NATIONAL RADIO ASTRONOMY OBSERVATORY

Site Development Program

December, 1957

ASSUMPTIONS

Broadly stated, the site development program must provide facilities necessary to immediately achieve optimum utilization of a 140-foot and an 85-foot telescope, 2,700 noise-free acres of Observatory land, and anticipate the availability of the largest antenna in the world by late 1961. Only in this way can the basic purpose of the Observatory, envisioned by the National Science Foundation, be achieved and maintained; i.e. to provide the Nation's radio astronomers with the unique scientific facilities, equipment and environment (which would not otherwise be available) necessary for that type of basic scientific research which will lead the world in contributing to our knowledge and understanding of the universe.

This estimate presumes the fundamental soundness and necessary vision inherent in the assumption broadly stated above. Consequently, it is logically and consistently extended below in the following more detailed assumptions:

(1) A very large antenna beyond the 140-foot and the 85-foot must be provided in the next four or five years. Planning for this must start immediately.

(2) An outstanding scientific staff, both permanent and visiting, necessary to achieve optimum utilization of the aforementioned major instruments and the advantages of a relatively noise-free site must be provided.

(3) An equally competent auxiliary and supporting engineering and technical staff and equipment, necessary to achieve an optimum in program and telescope flexibility and versatility must be provided.

(4) The minimum auxiliary and supporting staff and equipment necessary to adequately manage and maintain the site and structures must be provided.

(5) Adequate space appropriate to the needs and responsibilities of the staffs and equipments necessitated by (2) (3) and (4) above must be provided.

(6) Space and facilities appropriate to the basic personal needs of the visiting and permanent staff must be provided.

(7) Adequate electrical utilities necessary to meet the needs of the instruments now contemplated, and the site, must be provided.

(8) Facilities, to discharge the Observatory's responsibility as a center of scientific education and knowledge (meetings, synposia, congresses, lectures) and public education (museum, lectures) must be provided.

(9) Advantage should be taken of lower unit costs which could result from immediate construction of a larger facility designed to meet predictable growth and need.

(10) This estimate is based on the needs of the program and the site as of July 1, 1961.

REQUIREMENTS

Central Laboratory

Laboratory Construction	$1,180,460
Equipment	131,000
Total	$1,311,460

The Central Laboratory Building was planned originally for construction in four stages. The requirements generated by the above assumptions demand the immediate construction of the entire four stages; i.e., a two story structure comprising a central section of 19,000 square feet, a west wing of 12,000 square feet, an east wing of 13,900 square feet, and an assembly hall of 3,850 square feet complete with stage, seating facilities, and projection equipment. From the gross laboratory area (excluding the assembly hall) of 44,900 square feet must be subtracted 12,908 square feet for corridors, stair wells, lobby, reception areas and toilet facilities, leaving a net of 31,992 square feet for offices, laboratories, and special shops. It is estimated that this space will cost slightly less than $22.70 per square foot. The total cost includes all utilities for the building together with landscaping and paving of main driveway and parking areas.

The Central Laboratory Building will not only house the scientific, technical, and engineering staffs, but the Office of the Director, the Business Manager, and the Site Manager as well. It presupposes a scientific and technical staff of thirty-four including nine permanent and twenty-one visiting astronomers and graduate students with four secretaries and two librarians, and an equipment development and engineering staff of twenty-two, including five engineers, fifteen technicians and machinists (instrument makers) and two secretaries.

As now envisaged, the 31,992 square feet of net usable space would be distributed as follows:

Office of the Director and Deputy Director		
Offices	1,000	
Conference Room	504	1,504
Research		
Offices	4,284	
Laboratories (including transmitter development, electronic, antenna, low temperature, precision instruments, receivers, computers, data processing)	11,168	
Laboratory Stock Rooms	840	
Library and Records	1,680	
Conference Room	840	18,812
Equipment Development and Engineering		
Offices	1,428	
Design and Drafting	420	
Special Shops (including electronics machine, glass blowing, small welding and sheet metal)	3,801	
Shop Stock Room	840	
Conference Room	420	6,909
Site Management		
Offices		1,155
Business Management		
Offices	2,100	
Files	504	
Other (duplicating, etc.)	420	
Store Room	588	3,612
Total		31,992

The above estimate of staff and space requirements is based on the assumption that: (1) the 85-foot telescope will be in operation by September 1, 1958; (2) the 140-foot telescope will be in operation by January 1, 1960; (3) a very large antenna, for which studies must be started now, will be constructed about July 1, 1961; (4) additional research facilities of a smaller nature (arrays, etc.) will be available; and (5) facilities must be provided for the research and engineering staff, both permanent and visitor, needed to obtain optimum use of the basic instruments and for the necessary supporting staff, including technical, administrative, and maintenance.

In order to provide for a permanent continuing research program in varied fields, and in order to fulfill the general obligations of the Observatory, there should be a total of three radio astronomers on the staff by July 1, 1958. If the permanent staff is to use approximately 40% of the observing time of the two telescopes, a total permanent staff of about six is indicated, until the time when another instrument - beyond the 140-foot - is available. In view of the current shortage of radio astronomers, it would be both feasible and desirable to achieve this number by July 1, 1960. By the time a very large antenna is constructed late in 1961, a permanent staff of about nine is predicted.

The optimum number of programs in progress on a telescope at any one time is of the order of six. If there are fewer than this, the telescope is likely to be idle part of the time; if there are more than this, programs may not progress as rapidly as desirable. This is not a hard and fast rule, but is valid for planning purposes. Thus from shortly after the 85-foot is ready until the 140-foot goes into operation, there should be four to six observers in residence at the Obser-

vatory at all times. In addition, there will be some scientists preparing to observe, and others working on things other than the 85-foot. This implies that there should be approximately four visiting scientists observing with the 85-foot at any time, plus one or two doing other things. When the 140-foot is in operation, a maximum of 15 visitors can be accommodate from the standpoint of research facilities, although some might be students and not all of them would be observing at all times. With the advent of a very large antenna, twenty-one visiting scientists and students could be accommodated.

In order to support the needs of the research program and the developments connected therewith, three electronic engineers and two mechanical engineers will be required by 1961. In addition, the 85-foot will require one technician and the 140-foot will require two to assist in setting up and testing equipment and routine spot maintenance; a like number for other antenna will also be required. Moreover, for laboratory and special shop work, at least five high-grade technicians and machinists and several lower grade technicians will be needed to work with both the radio astronomers and the engineers.

The necessity for adequate laboratory and shop facilities cannot be over-emphasized since they are essential to the success of a program looking to the differing needs of many scientists and full utilization of the basic instruments. Moreover, the work in the laboratories and the shops will in large part determine the ultimate flexibility and versatility of the instruments. It is there that the development of new auxiliary equipments, techniques and procedures, or the modification of existing ones, will occur. The need for these supporting scientific and technical facilities is particularly critical to a program whose

nature is determined by the unilateral needs and particular desires of individual scientists from many different institutions.

This estimate envisages a business management and administrative service staff of approximately fourteen by July 1, 1961. Within this group will be the responsibility for budget and accounting, contracts and procurement, supply and property management, personnel, public relations, duplicating services, records, and transportation. It is estimated that only about 11% of the contemplated laboratory building will be used by this staff.

Only the immediate offices of the site manager need be accommodated in this structure.

No major scientific or educational institution can realize its objectives or fully discharge its true responsibility as a discoverer and dispenser of knowledge without having available to it the facilities for the collective interchange of scientific information on a personal basis. If the Observatory is to achieve the place in the national and international scientific community that its research facilities otherwise assure, it must have within itself appropriate space for scientific meetings, symposia, congresses, etc. No such facilities exist within a fifty mile radius of the Observatory, as they might if it were in or near a more urban area, or other scientific center. This circumstance only serves to underline the need. Quite selfishly, such scientific gatherings will reap a national and international harvest of new ideas, critical and objective opinion, and provocative intellectual stimulation that will keep secure the Observatory's planned for position of leadership in the field of the acquisition of new knowledge.

Quite separately, as a unique national scientific institution, the Observatory has an almost unparalleled responsibility and opportunity for public education in science. If the experience of other large observatories in the country is any index, public visitors to the Observatory should number in the hundreds of thousands. In this day when the national security depends so much on a renewed interest in and sound understanding of the ways and purposes of science on the part of the layman, the Observatory, if it has adequate facilities, can and should play an important role. In an adequate Assembly Hall, the Observatory may well reach as many as 200,000 Americans a year and introduce them to the wonder and reality of science as a part of the world in which they live. Through films, lectures, demonstrations, and exhibits, students, teachers and people from all walks of our life can catch a first-hand glimpse not only of the science of astronomy but of the challenge, the aspirations, the dedication, and the fruits of all science, everywhere.

Site and Telescope Maintenance Building

Construction	$358,200
Equipment	140,000
Total	$498,200

The site and telescope maintenance building was planned originally for construction in three phases. The requirements generated by the above assumptions require the construction of all three phases at this time. The area involved totals 14,576 square feet at an estimated cost of approximately $22.75 per square foot.

The central portion of one story will encompass 3,200 square feet and will include space for receiving and storage, a central electrical distribution control switch gear, a heating unit, and office and toilet facilities. The one story south wing includes an area of 7,536 square feet and provides space for an automotive and site maintenance machine repair shop, stock and store room, trades area including welding, machine, sheet metal, and carpenter shops, and paint room. The one story north wing will consist of a clear span building encompassing 3,840 square feet with a clear height to roof of 24 feet and equipped with a 10 ton crane supported on column brackets. This wing will be used primarily for major telescope maintenance, repair, and modification. Paved areas at front and rear are included in this estimate.

As now planned, the 14,576 square feet would be utilized as follows:

Central Portion

Receiving and Storage	1600	
Central Elec. Distr, control switch gear	800	
Office (Grounds Superintendent)	150	
Locker Room, toilets, etc.	300	
Corridors	350	3,200

South Wing (site maintenance and central stock room)		
Stock room	1920	
Automotive and Machine Repair Shop	1332	
General Shop Area	1440	
Paint Room	480	
Carpentry Shop	480	
Sheet Metal Shop	480	
Welding Shop	480	
Machine Shop	480	
Offices (Shop Foreman, Transportation)	324	
Corridors	120	7,536
North Wing (Telescope Maintenance & Repair)		3,840
Total		14,576

The above stated requirements are based on the fundamental assumption that adequate facilities must be provided for the proper maintenance and management of 2,700 acres of property, a multi-million dollar physical plant, and several large, complex, and extremely expensive scientific instruments. In no case do the plans, in terms of staff or facilities, call for more than the minimum activity necessary to meet the needs of the research program and the requirements of a responsible custodian in protecting a major capital investment.

One of the many factors generating the above requirements is one that recognizes that the maintenance will grow steadily year by year in connection with the Observatory. Simply stated, as the plant, instruments, and equipments currently planned acquire age, the need for maintenance, repair, and custodial activities and facilities will continually increase; as the programs of the Observatory expand in variety and size, the need for larger areas for stocks, supplies, storage, and equipment cannibalization and modification will expand. To avoid these fundamental facts of institutional and program life at this time is to invite the day when we will be forced to admit again that we have not adequately provided for the facility.

Cafeteria and Residence Hall

Construction	$697,130
Equipment	92,000
Total	$789,130

The cafeteria and residence hall is planned to accommodate both married and single visiting scientists. It includes a two-story residence hall, the first floor containing a lobby and six apartments for married couples. The second floor containing a lounge and twenty-four double rooms for single visiting scientists. It also includes the erection of a cafeteria and food service area in a one-story addition at the south end of the residence hall. The gross square feet involved exclusive of basements, totals approximately 23,314 square feet at a cost of about $29.65 per square foot.

The space is distributed approximately as follows:

First Floor Apartments and Lobby	8,639
Second Floor Rooms, Halls & Lounge	8,639
Kitchen	2,615
Cafeteria	1,620
Small Dining Room	815
Snack Bar (24 hour service)	486
Cafeteria Corridors, Entryways, Stairs	500
Total	23,314

The above estimate of housing and feeding requirements is based on the assumption that living quarters for at least twenty-one visiting scientists must be available for continuing occupancy by July 1, 1961. Furthermore, it is assumed that a few additional rooms must be available at all times for short-term visitors and for those times in the year when a greater number of graduate students are likely to be present. The plans for the cafeteria are based on the expectation that approximately 75 employees must be fed regularly and that at particular times

even greater numbers on a short term basis. The cafeteria and kitchen facilities also presuppose a gradual increase in permanent and visiting staff as the site becomes more fully utilized for research using relatively small and inexpansive, as well as larger, antenna.

Because of the geographic isolation of the site, and the absence of public living and eating facilities within a radius of 35 to 50 miles, the need for minimum living quarters and dining facilities should be self-evident. Furthermore, particularly from the standpoint of visiting scientists, it should be remembered that astronomical observations are conducted on a 24-hour basis and, therefore, proximity to the instruments becomes more of a professional necessity than a personal convenience. Full utilization of the instruments and efficient use of the scientists' time require such proximity.

In addition, it should be pointed out that the permanent staff, even though small, will have difficulty in locating adequate housing, locally. Homes for sale, lease, or rent are almost non-existent, and those that are, require in most cases a considerable investment in utilities and improvements to make them habitable. For this reason, as new permanent staff members are added, or replaced, it will be necessary to provide them, temporarily, with living quarters on the site until they can locate themselves in the neighboring area.

In summary, the success and significance of the Observatory's research activity is directly dependent on its ability to attract the finest possible staff - both permanent and visiting. While such men will be attracted primarily by the excellence of the scientific instruments, equipment, and facilities, they have a right to expect for themselves and their families, housing and eating arrangements that meet the minimum standards of decency, sanitation and convenience. As with all men, their professional dedication will and should be tempered by their personal responsibilities to themselves and their families.

Utilities

Electrical	$156,310
Sewerage	25,000
Water	75,800
Total	$257,110

The minimum utilities necessary for the proposed site development program are provided for in the above estimate. Before proceeding to a detailed description of the various systems, specific comment should be made with regard to the electrical utilities. This estimate provides for maximum use of existing power on the site under normal conditions. Provision is made for stand-by generation of electrical power in case of general power failure from incoming lines, which now occurs at not infrequent intervals especially during the winter season. However, as the activities of the Observatory increase, even with only two major telescopes, the cumulative demand may exceed the current supply. With the advent of a larger antenna, and other observing equipment provision for bringing additional power into the site will have to be made. For the time being, stand-by generation, coupled with the existing power, will meet the needs of sudden peak periods, heavy weather conditions, and other emergency situations.

Electrical Distribution System. Plans now approved contemplate the installation of the complete electrical system as follows:

a. Extend Monongahela overhead 12,400 volt power line to point where a transformer station and disconnect switch at 4160 volt will be located. An underground line will be carried from this point to a pit at the junction of the service road with main underground duct line running south of the main road. The 4160 volt underground line will then follow in a southwesterly direction to a connection in the 85-foot Telescope Control Building and will be complete with necessary electric

power switching equipment for this Control Building as a part of first phase installation. The underground system will terminate in a pit adjacent to the 140-foot Telescope site.

b. Phase II includes the extension of 4160 volt underground service to a location in the Laboratory Building and with switch gear located in structure; also extend 4160 vikt service to 140-foot Telescope Control Room.

c. Phase III - Extend 4160 volt underground service to Works Area and install main electrical switching station.

Extend 4160 volt underground service to Residence Hall and Cafeteria and install switch gear in this building.

Sewer System. Separate septic tanks and filter beds will be installed at both the 85-foot and 140-foot Telescope sites with effluent to flow toward Deer Run.

A central 8" underground sanitary sewer system will be provided in the building area with connections to each of the proposed buildings. The line will terminate in a sewerage treatment Plant with primary and secondary treatment and filtering through an extensive filter bed system. A chlorination pit is provided for chlorine treatment, should treatment be necessary before effluent flows into Creek.

Storm water drainage will be carried in a separate drainage line to the south and west and will include all roof and storm water drainage from each building area.

Water Facilities. A complete water system is provided as follows:

For the 85-foot and 140-foot Telescope controls, water will be piped from wells to be drilled nearby each location. It is anticipated that a volume of 15 G.P.M. may be secured which will be ample to supply the requirements for these two locations.

For the building area, an 8" cased test well has been drilled near the site of the Works Area. This well has produced a supply of suitable water of 15 G.P.M. capacity. If the Laboratory Building is constructed before the Works Area, another 8" cased well will be drilled near the Laboratory Building and will supply water for the first phase of Laboratory operation. When the Works Area is constructed, a central underground system is contemplated. This will connect the water from the Laboratory and Works Area and will include the installation of a 100,000 gallon overhead water storage system with booster pump so that all water will be pumped from wells to overhead tank. If at the time of construction of the Residence Hall and Cafeteria additional water is required, another well may be drilled near the location of the Residence Hall and tied into the central water system. By following this system of drilling wells, no wells will be located nearer than 750 feet apart, which follows the recommendation of Dr. Price, State Geologist.

Hard-Top Main Access Road

Construction $32,000

At the present time, the main access road of approximately 1-1/4 miles in length has been completed with the exception of the asphalt finished surface. This road will be adequate during the construction period. Upon completion of major construction, the road should be reconditioned and a finished surface laid down.