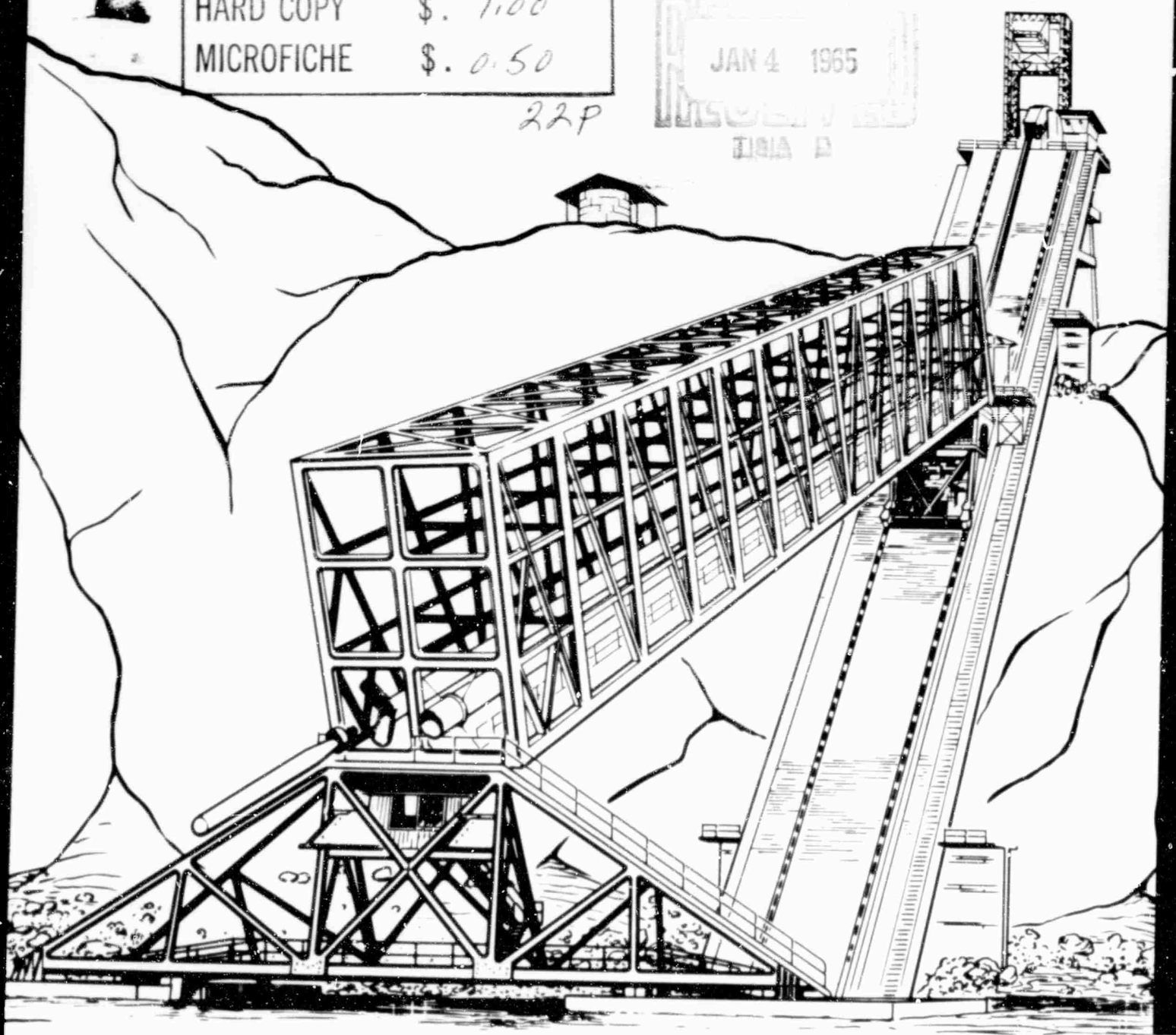
NOTS TP 3560

MORRIS DAM BALLISTIC RANGE



U. S. NAVAL ORDNANCE TEST STATION

AN ACTIVITY OF THE BUREAU OF NAVAL WEAPONS

CHINA LAKE, CALIFORNIA

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Commander

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Technical Director

FOREWORD

This report is one of a series whose purpose is to describe the underwater ordnance test facilities of the U.S. Naval Ordnance Test Station (NOTS), Pasadena, California.

The information contained in these reports is being disseminated to acquaint persons active in the development of underwater ordnance systems with the unique facilities that are available to assist them.

Other reports in this series are listed below:

TITLE	REPORT NO.
MORRIS DAM PROPULSION LABORATORY	NOTS TP 3559
YFU-44 DEEP DEPTH TEST FACILITY	NOTS TP 3561
LONG BEACH SEA RANGE	NOTS TP 3562

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MORRIS DAM

BALLISTIC RANGE

U. S. NAVAL ORDNANCE TEST STATION

UNDERWATER ORDNANCE DEPARTMENT

SYSTEMS OPERATIONS DIVISION

RANGE BRANCH

PASADENA, CALIFORNIA

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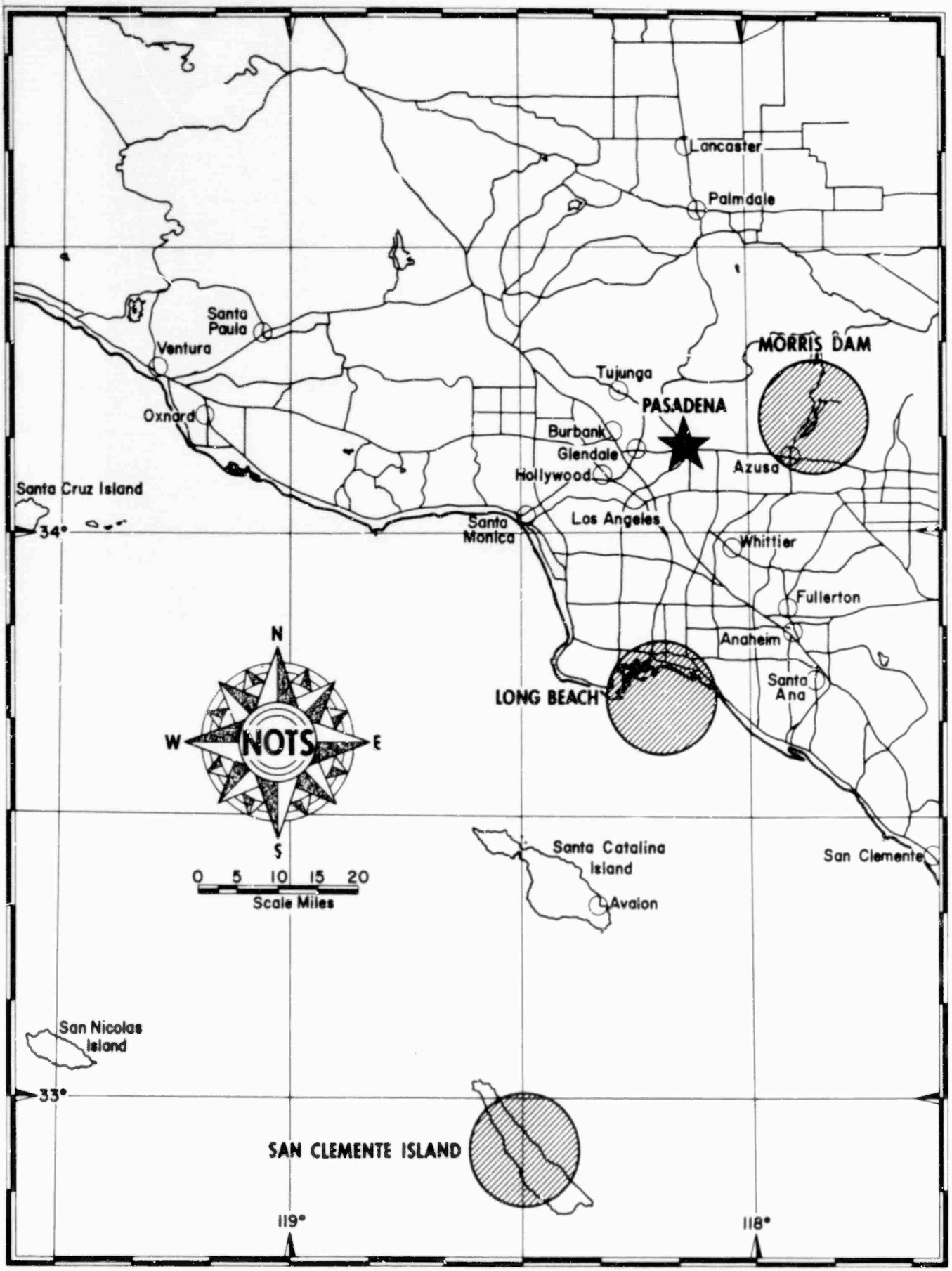
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INTRODUCTION

The Morris Dam Ballistic Range is located on a lake formed by Morris Dam on the San Gabriel River, about five miles north of Azusa, California. The location of this facility with relation to other NOTS range facilities is illustrated on the map facing this page.

The range facilities are used in the acquisition and study of water entry data, underwater trajectory characteristics and structural damage information on underwater and air to water projectiles.

Several facilities are provided for the launching of projectiles. Selection is made on the basis of the type of projectile being tested and the type of data to be acquired.

Each test area has available adequate instrumentation capabilities to allow the acquisition of a maximum amount of data with a high degree of reliability.

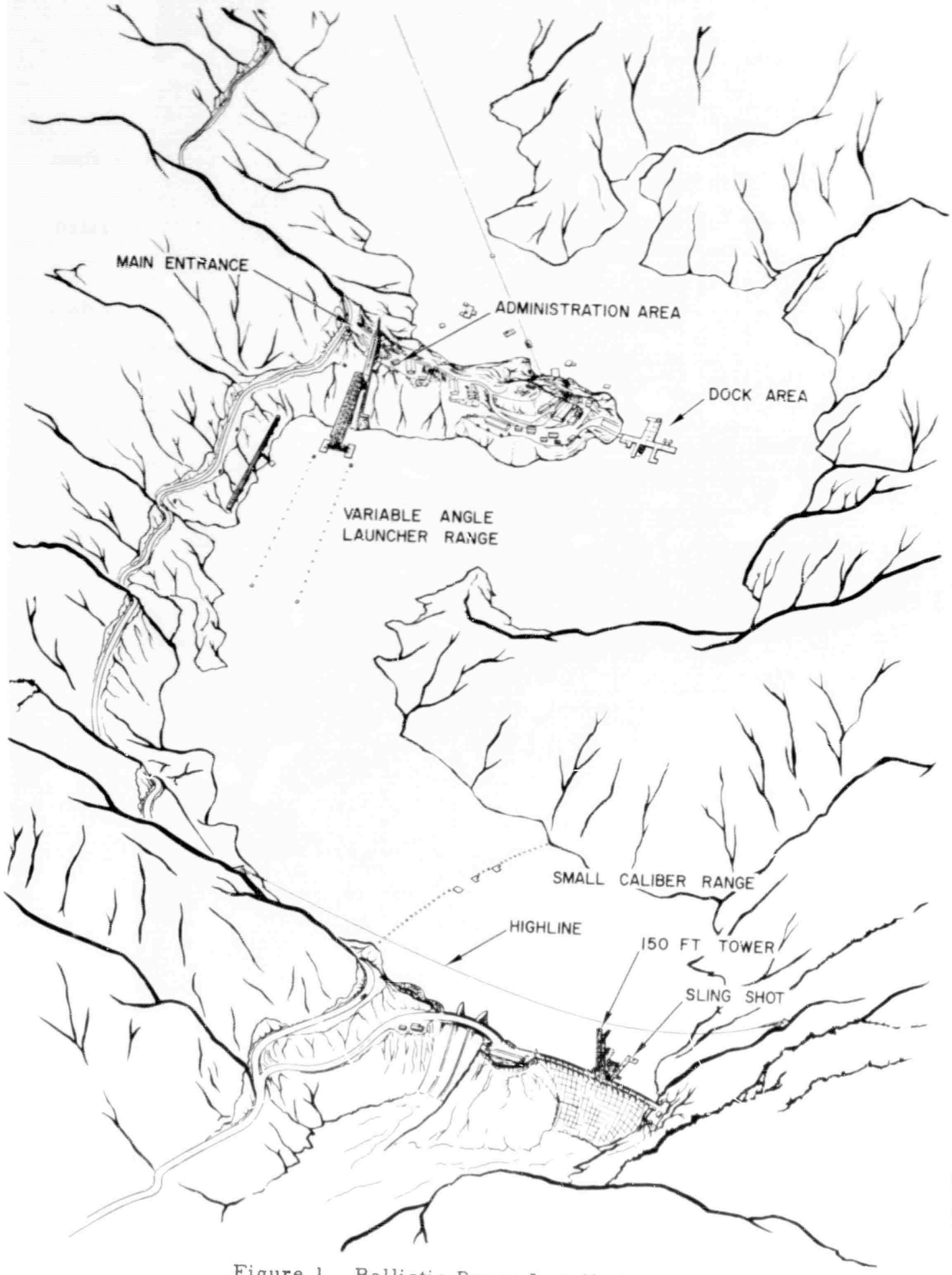

Figure 1. Ballistic Range Installations

MORRIS DAM BALLISTIC RANGE

The Morris Dam Ballistic Range facilities are divided primarily into two areas as illustrated in figure 1. The Variable Angle Launcher Range is located adjacent to a peninsula extending into the lake. The Small Caliber Ballistic Range is located in the lake area adjacent to Morris Dam.

VARIABLE ANGLE LAUNCHER RANGE

The Variable Angle Launcher Range is used primarily for large caliber projectiles which are either rail or tube launched.

VARIABLE ANGLE LAUNCHER

The Variable Angle Launcher (VAL), shown in figure 2, consists of two launching tubes, 22-1/2 inches and 32 inches in diameter, supported by an

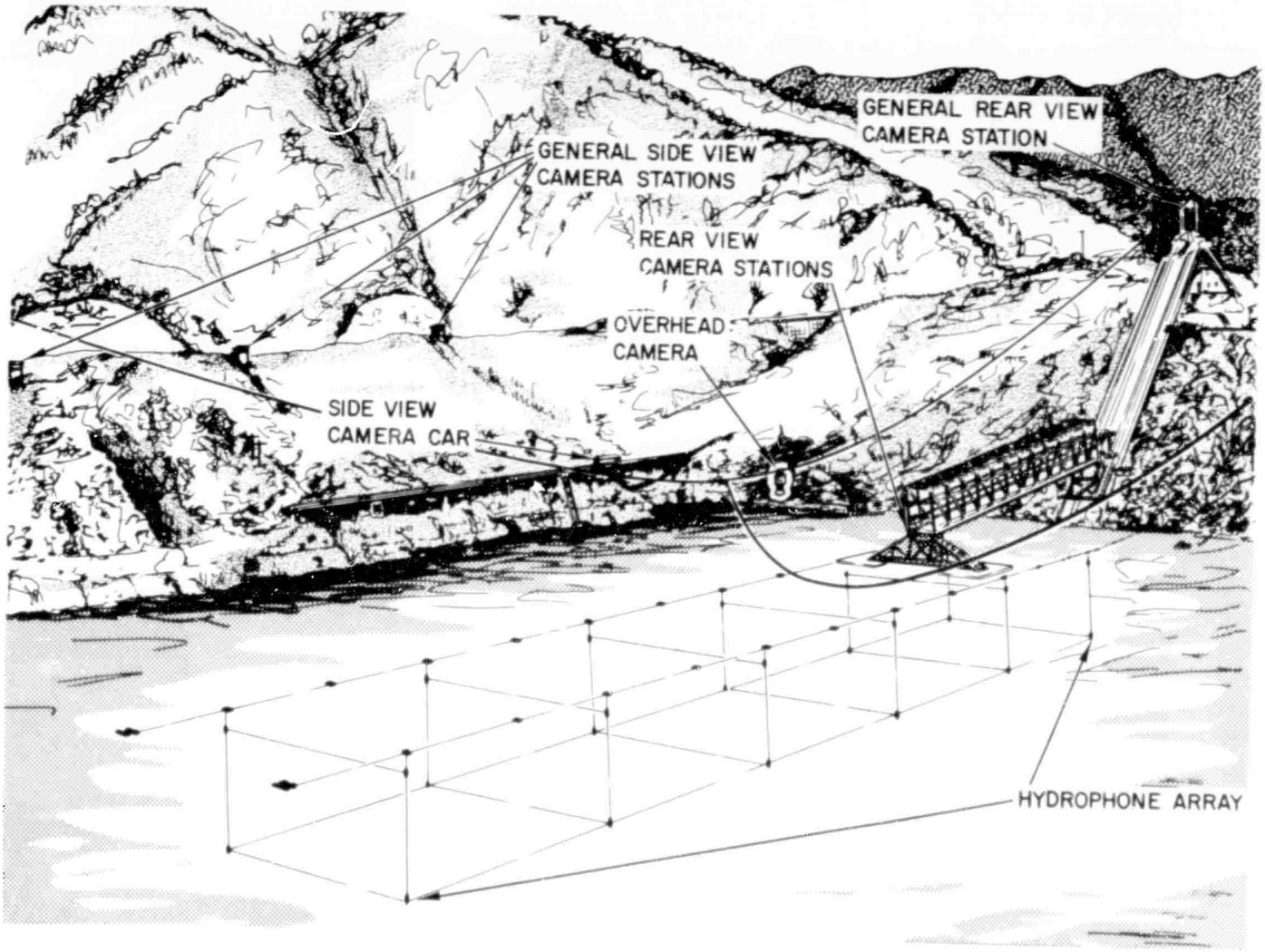

Figure 2. Variable Angle Launcher Installation

all-welded steel, movable bridge 300 feet long, 22 feet wide and 35 feet high. The muzzle end of the bridge rests on two welded steel barges. The shore end of the bridge pivots on a rail-mounted carriage which can be moved up and down a 45-degree slope to produce water-entry angles varying from 5 to 38 degrees from the horizontal.

OPERATION. Projectiles are launched by means of compressed air suddenly released from a 500 cubic foot air flask at pressures up to 1000 pounds per square inch. Velocities of 100 to 2000 feet per second can be attained, depending upon the gross weight of the projectile. Maximum allowable gross weight for a projectile is 4000 pounds.

When the projectile has a smaller diameter than the launching tube, a wooden or metal sabot is used to adapt the projectile to the tube. Figure 3 illustrates a typical sabot launching. Projectiles are launched into a hydrophone range 1000 feet long, 150 feet wide and 140 feet deep.

INSTRUMENTATION. The array of 24 hydrophones in the hydrophone range provides underwater trajectory data by picking up delayed sounder blasts from the projectile. Break sticks at the muzzle end of the launching tube provide air flight

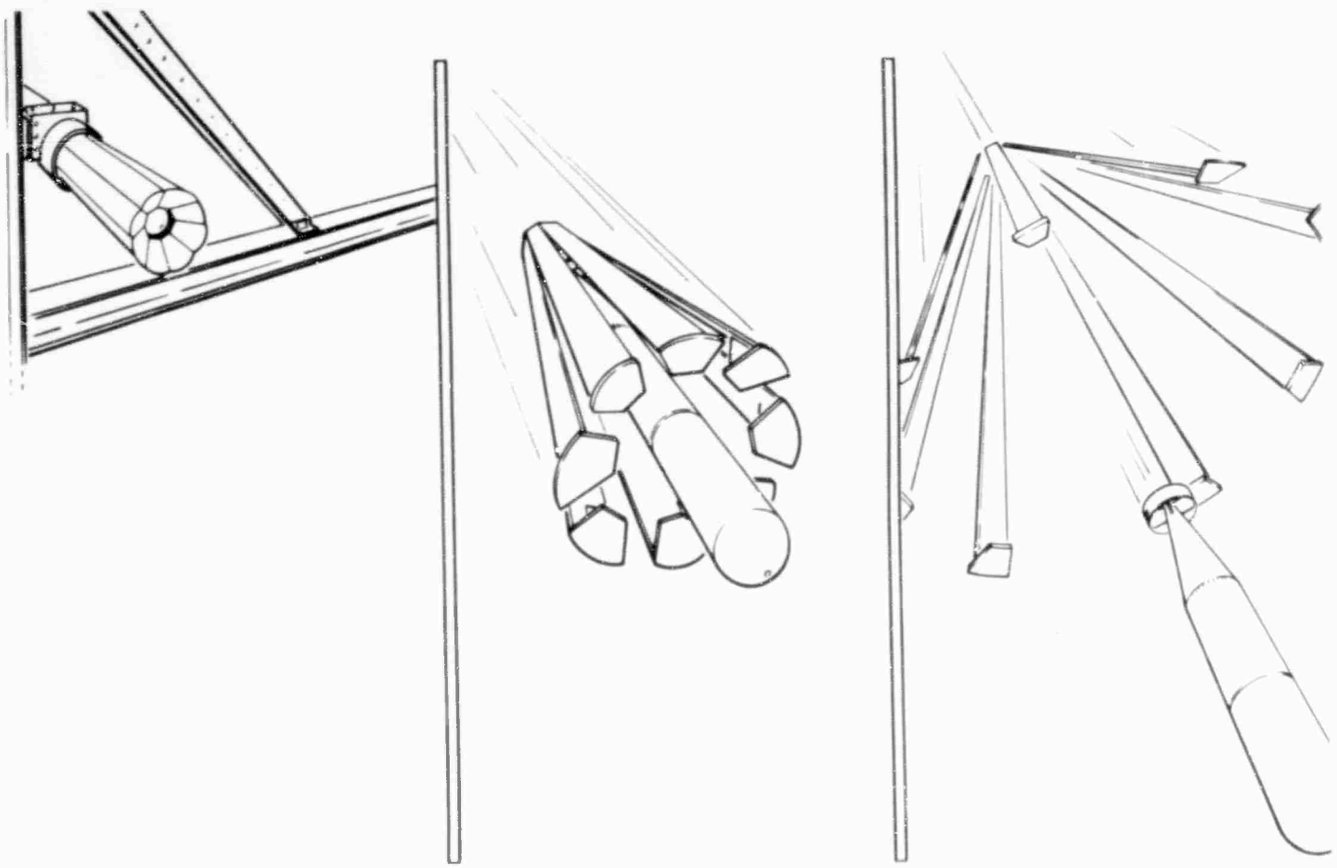

Figure 3. Launching a Projectile in a Sabot

velocity data. A 30-channel recording oscillograph with speeds up to four feet per second is used to record this data.

Projectile launchings are monitored by a number of high speed cameras. Side view camera stations contain four Mitchell cameras (three 70 mm and one 35 mm) and a Hulcher camera (2-1/4 by 2-1/2 inches at 50 frames per second or 2-1/4 by 5 inches at 25 frames per second). An Eyemo 35 mm camera and a K25 camera are mounted at rear view camera stations. A Mitchell 35mm camera is suspended from an overhead cableway directly over the projectile water entry point. A special rotating prism camera, used in conjunction with flares, is available to provide accurate measurements of velocity, deceleration, roll, whip, and pitch angles. This camera coverage provides a complete record of air trajectory at water entry.

All recording instruments and cameras are coordinated by a coded time base system utilizing a standard IRIG format. Additional instruments and cameras may also be used when desirable.

UNDERWATER RAIL LAUNCHER

The Underwater Rail Launcher consists of a pair of rails 40 feet long which can be lowered from a barge into the lake. It is used to launch projectiles from 10 to 22-1/2 inches in diameter at depths to eight feet. A typical launching is illustrated in figure 4.

Projectile launching is controlled from the launching barge. Projectiles may be self-propelled or driven by a rocket sled. They are sometimes fired at an impact plate suspended from a target barge. The position of the impact plate may be varied to provide impact angles of 5 to 90 degrees.

The Underwater Rail Launcher is normally operated in the dock area and can also be operated in the VAL Hydrophone Range. The instrumentation used for the VAL can also be used for the Underwater Rail Launcher. Additional instrumentation and sensors may be installed within the test vehicle. Data may be recorded internally or transferred through an instrumentation cable to the launching barge.

MK 32 LAUNCHER TUBE

The MK 32 Launcher Tube is used to simulate shipboard conditions in the launching of 12-3/4 inch diameter projectiles. The launcher tube is barge mounted and is fixed in the horizontal plane ten feet above the water surface.

Launchings are accomplished by means of compressed air (1/2 cubic foot at pressures up to 2000 pounds per square inch). A velocity of 40 feet per second may be obtained for a gross weight of 500 pounds.

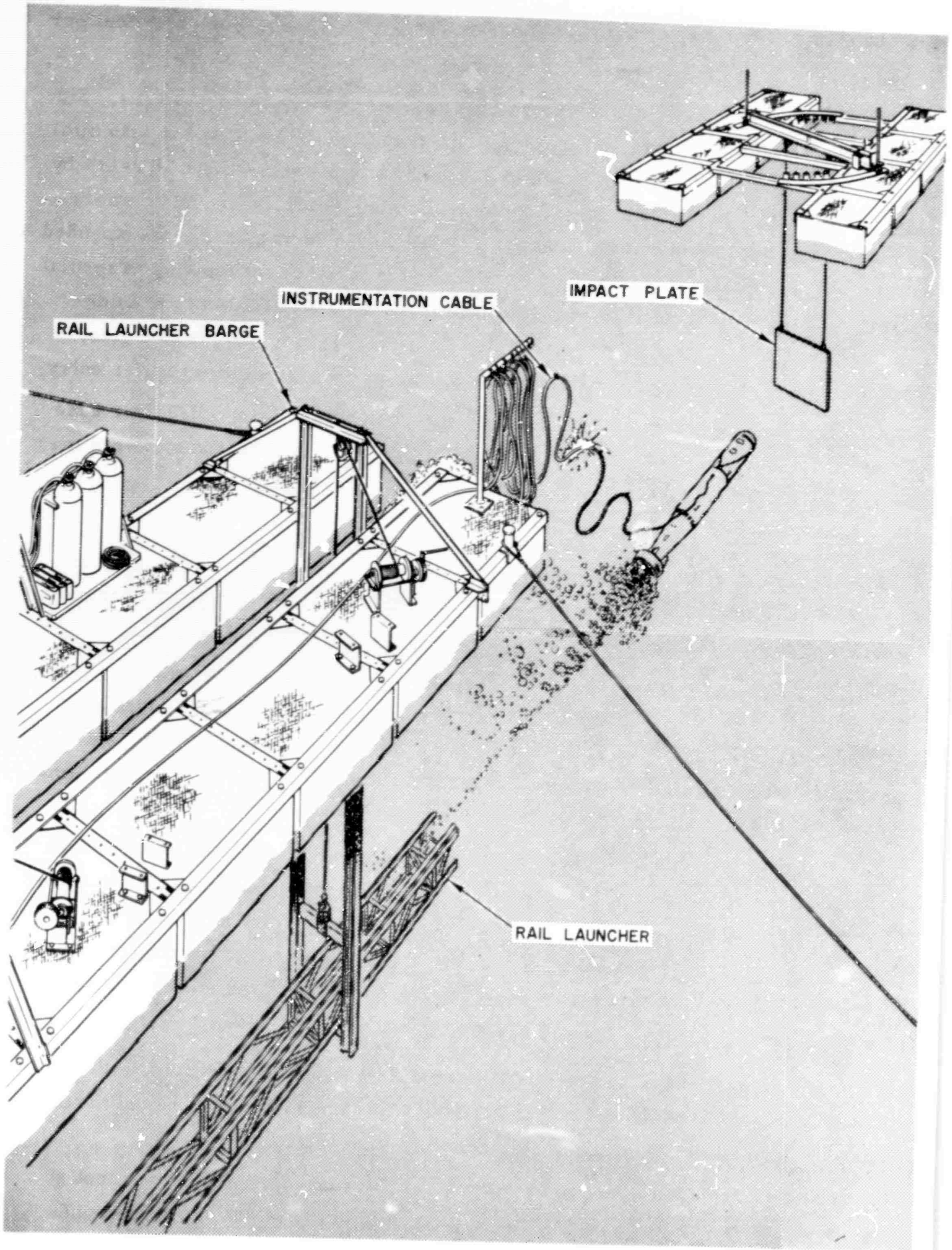

Figure 4. Typical Underwater Rail Launching

Launchings can be made into the VAL Hydrophone Range. The same instrumentation used for the VAL is available for use with the MK 32 Launcher Tube.

TIP-UP LAUNCHER

The Tip-up Launcher is a slide launch facility designed to launch torpedoes at entry angles variable from zero to 50 degrees. It is barge mounted and located approximately 10 feet above the water line. A typical launching from the Tip-up Launcher is illustrated in figure 5.

The Tip-up Launcher is operated manually. Launch angle is controlled by a stop pin or a restraining wire.

The VAL Hydrophone Range is the usual site for the tip-up launchings. All of the instrumentation associated with the hydrophone range is available for use with the Tip-up Launcher.

UNDERWATER BARGE

The Underwater Barge is a pontoon barge with a test platform which can be lowered as much as 150 feet for underwater tests. The test platform may be used for

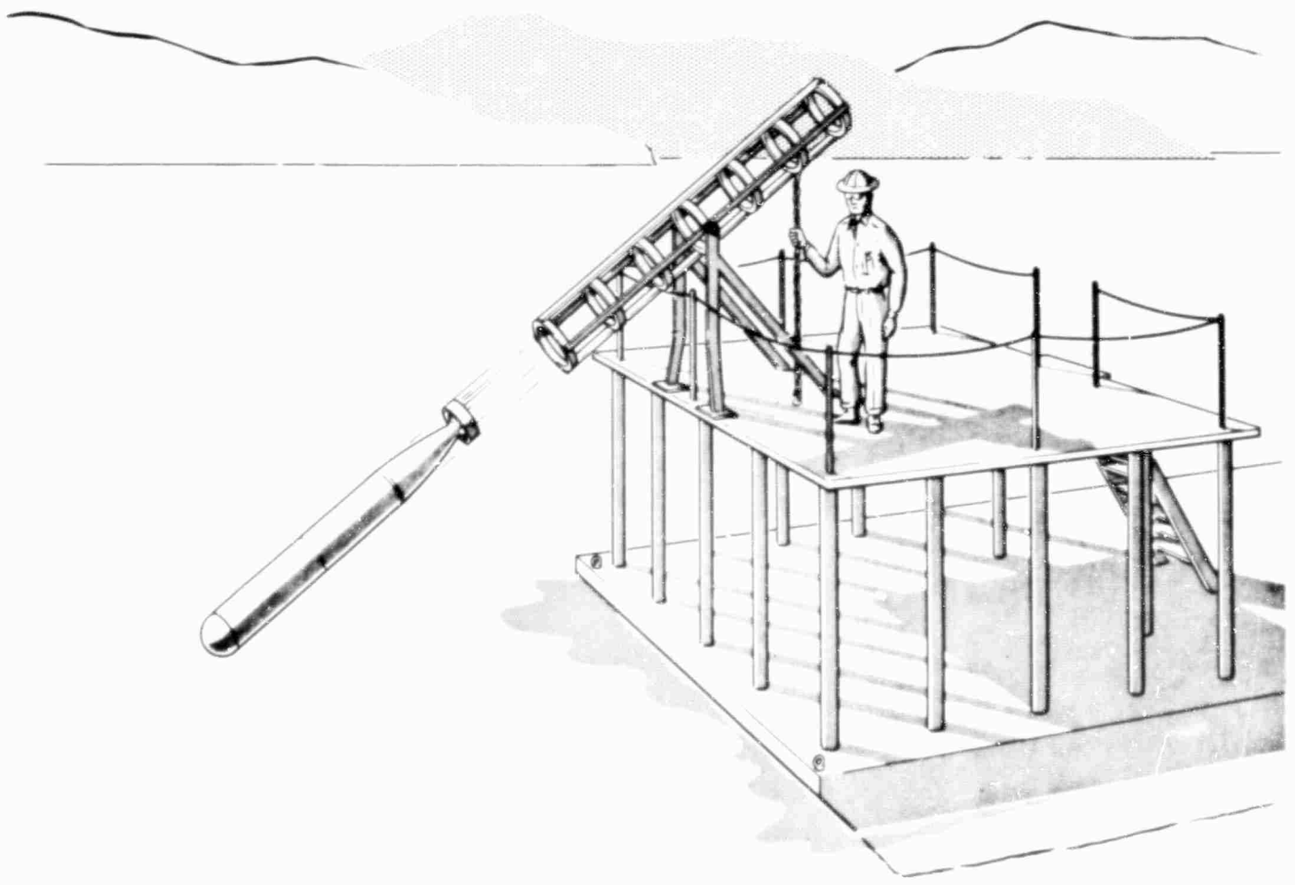

Figure 5. Typical Tip-up Rail Launching

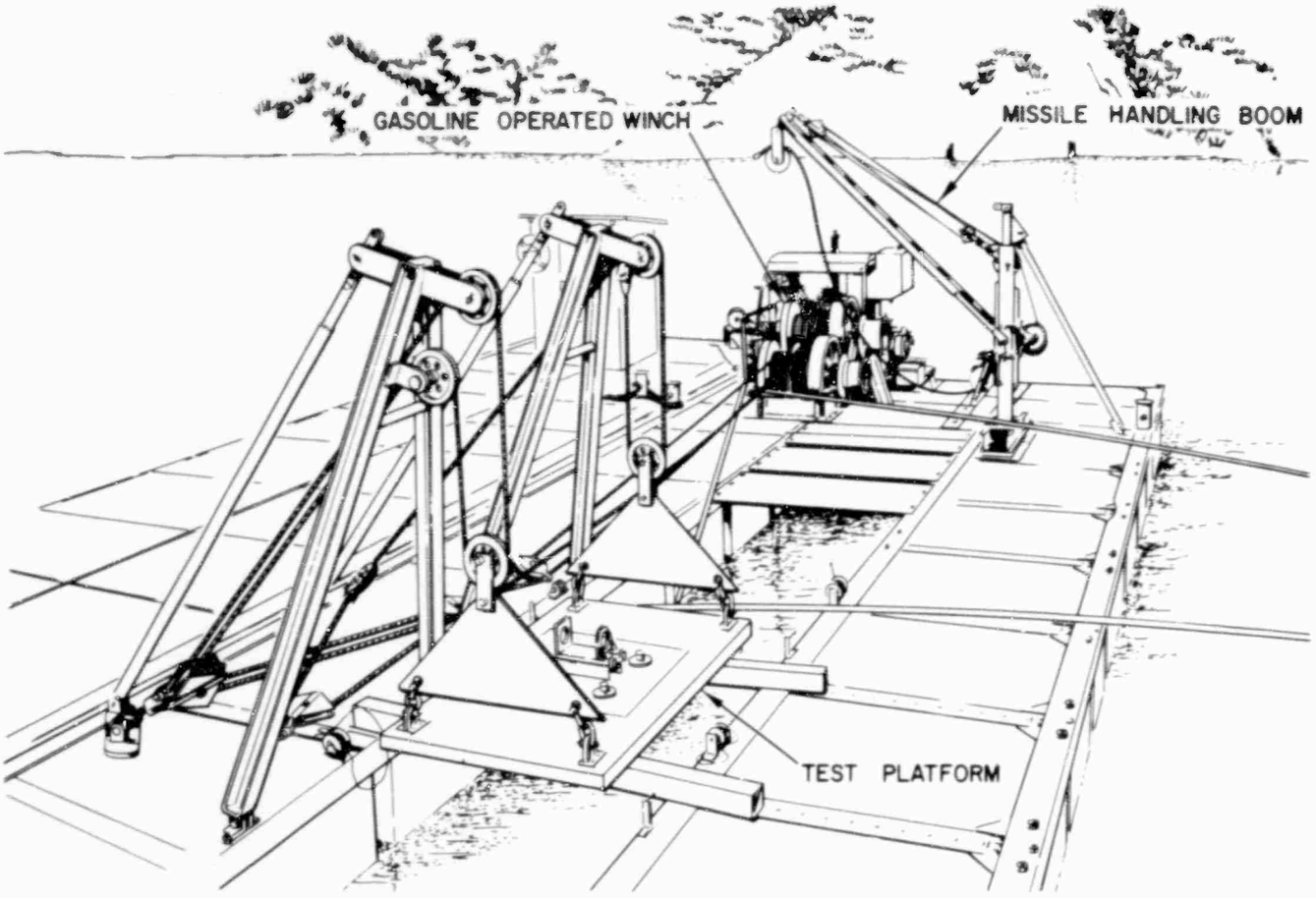

Figure 6. Underwater Barge

static firing tests, underwater launchings, and underwater acoustic tests. The Underwater Barge is illustrated in figure 6.

The test platform is raised or lowered by operating a gasoline-powered winch on the barge. Firings or launchings are controlled from the barge through underwater cables. The Underwater Barge may be operated at any point on the lake.

All instrumentation at the VAL hydrophone range is available for use with the Underwater Barge. Additional instrumentation may be installed in the test vehicle or on the barge.

SMALL CALIBER BALLISTIC RANGE

The Small Caliber Ballistic Range is located adjacent to the dam. The facilities at the range include the Slingshot Facility, 150 Foot Launching Tower, Highline, Eight Inch Launching Tube, Sinking Rate Facility, Mobile Hydrophone Array and various support buildings. A 48 foot square, steel mesh net is used to recover projectiles from the lake at the Small Caliber Ballistic Range Facilities.

SLINGSHOT FACILITY

The Slingshot Facility is used to observe the water entry and structural behavior of projectiles at steep entry angles. A projectile is hoisted to a cable suspended approximately 200 feet above the lake. Bungee shock cords attached to the projectile and anchored to barges on the lake are stretched to predetermined loads and upon sudden release of the projectile provide required projectile velocities at water entry. Optional shock cord hookups enable the Slingshot Facility to be used as a high velocity or variable angle system.

HIGH VELOCITY SYSTEM. The High Velocity System can attain velocities from free fall to 202 feet per second for a 500 pound projectile. Higher velocities are possible for lighter weights. An auxiliary anchor barge is used to stretch the shock cords to obtain desired projectile velocities. The High Velocity System can be used only with a water-entry angle of 90 degrees. Figure 7 provides an illustration of the High Velocity Slingshot System.

VARIABLE ANGLE SYSTEM. The Variable Angle System is used to provide water-entry angles from 65 to 90 degrees. Shock cords are connected from the projectile directly to the barge below. The water-entry angle is varied by moving the barge. Velocities to 150 feet per second depending on weight are attainable with this system. The Variable Angle System is illustrated in figure 8.

INSTRUMENTATION. A variety of sensing and recording instruments can be used with either slingshot system. All instrumentation is synchronized by a coded time base system utilizing a standard IRIG format.

CAMERA COVERAGE. Projectile motion is monitored by two or more 35 mm, 130 frames per second Mitchell cameras positioned 90 degrees apart. To observe projectile underwater behavior two 16 mm, 200 or 400 frame per second Photo-Sonics cameras are used. For clarity when using underwater cameras, the projectile is launched into a square plastic bag of filtered clear water and the cameras are placed inside the bag. All cameras are synchronized by the coded time base system.

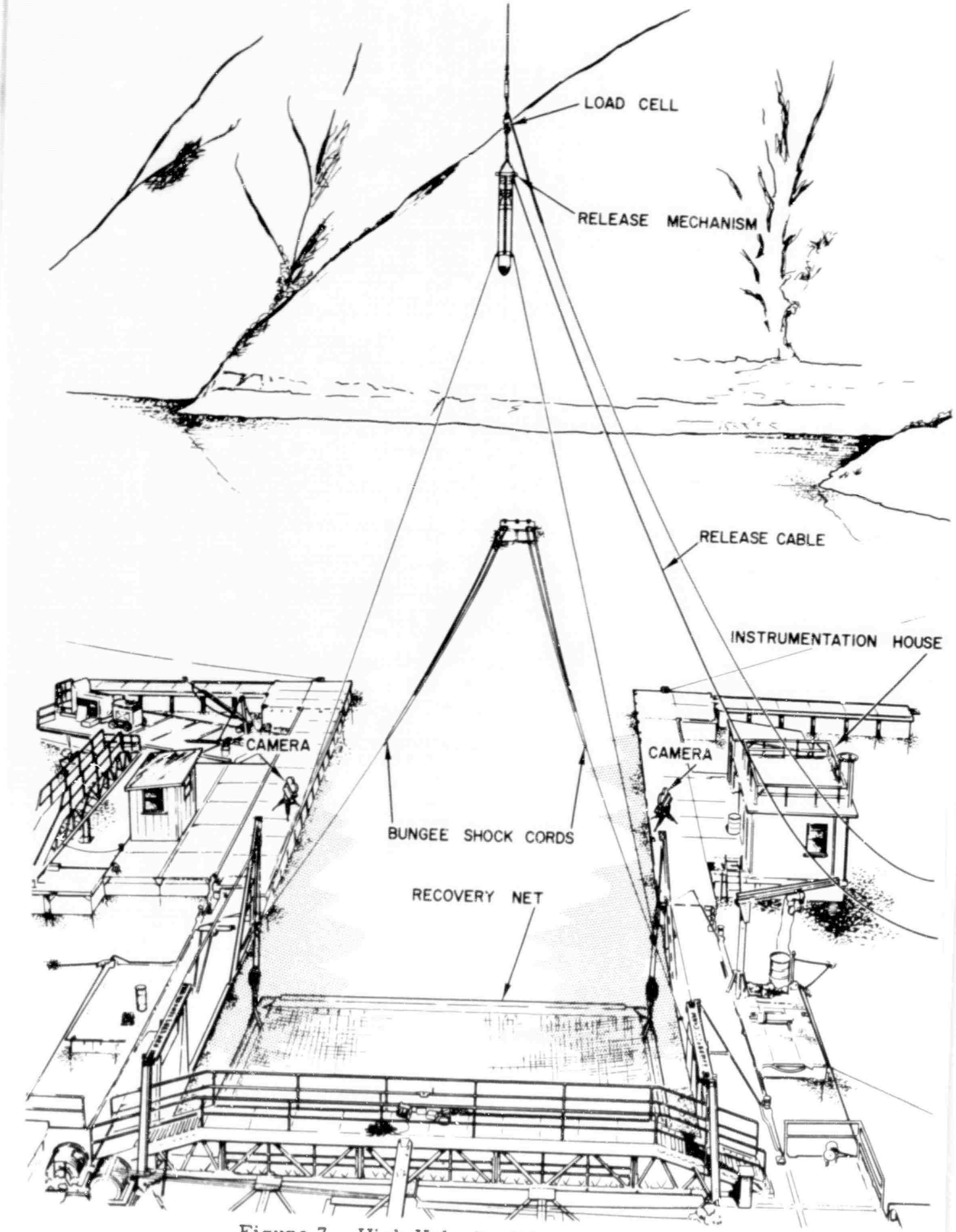

Figure 7. High Velocity Slingshot System

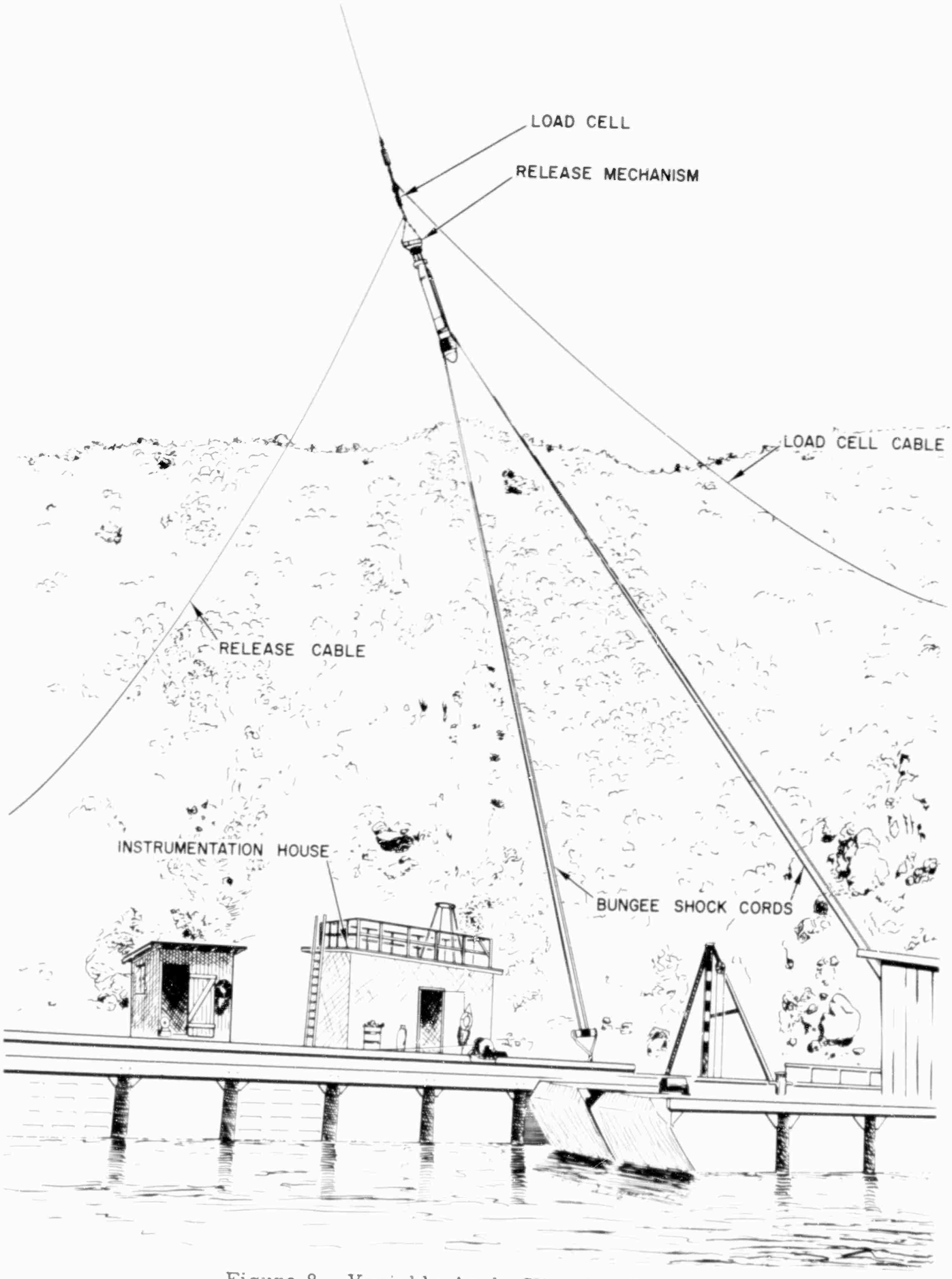

Figure 8. Variable Angle Slingshot System

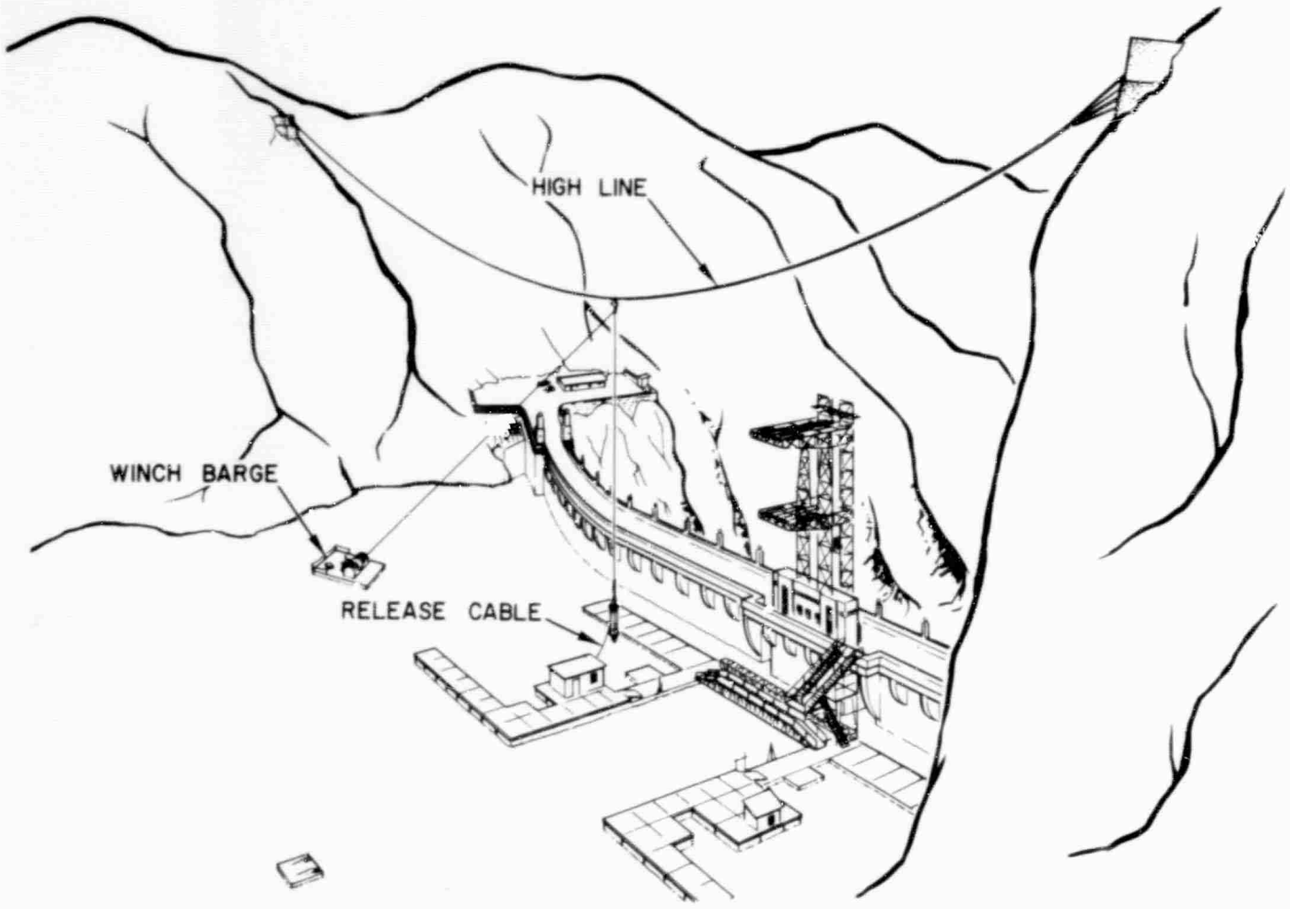

Figure 9. Typical Free Fall Drop From the High Line

HIGH LINE FACILITY

The High Line Facility is a steel cable system anchored in the mountains at each side of the dam. The average height of the cable over the surface of the water is 200 feet. The maximum weight limit of the cable is 8000 pounds.

In addition to its use as an integral part of the Slingshot Facility, the High Line Facility is also used for free fall drops. All instrumentation at the Slingshot Facility may also be utilized in conjunction with the High Line Facility.

In cases where information regarding underwater trajectory of projectiles is desirable, drops are made into a mobile hydrophone array which is described later. A typical free fall drop from the High Line is illustrated in figure 9.

150 FOOT LAUNCHING TOWER

The 150 Foot Launching Tower is located on top of Morris Dam and faces the lake created by the dam as illustrated in figure 10. It is used principally for launching rockets and rocket propelled projectiles. Launch platforms are located at 50, 100, and 150 foot levels above the top of the dam which is 1175 feet above

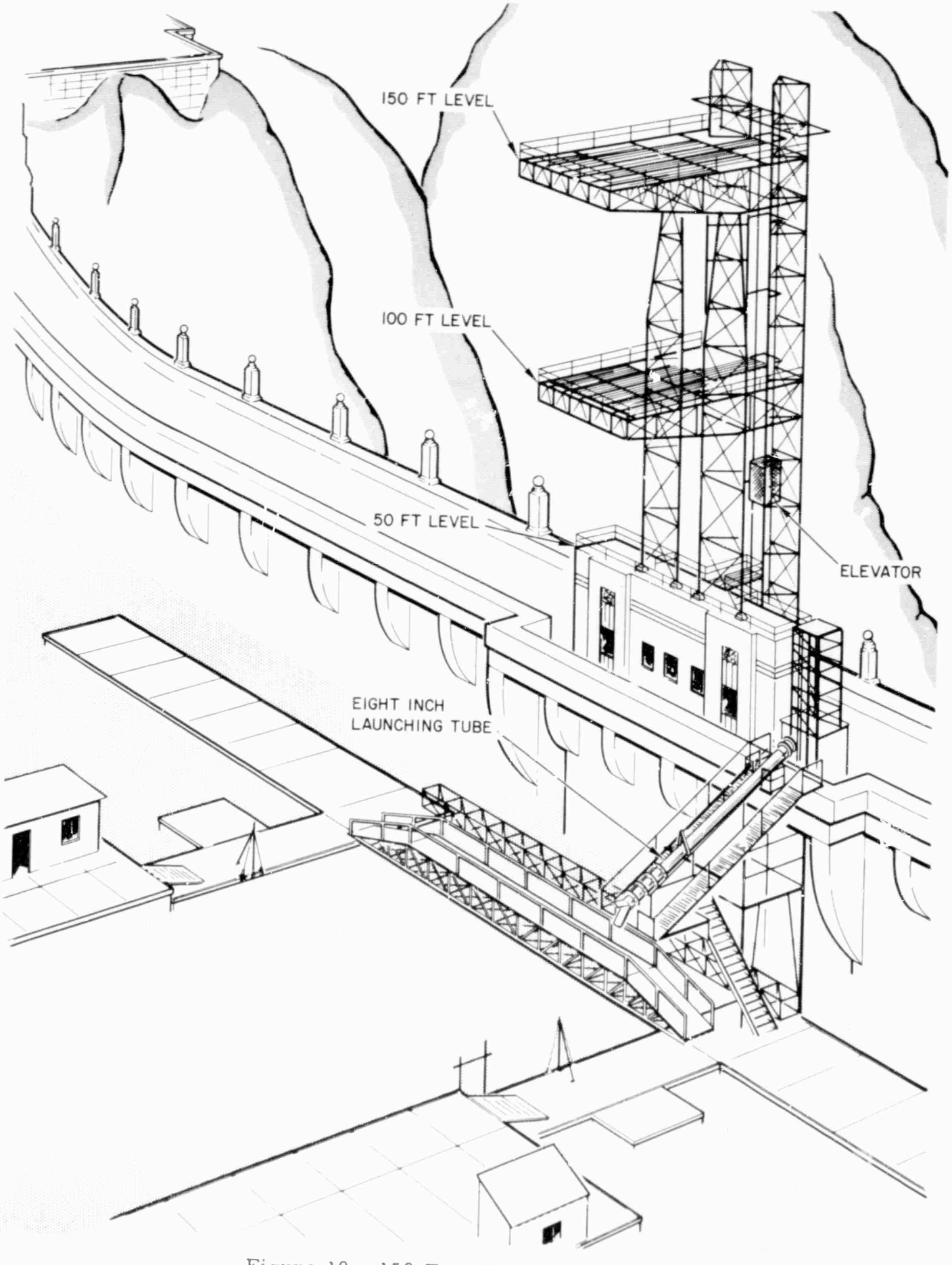

Figure 10. 150 Foot Launching Tower

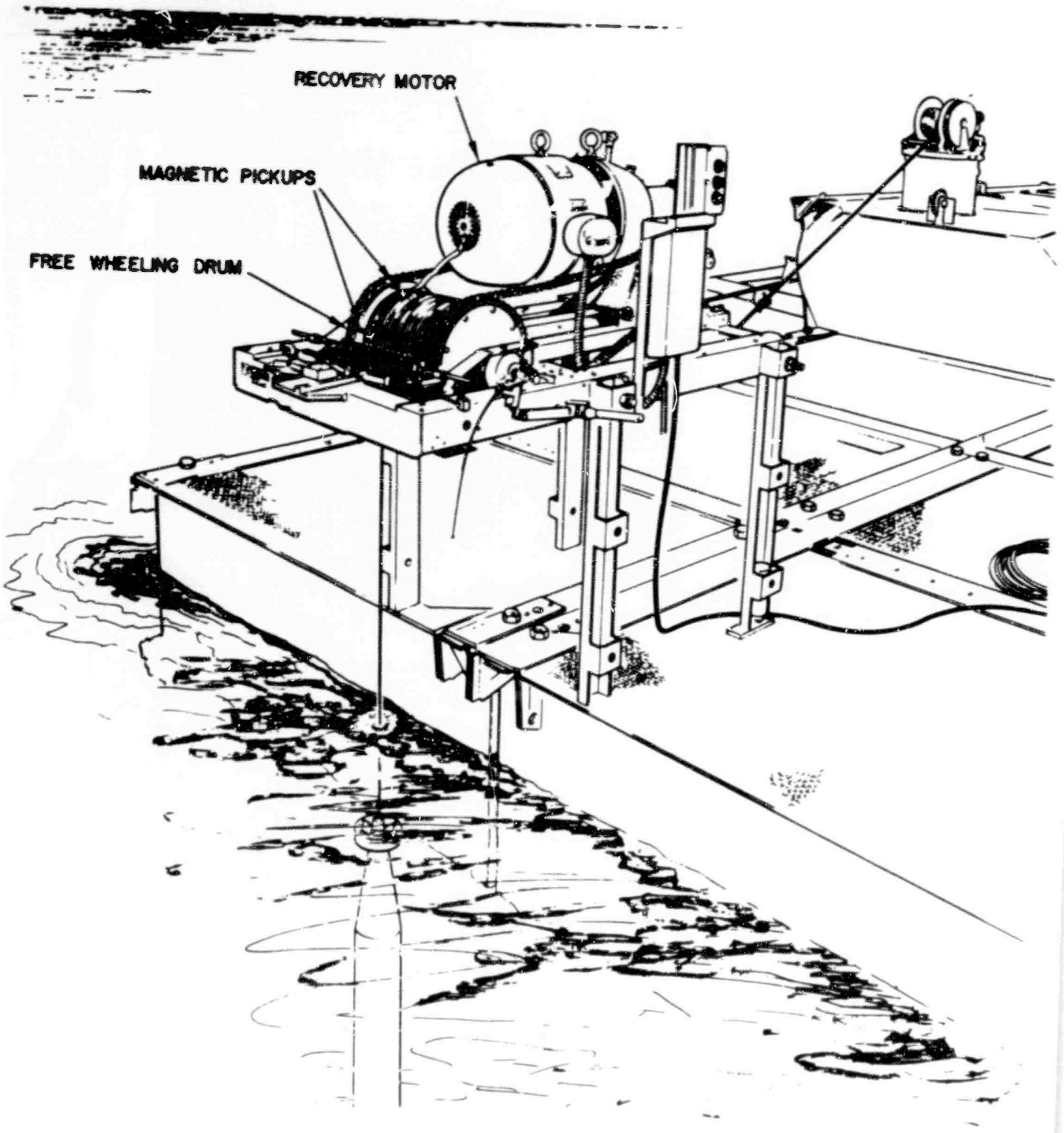

Figure 11. Sinking Rate Facility

sea level and normally 30 to 45 feet above the water level. The tower is provided with an elevator to lift equipment and personnel.

Complete instrumentation and camera facilities are available for launchings from the tower. The mobile hydrophone array is available for determining underwater trajectories. All cameras and instruments are synchronized by the coded time base system.

EIGHT INCH LAUNCHING TUBE

The Eight Inch Launching Tube located as indicated on figure 10 is 43-1/2 feet long and is capable of launching projectiles with diameters of eight inches or less. Its launch angle may be varied from 19 to 40 degrees and tube bias break sticks are provided for velocity measurements. The instrumentation at the 150 Foot Launching Tower is also used for the Eight Inch Launching Tube.

SINKING RATE FACILITY

The Sinking Rate Facility is a barge mounted device for measuring underwater sinking rates and is illustrated in figure 11. Magnetic pickups on the freely moving cable drum yield velocity data used in computing sinking rates. The maximum load capability of the Sinking Rate Facility is 400 pounds.

MOBILE HYDROPHONE ARRAY

The Mobile Hydrophone Array consists of 12 hydrophones arranged in a 150 foot cube and suspended in the lake from a floating barge as illustrated in figure 12. The Mobile Hydrophone Array is used to plot the trajectory of projectiles after they have entered the water and it may be positioned at any of the Small Caliber Ballistic Range facilities.

SUPPORT FACILITIES

A number of buildings are used in the support of the Morris Dam Ballistic Ranges. In addition to those buildings used for maintenance of the ballistic range facilities and equipment, space is provided for the assembly of projectiles and the storage of explosives.

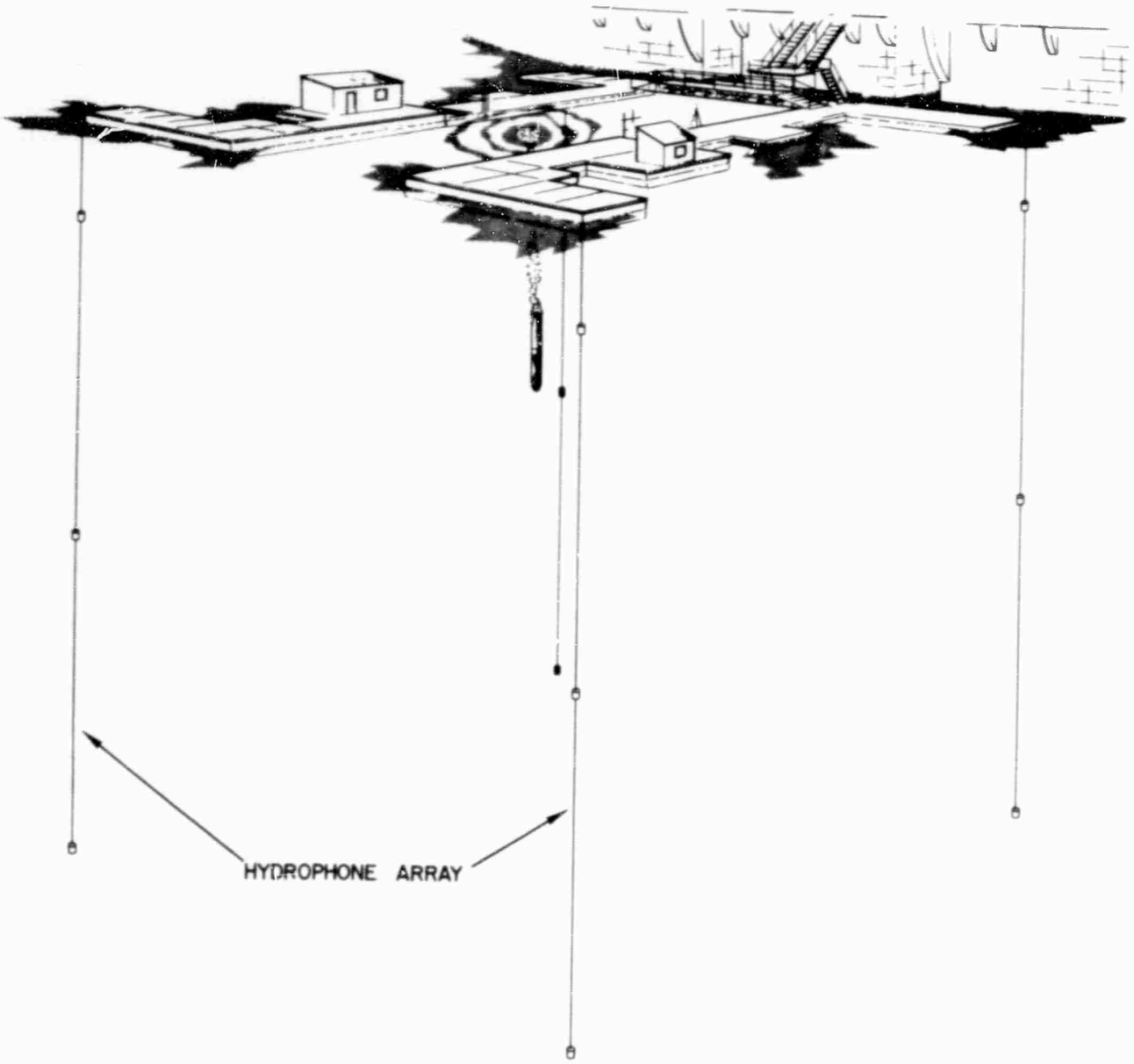

Figure 12. Mobile Hydrophone Array