the Federal Government if estimates of investment and operating costs had been made. Such costs could easily amount to hundreds of millions of dollars over a 15- to 20-year period. The current study should provide more perspective because estimated benefits can be weighed against estimated costs.

CHAPTER 3

COST, SCHEDULE AND PERFORMANCE

This chapter provides information on changes in the cost, schedule and performance status of the project. It also points out that the imposed design-to-cost target of $58.2 million for the project was low in that it did not provide sufficiently for (1) inflation and (2) a payload that would satisfy the needs of all users of the project data--primarily the need for all-weather sea surface temperature measurements. The close relationship between costs and performance (or capability of the satellite sensor payload to satisfy the needs of the users) is summarized in appendix II which shows how project costs have evolved.

PROJECT COSTS PRESENTED TO THE CONGRESS

In requesting budget authority to start the SEASAT project, NASA informed the Congress in early 1974 that the project cost estimate ranged from $35 million to $55 million--excluding the cost of the launch vehicle. The $55 million estimate was for a five-sensor satellite that met the requirements established by the users. The $35 million estimate was a design-to-cost approach which set out a cost target to determine whether deleting sensors would be acceptable to the users.

In March 1975, NASA informed the Senate Appropriations Subcommittee on HUD-Independent Agencies that the estimated project

costs were in the range of $50-$60 million--excluding the cost of the launch vehicle and costs of tracking and data acquisition. At that time, as discussed below, the project cost ceiling, including launch vehicle and tracking and data acquisition costs, was $58.2 million and the payload envisioned would not meet all of the users' experimental requirements.

DESIGN-TO-COST CEILING

We were informed by NASA officials that a $58.2 million cost target was imposed on the SEASAT-A project in December 1973 in the expectation that user requirements could be adequately satisfied with such a dollar amount. According to NASA officials, this target was based on the results of an October 1973 NASA/User Task Team study which had the goal of establishing and recommending a set of requirements, costs and schedules to accomplish the SEASAT-A mission. The October 1973 target of $58.2 million assumed a five-instrument system as shown in appendix II.

Following the Task Team effort, studies were initiated by JPL and Wallops Flight Center/Applied Physics Laboratory (WFC/APL). By May 1974, both studies showed that the five-instrument system would cost more than $58.2 million due mainly to better definition of instrument specifications and because of inflation. As shown in appendix II, WFC/APL estimated that such a system would cost $85.2 million and JPL estimated an alternate system (one without

the synthetic aperture radar) would cost $65.9 million. Following a May 1974 review of these estimates, NASA Headquarters established a firm $58.2 million design-to-cost program guideline for a four-instrument system. This amount was confirmed as a cost ceiling when the project was approved by NASA Headquarters in November 1974.

COST AND PERFORMANCE TRADE-OFFS

In order to assess the impact of remaining within the $58.2 million cost target established in 1973, tradeoff studies were conducted as summarized in appendix II. The payload configuration, established by NASA in August 1974, eliminated one sensor, reduced the capability of another and proposed combining the remaining two. The effect of these reductions on the capability of the satellite and the needs of the users is discussed in the next chapter.

INCREASE IN PROJECT COSTS

A reassessment of the impact of inflation on costs and an upgrading of the payload performance caused an increase in estimated project costs. The $58.2 million ceiling was a matter of concern to NASA and JPL officials because it did not reflect a sufficiently high inflation rate. An inflation rate of five percent, included in the ceiling, was the one generally used by NASA at that time. The expressions of concern by the user community--discussed in the next chapter--influenced NASA to improve the technical performance of the satellite.

Meetings between JPL and NASA officials in May and June 1975 to discuss the above concerns resulted in a July 1975 decision to increase the cost of the project by $16.5 million to $74.7 million. The increase was attributable to:

Reason	Amount (millions)
Inflation adjustment	$ 6.6
Addition of radiometer	6.2
Upgrading altimeter	1.1
Other net changes	2.6
	$16.5

We were informed by NASA project officials that the increased $16.5 million will not come from funds authorized to date; rather, it will be dealt with in NASA's fiscal years 1977 and 1978 budget requests to the Office of Management and Budget and the Congress. The relationship of SEASAT-A project estimates to NASA's applications programs budget through fiscal year 1979 is shown in appendix III.

CURRENT PROJECT COSTS

We were informed by NASA officials that the current (January 1976) project cost estimate is $74.5 million which reflects a $200,000 decrease from the July 1975 estimate due to a decrease in expected launch vehicle costs. A breakdown of the July 1975 estimate of $74.7 million is shown in appendix IV. It is to be noted that this estimate does not include three types of project-related costs which are discussed below.

Costs not included in estimate

We were informed by NASA officials that approximately 109 man-years of in-house civil service support would be required to support the project. The costs associated with this support are not included in the project cost estimate in accordance with NASA's normal practice.

The surface truth program associated with the project includes tests using aircraft mounted sensors to collect oceanographic data which is used in part to develop equations to convert raw sensor data into geophysical data (wind speed, wave height, etc.). NASA officials informed us that the estimated cost of the aircraft program activities contributing to the SEASAT-A surface truth program is between $5 million and $6 million. They stated, however, that these costs would have to be prorated into a number of efforts, including non-SEASAT-related activities. NOAA's plans for support of the surface truth program are touched on in chapter 4.

NASA is relying upon the SEASAT user agencies to pay the costs related to analysis and dissemination of SEASAT data.

SCHEDULE

In August 1974, NASA's plan called for a satellite launch in the second quarter of 1978. This event was to be preceded by considerable activity, including selection of a satellite contractor in March 1975. The satellite contractor was not selected until November 1975; however, NASA has not changed the scheduled launch date.

We were informed that the originally scheduled launch date is still valid due to a change in procurement strategy. Under the original procurement plan, WFC/APL was to be responsible for integrating all of the sensors into a module which was, in turn, to be integrated into a spacecraft to be provided by a private contractor. It was subsequently decided to have a private contractor provide the spacecraft, to build the sensor module and to integrate the sensors into the satellite system (spacecraft and sensor module). NASA believes this approach will reduce some of the time-consuming interface that was inherent in the original procurement plan.

CHAPTER 4

USER PARTICIPATION AND COMMITMENTS

Because NASA views the SEASAT project as being dedicated to users of oceanographic data, it sought their involvement in early 1973 to assure that the data and information to come from the satellite would be designed for them. NASA justified the project to the Congress on the basis that user organizations would provide scientific and technical manpower and money to make use of the satellite data.

OCEANOGRAPHIC COMMUNITY

There are a large number of governmental, institutional and private organizations and individuals making up the oceanographic community. In the Federal Government alone marine science and other oceanic activities are conducted by twenty-one organizations in six departments and five agencies. There are literally hundreds of state, regional, industrial and nonprofit organizations with oceanic interests. The organizations that participated in the development of SEASAT are listed in appendix I.

USER NEEDS

During the feasibility study phase of SEASAT-A in early 1973, NASA sought the involvement of the oceanographic community to assure that SEASAT-A would be designed for the users. This involvement took place through a SEASAT-A User Working Group which was chaired by an individual from NOAA.

As discussed in chapter 3, a NASA/User Task Team established and recommended a set of requirements to fulfill user needs. The Team's October 1973 report set forth the measurement priorities of DOD and NOAA and related them to the involved sensors.

Because of the cost ceiling imposed by NASA, it was not possible to build a five-sensor satellite that met the user requirements. Accordingly, it was decided to eliminate the scanning multifrequency microwave radiometer, reduce the data collection capability of the synthetic aperture radar and consider integrating the altimeter and scatterometer. This downgrading of the satellite payload and its effect on user needs is discussed below.

During the latter part of 1974, considerable concern was expressed over the downgrading in letters to NASA and to the Chairman of the SEASAT-A User Working Group. Specific effects cited in these letters from users were:

Scanning multifrequency microwave radiometer (SMMR)

Deletion of this instrument would result in the loss of the ability to make significant scientific measurements. The SMMR is to (1) make all-weather sea surface temperature measurements, (2) provide for the determination of higher wind speeds as an important corroboration of and extension to the scatterometer data, (3) correct altimeter-derived altitudes to the $\pm$ 10 centimeter level, (4) correct the scatterometer wind measurements in the presence of atmospheric water, and (5) provide determinations of liquid and vaporous water in the atmosphere.

Synthetic aperture radar (SAR)

Limitation of the SAR to the direct readout mode would result in the loss of global sampling which would significantly decrease coverage for wave monitoring and forecasting capability.

Altimeter and scatterometer

Some users were willing to accept the integration of the altimeter and scatterometer into one instrument providing that no data would be degraded. However, concerns were expressed that combining the instruments (1) would not be feasible unless "fast" switchings of the modes would be possible, (2) could terminate or impair the collection of data due to technical problems, and (3) would change the design of the scatterometer enough to increase performance risks.

LACK OF USER COMMITMENTS

Our contacts with the user community showed considerable interest in the project and internal commitments of in-house personnel over the past two years. However, we also found a lack of formal agreements with firm commitments of resources to participate in the project. NOAA and DOD are the primary user agencies. A discussion of their involvement and status of agreements for project participation follows. Information is also provided on possible Canadian participation.

NOAA

NOAA's goals include the development and operation of a national system to monitor and predict weather and environmental

conditions for protecting life and property and to increase the efficiency and productivity of Government, industry and the individual. The types of information to be developed from SEASAT-A data are expected to be of benefit to NOAA in fulfilling its goals. A JPL August 1974 project plan envisioned that operational SEASATs would be built and flown by NOAA.

There has been considerable coordination between NASA and NOAA at the project and policy level and project-level plans have been formulated for NOAA participation in the data acquisition, analysis, utilization and archival phases of the project. Internal NOAA plans to participate in the SEASAT project over a five-year period envisioned a budget of about $10 million. The plans called for support of (1) basic research in the maritime community, (2) an aircraft and ship program which would develop techniques for the SEASAT surface truth program, (3) development of the means to convert SEASAT data into geophysical units, and (4) operational demonstrations using the data for oceanography and meteorology programs.

NOAA requested $730,000 for fiscal year 1976 to support the development of techniques for processing, analyzing and using data from SEASAT-A. House and Senate conferees deleted the $730,000 from the final appropriation bill; however, their report stated that they would not object if the effort were carried out with existing funds. We were informed in late January 1976 by a NOAA official that NOAA has agreed to support the SEASAT program. He

further stated that $500,000 of fiscal year 1976 funds to support SEASAT would be reprogrammed.

As of the end of January 1976, there was no formal interagency agreement between NOAA and NASA setting forth the respective roles and commitments of resources by the two agencies in the SEASAT-A project. We were informed by NASA officials that a Memorandum of Agreement between NOAA and NASA is currently in the process of being prepared.

DOD

DOD has an interest in obtaining environmental data for weather predictions from SEASAT-A. DOD's interest in weather data is centered in the Naval Weather Service Command and its FNWC facility at Monterey, California. Project personnel envision the use of FNWC facilities to demonstrate the operational utility of data generated by the SEASAT-A satellite. Navy and NASA personnel have been working on plans for this demonstration since 1974; however, there is no assurance of sufficient budget support by the Navy.

In August 1975, the NASA Project Manager reported that Navy officials indicated that immediate budget action was necessary to support the FNWC demonstration. They also indicated that a formal exchange of intent and commitment statements between DOD and NASA must be made to start funding action.

On December 17, 1975, the JPL SEASAT-A Project Manager and the Commanding Officer of FNWC signed a "Memorandum of Agreement for a Real-Time User Data Demonstration for the SEASAT-A

Project." The document, which contains a statement that resources will be required to carry out the demonstration, is being circulated within NASA and DOD for approval.

As of the end of January 1976, there was no formal interagency agreement between NASA and the Navy setting forth the respective roles and commitments of resources by the two agencies in the SEASAT-A project.

Canadian participation

We were informed by NASA officials that during the past year representatives from the Canada Centre for Remote Sensing began discussing with NASA personnel a plan to develop a digital method for processing data which will help to evaluate the SAR's iceberg detection ability. The plan called for the Canadians to equip a station of their own at St. John's, Newfoundland, and to provide NASA with a duplicate set of processing equipment. In return, the Canadians wanted the SAR to operate over their station and wished to exchange their data for SAR data NASA obtains from its Fairbanks station.

In January 1976, NASA asked the Canadians to elaborate and formalize plans for building a SAR digital processor and has indicated that NASA is prepared to give consideration to a Canadian proposal. We were informed by NASA officials that because of current Canadian budget revisions, it is not yet certain that Canadian Government approval will be given to participation in the SEASAT-A project.

NASA POSITION ON USER PARTICIPATION

We discussed our observations on the lack of formal agreements between NASA and the user agencies with cognizant NASA officials. We also discussed the question of agency responsibility regarding possible future operational SEASAT-type systems.

NASA officials informed us that they are of the opinion that there are clear understandings in NASA, NOAA, DOD and other agencies and institutions regarding roles and responsibilities in the SEASAT-A project and formalized agreements are being prepared.

NASA officials feel that it is too early in the development of the technology of gathering ocean dynamics information by satellite to answer the question of which agency should take the leadership role in future operational systems.

NASA justified the SEASAT-A project to the Congress on the basis that user organizations would provide the scientific and technical manpower and money to make use of the satellite data. The users were heavily involved in the early stages of the project and have developed plans to participate in the data analysis and utilization phases of the project. In the cases of NOAA and DOD, plans have been developed and implementing formal agreements--subject to approval within NOAA, DOD and NASA--are being prepared. With respect to NOAA, the Congress has not provided line item authority for participation in the project.

In our opinion, there should have been top-level agreements among NASA, NOAA and DOD concerning SEASAT-A participation prior to project approval within NASA. We believe such agreements would have provided more assurance that the project data will be effectively utilized. Such agreements should have addressed the respective agency roles, responsibilities, policies and organizational relationships. Further, there should have been clear understandings of resources to be provided by each agency. We recognize that any such agreements are subject to change by future Administrations and future Congresses. However, we believe the costs and potential benefits of the project are such that firm agreements between top agency officials were warranted.

Further, in our opinion, it is not too early to address the question of which agency should take the leadership role in future operational systems.

USER ORGANIZATIONS THAT PARTICIPATED IN THE DEVELOPMENT OF SEASAT

GOVERNMENT

Department of Commerce

- National Oceanic and Atmospheric Administration
  - National Weather Service
  - National Environmental Satellite Service
  - National Ocean Survey
  - Environmental Research Laboratories
  - National Marine Fisheries Service
  - National Data Buoy Center
- Maritime Administration

Department of Defense

- Office of Naval Research
- Naval Research Laboratory
- Naval Weapons Laboratory
- Navy Weather Service Command
- Naval Oceanographic Office
- Defense Mapping Agency
- Army Corps of Engineers

Department of Interior

- Geological Survey

Department of Transportation

- Coast Guard

User Organizations that Participated in the Development of SEASAT

GOVERNMENT

Energy Research and Development Administration

Environmental Protection Agency

National Science Foundation

National Aeronautics and Space Administration

INSTITUTIONS

National Academy of Sciences

National Academy of Engineering

Smithsonian Astrophysical Observatory

Woods Hole Oceanographic Institution

Scripps Institution of Oceanography/
University of California

University Institute of Oceanography/
City College of New York

Battelle Institute

PRIVATE SECTOR

American Institute of Merchant Shipping

American Petroleum Institute

Sea Use Council

SELECTED SEASAT-A PROJECT COST ESTIMATES

Source and Date of Estimate	Payload Configuration: Altimeter	Scatterometer	Combined Altimeter Scatterometer	SMMR 5 freq.	NEMS 2 freq. (1)	V/IR Radiometer	Synthetic Aperture Radar: Global	Synthetic Aperture Radar: Experimental	Total Cost Estimate ($ millions)	Remarks
SEASAT-A Study Task Team, October 1973	X	X		X (3)		X	X		58.2	(2)
NASA Testimony before House Committee on Science and Technology Feb-Mar 1974	X	X		X		X			35.0	(4) (6)
	X	X		X		X	X		55.0	(5) (6)
JPL Alternate Payload May 9-10, 1974	X	X		X		X			65.9	(2)
WFC/APL Baseline Mission May 9-10, 1974	X	X		X		X	X		85.2	(2)
WFC/APL Reduced Mission July 17-18, 1974 Final	X	X			X	X		X	62.1	(2)
WFC/APL Minimized Costs July 17-18, 1974			X		X	X		X	58.2	(2)
JPL Alternate Payload July 17-18, 1974	X	X		X		X			62.0	(2)
APL/JPL/WFC Meeting Reduced Baseline Aug 1974	X	X			X	X		X	65.4	(2)
NASA Headquarters Meeting August 16, 1974			X			X		X	58.2	(2)
NASA Presentation to Senate Appropriations Subcommittee for HUD-Independent Agencies March 1975	X	X				X		X	50.0 - 60.0	(7)
NASA Headquarters Increased Payload Authorization July 1975	X	X		X		X		X	74.7	(2)

(1) Lesser capability than SMMR.
(2) Includes costs of satellite, payload, launch vehicle and tracking and data acquisition.
(3) Four frequency SMMR contemplated.
(4) Alternative mission payload.
(5) Baseline mission payload
(6) Satellite system cost, excluding launch vehicle.
(7) Satellite system cost, excluding launch vehicle and tracking and data acquisition

APPENDIX II

SEASAT-A PROJECT ESTIMATES COMPARED TO NASA'S SPACE APPLICATIONS BUDGET AUTHORITY

	FY 75	FY 76	Transition Period	FY77	FY78	FY79
	----------(millions)----------					
Space Applications budget authority (1)	$175	$175	$55	$179	$138	$108
SEASAT August 1974 $58 million estimate (2) (4)	6	17	--	18	14	3
SEASAT July 1975 $75 million estimate (3) (4)	8	17	5	23	18	4

(1) Based on NASA January 1975 data submitted to Senate Appropriations Subcommittee on HUD-Independent Agencies. Does not provide for new starts beyond FY77.

(2) Based on JPL preliminary Project Implementation Plan, August 16, 1974.

(3) Based on NASA FY76 budget estimates through transition period and spread of balance at same rate established in August 1974.

(4) Includes launch vehicle and tracking and data acquisition costs which are not funded from applications budget.

SEASAT-A PROJECT COST ESTIMATES
JULY 1975

Center and Project Item		Amount (millions)
Jet Propulsion Lab		$53.79
Project management and contingency	$ 9.68	
Satellite system	31.48	
Mission operations	5.53	
SAR (1)	4.60	
SMMR (2)	2.50	
Wallops Flight Center		7.37
SES (3) and SAR	2.77	
Altimeter	4.60	
Goddard Space Flight Center (4)		.50
Langley Research Center (5)		4.04
Launch Vehicle (6)		5.00
Tracking and Data Acquisition		4.00
Total		$74.70 (7)

(1) Synthetic Aperture Radar
(2) Scanning Multifrequency Microwave Radiometer
(3) Satellite Engineering Support
(4) Visible and Infrared Radiometer
(5) Wind Field Scatterometer
(6) October 1, 1975 NASA estimate for launch vehicle was $4.8 million
(7) Does not include costs for SEASAT-A Surface Truth Program, Data Analysis Program, or in-house Civil Service Support

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