MISCELLANEOUS PAPER C-74-15

COST AND FEASIBILITY STUDY; ALTERNATE DESIGNS TO PERMIT USE OF SLIP FORM AND OTHER TECHNIQUES TO MAXIMIZE ECONOMIES, TRUMBULL LAKE DAM, PEQUONNOCK RIVER BASIN, CONNECTICUT

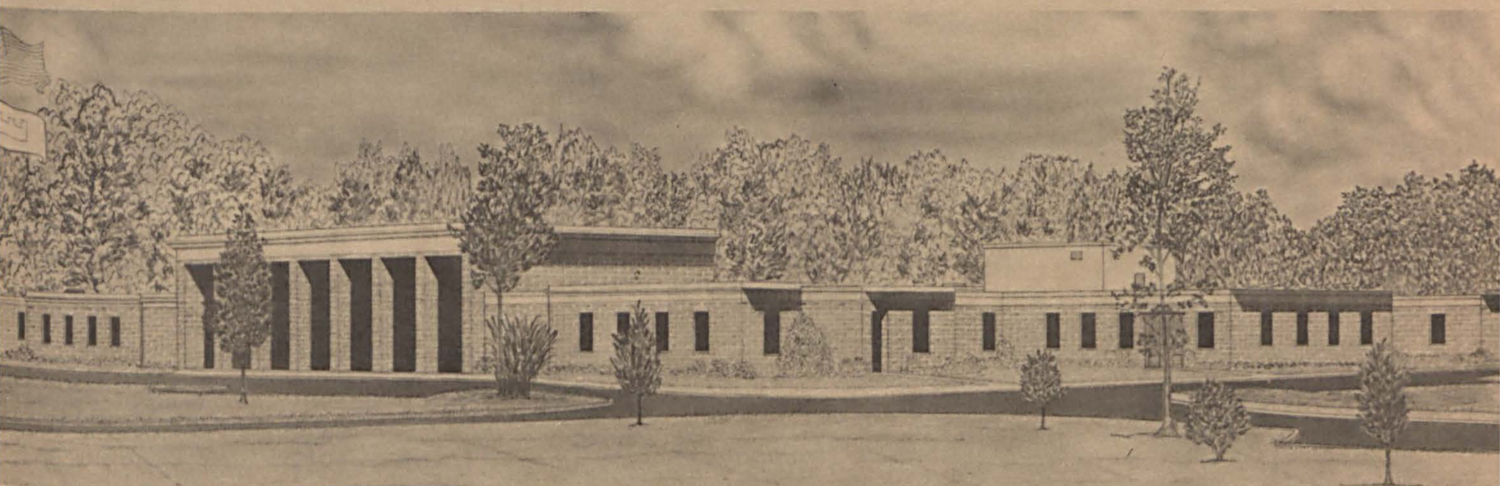
by

J. F. Camellerie, Consulting Engineer
23 Green St., Huntington, New York 11743

August 1974

Final Report

Approved For Public Release; Distribution Unlimited



Prepared for U. S. Army Engineer Division, New England
Waltham, Massachusetts 02154

Published by Concrete Laboratory
U. S. Army Engineer Waterways Experiment Station
P. O. Box 631, Vicksburg, Miss. 39180

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: Miscellaneous Paper C-74-15	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): COST AND FEASIBILITY STUDY; ALTERNATE DESIGNS TO PERMIT USE OF SLIP FORM AND OTHER TECHNIQUES TO MAXIMIZE ECONOMIES, TRUMBULL LAKE DAM, PEQUONNOCK RIVER BASIN, CONNECTICUT	5. TYPE OF REPORT & PERIOD COVERED: Final report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): J. F. Camellerie	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: J. F. Camellerie, Consulting Engineer, 23 Green Street, Huntington, N. Y. 11743	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: U. S. Army Engineer Division, New England, 424 Trapelo Road, Waltham, Mass. 02154	12. REPORT DATE: August 1974
	13. NUMBER OF PAGES: 509
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): U. S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, Miss. 39180	15. SECURITY CLASS. (of this report)
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Concrete
Concrete costs
Dam construction
Slip form techniques
Trumbull Lake Dam

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The ten books incorporated in this report were prepared by J. F. Camellerie, P.E., Consulting Engineer, Huntington, New York, under contract to the U. S. Army Engineer Division, New England. The primary purpose in this study was to determine the feasibility of the use of slip form techniques to dam construction; however, the report includes cost studies of other types of conventional dam construction.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

FOREWORD

The ten books incorporated in this report were prepared by J. F. Camellerie, P.E., Consulting Engineer, Huntington, New York, under contract to the U. S. Army Engineer Division, New England. The primary purpose in this study was to determine the feasibility of the use of slip form techniques to dam construction; however, the report includes cost studies of other types of conventional dam construction.

INDEX

COST AND FEASIBILITY STUDY
ALTERNATE DESIGNS TO PERMIT USE
OF SLIP FORM AND OTHER TECHNIQUES
TO MAXIMIZE ECONOMIES

BOOK C
CONVENTIONAL CONSTRUCTION

BOOK C - CONVENTIONAL CONSTRUCTION

Plates, Drawings, and Sketches

1 Plates 2-4 through 2-6

2 Drawings 209-C-1 through C-3

3 Drawings 270-C-2 (Probably should be 209-C-2)
Drawings 290-C-3 (Probably should be 209-C-3)

4 Sketches 209-SC-1 and SC-2 (in Book CA)

5 Sketches 209-SC-19 through SC-22 (in Book CA)

6 Sheets EC-S, EC-1, EC-2, EC-2A, EC-3

GENERAL DESCRIPTION OF DAM

GENERAL DESCRIPTION OF DAM STRUCTURE

Gravity Dam Section - The dam section, both overflow and nonoverflow, will be constructed of concrete materials founded on rock. Length of dam at elevation 280 will be 915 feet between rock abutments. From the right abutment the non-overflow section is 410 feet long followed by a 350-foot overflow section (ungated) and ending with a 155 foot non-overflow section to the left abutment. From elevation 280 the valley depresses on the base line such that the deepest monolith is approximately 150 feet deep. There are 16 monoliths, 10 non-overflow and 6 overflow; they are 60 feet wide between vertical bulkhead joints except monoliths No. 1 and No. 13 are 50 feet wide and monolith No. 16 is 35 feet wide. (SEE PLATES 2-4, 2-5, & 2-6.) All monoliths will have an upstream face sloped at 1/12 and downstream face sloped at 9/12 except monolith No. 2 has a multiple step upstream face of 1/12 to 7.5/12 and monolith No. 14 and No. 15 have a downstream slope of 1/1. An 8' x 6' drainage gallery will be provided within the dam near the heel for all monoliths except monolith No. 1, No. 14, No. 15 and No. 16, and a 14' x 14' water supply gallery 87 feet long will be provided in monoliths No. 6 and No. 7.

Pumping Station - Non-overflow monolith No. 6 will house the pumping station which is 30 feet wide, 52 feet long, (14 feet into gravity section at El. 199 and 31.25 feet into gravity section at elevation 167) and 32 feet high from elevation 167. The exterior portion of the pumping station will terminate over the downstream toe such that it is wholly cradled by the dam section. The exterior portion of the roof will be a formed concrete structure to take the surcharge of ice and snow sliding off the downstream slope of the dam.

Access Gallery - Non-flow monolith No. 7 will provide at station 4-40 a 10' x 10' access gallery from the downstream parking area to the control chamber, water supply and drainage gallery at elevation 167. An entrance gallery is provided at top of dam in monolith No. 2.

CORPS OF ENGINEERS

U.S. ARMY

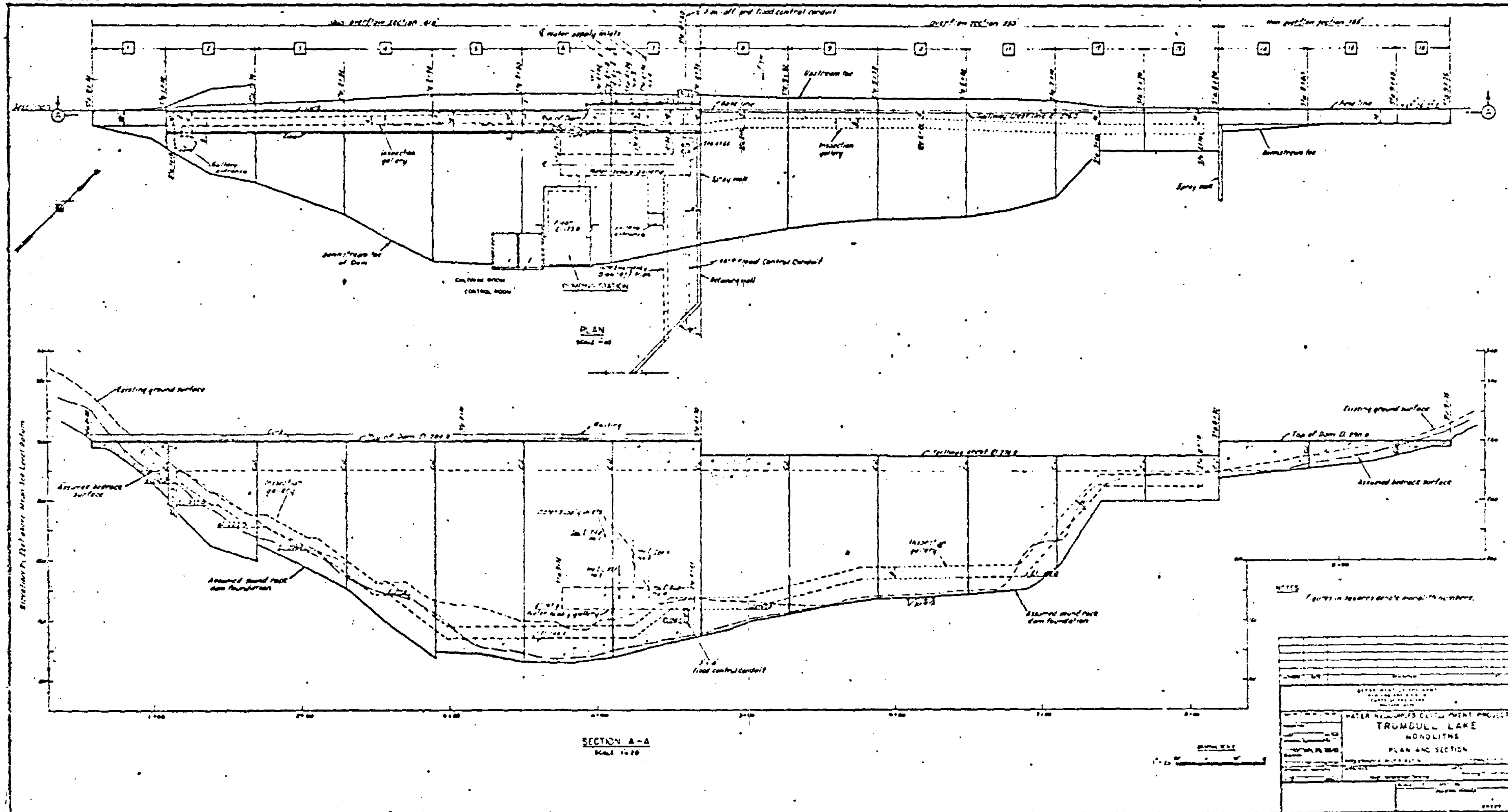
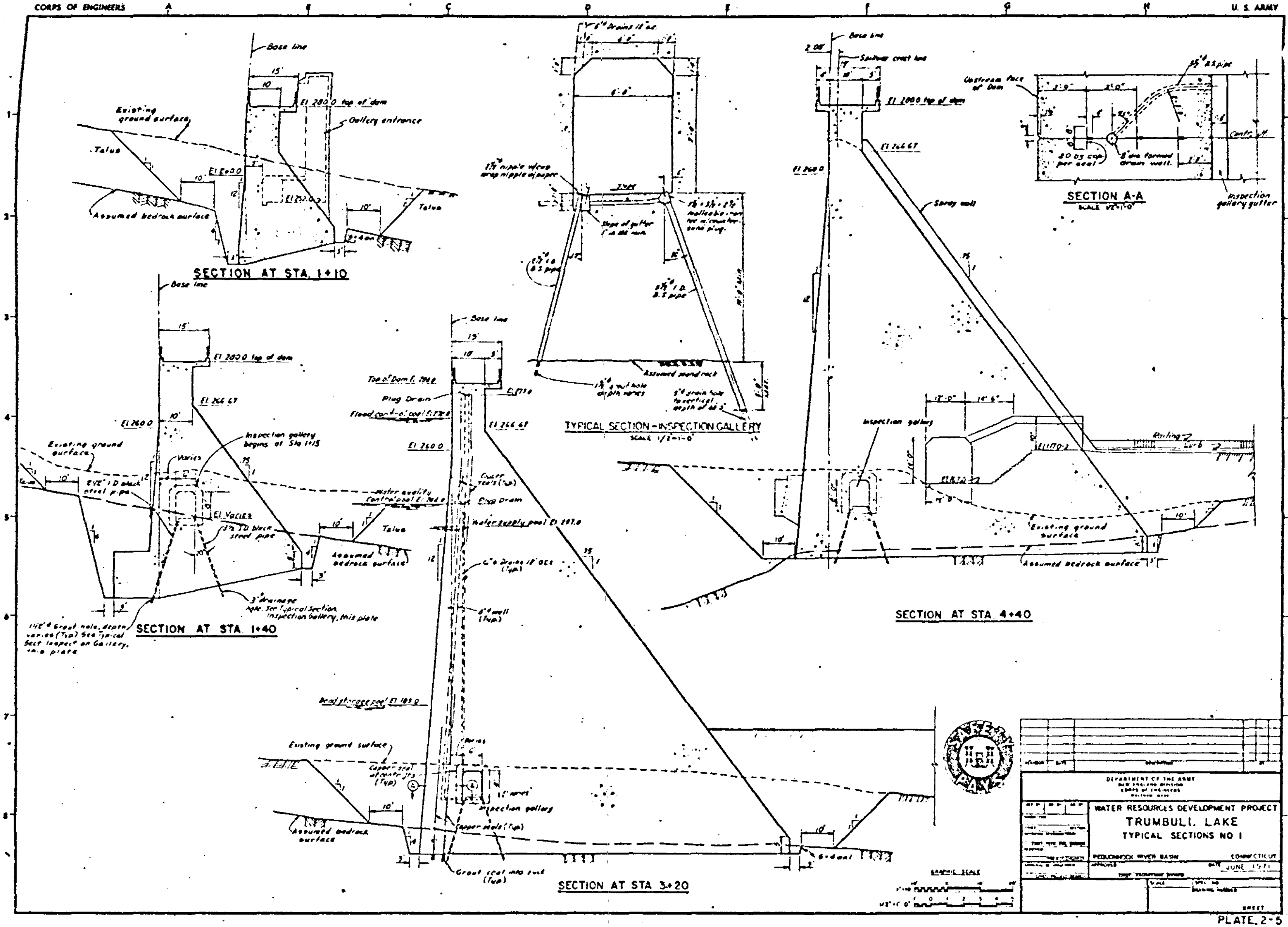
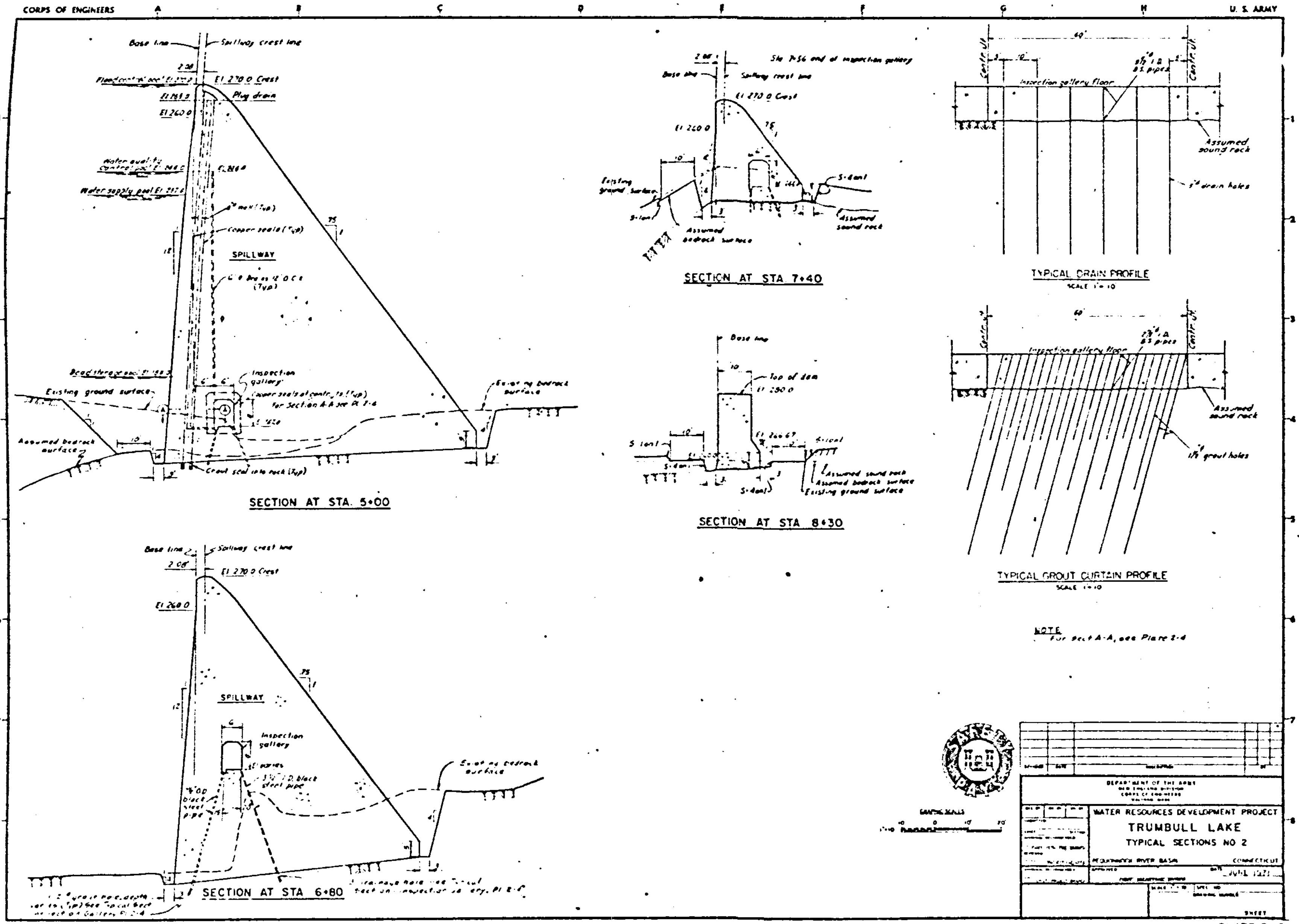


PLATE 2-4



CORPS OF ENGINEERS
U. S. ARMY
SECTION AT STA. 1+10
SECTION AT STA. 1+40
SECTION AT STA 3+20
SECTION AT STA 4+40
TYPICAL SECTION - INSPECTION GALLERY
SECTION A-A
Existing ground surface
Assumed bedrock surface
Talus
Base line
El 280.0 top of dam
Gallery entrance
El 266.67
El 260.0
Inspection gallery
Spray wall
Railing
Water quality control pool
Water supply pool
Dead storage pool
Flood control pool
Top of Dam
Plug Drain
Upstream face of Dam
Inspection gallery gutter
DEPARTMENT OF THE ARMY
WATER RESOURCES DEVELOPMENT PROJECT
TRUMBULL LAKE
TYPICAL SECTIONS NO I
CONNECTICUT
GRAPHIC SCALE

PLATE 2-5


CORPS OF ENGINEERS
U. S. ARMY
Base line
Spillway crest line
El 270.0 Crest
Plug drain
El 260.0
SPILLWAY
Inspection gallery
Existing ground surface
Assumed bedrock surface
Existing bedrock surface
Grout seal into rock (Typ)
SECTION AT STA. 5+00
Top of dam
El 280.0
Assumed sound rock
Assumed bedrock surface
Existing ground surface
SECTION AT STA 7+40
SECTION AT STA 8+30
SECTION AT STA 6+80
Inspection gallery floor
Assumed sound rock
TYPICAL DRAIN PROFILE
TYPICAL GROUT CURTAIN PROFILE
NOTE
For sect A-A, see Plate 2-4
DEPARTMENT OF THE ARMY
WATER RESOURCES DEVELOPMENT PROJECT
TRUMBULL LAKE
TYPICAL SECTIONS NO 2
CONNECTICUT

FACTORS AFFECTING CONSTRUCTION AND METHODOLOGY

CLIMATE CONSIDERATIONS

The site of this project is in southwestern Connecticut just 5 miles north of Bridgeport, an area of temperate to cool climate with temperatures ranging from -20 to + 100 degrees Fahrenheit with a mean annual temperature of 50°. Freezing temperatures may be expected mid-October to mid-April with a mean temperature of 37 degrees Fahrenheit. The construction season is generally mid-March thru mid-November with a range of 10 to 100 degrees Fahrenheit and a mean temperature of 60 degrees. During the hottest months of July and August the temperature will run 40 to 100 degrees with a mean of about 72 degrees.

Precipitation is uniform throughout the year at a mean of 4 inches per month. The precipitation may go as high as 18 inches per month and it is possible to have a month in which there is no rain at all. Snow cover on the ground may be expected from mid-December to mid-March.

Concrete work performed prior to March 15th and after November 15th will require winter protection.

HYDROLOGICAL CONSIDERATIONS, STREAM DIVERSION AND CONSTRUCTION SEQUENCE

The river basin is subject to flooding which is most likely to occur during the hurricane season. Droughts are frequent with flow of stream down to nothing. Existing stream invert at the dam site is approximately 159 feet.

During construction, provisions must be made for passing the 10-year all-season peak discharge of 1,700 cfs. A two phase scheme is conceived which employes diversion through open or partially completed monoliths and through the flood control conduit. First phase diversion will utilize an open monolith for passing both normal and floodflows; the second phase will use the flood control conduit for passing normal flows (50 cfs or 3± csm) with excess flows passing over a partially completed monolith.

In this study we select the first river diversion through monolith No. 8, utilizing a channel having a minimum area of 350 square feet below elevation 165.0 and coinciding partially with the permanent channel for the intake structure. For the flow of 1700 cfs this channel will result in an upstream water level of less than 170.0 feet mean sea level. The top of cofferdams was therefore set at 172.0 feet.

The diversion preparations include the construction of a cellular cofferdam just east of monolith No. 7, up and down stream, parallel to the future retaining wall. (SEE DRAWING 270-C-2). The cofferdam will be extended up and downstream towards the west bank of the river.

During this diversion stage, excavation will be completed for monoliths No. 4, 5, 6, 7, and 9 and for the retaining wall. Concrete placement will be started in these structures and expedited in monoliths No. 4, 6, and 7. Monolith 5 will be raised to elevation 162.5 to pass possible flood flows during the second diversion stage together with two diversion conduits in monolith 7. If necessary, the placing of monolith 6 and 7 will be delayed at elevation 174.0 to allow for installation of mechanical equipment directly from above. Monolith No. 9 will be raised to elevation 192.5. During highwater periods concrete placement will shift to the abutment blocks, with emphasis on monoliths 1, 2, and 3. (SEE DRAWING 209-C-3).

In the second stage diversion, the first stage cofferdam will be levelled and the second stage cofferdam will be placed upstream and downstream of blocks 8 to 10. (SEE SKETCHES 209-SC-1 & 2).

The upstream cofferdam will be constructed to elevation 172.0.

Equipment for the pump station and water supply gallery will be installed to allow for further placement of concrete in monoliths 6 and 7.

The water will be ponded to allow higher waterflows to pass through the diversion conduits and over monolith 5. The downstream cofferdam will be constructed to elevation 170.0 for protection from tailwater.

Excavation under monolith No. 8 will be completed and concrete placed to elevation 170.0

Concrete placement will be finished in monoliths 1 to 4 and expedited in monoliths 6 and 7.

Concrete placement will continue in various abutment monoliths on the east bank.

After monoliths 6 and 7 reach elevation 200.0, monolith No. 8 will be raised to elevation 185.0 and held until all monoliths with the exception of monolith No. 5, reach the elevation 207.5.

Monolith 5 will be raised a minimum of 15 ft. behind monolith No. 8. Monolith 8 will be raised 15 ft. behind all other monoliths.

A flume diversion was considered in lieu of cofferdams. It is our opinion that the flume may best be placed on the west bank of the river along the railroad bed and passing through monolith No. 4 or 5. Placing the flume along the east bank would result in a much longer run due to the topography and complications caused by the borrow operations. The railroad bed will facilitate flume construction on the west bank.

Because of the width of the valley upstream of the dam site and the low gradient of the valley floor, the flume will have to run about 3000 feet upstream with a cross section of approximately 45 by 8 feet. A short, low dam, about 200 feet long, will be needed at the upstream end of the flume to provide a settling basin and collection point for the water before it enters the flume. Down stream the flume will have to be extended approximately 2000 feet to protect the work from tail waters in periods of heavy flow. As an alternate to extending the flume downstream, a cofferdam may be built just downstream of the dam site where the valley is still narrow, thereby protecting the work from tail waters. The construction of the flume downstream of the dam site is probably not acceptable for ecological reasons.

This flume must be cut into rock side hill and/or built up with fill and since sheet piling cannot be driven into rock, in effect one side of the flume will have to be constructed to take full hydrostatic pressure. As an alternate, the flume may be constructed entirely on fill with sides and bottom of waterproof construction.

In the light of the above considerations, we have based this study on cofferdam solutions as shown on drawing No. 209-C-2.

SOIL CONDITIONS AND GEOLOGY

Bed rock consisting of foliated metamorphic rock underlies the dam site out-cropping on the east side of the valley except for the shelf under monoliths Nos. 13, 14 and 15 where a shallow mantle of silt and sand varying in depth from nothing to ten feet covers the rock.

The west side of the valley slopes rather uniformly at 25 to 30 degrees to the horizontal with a mantle of talus deposits approximately 12 feet thick. Rock and gravel spoil from previous construction underlies monolith No. 4 to a depth up to 20 feet.

The valley floor underlying monoliths Nos. 5 through 8 has a sedimentary pervious fill of silty sand, gravel and bolders up to thirty feet deep at the thickest point. The present stream is channelized in this relatively flat valley floor.

Both east and west abutments are heavily foliated with trees and shrubs.

Sand and gravel deposits in layers to forty feet deep, and having characteristics satisfactory for use as concrete aggregate, are to be found in the valley floor approximately

2000 feet upstream of the dam. The location of these deposits is shown on drawing 209-C-1 and is designated as areas "A" and "B". Area "A" is a mix of sand and gravel whereas area "B" is primarily sand. Approximately 750,000 yards of material are available in these two areas with one-third of it above the water table. By controlling the borrow operation, between areas "A" and "B", the mixture of sand and gravel may be kept fairly close to the job requirements of the concrete mix.

These borrow pits as well as areas further upstream may also be used to furnish fill for stream diversion and other work.

ENVIRONMENTAL PROTECTION

Generally speaking, great care will be taken not to disturb area appearance or, when appearance is disturbed, to restore the area to its original appearance, or at least an appearance that is harmonious with the rest of the environs. This includes preservation of flora, fauna and terrain features. In order to accomplish this, no operations will be permitted downstream of the dam site and operations at the abutments will be very restricted. In keeping with this requirement, the tail tower will be erected by helicopter, thereby avoiding the defacement resulting from bringing heavy equipment into this area overland. Actually, this may very well be the most economical method of erection. The head tower, cableway pick-up point and cement air slide head will be placed on the relatively flat and sparsley treed knoll overlooking the west abutment in the area to be developed as a recreational area. (SEE DRAWING 209-C-2).

In order to reduce activity in this area, as well as for reasons of economy, it is planned to quarry and process the aggregates in the valley. The batch plant will also be located in the valley and fed cement via an air slide from the upper access area. Cement, forms, chemicals, equipment, etc., are delivered at this area or as an alternate, may be delivered utilizing the lower access roads. The cableway, as planned in this study, is capable of picking up only from the upper area. It is possible to bring the head tower track nearer the abutments and increase the arc of travel to pick up from the lower access road, but this will involve some difficulty and expense due to less favorable ground contours.

Prevention of water pollution requires ponding and settling of diverted waters. Drawing 209-C-2, showing the stream diversion, shows a settling basin just south east of the downstream cofferdam. During the second phase, ponding will be effected by the dam itself. Waste water from washing, jetting, curing, etc, must be processed before release into the river.

It is planned that all cement and materials handling equipment is equipped with dust collector systems and that roads and other trafficked areas will be sprinkled or treated as required. The granular soil to be found in the stream bed should not give much trouble in this respect. Costing includes carting away all debris except selected materials which may be burried within the reservoir area as no burning is permitted on site. Chipping of tree trunks and other wood debris is anticipated as an economical method of disposal by recycling.

ACCESS TO SITE

There are only three directions of access to the site:

a) Improvement and widening of the old railroad road bed connecting with Whitney Avenue from the north (upstream).

b) Improvement and widening of the old railroad road bed connecting with Church Hill Road to the south (downstream). The railroad bed is continuous but will be severed in half when the west abutment monoliths are constructed.

c) Construction of the upper access road connecting with Valdemere Avenue to the west of the sest abutment, plus a temporary extension to the cableway head tower area.

There is no access from the east. The only approach to the east bank will be across the river by constructing a small bridge.

In this study it is planned to receive shipments mainly from the Valdemere Avenue approach, transferring the materials and equipment via the cableway directly to the dam construction. An air slide carries cement directly to the cement storage bins. Heavy equipment and some shipments and personnel will reach the job site via the lower access road.

An access road is planned connecting the railroad bed road (lower access road) with the batch plant and borrow areas on the east bank (SEE DRAWING 209-C-1 & 2.)

LABOR SUPPLY

This is an area of good labor availability and no problem is anticipated in number and skill of workers required, particularly since it is long range employment. Labor costs in this area run about 5% higher than the national mean and an escalation of 8% per year is assumed. It is anticipated that neither travel pay nor camp facilities will be required.

CONCRETE

For the purposes of this study, it has been determined that the concrete required for this dam is of four types as follows and in following quantities. All concrete will be air entrained:

a) INTERIOR MASS CONCRETE
(all areas except as listed below)

Total Quantity Required:	93,000	CY
Mix Design:		
Portland Cement, Type II	1.40	cwt
Fly Ash	1.10	cwt
Coarse Aggregate 6" Max.	29.32	cwt
Fine Aggregate	8.14	cwt
Water	1.62	cwt
1-1/2" slump		
Air Entrainment		

b) EXTERIOR MASS CONCRETE
(All upstream faces, downstream face of spillway monoliths.)

Total Quantity Required:	26,000	CY

This quantity is based on an average face thickness of 6 feet.

Mix Design:

Portland Cement, Type II	1.83	cwt
Fly Ash	.78	cwt
Coarse Aggregate 6" Max.	29.32	cwt
Fine Aggregate	8.14	cwt
Water	1.62	cwt

c) 3,000 psi Concrete
(pumping station)

Total Quantity Required:	5,000	CY

d) 4,000 psi Concrete
(flood control conduit)

Total Quantity Required:	3,000	CY

Mass concrete will be cooled to 50° F. by means of a 130 ton capacity refrigeration plant which will furnish either flaked ice or chilled water or both as required. Introduction of flaked ice into the mix in lieu of equal weights of water will be sufficient during most of the year. Sprinkling of the aggregates with chilled water will be required June through mid September. Hot weather concreting procedures will also have to be carefully adhered to in the hot summer months to insure placing at temperatures no greater than 50° F.

CONCRETE PRODUCTION

Economy, environment and job control all point to in-situ concrete production on this job. This study is

Revised

based on a quarry operation in borrow areas A and B, aggregate processing using portable equipment and batch facilities to provide a rated capacity of 160 yards per hour of concrete. The minimum capacity required by EM 1110-2-2000 is 80 yards per hour based on preventing cold joints in the concrete. It is our judgment that although one 4 yard mixer just meets the above minimum requirement, the higher capacity will give optimum economy in the placing operation. Further, two mixers furnish the necessary safety if one mixer becomes inoperable.

QUARRY OPERATION

The potential aggregate sources are glacio-fluvial deposits which do not require any drilling or blasting.

A geological report indicates that a major part of the deposits will be found below water-table.

It is therefore suggested using a dragline in view of possible wet excavation.

It seems that the hourly demand of the aggregate plant, which is 225 tons or 135 bank cubic yards, can be met with a 2-1/2 cubic yard dragline which could be crawler mounted.

The output of a 2-1/2 cubic yard dragline would be approximately 165 cubic yards per hour, assuming 70% efficiency and 50% optimum working condition.

In order to service the loading equipment and the aggregate plant in an economical way, we suggest using 6 cubic yard rear dump trucks.

The standard 7 cubic yard hopper of the grizzly is sufficient but could be extended to receive approximately 24 cubic yards if needed.

Calculations indicate that the four - 6 cubic yard dump trucks operating on 5 to 6 cycles per hour will satisfy the aggregate plant and the dragline output.

It will be required to build an all-weather gravel surfaced road between the loading area and the discharge point of the trucks. The grade will be in the vicinity of 3 to 4%.

Revised

CRUSHING PLANT OPERATION

A preliminary investigation of data available indicates that an aggregate plant with a primary, secondary and tertiary crusher will be required in order to produce aggregate of the desired gradation.

A portable aggregate plant was selected because of its bigger resale value as compared to a stationary plant. With a construction project of this relatively moderate concrete demand this will be an important factor in keeping the cost per yard within limits. The location of the aggregate plant is shown between the aggregate borrow areas and the mix plant at a high enough elevation to remain in the dry. Handling equipment will convey the excavated material to a ramp alongside the primary crushing plant and dump it into a vibrating grizzly feeder to screen out oversize material. The screened stone will be fed into a 2036 jaw crusher to produce the first reduction in size.

A portable conveyor will feed the material to the vibrating screen at the secondary crusher unit for further reduction by a gyratory type crusher. Thence a conveyor will transport the aggregate to a vibrating screen, equipped with a single screw classifier. This unit supplies via conveyor the tertiary crushing plant, which will be operating in closed circuit with the aforementioned vibrating screen.

A conveyor belt will discharge the first aggregate size from the above unit onto a stockpile.

The remainder of the material will be conveyed to two consecutive portable screening plants for further distribution to individual stockpiles according to aggregate sizes. The stockpiled material will occupy an area of approximately 200 feet long by 40 feet wide. A tunnel conveyor, supplied by short belt feeders will run under the whole length of the aggregate stockpile and feed the individual aggregate sizes to the top bins of the mixing plant.

All portable plant units will be installed without running gear on concrete foundations.

BATCH PLANT

Since various mixes are required for this project, we suggest using a selector system with provisions for pre-set automatic batching. Individual scales and hoppers for all materials as well as graphic recording for the amount of material entering each batch will be needed.

We have planned to use two - 4 cubic yard tilting mixers with weigh batchers sized accordingly. The mixers will retain the batch for a total of 2 minutes mixing time plus approximately one minute charging, discharging and contingency for a complete cycle of 3 minutes. This cycle will enable the two - 4 cubic yard mixers to furnish a maximum of 160 cubic yards of concrete per hour.

We envision the batch plant having the following characteristics:

1 - One - 270 cy. five aggregate compartment bin with equally divided central cement compartment for cement and fly ash and total aggregate storage of approximately 260 tons (3000 # heap per cubic yard of material). The cement compartment to include high and low level bindicator switches with signal lights and pneumatic fill pipe assembly; aggregate compartments to include hi-lo signals only.

2 - A motorized distributor assembly on top of the overhead storage bins will distribute the aggregates from the aggregate charging equipment to the various aggregate storage compartments. Bin selector switch mounted in control panel will be utilized to control this operation.

3 - One fully automatic cement weigh batcher with weigh hopper and cone discharge gate, controlled by pneumatic ram with solenoid operated air control valve, scale levers and linkage for central dial unit.

4 - Four fully automatic aggregate weigh batchers for sand, fine, intermediate and coarse aggregate and one fully automatic cobble bathcer for 6" material, all air operated and tied into a central recording unit.

Revised

5- One fully automatic water batcher with weighing and recording equipment.

6- Fully automatic air entraining and water reducing agent admixture dispensers tied in with the water batcher and equipped with weighing and recording units.

7- In order to control all batchers collectively and individually, a control panel is required with indicating lights, automatic batch and discharge buttons and a discharge sequence timer for discharging materials in any desired sequence.

8- Charging the two - 4 cubic yard mixers will be done by means of a two-way air operated mixer charging chute.

9- One central electric motor control panel to service miscellaneous motors layed out for 440 V, 3 phase 60 hz. and including a 110 V transformer.

10- The refrigeration equipment will include two compressors with three ice machines and ice handling equipment such as ice screws, elevator, daily use tank, weigh batcher and controls to record the amount of ice entering each batch.

11- Dust control equipment for the batching plant should include two dust collectors for the cement tank and mixers and a batcher vent.

12- Two silos will provide storage for cement and flyash at 300 tons and 230 tons respectively. Both units will include a pumping system for reclaiming the material to the center compartments of the overhead bind and a dust collecting system.

CONCRETE PLACEMENT

A radial cableway seems to be the most economical method of concrete placement for this site. The cableway selected has a 6 cy capacity with a 3 minute cycle or an hourly placing rate of 120 cy. Effective placing time during an

8 hour shift will be 6 hours or 720 cy per shift, (see sketch 209-C-3) which means that overtime placing at 120 yards per hour will be required on a few of the larger blocks.

The fixed tower of the cableway will be installed on the east bank; the movable tower, which is the head tower and includes the hoisting machinery will operate on the west abutment. The concrete or bucket transfer point is projected into the area at monolith 13 on the east abutment, this point being approximately 120 feet from the mixing plant at elevation 245.0 ± .

The concrete placing sequence envisioned in this study will be as shown on drawing 290-C-3. Phase I, performed during the first stream diversion will take 62 days to complete with a placement of 51,000 yards of concrete. Phase II, which will be performed after the stream is diverted through the flood control conduits, will take 123 days and involve the placement of 74,500 yards of concrete. Four months must be allowed between phases to allow for cofferdam levelling and installation of additional cofferdams and sheet piling.

Pour scheduling allows for a slow start since considerable time is spent on rock cleanup and building or adjusting foundation forms. Between lifts, time will be required for concrete cleanup, moving and setting forms, installation of embedded items, etc.

The full capacity of the concrete placing system will only come into play after a major number of monoliths have reached the cantilever form stage.

Placements shown are based on seven and one-half foot lifts with concrete demand as shown on sketches 209-SC-13 thru 18. This sequence results in a plant utilization factor of 42 percent obtained by dividing average concrete placement per hour by rated batch plant capacity of 160 yards per hour. 425,650 square feet of horizontal joints and 51,600 square feet of transverse vertical joints will be required.

Revised

FORMING SYSTEM

The form system included in this study is the normal cantilever type form universally used in dam construction for 7'-6" lifts and including a hinged section on the downstream side to facilitate concrete placement from buckets, as shown on sketch 209-SC-19. The forms are brought to the monolith via the cableway or a crawler crane operating on the valley floor and handled in place from lift to lift by a small hydraulic boom crane. The types of formwork required are as follows:

- Foundation Forms
- Lift Starter Forms
- Cantilever Forms
- Monolith Bulkhead Forms
- Gallery Forms
- Wall and Slab Forms (Power station and top slab)
- Stair Forms.

SEE SKETCH 209-SC-20 for FORM REQUIREMENTS in each category.

The first concrete lift placed on the rock surface will utilize built-in-place forms which are anchored to and braced against the bedrock.

Lift starter forms will be used until the concrete is raised high enough to provide anchorage space for the legs at the cantilever forms.

Inverted cantilever forms may be used for this phase of construction with the bolts installed at the top of each started form lift to serve as anchors for the legs of the first regular cantilever forms. SEE DRAWING 209-C-3 for disposition of foundation and lift starter forms.

Cantilever forms and inverted cantilever forms may serve as bulkheads. When cantilever forms are used in the normal position, a 15-foot differential elevation will be required in order to allow for cantilever anchorage clearance.

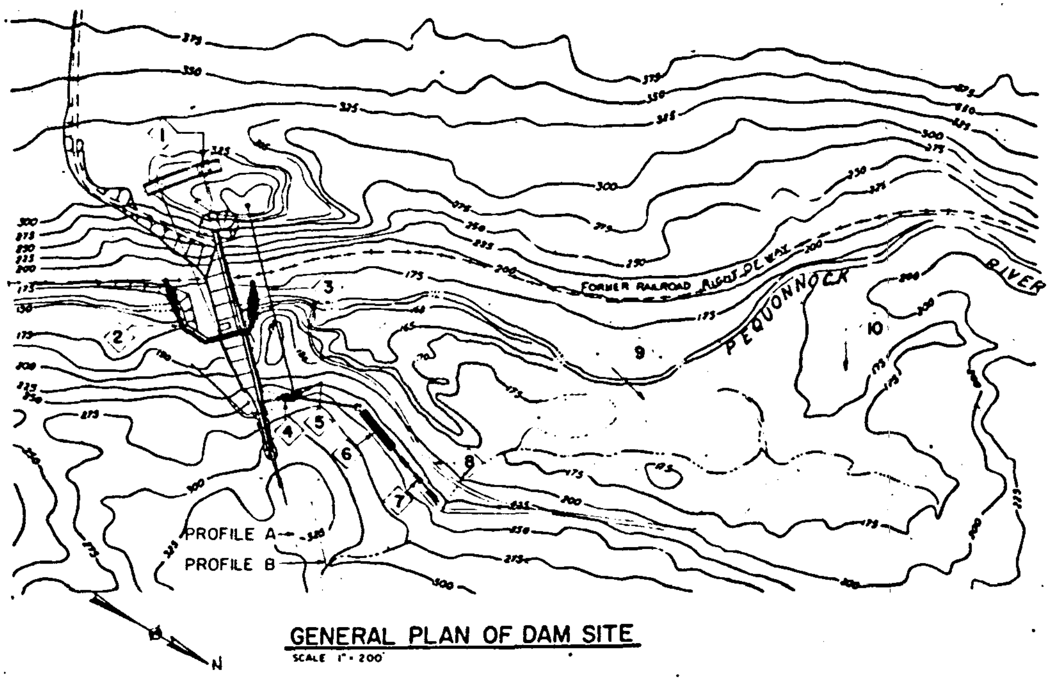
Revised

CONSTRUCTION SCHEDULE

It is anticipated that the contract for this work will be let by October 1st, 1972 and that procurement and stripping will actually start at this time. Procurement can be continued over the winter in order to start plant erection in the Spring. As much stripping as possible must be done in the fall of 1972 in order to finish up in April of 1973, with a lay-off in the winter. This will allow start of diversion work and plant erection on April 1st of 1973. SEE CONSTRUCTION SCHEDULE Sketch 209-SC-21 showing items on critical path only. Concreting is started in late 1973 and completion in 1974. It is suggested that the winter of 1974-1975 be allowed the contractor for demobilization, cleanup, testing, environmental work and contingency time. Because of the tightness of this schedule, the penalty clause should not be effective earlier than April 1st, 1975. This is admittedly a very tight schedule but it is entirely feasible. If work cannot start by October 1st of this year, in effect a full construction season will be added to the construction schedule as shown on Sketch 209-SC-22 with an escalation cost of 6 to 7 percent to the entire project.

Because of design considerations, extraordinary care must be taken in executing the foundation grouting. This will require progressive grouting from one abutment to the other or from a central point towards the abutments. This parameter has not actually been integrated into the construction sequence shown, but it is felt that with little change in sequencing this requirement may be met without change in over-all time or construction cost.

CORPS OF ENGINEERS U. S. ARMY

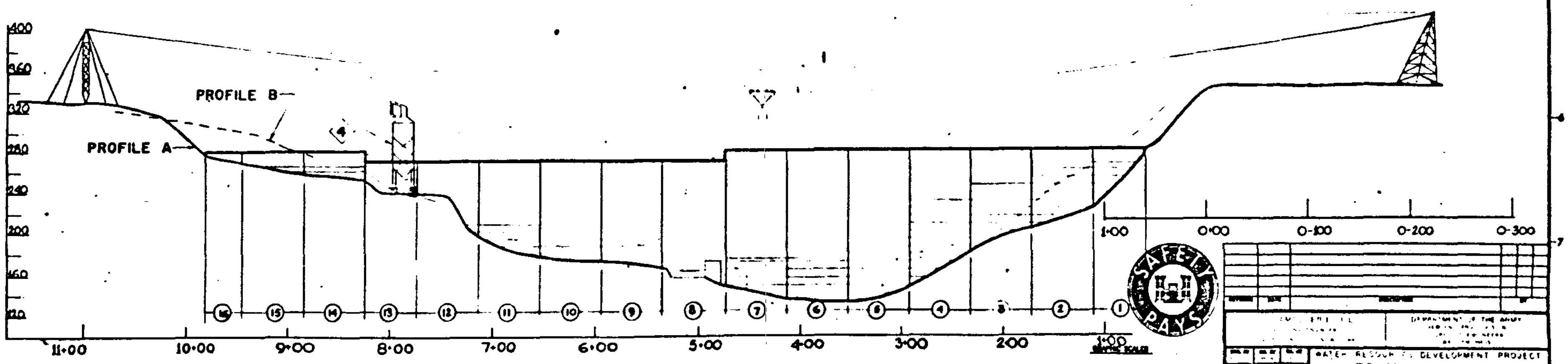


NUMBER DESIGNATIONS

1. RADIAL CABLEWAY
2. COFFERDAM
3. CEMENT AIR SLIDE
4. CONCRETE BATCH PLANT
5. CEMENT BINS
6. AGGREGATE STOCK PILES
7. AGGREGATE CRUSHERS AND SCREENS
8. ACCESS ROADS
9. BORROW AREA A
10. BORROW AREA B

GENERAL PLAN OF DAM SITE

SCALE 1" = 200'



UPSTREAM ELEVATION

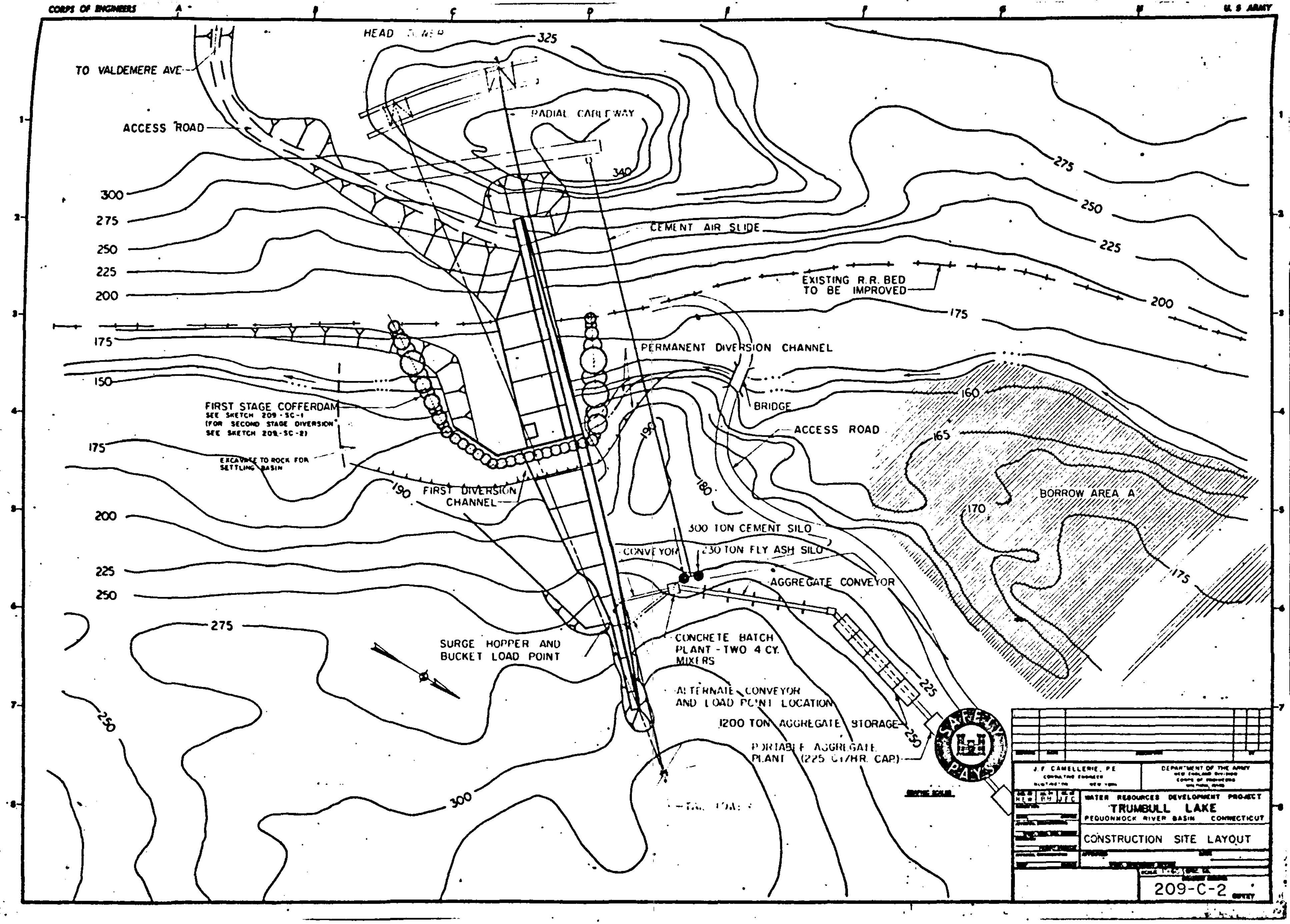
WATER RESOURCES DEVELOPMENT PROJECT

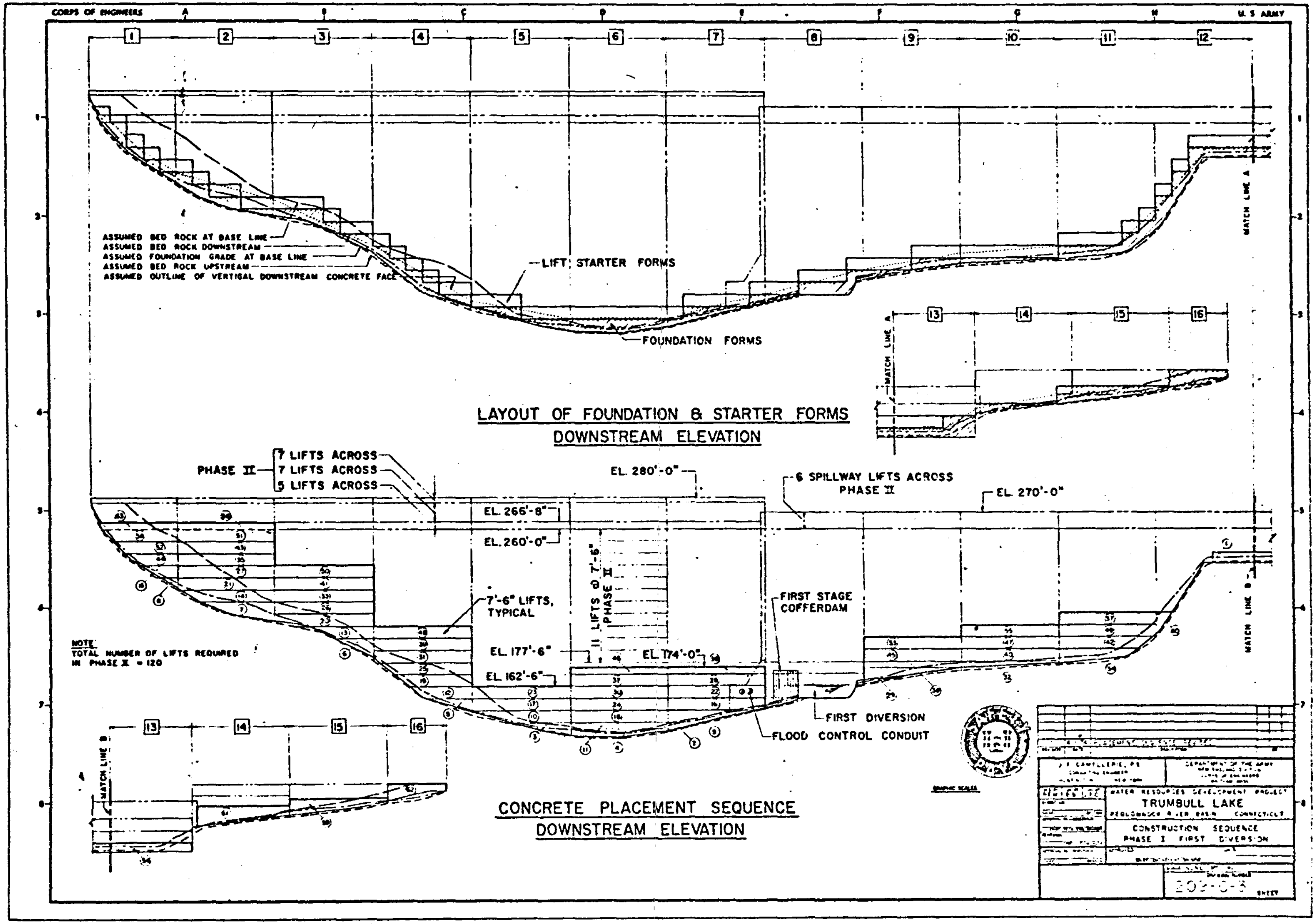
TRUM LAKE

CONNECTICUT

PLAN AND LAYOUT

209-C-1


CORPS OF ENGINEERS
U S ARMY
HEAD
325
TO VALDEMERE AVE
RADIAL CABLEWAY
ACCESS ROAD
340
300
275
250
225
200
175
150
CEMENT AIR SLIDE
EXISTING R.R. BED
TO BE IMPROVED
PERMANENT DIVERSION CHANNEL
BRIDGE
ACCESS ROAD
FIRST STAGE COFFERDAM
SEE SKETCH 209-SC-1
(FOR SECOND STAGE DIVERSION
SEE SKETCH 209-SC-2)
EXCAVATE TO ROCK FOR
SETTLING BASIN
FIRST DIVERSION
CHANNEL
190
180
160
165
170
BORROW AREA A
300 TON CEMENT SILO
CONVEYOR
230 TON FLY ASH SILO
AGGREGATE CONVEYOR
SURGE HOPPER AND
BUCKET LOAD POINT
CONCRETE BATCH
PLANT - TWO 4 CY.
MIXERS
ALTERNATE CONVEYOR
AND LOAD POINT LOCATION
1200 TON AGGREGATE STORAGE
PORTABLE AGGREGATE
PLANT (225 CY/HR. CAP)
SAFETY PAYS
J.F. CAMELLERIE, P.E.
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WATER RESOURCES DEVELOPMENT PROJECT
TRUMBULL LAKE
PEQUONNOCK RIVER BASIN CONNECTICUT
CONSTRUCTION SITE LAYOUT
209-C-2



CORPS OF ENGINEERS
U. S. ARMY
ASSUMED BED ROCK AT BASE LINE
ASSUMED BED ROCK DOWNSTREAM
ASSUMED FOUNDATION GRADE AT BASE LINE
ASSUMED BED ROCK UPSTREAM
ASSUMED OUTLINE OF VERTICAL DOWNSTREAM CONCRETE FACE
LIFT STARTER FORMS
FOUNDATION FORMS
MATCH LINE A
LAYOUT OF FOUNDATION & STARTER FORMS
DOWNSTREAM ELEVATION
PHASE II
7 LIFTS ACROSS
7 LIFTS ACROSS
5 LIFTS ACROSS
EL. 280'-0"
6 SPILLWAY LIFTS ACROSS
PHASE II
EL. 270'-0"
EL. 266'-8"
EL. 260'-0"
11 LIFTS @ 7'-6"
PHASE II
7'-6" LIFTS, TYPICAL
FIRST STAGE COFFERDAM
EL. 177'-6"
EL. 174'-0"
EL. 162'-6"
NOTE:
TOTAL NUMBER OF LIFTS REQUIRED IN PHASE II = 120
FIRST DIVERSION
FLOOD CONTROL CONDUIT
MATCH LINE B
CONCRETE PLACEMENT SEQUENCE
DOWNSTREAM ELEVATION
TRUMBULL LAKE
CONSTRUCTION SEQUENCE
PHASE I FIRST DIVERSION

CONSTRUCTION COSTS

AND ANALYSIS

ESTIMATED COSTS

It is estimated that with construction starting by October 1st, 1972 the cost of the concrete dam will be slightly over seven million dollars as shown on Cost Sheets EC-1 thru EC-4. The direct costs are distributed as follows:

Cementatious Materials	$ 347,000	9.9%
Plant & Plant Operation	1,699,608	48.8%
Cooling	100,600	2.9%
Concrete Placing & Vib.	134,634	3.8%
Joint Treatment, Finish., and Curing	207,364	6.0%
Forms	535,658	15.4%
Miscellaneous Inserts	460,418	13.2%
TOTAL DIRECT COSTS	3,485,282	100.0%

Additional cost for environmental control is estimated at $280,000 including reasonable water turbidity, dust and noise control and landscape renewal. This is 8% of the direct costs. Sitework and field overhead are estimated at $2,310,000 or 67 percent of direct cost.

To these costs have been added escalation for the period during which purchasing and construction will be in progress and appropriate percentages for general overhead, profit, contingency and bid bond.

The methods and materials used are in conformity with current Corps of Engineers specifications without modification and the costs were carefully arrived at by appropriate analysis based on quotations, rentals, crew studies, salvage values and cost experience. Labor rates, benefits, insurances, taxes and attitudes were all given full consideration. The methods used are methods in common use in the industry, utilizing cableway transport and cantilever forming raised by mechanized equipment. The production anticipated is consistant with a well organized aggressively managed operation free of unusual delays due to labor, environment enthusiasts, climatic problems or material shortages. Normal delays, costs and inefficiencies have been included in the estimated cost.

J.F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JUN 1,1972
REVISED APRIL 1, 1974

SHEET NO. EC-S

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. CORPS/ENGR

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
SUMMARY CONVENTIONAL CONSTRUCTION						
SHEET EC-1				2,514,020		1,013,820
" EC-2				746,620		113,410
" EC-3				820,800		620,900
				4,081,440		1,748,130
ESCALATION THRU 1974			2%	81,630	11%	192,290
				4,163,070		1,940,420
PAYROLL, TAXES & INSUR.					14%	271,660
						2,212,080
				→		4,163,070
TOTAL COST TO CONTRACTOR						6,375,200
O'HD, PROFIT & CONTINGENCY					8%	510,000
						6,885,000
BID BOND					3/4%	52,000
TOTAL CONTRACT PRICE						6,973,000
VISTA AREA						80,000
TOTAL ITEM 04						7,017,000

SP 10196A

	J.F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JUN 1, 1972 REVISED APRIL 1, 1974	SHEET NO. EC-1
		PROJECT: TRUMBULL LAKE DAM	
		ARCHITECT: NEW ENGLAND DIV. CORPS/ENGR	

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
ITEM 04 DAM						
CLEARING & GRUBBING	360,000	S.F.	.05	18,000	-	SUB
DISPOSAL	250,000	S.F.	.03	7,500	-	SUB
EXCAV., UNCLASS	36,000	CY	2.00	72,000	-	SUB
EXCAV., ROCK	10,000	CY	10.	100,000	-	SUB
EXCAV., TALUS	14,000	CY	3.00	42,000	-	SUB
HAND CLEANING	70,000	S.F.	.75	52,500	-	SUB
CULVERT PIPE	-	L.F.	4.50	-	1.50	----
CHAIN LINK FENCE	850	L.F.	3.50	3,000	2.00	1,700
FOUNDATION GROUTING	50,000	S.F.	.90	45,000	-	----
DIVERSION STAGE I	-	L.S.	-	547,000	-	SUB
DIVERSION STAGE II	-	L.S.	-	167,000	-	SUB
CEMENT	10,755	TONS	27.20	292,000	-	----
FLY ASH	6,115	TONS	9.00	55,000	-	----
BORROW OPERATION	240,000	TONS	.30	72,000	.29	69,500
AGGREGATE PRODUCTION	231,000	TONS	.53	128,000	.34	78,500
BATCH PLANT OPER	127,000	C.Y.	3.44	437,360	1.75	222,300
CABLEWAY OPER	127,000	C.Y.	2.00	254,000	.61	77,470
CONCRETE PLACING	127,000	C.Y.	.06	8,000	.52	66,000
VIBRATION	127,000	C.Y.	.35	44,400	.41	52,100
HOR JOINT TREATMENT	425,650	S.F.	.05	22,000	.15	63,850
FINISHING	146,000	S.F.	.05	7,300	.28	41,000
CURING	430,800	S.F.	.01	4,310	.01	4,310
FORMS: FDN.	18,300	CA	.80	14,640	3.00	55,000
LIFT STARTERS	12,830	CA	.55	7,100	1.17	15,000
CANTILEVER	107,270	CA	.55	59,800	1.17	125,600
BULKHEAD	51,600	CA	.55	28,400	1.17	60,400
STAIRS	1,300	CA	.30	390	1.25	1,625
SPRAY WALL	800	CA	.30	240	1.50	1,200
SLAB (P.H.)	2,470	CA	.75	1,850	1.00	2,470
SLAB (TOP)	2,350	CA	.25	590	.75	1,760
WALLS (P.H.)	7,080	CA	.75	5,310	2.00	14,160
DAM (TOP)	12,400	CA	.25	3,100	1.50	18,600
RET. WALLS	7,450	CA	.25	1,860	1.00	7,450
CURBS	3,300	CA	.50	1,650	1.50	4,950
GALLERY	16,500	CA	.65	10,720	1.75	28,875
				2,514,020		1,013,820
SP 10196A		C-21-				

	J. F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JUN 1, 1972 PRICED BY SHEET NO. EC-2 PROJECT: TRUMBULL LAKE DAM ARCHITECT: NEW ENGLAND DIV. CORPS/ENGRS.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
HYDRAULIC PACKAGE	1	L.S.	-	303,680	-	-
EXTENSION 36" BLOW-OFF	1	L.S.	-	5,000	-	2,000
SHORING	35,800	C.F.	.06	2,150	.06	2,150
3½"Ø STEEL PIPE	1,160	L.F.	3.50	4,060	5.50	6,380
2½" Ø " "	2,150	L.F.	1.75	3,760	3.50	7,530
3" DRAINAGE HOLES	2,880	L.F.	7.20	20,750	-	SUB
1½" GROUT HOLES	9,240	L.F.	8.00	73,920	-	SUB
6" DRAINS	2,770	L.F.	1.50	4,150	-	SUB
8" WELLS	1,070	L.F.	2.00	2,140	-	SUB
PLUMBLINE SHAFT	120	L.F.	3.00	360	2.50	300
REINF. STEEL	100,000	#	.15	15,000	.08	8,000
BACKFILL	12,000	C.Y.	-	-	2.00	24,000
ROCK SLOPE PROT.	800	C.Y.	3.00	2,400	10.00	8,000
ROCK GRAVEL	1,200	C.Y.	4.50	5,400	2.50	3,000
BIT. CONC. PAVING	1,200	S.Y.	5.00	6,000	-	SUB
ALUM. HANDRAIL	1,000	L.F.	10.	10,000	3.00	3,000
COPPER WATER STOP	4,000	L.F.	3.50	14,000	4.00	16,000
FORMWORK, STAIR TOWER	2,300	CA	1.50	3,450	3.50	8,050
WEEKEND OVERTIME				-		15,000
ENVIRONMENTAL WORK						
TURBIDITY CONTROL			-	90,000	-	SUB
DUST CONTROL ON ROADS			-	1,000	-	-
NOISE CONTROL, EQUIP			-	100,000	-	-
LANDSCAPE RENEWAL			-	25,000		10,000
R.R. BED "	270,000	SQ.FT	.20	54,000	-	SUB
		[illegible]		746,620		113,410

SP 10196A

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUN 1, 1972 REV. SKETCH# EC

TRUMBULL LAKE DAM

NEW ENGLAND DIVISION CORPS OF ENGINEERS

HYDRAULIC PACKAGE

Description	Quantity	Unit	Unit Price	Estimated Amount
Gate Valves 16" Manual	2	Ea	$1,000	2,000.00
Gate Valves 16" Automatic	4	Ea	1,600	6,400.00
Gate Valves 24" Manual	4	Ea	3,600	14,400.00
Gate Valves 24" Automatic	4	Ea	4,800	19,200.00
Gate Valves 36" Automatic	1	Ea	6,700	6,700.00
Water Supply Pipe 16"	225	LF	18.00	4,050.00
Water Supply Pipe 24"	200	LF	26.00	5,200.00
Water Supply Pipe 36"	600	LF	48.00	28,800.00
Blow Off Pipe 36"	90	LF	50.00	4,500.00
Double 3' x 4' Gates	1	Job	LS	70,000.00
Intake Screen, 24"	4	Ea	2,000.00	8,800.00
Bulkhead Gate	1	Ea	5,000.00	5,000.00
Gate Vent System	1	Job	LS	5,000.00
~~Float Well & Accessories~~	1	Job	LS	3,000.00
Heating & Vent. System	1	Job	LS	5,000.00
Crane & Hoist	1	Job	LS	7,140.00
Diesel Engine	1	Job	LS	10,000.00
Sump Pumps	1	Job	LS	5,000.00
Electric Systems	1	Job	LS	30,000.00
Grounding System	1	Job	LS	4,000.00
Tile Gage	1	Job	LS	4,000.00
Log Boom	1	Job	LS	10,000.00
Water Quality Control	1	Job	LS	3,300.00
Instrumentation	1	Job	LS	15,000.00
Downstream Measuring Weir	1	Job	LS	10,000.00
TOTAL COST - 1971				286,490.00
ESCALATION to 1972 @ 6%				17,189.40
COST IN 1972				303,679.40

J.F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JUN 1, 1972 PRICED BY SHEET NO. EC-3

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV.CORPS/ENGR

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
EQUIPMENT						
YARD CRANE	1 x 15	Mos	4500	67,500	1500 1200	40,500
HYDRAULIC BOOM CRANE	2 x 10	"	1500	30,000	1400	28,000
COMPRESSORS	2 x 10	"	1100	22,000	1300	26,000
UTILITY TRUCKS	2 x 18	"	800	28,800	940	33,800
PERSONNEL STAIR TOWERS	3 x 12	"	80	2,900	-	2,000
DOZER	1 x 18	"	1200	21,600	1330	21,600
SUB TOTAL				(172,800)		(151,900)
FIELD OVERHEAD						
ACCESS ROAD TOP	7,350	S.F.	1.50	11,000		SUB
BRIDGE	1	EA		1,000		5,000
IMPROVE R.R. BED	268,000	S.F.	1.50	402,000		SUB
ACCESS ROAD VALLEY	72,000	S.F.	1.00	72,000		SUB
FIELD OFFICES, SHOPS & STOR				30,000		3,000
HARDWARE & TOOLS				45,000		-
FUEL & OIL				12,000		-
START-UP & LAYOUT				-		5,000
MIX DESIGNS				1,000		SUB
CONCRETE TESTING				25,000		SUB
TEMPORARY LIGHTING				2,000		6,000
SANITARY FACILITIES				6,000		SUB
CLEAN-UP				-		20,000
HEATING				24,000		-
PROJECT MANAGER	1 x 130	WKS		-	500	65,000
SUPERINTENDANT	1 x 90	"		-	400	36,000
PROJECT ENGINEER	1 x 90	"		-	400	36,000
CLERKS	2 x 90	"		-	200	36,000
SURVEYORS	4 x 90	"		-	250	90,000
UTILITY MECHANICS	6 x 60	"		-	300	108,000
WATCHMEN	3 x 130	"		-	100	39,000
WINTER PROTECTION				2,000		5,000
COMMUNICATIONS				5,000		5,000
POWER DISTRIBUTION				10,000		10,000
	C-22					
				820,800		620,900

LABOR RATES

The labor rates used for making this study are as follows and include fringe benefits but not payroll taxes and insurance.

Carpenters	$ 9.00
Bricklayers	8.90
Ironworker	10.20
Crusher Operator	7.75
Crane Operator	8.60
Oiler	6.85
Cableway Operator	8.10
Conveyor Operator	7.75
Mechanics	7.90
Rescreen Operator	7.75
Maintenance Engineer	7.90
Air Tool Operator	6.85
Laborer	5.60

SALVAGE RATES

Salvage rates used are as follows:

Mobile Aggregate Plant	75%
Mixing Plant	33%
Cementveyor	40%
Cableway	50%
High Pressure Hoses	50%
Dragline	60%
Trucks	40%
Concrete Buckets	33%

These salvage values are based on brand new equipment and represent reasonable values in an active industry. Doubts on the part of the contractors and others concerned as to the future availability or profitability of this type of work will result in lower salvage estimates or none at all. In this respect, mobile equipment and equipment of universal use will fare best. Appropriate monies have been incorporated for proper maintenance of the equipment during its use.

The difficulty of reducing crew sizes below certain minimums, and in fact reducing crew sizes at all, has been given full consideration in this study as regards smaller placements.

FINANCING COSTS

No provision was made for the cost of financing to the contractor. The burden of financing equipment, materials and subcontracts usually falls upon the shoulders of the vendors and the prices used include this consideration. Payroll costs are, of course, the burden of the contractor and he may well consider these costs in the face of the prospect of payment delays and retentions.

76952

COST ESCALATION

Escalation assumes a continued inflation on a decelerated rate, therefore percent cost increases have not been projected mathematically but have been tempered by our best judgement based on present attitudes and economic indicators. The escalation used is actually as follows:

Labor	1973............	8%
	1974............	6%
	1975............	4%
Materials	1973............	8%
	1974............	4%
	1975............	4%

In making calculations the labor was assumed to be divided equally between 1973 and 1974 so that:

1/2 of labor in 1973 @ 8% escalation	4%
1/2 of labor in 1974 @ 8% plus 6% escalation	7%
TOTAL ESCALATION FOR LABOR............	11%

Materials and subcontracts are made earlier and are subject to less escalation:

3/4 of purchases in 1972 @ no escalation	0%
1/4 of purchases in 1973 @ 8% escalation	2%
TOTAL ESCALATION FOR MATERIALS	2%

It is interesting to note if the contract is not let until 1973 the escalation may be as follows:

30% of labor in 1973 @ 8% escalation	2.4%
50% of labor in 1974 @ 8 + 6%	7.0%
20% of labor in 1975 @ 8 + 6 + 4%	3.6%
	13.0%
1/2 of purchases in 1973 @ 8%	4.0%
1/2 of purchases in 1974 @ 8% + 4%	6.0%
	10.0%

This represents an additional cost of:

2% of $2,000,000		$40,000	
8% of $4,000,000		320,000	
	$	360,000	or 6%

CONCLUSION

It is our opinion that this is a very realistic cost estimate and makes an excellent base for comparison with any other construction innovations that may require analysis as to actual savings that may be achieved.

COMMENTS AND RECOMMENDATIONS

COMPRESSED SCHEDULES AND CONSTRUCTION ORIENTED DESIGN

It is obvious that compressed construction schedules will result in significant savings in the areas of overhead costs, funding, environmental control, field inspection, accounting and inflationary escalation. This is, therefore, a prime area for reasarch in order to cut construction costs. Construction oriented design cannot be over-estimated in this regard; in-house construction experts or outside consultants must be used early in the design process. The designer cannot wait for contractor input; this comes too late. Those designs which minimize foundation work and volume of material handled offer maximum promise.

EARLIER CONTRACT AWARDS

As long as we are in an inflationary era, early start of construction will be as important as compressed schedules. With costs escalating at one-half percent per month or so, design must be implemented as aggressively as the construction. Phased contracts are desirable in this respect. Contract awards should not be delayed unless the risks considerably out-weigh the cost of monthly escalation.

FINANCING COSTS

The cost of financing the work eventually falls on the Owner. Since the Owner can generally finance work at several percent less than the contractor, it is advisable to make mobilization payments, avoid unnecessary delays in payments and keep retention to a minimum.

CONTINGENCY

It almost always pays the Owner to take as much of the contingency as possible. When the contractor takes the contingency, the Owner pays all of it whether it ever develops or not. When the Owner takes the contingency, he pays only for those unexpected costs that do arise.

STREAM DIVERSION

The incorporation of stream diversion into and through the dam by extending and gating the overflow conduit will save considerable money in diversion work and should be made part of this design.

CONSTRUCTION ECONOMY STUDIES

It is interesting to note that the highest percentage of direct cost is in the area of plant. Assuming that the plant is efficiently designed to the construction requirements of a particular dam construction, the cost is pretty well a function of volume and offers little promise for savings induced by technological changes in the plant itself. Considerable savings may, however, be achieved by making the concrete demand as nearly equal on a daily basis as possible. The desirability of equal concrete placements offers maximum incentive for study to reduce construction costs.

For this dam, cementatious materials comprise 10 percent of direct cost. The cost here may be reduced by either reducing cement content, substituting more flyash, using less concrete volume, or a combination of all.

Formwork constitutes a significant percentage of the direct costs and offers a good target for study.

It is interesting to note that placing and vibration combined comprise less than four percent of the direct cost and offer little promise for savings.

COST AND FEASIBILITY STUDY

ALTERNATE DESIGNS TO PERMIT USE

OF SLIP FORM AND OTHER TECHNIQUES

TO MAXIMIZE ECONOMIES

BOOK CA

CONVENTIONAL CONSTRUCTION

APPENDIX: ILLUSTRATION AND COST SHEETS

BOOK CA - CONVENTIONAL CONSTRUCTION

APPENDIX: ILLUSTRATION AND COST SHEETS

1 Sketches 209-SC-1 through SC-22

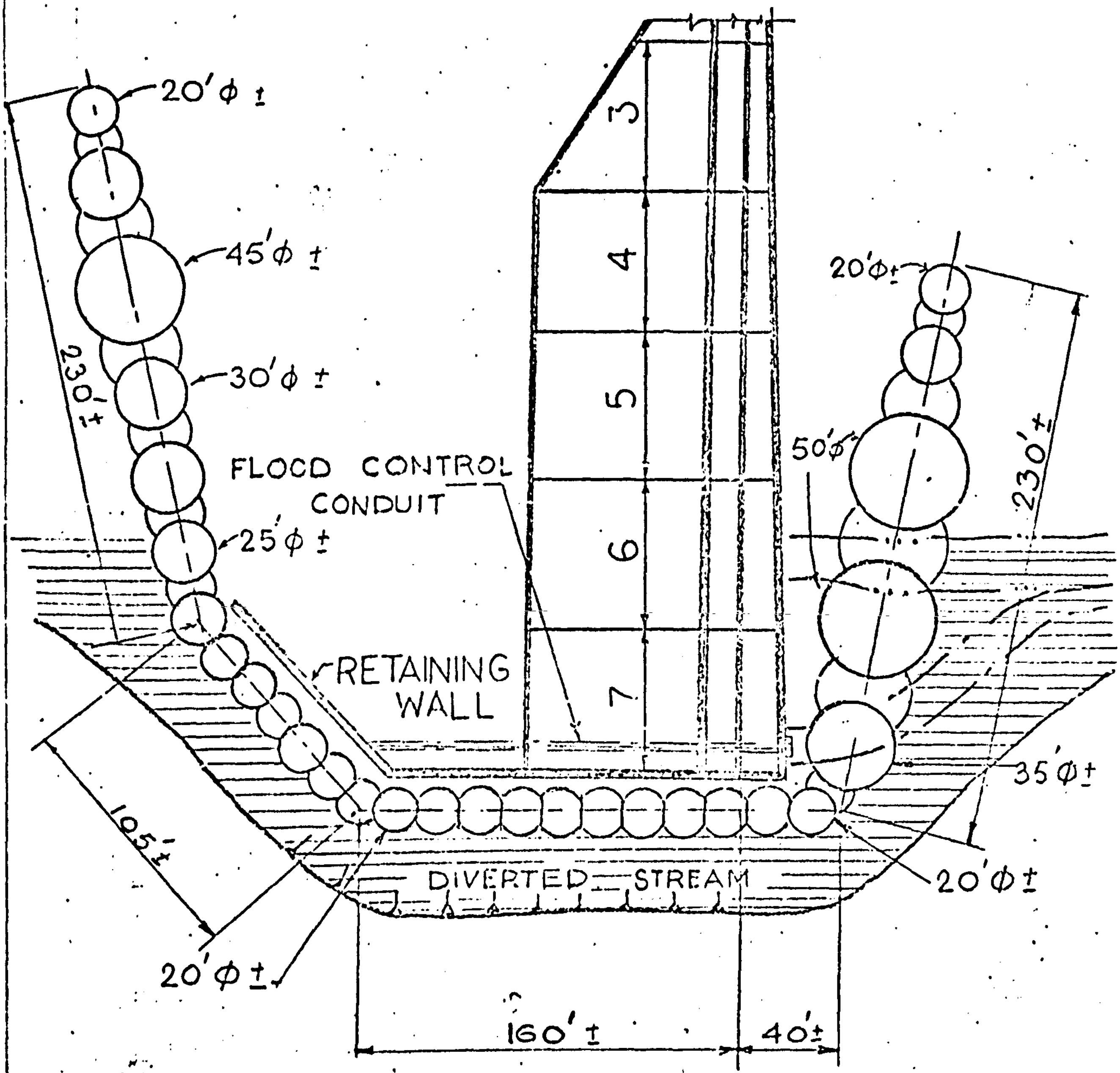
2 Sketches EC-S1 through S38

ILLUSTRATIONS

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1, 1972 REV. SKETCH # 209-SC-1

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
STREAM DIVERSION, STAGE-I



STAGE - 1

LAYOUT OF CELLULAR COFFER DAM

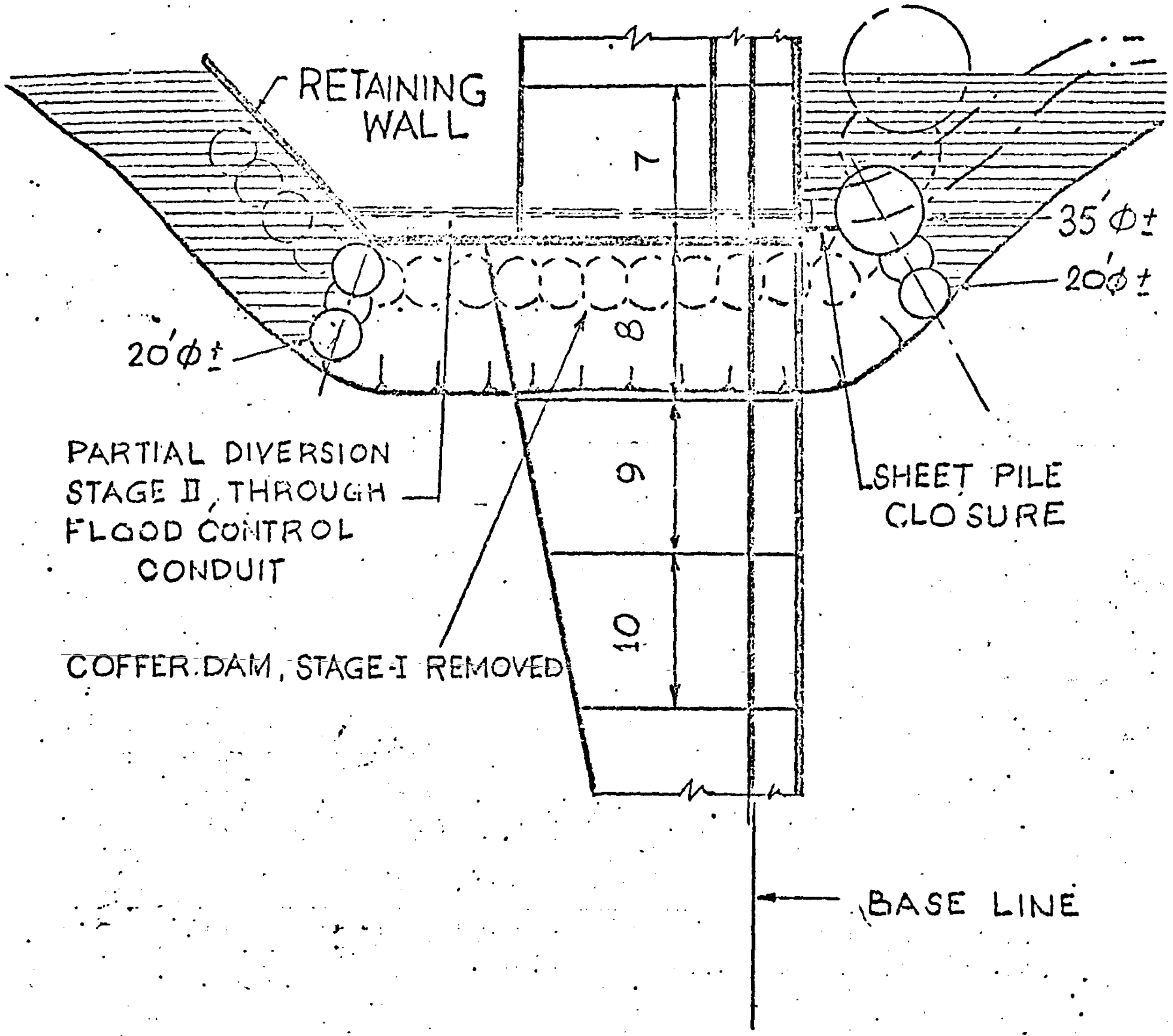
J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1, 1972 REV. SKETCH # 209-SC-2

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN

STREAM DIVERSION, STAGE



STAGE - II

LAYOUT OF CELLULAR COFFER DAM

J. F. CAMELLERIE, P.E. 23 GREEN STREET HUNTINGTON, N. Y.	DATE JUN. 1, 1972 REV. SKETCH# 209-SC TRUMBULL LAKE DAM PEQUONNOCK RIVER BASIN, CONN CABLEWAY CYCLE STUDY

ASSUME CENTER OF MASS ~ 500 FT FROM PICKUP HOR
160 " BELOW " VER

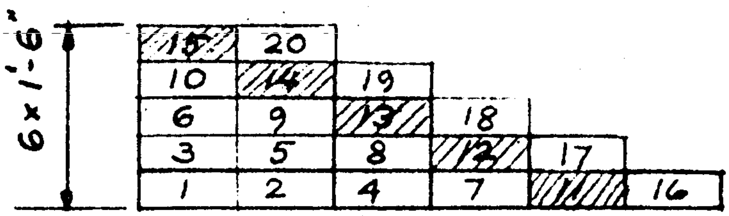
CABLEWAY-BUCKET CYCLE

LOAD BUCKET			30 SEC
HOIST CLEAR OF DOCK			10 "
HORIZ. TRAVEL			
ACCELERATE	~100'	10 SEC	
TRAVEL	~300'	12 "	
RETARD	~100'	10 "	
		32 "	
VERT. TRAVEL			
ACCELERATE	~30'	10 SEC	
LOWER	~110'	17 "	
RETARD	~30'	10 "	
		37 "	
VERTICAL TRAVEL CONTROLS:			37 "
SPOT & DUMP BUCKET.			40 " 3
RETURN TO DOCK			37 ".
LAND BUCKET			15 "
			169 SEC
			2 MIN 44 SEC
			SAY 3 MIN.

J. F. CAMELLERIE, P.E. 23 GREEN STREET HUNTINGTON, N. Y.	DATE JUNE 1/72 REV. APR 11 '72 SKETCH # 209-SC-4 TRUMBULL LAKE DAM PEQUONNOCK RIVER BASIN, CONN. CONC. OPERATION STUDY

IT IS ASSUMED THAT THE CABLEWAY AVAILABILITY WILL BE 75%.
START-UP PRODUCTION WILL BE REDUCED TO ALLOW FOR GETTING OFF THE ROCK.
PRODUCTION WILL ALSO BE REDUCED AT THE END OF THE JOB TO ALLOW FOR SMALL POURS IN THE TOP OF THE DAM.
THE MIXING PLANT CAPACITY FOR A CABLEWAY WITH A POURING RATE OF 120 CY PER HR SHOULD BE APPROX. 1,5×120 CY = = 180 CY/HR.
FOR A 3 MIN. MIX CYCLE 180/20 = 9 CY. USE 2-4 CY MIXERS.

MIN. CAPACITY OF CONC. MIXERS REQUIRED IN ACCORDANCE WITH EM 1110-2-2000:
MAX. SIZE OF PLACEMENT = 4 CY
AVERAGE LIFT = 18"
MONOLITH WIDTH = 60'
MAX. TIME BETWEEN PLACEMENTS: 2 HRS



40 PLACEMENTS REQ. FOR COMPLETE 2 HR CYCLE

PLACEMENT PROFILE

PLACEMENT AREA = 108 CF/1,5 = 72 SF = 8,5 × 8,5
60/8,5 = 7^+ PLACEMENTS ACROSS. SAY 8 PLACEMENTS.
TOTAL № OF PLACEMENTS = 8 × 5 = 40 EA ACROSS 60 FT
MIN. CONC. REQUIRED PER HR = $\frac{40}{2} \times 4$ = 80 yd/HR

MIXER CYCLE:

CHARGING	20	SEC
MIXING	120	"
DISCHARGE	15	"
CONTINGENCY	15	"
TOTAL	170	SEC

№ OF BATCHES MIXED PER HR. = 3600/170 = 21

MIXER CAPACITY REQ. = 80/21 = 3.8 cy.

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1/72 REV. SKETCH# 209-SC-5

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
CONC. OPERATION STUDY

ASSUME AVERAGE MIXER OUTPUT OF 120 CY/HR

REQUIRED CEMENT & FLYASH SUPPLY / HR

C.: 120 CY × 192# = 23,000# = 61 bbl = 11,5 TONS

F.A.: 120 CY × 79# = 9500# = 33 " = 4,75 "

ASSUME 6 HR PRODUCTION PER DAY OR SHIFT.

REQUIRED SUPPLY / DAY

CEMENT: 11,5 TONS × 6 = 69,0 TONS

FLYASH: 4,75 " × 6 = 28,5 "

MIX FOR INT. CONCRETE PER CY.

P.C.		192#		
F.A.		79#		
FINE AGG. #4-	29%	940#	5,64 CF	64,5 TONS/HR
3/4" - #4	17,8%	674#	4,06 "	39,5 "
1 1/2" - 3/4"	17,8%	674 "	4.00 "	39,5 "
6" - 1 1/2"	35.6%	1348"	8.00 "	79,0 "
	100%	4078#	21,70 CF	222.5 TONS/HR

REQ. AGGREGATE PRODUCTION PER HR.

120 CY × 1,85 TONS = 222 TONS/HR

127,00.0 yd CONC. × 1.85 TONS. = 231,000 Ton Total

PLUS COFFERDAM ETC 9,000

240,000 To.T. PROD.

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1/72 REV. SKETCH# 209-SC-6

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN

QUARRY OPERATION STUDY

AGGREGATE PLANT PRODUCTION : 225 TONS/HR OR 150 CY LOOSE

LOOSE CY - 1,5 TONS/CY
BANK CY = 1,7 " "

AGGREGATE PLANT DEMAND PER MINUTE = $\frac{225}{60}$ = 3,75 TONS

LOOSE CY REQ. = $\frac{3,75}{1,5}$ = 2,5 CY

BANK CY REQ = $\frac{3,75}{1,7}$ = 2,2 cy

2½ CY DRAGLINE OUTPUT = 195 cy
ASSUME 50% OF OPTIMUM OUTPUT WHICH IS A FACTOR OF 0,85
∴ ACTUAL OUTPUT = 165 cy

TRUCK CYCLE

WAIT	0,5 MIN
LOAD	3,0 "
PULL OUT	0,25 "
HAUL	
2000 FT 5% UP	2,00 "
WAIT	0.5 "
DUMP	1.0 "
PULL OUT	0,25 "
RETURN	1,5 "
TOTAL	9,0 MIN

No OF CYCLES IN 50 MIN = $\frac{50}{9}$ = 5,5

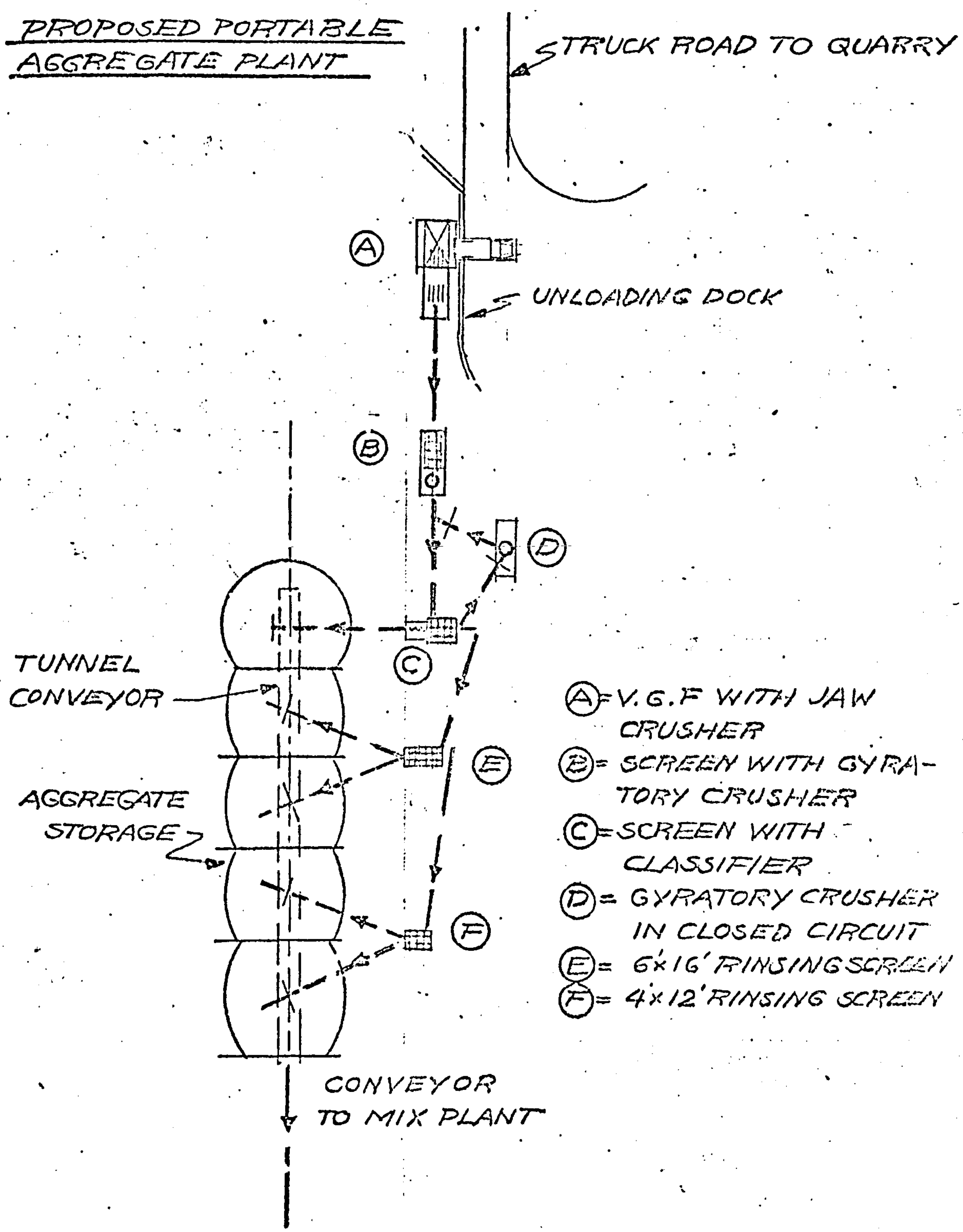
5,5 × 7 BANK YARDS/TRUCK = 38,5 cy

4 TRUCKS WILL DELIVER 4 × 38,5 cy = 154 CY/HR
(>150 CY)

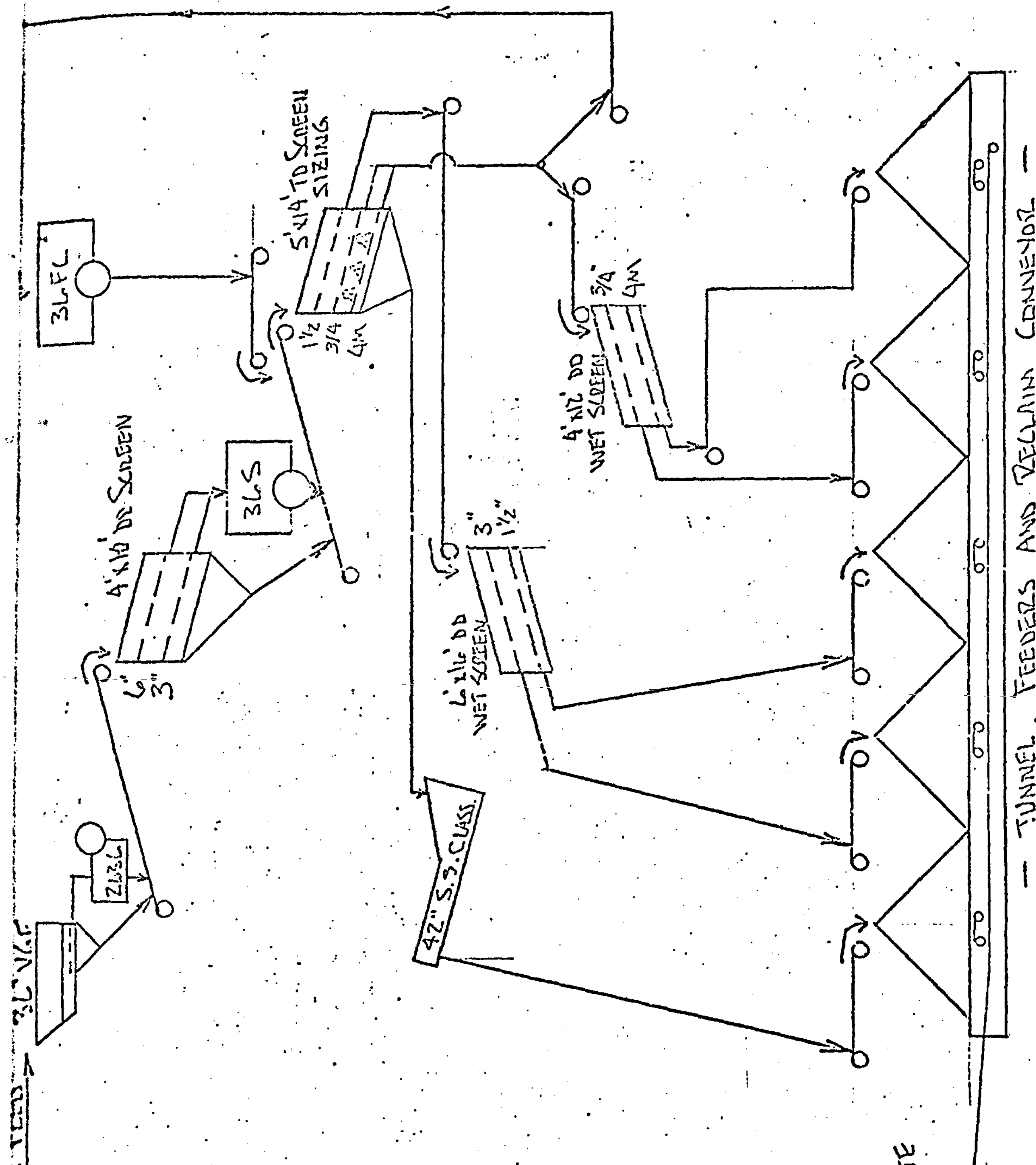
J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1/72 REV. SKETCH# 209-SC-7

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
AGGREGATE OPERATION



209-SC-8



AGGREGATE PLANT
FLOW DIAGRAM

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE REV. SKETCH# 209-SC

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN
CONC. PLACEMENT STUDY

THICKNESS OF CONC. LAYERS FOR A 2 HR CAPACITY OF 160 CY & 240 CY
(4 CY) (6 CY)

LIFT #	$y = \frac{AREA^{SF}}{27}$	$\frac{160\ YD/HR}{Y\ YD/FT}$	$\frac{240\ YD/HR}{Y\ YD/FT}$
1	256 yd/ft	0,63 FT/HR	0,94 FT/HR
2	242	0,66	1,00
3	228	0,70	1,05
4	214	0,75	1,12
5	200	0,80	1,20
6	186	0,86	1,30
7	172	0,93	1,40
8	158	1,03	1,57
9	145	1,10	1,65
10	131	1,22	1,83

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
COST STUDY

PRODUCTION TIME AND QUANTITIES

STAGE	TOTAL CY	AVERAGE CY DAILY POUR	DAYS	MONTHS
1	52,500	850	62	3.1
2	74,500	600	123	6.2
TOTAL	127 000		185	9.3

AVERAGE PRODUCTION PER SHIFT = 577 CY *
" " " WEEK 3,430 cy
" " " MONTH = 13,700 cy
" " " HOUR = 72 cy
" " " " = 96 cy **

* TOTAL NO OF SHIFTS = 185 + 35 OT SHIFTS
= 220 SHIFTS TOTAL

** BASED ON 6 HRS ACTIVE PLACEMENT PER SHIFT.

PRODUCTION PER "PAY SHIFT" FOR COST BASIS @ 220 SHIFTS
+ 17 SHIFTS (35/2 FOR O'TIME PAY)
237 SHIFTS

$\frac{127,000}{237}$ = 536 YDS {EXTRA PAY FOR SHIFT WORK

$\frac{127,000}{220}$ = 577 YDS (NO PREMIUM PAY)

USE 550 YDS/SHIFT

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUN 1, 1972 REV. SKETCH # 209-SC-11

TRUMBULL LAKE DAM

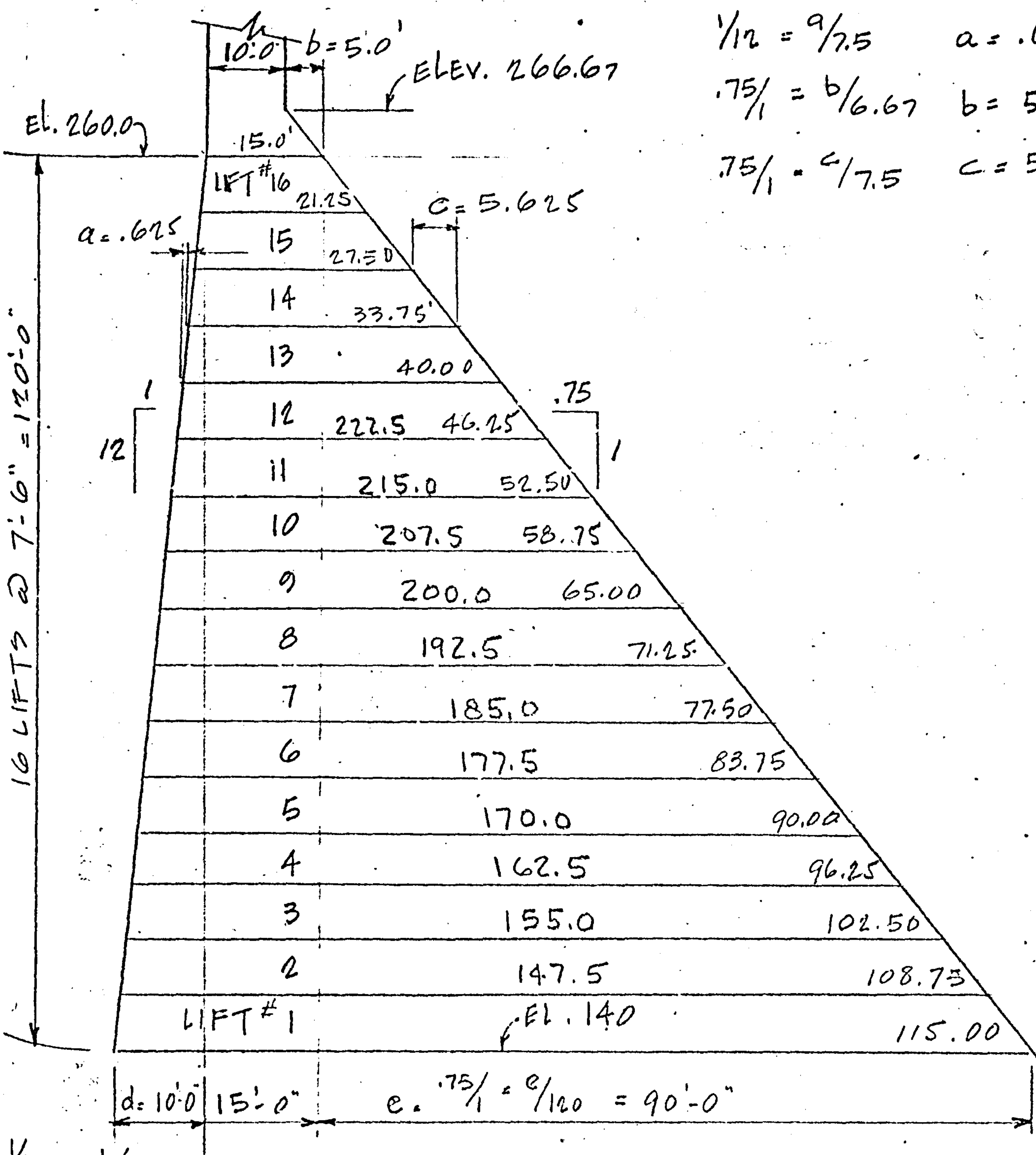
PEQUONNOC RIVER BASIN, CONN.

CONCRETE VOLUMES

$1/12 = a/7.5$ $a = .625$

$.75/1 = b/6.67$ $b = 5.0'$

$.75/1 = c/7.5$ $c = 5.6$



$1/12 = d/120$

$d = 10'-0"$

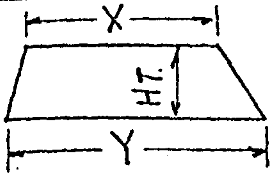
J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUN 1, 1972 REV. SKETCH# 209-

TRUMBULL LAKE DAM

PEQUONNOC RIVER BASIN, CONN.

CONCRETE VOLUMES



VOLUME A = VOLUME OF 1' CENTER STRIP OF LIFT
VOLUME B = VOLUME OF LIFT.

2.22

LIFT	LENGTH	HT	X	Y	(X+Y)/2	VOLUME A C.Y.	VOLUME B C.Y.
16	60'	7.5'	15.0	21.25	18.13	40.3	302
15			21.25	27.50	24.38	54.2	406
14			27.50	33.75	30.63	68.2	512
13			33.75	40.00	36.88	82.	615
12			40.00	46.25	43.13	95.7	718
11			46.25	52.50	49.38	109.8	823
10			52.50	58.75	55.63	125.	937
9			58.75	65.00	61.88	137.5	1032
8			65.00	71.25	68.13	152.	1140
7			71.25	77.50	74.38	165	1238
6			77.50	83.75	80.63	179.	1340
5			83.75	90.00	86.88	193.	1440
4			90.00	96.25	93.13	207.	1550
3			96.25	102.50	99.38	221.	1660
2			102.50	108.75	105.63	234.	1755
1	60'	7.5'	108.75	115.0	111.88	248.	1860

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1972 REV. SKETCH# SC-13

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
CONV. CONSTRUCTION

CONCRETE DEMAND SCHEDULE

MONTH-

WORKING DAY	PLACEMENT DESIGNATION	CONCRETE DEMAND (Yds)	PLACING RATE Yds/HR	REMARKS
1	1	250	40	BASE LIFT
2	2	115	20	"
3 x 2 SHIFTS	3	540	45	"
4 x 2	4	650	55	"
5 x 2	5	730	60	"
6	6	350	60	"
7	7	385	75	"
	8	60		
8 x 2	9	1080	90	"
9 x 3	10	1860	105	
10 x 2	11	1000	85	
11 x 2	12	900	75	

CA-15

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1972 REV. SKETCH# JC-14

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

CONV. CONSTRUCTION

CONCRETE DEMAND SCHEDULE

MONTH-

WORKING DAY	PLACEMENT DESIGNATION	CONCRETE DEMAND (Yds)	PLACING RATE Yds/HR	REMARKS
12	13	615	105	
13	14	615	105	
14	15	175	30	
15 x 2	16	1180	100	
16 x 3	17	1670	95	
17 x 3	18	1875	105	
18 x 2	19	1120	95	
19	20	900	120	
20	21	700	115	
21 x 2	22	1440	115	
22 x 3	23	1650	95	

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1 1972 REV. SKETCH # SC-15

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
CONV. CONSTRUCTION

CONCRETE DEMAND SCHEDULE

MONTH-

WORKING DAY	PLACEMENT DESIGNATION	CONCRETE DEMAND (Yds)	PLACING RATE Yds/HR	REMARKS
23 × 3	24	1710	95	
24 × 2	25	1350	115	
25+	26	900	120	
26	27	600	100	
27 × 2	28	1490	120	
28	29	440	75	BASE
29 × 3	30	1760	100	
30 × 2	31	1220	105	
31	32	340	60	
32	33	795	120	
33 × 2	34	960	80	

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1 1972 REV. SKETCH# SC-16

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
CONV. CONSTRUCTION

CONCRETE DEMAND SCHEDULE

MONTH-

WORKING DAY	PLACEMENT DESIGNATION	CONCRETE DEMAND (Yds)	PLACING RATE Yds/HR	REMARKS
34	35	485	80	
35	36	660	110	
36×2	37	1500	115	
37	38	700	120	
38×2	39	1220	105	
39×2	40	1340	115	
40	41	690	115	
41+	42	940	120	
42	43	380	65	
43	44	300	50	
44×2	45	1300	110	

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

CONCRETE DEMAND SCHEDULE

MONTH-

WORKING DAY	PLACEMENT DESIGNATION	CONCRETE DEMAND (Yds)	PLACING RATE Yds/HR	REMARKS
45	46	600	100	
46x2	47	1180	100	
47x2	48	1140	95	
48x2	49	1040	90	
49	50	615	105	
50	51	280	50	
51	52	285	50	
52x2	53	1180	100	
53	54	350	60	
54x2	55	1130	95	
55	56	185	30	

Revised

CONCRETE DEMAND SCHEDULE

MONTH -

WORKING DAY	PLACEMENT DESIGNATION	CONCRETE DEMAND (Yds)	PLACING RATE Yds/HR	REMARKS
56 x 2	57	1020	85	
57	58	205	35	
58	59	65	11	BASE
59	60	90	15	"
60	61	320	55	"
61	62	104	20	"
62	63	135	25	
63 TO 185	TOTAL 123	74,500	75 AV.	

(185 + 35 O'TIME SHIFTS @ 1.5 TIME = 237 pay days)

TOTAL PLACEMENT: 125,389 CY

CONCRETE PER DAY: 680 CY AVERAGE

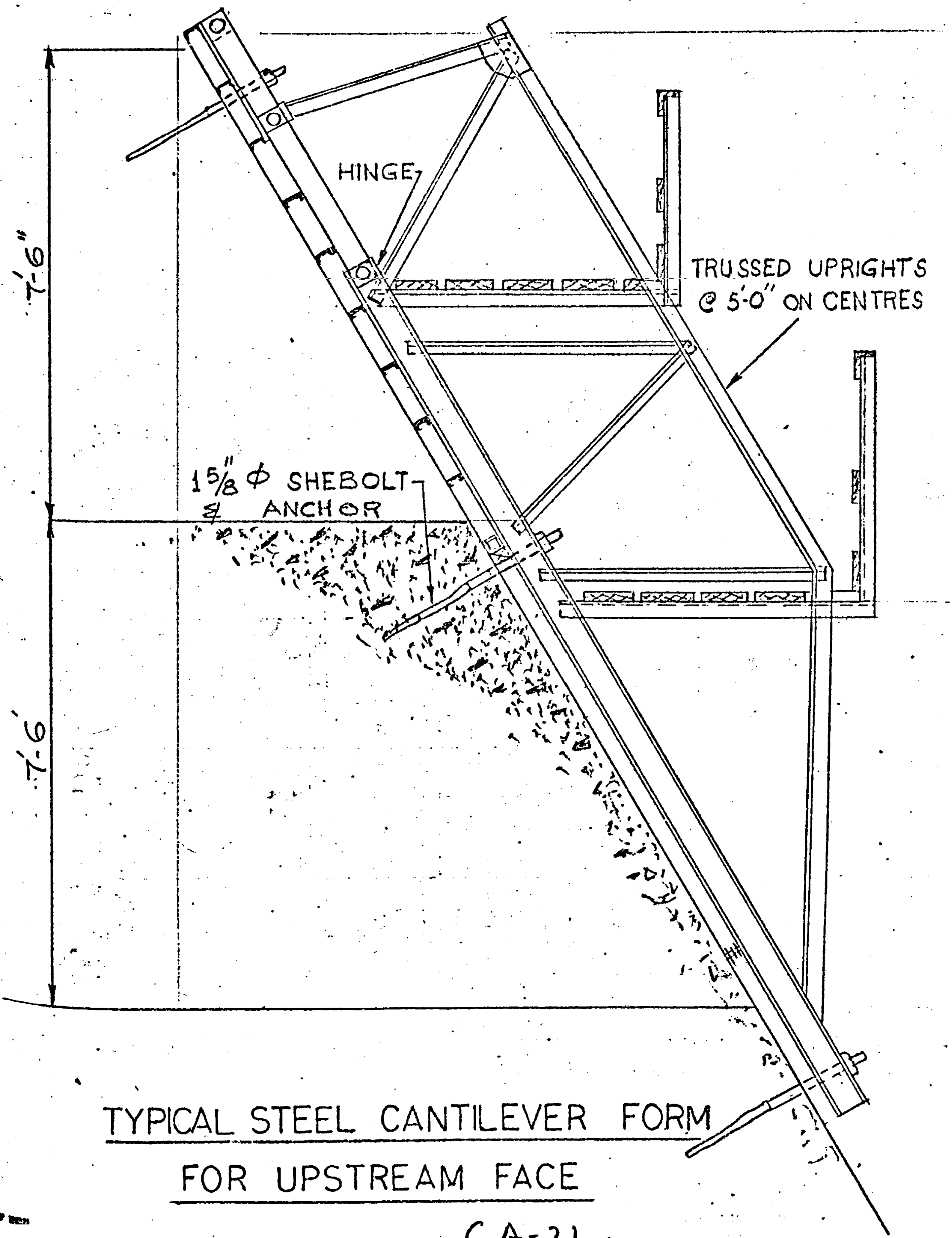
CONCRETE PER PAY DAY: 530 CY AVERAGE

PLANT UTILIZATION: 530/1280 = 42 %

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM.
PEQUONNOCK RIVER BASIN, CONN
STEEL FORMS.



TYPICAL STEEL CANTILEVER FORM
FOR UPSTREAM FACE

CA-21

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1/77 REV. APR. 1/74 SKETCH# 204-SC-20

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
FORM COST STUDY

FORM AREAS

	TOTAL AREAS	REQ. FORM MATERIAL
FOUNDATION		
UPSTREAM FACE	5,562 SF	1,800 SF
DOWNSTREAM FACE	6,221 "	2200 "
BULKHEAD	6,500 "	2,500 "
TOTAL	18,283 SF	6.500 SF
STARTER FORMS		
UPSTREAM	6,430 SF	1,400 SF
DOWNSTREAM ~	6,400 "	1,400 "
TOTAL	12,830 SF	2,800 SF
GALLERY & OTHER INT. FORMS	16,500 SF	3,000 SF
PUMP STATION FORMS	9,550 SF	5,000 SF
WATER GALLERY FORMS	2200 SF	1,500 SF
CANTILEVER FORMS 10 SETS REQ. 10×60'×8'	107,270 SF	4800 SF
BULKHEAD FORMS 7 SETS REQ. 7×120'×8'	51.600 SF	6,720 SF
CREST FORMS 2 SETS REQ 2600×2	18.100 SF	5.200 SF
RETAINING WALL	7,450 SF	2500 SF

Revised

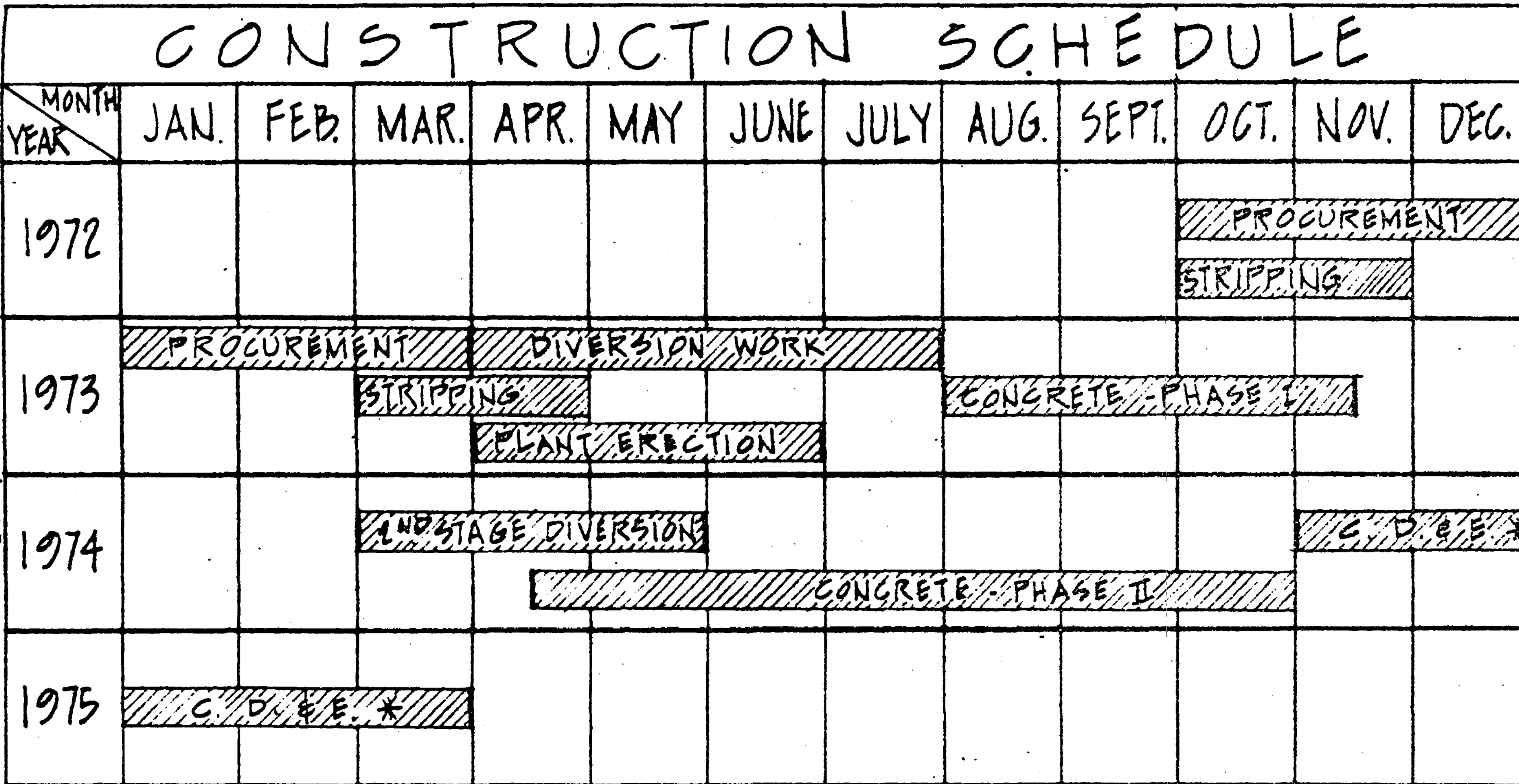
J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1, 1972 REV. APR. 1, 1974 SKETCH# 204-SC-

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

CONSTRUCTION SCHEDULE

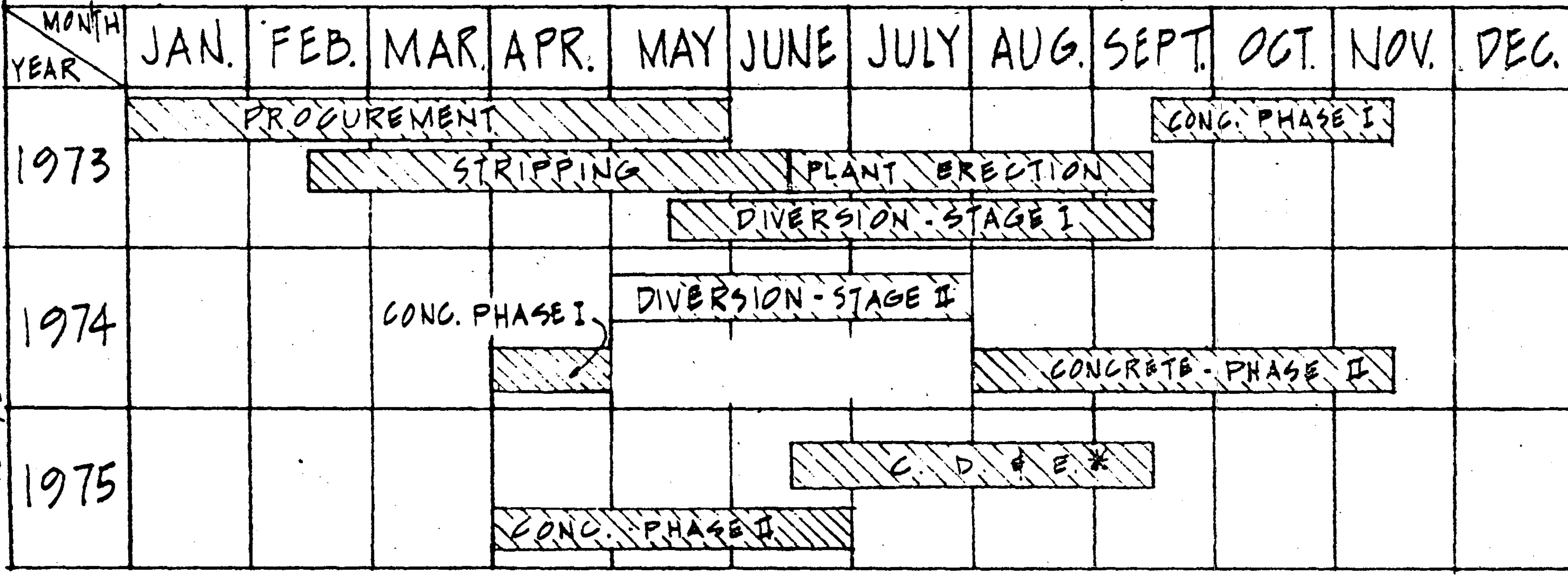


* CLEAN-UP, DEMOBILIZATION & ENVIRONMENT

CONTRACTURAL COMPLETION DATE MARCH 15TH, 1974

Revised

CONSTRUCTION SCHEDULE - DELAYED CONSTRUCTION START



* CLEAN-UP, DEMOBILIZATION & ENVIRONMENT

CONTRACTURAL COMPLETION DATE SEP 15, 1975

Revised

J. F. CAVALLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 7, 1972, REV. APR 1, 1974 SKETCH NO. 107 · SC 56

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN CONN.

CONSTRUCTION SCHEDULE - DELAYED CONST. START

COST STUDY SHEETS

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1/72 REV. SKETCH# EC - S1

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN
CONCRETE ESTIMATE

	CY	CEMENT	FLYASH
INT. CONC	93000	x1.40 = 130,000 CWT /376 = 34,500 bbl	x1.10 = 102,000 CWT /286 = 35,600 bbl
EXT	26000	x1.83 = 47,500 CWT /376 = 12,600 bbl	x.78 = 20,300 CWT /286 = 7,100 bbl
3000 PSI 4000 PSI	8 000	x 4.70 37,600 CWT x1.25 bbl = 10,000 bbl	
		57.100 bbl	42,700 bbl
		215.100 CWT	122,300 CWT

57100
42700
TOTAL 99,800 bbl

215,100/20 = 10,755 TONS (CEMENT)
122,300/20 = 6,115 TONS (FLYASH)

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN
AGGREGATE OPERATION

QUARRY OPERATION 1600 TONS/SHIFT

COST PER SHIFT	LABOR	SUPPLIES	TOTAL
1 FOREMAN	8.60 76.00	—	76.00
1 DRAGLINE OPERATOR	68.80	—	68.80
1 OILER	55.20	25.00	80.20
1 SPOTTER	44.80	—	44.80
TOTAL /SHIFT	244.80	25.00	269.80
TOTAL /TON			.17
MISC. TOOLS ETC.		15.00	.01
AGGREGATE HAUL			
4 TRUCK DRIVERS	169.50		169.50
TOTAL / TON			.11

EQUIPMENT	EQUIPM.	SALVAGE	NET
1 $2\frac{1}{2}$ CY DRAGLINE	100.000	60.000	40.000
4 6CY REAR DUMP TRUCKS	52.000	20.000	32.000
			72.000

RENTAL $4000/MO × 240,000 / 22×1600 = 27,500

$3,200/MO × " = 22,000

49,500 + MOBILIZ & ADD'L TIME

SAY 10 MOS × 7,200 = $72,000 USE

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

OPERATION OF AGGREGATE PLANT

COST PER SHIFT (1580 TONS/SHIFT)

	LABOR		SUPPLIES	TOTAL
1 FOREMAN	9.50	76.00	—	76.00
1 PR. CRUSHER OPERATOR	7.80	62.50	—	62.50
1 OPER. FOR OTHER CRUSHERS	7.80	62.50	—	62.50
1 OILER	6.75	54.00	—	54.00
1 WELDER	10.20	81.60	—	81.60
1 MECHANIC	7.80	62.50	—	62.50
1 CRANE OPER.	—		—	—
1 OILER	—		—	—
1 CONV. OPERATOR	8.00	64.00		64.00
POWER / HR	—		10.00	10.00
REPAIR PARTS	—		60.00	60.00
OIL, GREASE & MISC.	—		10.00	10.00
TOTAL COST/SHIFT				543.10
① COST / TON				.34
② COST/CY (① × 1.9)				.64

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1/72 REV. SKETCH# EC-54

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN
COST STUDY-DIRECT COST

MIX PLANT CHARGING RESCREENING, CEMENT HANDLING & CONCRETE MIXING

MASS CONCRETE PLACEMENT WILL BE DONE 1 SHIFT PER DAY TOTALING 231 DAYS & SHIFTS. DURING THIS PERIOD APPROX. 127000 CY OF CONCRETE WILL BE POURED.
AVERAGE PRODUCTION PER SHIFT = 550 CY

COST PER SHIFT

	LABOR	SUPPLIES	TOTAL
1 SUPER OR FOREMAN	9.50 76.00	——	76.00
1 PLANT OPERATOR	7.80 62.50	——	62.50
1 RESCREEN OPER.	7.75 62.00	——	62.00
1 ASSIST RESCREEN OPER	7.75 62.00	——	62.00
1 CONC. DISPATCHER	5.60 44.80		44.80
1 LABORER	5.60 44.80	——	44.80
2 MAINTENANCE LAB.	6.80 109.00	——	109.00
POWER	——	10.00	10.00
REPAIR PARTS #25,000	——	150.00	150.00
OIL, SUPPLIES	——	30.00	30.00
TOTAL COST PER SHIFT			651.10
TOTAL COST PER CY			1.18

CEMENT LOSS & ADMIXTURE COST

CEMENT LOSS 1.5% OF COST/CY .02

1.20 /CY

550 cy / SHIF...

CONCRETE COOLING
COST PER SHIFT

	LABOR	SUPPLIES	TOTAL
1 OPERATOR OF REFRIG. EQUIPMENT	7.80 62,50	——	62.50
1 MAINTENANCE LABOR	6.80 54.50	——	54.50
POWER, WATER	——	30.00	30.00
REPAIR PARTS	——	30.00	30.00
MISC.	——	25.00	25.00
TOTAL COST PER SHIFT			202.00
COST PER CY			.36

CONC. HAUL
COST PER SHIFT

	LABOR	SUPPLIES	TOTAL
1 BELT OPERATOR	7.80 62,50	——	62,50
1 MAINT. LABOR	——	——	——
POWER	——	2.00	2.00
REPAIR PARTS	——	10.00	10.00
MISC.	——	5.00	5.00
TOTAL COST PER SHIFT			79,50
COST PER CY			.15

TOTAL BATCH OPERATION = 1.20
.36
.15
1.71 / CU. YD. SAY ...

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

CONCRETE

	LABOR	EQUIPMENT	SALVAGE	NET
QUARRY & HAUL TO AGGREGATE PLANT COST/CY	SHEET EC-S2	SHEET EC-S2		
CONC. DELIVERY				
1 CONVEYOR ON A-FRAME COST/CY	SHEET EC-S3	INCL. IN AGG. PLANT		
MIXING PLANT				
CONTAINING 175 CY AGGREGATE STORAGE, 2-4CY MIXERS, ICE PLANT, 2 CEM. SILOS & RECLAIMING SYSTEM, DUST CONTROL		432,000	150,000	282,000
INSTALLATION + MISC.				110,000
CEMENT HANDLING				
CEMENTVEYOR		60,360	25,000	35,360
INSTALLATION				10,000
				437,360
AGGREGATE PLANT				
INSTALLATION INCL. EXCAV. & GRADING				10,000
GRIZZLY & PRIMARY CRUSHER. SCREEN & SECONDARY GYRASPHERE CRUSHER. SCREEN & TERTIARY GYRASPHERE IN CLOSED CIRCUIT.		490,000	380,000	110,000

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1/72 REV. SKETCH# EC-57

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
COST STUDY - PLANT & EQUIPMENT

CONC. CONT.

	LABOR	EQUIPMENT	SALVAGE	NET
2 RINSING SCREENS 1 CLASSIFIER 5 STOCKPILES WITH TUNNEL RECLAIM-CONVEYOR				
WATER DISTRIB. ELECTRIC SYSTEM	3000.00	5000.00		8000.00
TOTAL				128.000
COST PER CY				1.01
COST PER TON				.53

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE '72 REV. SKETCH# EC - 58

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN
COST STUDY — DIRECT COST

CABLE WAY OPERATION
COST PER SHIFT

THE CABLEWAY WILL HANDLE APPROX 127,000 CY OF CONCRETE

CABLE REPLACEMENTS

	LABOR	SUPPLIES	TOTAL
HOISTING LINE	——	——	——
	NOT	REQUIRED	

CABLEWAY OPERATION

	LABOR	SUPPLIES	TOTAL
1 OPERATOR	8.60 68.80	——	68.80
1 OILER	6.90 55.20	——	55.20
1 RIGGER	6.95 63.20	——	63.20
1 BELLBOY	44.80	——	44.80
1 MAINTENANCE ENG.	7.90 63.20	——	63.20
POWER	——	10.00	10.00
REPAIR PARTS & SUPPLIES	——	30.00	30.00
TOTAL PER SHIFT			335.20
COST PER CY.			.61

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1/72 REV. SKETCH # EC-59

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
COST STUDY – PLANT & EQUIPMENT

CABLEWAY

	LABOR	EQUIPMENT	SALVAGE	NET
FACILITY PURCHASE				
6 CY CABLEWAY		395.000	200.000	195.000
CABLES	—	—	—	INCL. ABV.
INSTALLATION				
EXCAV. & GRADING	—	—	—	15,000
TIES & RAILS	—	—	—	5.000
COUNTERWEIGHT CONC. 170 CY	—	—	—	8.000
ELECTRICAL	—	—	—	5.000
MISC. (AIR LIFT ETC.)	—	—	—	25.000
TOTAL				253.000
TOTAL / CY				$ 2.00

CONCRETE PLACEMENT

	LABOR	EQUIPMENT	SALVAGE	NET
2 – 6 CY BUCKETS	—	12,000	4.000	8,000 (1)
AIR & WATER CUTTING	—	20,000	10,000	10,000 (2)
FINISHERS	—	3,000	—	3,000 (3)
TOTAL				21,000
TOTAL / CY				$ 0.17

(1) IN PLACING .06 / cy
(2) IN HOR ST. .08 / cy
(3) IN FINISHING .03 / cy + .02 TIE HOLES = .05

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1/72 REV. SKETCH# EC-510

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

COST STUDY - DIRECT COST

PLACEMENT CREW (COST PER SHIFT)

	LABOR	SUPPLIES	TOTAL
1 FOREMAN 6[10]	48.80	—	48.80
4 LABORERS	179.20		179.20
1 BUCKET DUMPER	44.80	—	44.80
MISC. SUPPLIES	—	25.00	25.00
1 CARPENTER (CHARGED TO FORMS)	—	—	
TOTAL			297.80
COST PER CY			.55
4 VIBRATOR MEN	179.20		179.20
VIBRATORS PER SHIFT	—	55.00	55.00
TOTAL			234.20
COST PER CY			.42

SEE SHEET EC-511

23 GREEN STREET
HUNTINGTON, N. Y.

[illegible] LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
COST STUDY – DIRECT COST

CONCRETE PLACING

PICK-UP POINT	1 MAN
SPREADING	4 MEN
FOREMAN	1 MAN

6 MEN @ 5.60 = $36.60
+ .50 Foreman = .50
$37.10 per hour

Cost per DAY = 37.10 × 8 = $296.10/day

CONCRETE PLACED PER DAY = 127,000 / 222 = 575 yds

COST PER YD. = 296.10 / 575 = .52 ¢

CONCRETE VIBRATION

4 MEN @ 5.60 = $22.40/hr
COMP. OPER @ 7.40 = 7.40/hr
$29.80 × 8 = $238.00
VIBRATORS (4 INCL 2 SPARES) 50.00
COMPRESSOR (ADD'L) 150.00
$438.00

COST PER YD = $438.00 / 575 = .76 (.41L + .35M)

FINISHING

2 MEN @ 8.87 = 17.74
1 HELPER @ 7.15 = 7.15
Foreman .50 = .50
$25.39/hr = $204/day

COST PER SQ FT = 204.00 / (7.5 × 120) = .225 ¢

J. T. CAVALLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
COST STUDY – DIRECT COST

CLEANUP & CURE
COST PER SHIFT

	LABOR	SUPPLIES	TOTAL
1 FOREMAN	7.35 52.80	——	58.80
2 AIR-TOOL OPERATORS	6.85 109.60	——	109.60
2 LABORERS	89.90	——	89.90
PARTS & SUPPLIES	——	30.00	30.00
TOTAL COST/SHIFT			288.30
COST / CY			.52 (.17/ф')
AIR TOOLS / CY			.05 (.02/ф')
FROM SHEET EC-59			.08 (.03/ф')

WEEKEND SHIFT (FOR 45 WEEKENDS)

2 LABORERS 90 DAYS.			
COST / CY			
SATURDAY × 1½			6,050.00
SUNDAY × 2			8,060.00
			14,110.00
COST / CY			.11

PATCH & FINISH
COST PER SHIFT

		LABOR	SUPPLIES	TOTAL
1 FOREMAN (WORKING)	8.75	70.00	——	70.00
1 FINISHER	8.25	66.00	——	66.00
1 LABORER		44.80	——	44.80
SUPPLIES			30.00	30.00
COST / SHIFT				210.80
COST / CY				.38 (.33 L .05 M)

COST PER SQ.FT = .38 × 127,000 / 146,000 = .33
.23 Sheet EC-511
.56/2 = .28 AV.

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
COST-STUDY, PLANT & EQUIPMENT

UTILITIES & SERVICE FACILITIES

SHOPS & BLDG'S.

	ESTIM. NET COST
SHOP	12,000
ELEC. SHOP	5.000
PIPE & RIGGING SHOP	5.000
TIRE SHOP	2.000
FORM DECK	2.000
TOOL SHEDS	3.000
WATER, SANITATION	3.000
MISC.	5.000
GRADING	5.000
	$ 42,000

INCL IN FIELD O'HD

SERVICE EQUIPMENT & FACILITIES

1-90 TON CRAWLER	90,000	F/O
2 FORKLIFTS	24,000	F/O
1 GRADER	10.000	F/O
2 PICKUPS	8.000	F/O
2 AIR COMPRESSORS	25.000	F/O
ELEC. SUBSTATION	15.000	COEPS
POWER DISTRIBUTION, LIGHT	20.000	F/O
AIR DISTRIB. & WATER	30.000	SHEET-EC-59
WELDING MACHINES	1.500	F/O
COMMUNICATION SYSTEM	10,000	F/O
	$ 233.500	

DEWATERING

PUMPS	$ 10.000	F/O.

TOTAL $ 285.500

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN
HORIZONTAL JOINTS

AREA OF MONOLITH SURFACES.

1.	115'	x 93'	=	10700	S.F
2.	108.5'	x 162'	=	17560	S.F.
3.	102.5'	x 216'	=	22200	"
4.	96.25'	x 245'	=	23470	"
5.	90'	x 300'	=	27000	"
6.	83'75	x 354'	=	29600.	"
7.	77.5'	x 460'	=	35600	"
8	71.2'5	x 480'	=	34200	"
9.	65'	x 515'	=	33500	"
10.	58'75	x 535	=	31500	"
11.	52'5	x 565	=	29650	"
12.	46.25	x 605	=	28000	"
13.	40'	x 632	=	25280	"
14.	33.75'	x 648	=	21800	"
15.	27.5	x 726	=	20000	"
16.	21.25	x 746	=	15500	"
17.	15'	x 794	=	11900.	"
18.	405'	x 10'	=	4050'	"
19.	414'	x 10'	=	4140'	"
		TOTAL	—	425650	S.F.

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1, 1972 REV. SKETCH# EC-S/5

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

EXCATION - COST STUDY

HAND CLEANED BED ROCK SURFACE.

1.	300'-0" x 60'-0"	=	18,000	S.F.
2.	230'-0" x 42'-0"	=	9,660	S.F.
3.	60'-0" x 50'-0"	=	3,000	S.F.
4.	106'-0" x 110'-0"	=	11660	S.F.
5.	40'-0" x 10'-0"	=	400'	S.F.
6.	155'-0" x 18'-0"	=	2790	S.F.
			45510	S.F.
	10% EXTRA FOR SLOPE		4551	S.F.
	TOTAL AREA		50061	S.F.

ADDITIONAL HAND CLEANING -

420'-0" x 50'-0" = 21,000

TOTAL AREA - 71,061 S.F

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM,
PEQUONNOCK RIVER BASIN, CO
EXCAVATION-COST STUDY

LIMIT OF CLEARING SURFACE -

1.	230'-0" x 112'-0"	=	25400 SF.
2.	235'-0" x 53'-0"	=	12500 S.F.
3.	27'-0" x 115'-0"	=	3105 S.F.
4.	355'-0" x 350'-0" ±	=	124500 S.F.
	10% EXTRA FOR SLOPE	=	12450 S.F.
5.	300'-0" x 320'-0"	=	96000 S.F.
6.	210'-0" x 300'-0"	=	63000 S.F.
	5% EXTRA FOR SLOPE	=	3150
7.	135'-0" x 100'-0"		13500

TOTAL AREA = 353605 S.F.

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1/72 REV. APR. 1/74 SKETCH# EC-5 17
TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
FORM COST STUDY

FORM AREAS

	TOTAL AREAS	REQ. FORM MATERIAL
FOUNDATION		
UPSTREAM FACE	5,562 SF	1,800 SF
DOWNSTREAM FACE	6,221 "	2200 "
BULKHEAD	6,500 "	2,500 "
TOTAL	18,283 SF	6,500 SF
STARTER FORMS		
UPSTREAM	6,430 SF	1,400 SF
DOWNSTREAM	6,400 "	1,400 "
TOTAL	12,830 SF	2,800 SF
GALLERY & OTHER INT. FORMS	16,500 SF	3,000 SF
PUMP STATION FORMS	9,550 SF	5,000 SF
WATER GALLERY FORMS	2200 SF	1,500 SF
CANTILEVER FORMS 10 SETS REQ. 10×60'×8'	107,270 SF	4800 SF
BULKHEAD FORMS 7 SETS REQ. 7×120'×8'	51,600 SF	6,720 SF
CREST FORMS 2 SETS REQ 2600×2	18,100 SF	5,200 SF
RETAINING WALL	7,450 SF	2500 SF

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1st '72 REV. SKETCH# EC-5/5

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

FORM COST.

UPSTREAM FACE FORMS (FOUND. FORMS)

POUR	LENGTH (F)	HEIGHT (F)	AREA (S.F.)
1. a)	9	6	54
b)	7	6·67	46·69
c)	13	7·5	97·5
d)	6	7·5	45
e)	10	7·5	75
f)	7	7·5	52·5
g)	6	7	42
2. a)	10	7·5	75
b)	10	7·5	75
c)	16	7·5	120
d)	14	5	70
3. a)	30	7	210
b)	11	7·5	82·5
c)	15	7·5	112·5
d)	5	5	25
4. a)	10	7·5	75
b)	10	7·5	75
c)	12	7·5	90
d)	10	7·5	75
e)	12	7·5	90
5. a)	30	7·5	225
	11	7	77
			1880·69

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1 '72 REV. SKETCH# EC-5

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CO
FORM COST

UPSTREAM FACE FORMS (FOUND. FORM

POUR	LENGTH (F)	HEIGHT (F)	AREA (S.F.)
			B.F. 1889·69
6	60	6	360
7 a)	10	7·5	75
b)	30	7·5	225
c)	12	7·5	90
8 a)	10	7·5	75
b)	20	7·5	150
c)	15	6	90
9. a)	30	6	180
b)	19	6	114
10.	60	3	180
11 a)	10	7·5	75
b)	11	7·5	82·5
c)	40	7·5	300
12. a)	40	6	240
b)	6	7·5	45
c)	12	7·5	90
d)	7	7·5	52·5
e)	12	7·5	90
f)	8	7·5	60
g)	5	3.	15
13. a)	20	7·5	150
			4628·69

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE June 1st '72 REV. SKETCH# EC-520

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
FORM COST.

UPSTREAM FACE FORMS (FOUND. FORMS.)

POUR	LENGTH (F)	HEIGHT (F)	AREA (S.F.
			B.F. 4628·69
13 b).	50	6	30
14 a)	10	6·67	66·7
b)	25	7·5	187·5
15.	40	10	400
16.	25	10.	250
		TOTAL	5562·89 SF

5563 ÷ 4 = 1400

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM.
PEQUONNOCK RIVER BASIN.
FORM COST

DOWN STREAM FACE FORMS
(FOUND FORMS)

	POUR	LENGTH (Ft)	HEIGHT (Ft)	AREA (
	1. a)	7·5	6	45
	b)	4	6·67	26·68
	c)	7·5	7·5	56·25
	d)	11	7·5	82·5
	e)	13	7·5	97·5
	f)	14	7·5	105
	g)	4·5	5	22·5
	2. a)	24·5	7·5	183·75
	b)	33	7·5	247·5
	c)	8·5	7·5	63·75
	3. a)	10	7·5	75
	b)	18	7·5	135
	c)	16·5	7·5	123·75
	d)	11	7·5	82·5
	4. a)	15·5	7·5	116·25
	b)	16	7·5	120
	c)	17	7·5	127·5
	d)	25	7·5	187·5
	e)	8·5	6	51
	5. a)	20	7·5	150
	b)	43	7·5	322·5

2421·43

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM.
PEQUONNOCK RIVER BASIN, CONN
FORM COST.

DOWN STREAM FACE FORMS
(FOUND. FORMS)

	POUR	LENGTH (Ft)	HEIGHT (Ft)	AREA (S.F.) B.F. 2421·43
	5. c)	30	1·5	45
	6.	60	3	180
	7 a)	40	7·5	300
	b)	25	7·5	187·5
	8. a)	30	7·5	225
	b)	25	7·5	187·5
	c)	12	2	24
	9. a)	20	7·5	150
	b)	35	7·5	262·5
	c)	15	1·5	22·5
	10.	60	7·5	450
	11. a)	20	7·5	150
	b)	12	7·5	90
	c)	10	7·5	75
	d)	31	4·5	139·5
	13. a)	13	7·5	97·5
	b)	34	2.	68
	14. a)	37	6·67	246·79
	b)	23	2	46.
	15. a)	53	6·67	353·51
	b)	30	1·5	45
	16.	25	5.	125

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1st '72 REV. SKETCH# EC-523

TRUMBULL LAKE DAM,
PEQUONNOCK RIVER BASIN, CONN,
FORM COST.

DOWN STREAM FACE FORMS
(FOUND. FORMS)

	POUR	LENGTH (FT)	HEIGHT (FT)	AREA (S.F.) B.F. 5891.73
	12 · a)	40	3	120
	b)	5	7.5	37.5
	c)	8	7.5	60
	d)	11	7.5	82.5
	e)	4	7.5	30
			TOTAL	6221.73 (SF)

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1st '72 REV. SKETCH# EC-52[illegible]

TRUMBULL LAKE DAM.

PEQUONNOCK RIVER BASIN, CONN.

FORM COST.

LIFT STARTER FORMS (UP-STREAM)

POUR	LENGTH (F)	HEIGHT (F)	AREA (S.F.)
1 a)	10	6.67	66.7
b)	10	7.5	75
c)	10	7.5	75
d)	10	7.5	75
2 a)	10	7.5	75
b)	10	7.5	75
c)	20	7.5	150
d)	20	7.5	150
3. a)	30	7.5	225
b)	10	7.5	75
c)	20	7.5	150
4. a)	10	7.5	75
b)	10	7.5	75
c)	10	7.5	75
d)	10	7.5	75
e)	20	7.5	150
5. a)	30	7.5	225
b)	30	7.5	225
6. a)	60	7.5	450
7. a)	10	7.5	75
b)	40	7.5	300
c)	10	7.5	75
			2991.7

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, C
FORM COST.

LIFT STARTER FORMS-(UP-STREA

POUR	LENGTH (F)	HEIGHT (F)	AREA (SF) B.F. 2991'7
8 a)	10	7·5	75
b)	30	7·5	225
c)	20	7·5	150
9. a)	30	7·5	225
b)	30	7·5	225
10.	60	7·5	450
11. a)	10	7·5	75
b)	10	7·5	75
c)	40	7·5	300
12. a)	40	7·5	300
b)	10	7·5	75
c)	10	7·5	75
13.	30	7·5	225
14. a)	10	3·33	33·3
b)	50	6·67	333·5
15.	60	10.	600
		TOTAL	6427·5 SF

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN
FORM COST

CANTILEVER FORMS SHALL BE USED FOR STARTER FORMS

ACTUAL FORM MATERIAL REQUIRED:

CANT. FORMS	4800 SF
BULKHEADS	6720 "
	11520 SF × 7.20 = 82,900

CANT. FORM DELIVERED WITH PLATFORM + 2 ANCHOR BOLTS, 10 FT MODULES = 7.20/SF

TOTAL FORM COST	82,900
25% SALVAGE	− 20,700
	$ 62,200

PIGTAILS	5600 EA	9,000
SHEBOLTS	2000 EA	16,860
BRACKETS	290 EA	3,000
		$ 28,860

FORMS TO BE USED FOR

STARTERS	12,830 SF
CANTILEVERS	107,270 "
BULKHEADS	51,600 "
	171,700 SF

FORM COST PER SF

FORMS LESS SALVAGE	62.200
SHEBOLTS, PIGTAILS	28.860
TOTAL	91.060 / 171,700 SF = .53

SAY .55¢/SF

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE REV. SKETCH# EC-527

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
STAIR FORMS

FORM SURFACE AREA FOR THE

(1) STAIRS OF INSPECTION GALLERY.

TREAD = 11" → WIDTH, 6'-0" → LENGTH.
RISERS = 7.5"

332 NOS. OF STEPS, NOS. OF RISERS = 334.

AREA OF FORM = $6'\text{-}0'' \times \left(\frac{7.5}{12}\right)' \times 334$

TOTAL AREA = 1240 S.F.

(2) STAIRS OF WATER SUPPLY GALLERY.

RISERS - 8" HT., → $15 \times 3.5' \times \left(\frac{8}{12}\right)'$ = 35 S.F.
3.5' LONG
15 NOS.

TOTAL AREA 1275 S.F

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

FORM AREA FOR STAIR OF STAIR TOWER.

TOTAL HEIGHT 26'-8"

RISERS — 8" HEIGHT

TRADES - 3'-6" LONG, WIDTH - 10"

TOTAL RISERS = 40 NOS.
TOTAL TRADES = 35 NOS.

FORM FOR RISERS = 3.5 × 8'/12 × 40 ≃ 94 S.F.

FORM FOR BOTTOM
OF STAIR SLAB = 5 × 3.5' × 7.8' = 137 S.F.

SIDE WALLS STRAIGT - 2×2×6.5' × 26.67 = 694 S.F.

2 CURVED = 2×2× 3.14×3.5' × 26.67 = 1170 S.F.

RAILINGS - 2×3.5' × 39'-0" = 273 S.F.

TOTAL — 2368 S.F.

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1, 71 REV. SKETCH# EC-S2
TRUMBULL LAKE DAM
PERAUMAUCK RIVER BASIN, C...
3½"ø PIPE

3½"ø I.D. B.S. PIPE.

NO. OF MONOLITH	LENGTH OF 3½"ø PIPE Av.	NO OF PIPE IN EACH MONO.	TOTAL L.F. OF 3½"ø PIPE
2	29'	6	174
3	17'	6	102
4	11'	6	66
5	13'	6	78
6	15'	6	90
7	17'	6	102
8	16'	6	96
9	14'	6	84
10	14'	6	84
11	17'	6	102
12	17'	6	102
13	12'	6	72
	192'	72	1,152 L.F.

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1972 REV. SKETCH# EC-530

TRUMBULL LAKE DAM.
PEQUONNOCK RIVER BASIN; CONN.
2½" ø PIPE

2½" ø I.D. B.S. PIPE

NO OF MONOLITH	LENGTH OF 2½"ø PIPE/MONO AV.	NOS. OF PIPE IN EACH MONO.	TOTAL L.F. OF 2½"ø PIPE
2	27'	12	
3	15'	13	
4	9'	13	
5	11'	13	
6	13'	13	
7	15'	13	
8	14'	13	
9	12'	13	
10	12'	13	
11	15'	13	
12	15'	13	
13	10'	12	
	168'	154	2147 LF.

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1, 72 REV. SKETCH # EC-531

TRUMBULL LAKE DAM.

PEQUONNOCK RIVER BASIN COMM

DRAIN HOLES

3″Φ DRAIN HOLES

NO. OF. MONO.	AV. LENGTH, OF 3″Φ DRAIN HOLES.	NO. OF HOLES IN EACH MONO.	TOTAL LF. OF. 3″Φ DRAIN HOLES.
2	40′	6	
3	40′	6	
4	40′	6	
5	40′	6	
6	40′	6	
7	40′	6	
8	40′	6	
9	40′	6	
10	40′	6	
11	40′	6	
12	40′	6	
13.	40′	6	
		72	2,880 L.F.

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1, 1 REV. SKETCH# [illegible]

TRUMBULL LAKE DAM.

PEQUONNOCK RIVER BASIN, CONN.

GROUT HOLES

$1\frac{1}{2}$" ϕ GROUT HOLES.

NO. OF MONO.	AV. LENGTH OF $1\frac{1}{2}$" ϕ GROUT HOLES.	NO. OF HOLES IN EACH MONO.	TOTAL L.F. OF $1\frac{1}{2}$" ϕ HOLE.
2	60'	12	
3	60'	13	
4	60'	13	
5	60'	13	
6	60'	13	
7	60'	13	
8	60'	13	
9	60'	13	
10	60'	13	
11	60'	13	
12	60'	13	
13	60'	12	
		154	9,240 LF

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1, 72 REV. SKETCH# [illegible]

TRUMBULL LAKE DAM.

PEQUONNOCK RIVER BASIN, CONN.

6" DRAINS

6"ϕ DRAINS 12' O.C. ±

NO. OF HO NO.	AV. LENGTH OF DRAIN.	NO. OF DRAINS	TOTAL L.F.
2	8'	2	16
3	27'	5	135
4	61'	5	305
5	88'	5	440
6	88'	5	440
7	76'	5	380
8	69'	5	345
9	54'	5	270
10	48'	5	240
11	39'	5	195
12	3'	1	3
		TOTAL	2769 L.F.

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM,
PEQUONNOCK RIVER BASIN, CONN.
8" DRAIN WELL

8" DIA FORMED · DRAIN WELL.

NO. OF MONOLITH & STA.	LENGTH OF DRAIN WELL	
2, 1+15	33'	
3, 1+70	61'	
4 2+30	93'	
5 2+90	129'	
6 3+50	135'	
7 4+10	135'	
8 4+70	116'	
9 5+30	98'	
10 5+90	85'	
11 6+50	83'	
12 7+10	56'	
13 7+70	23'	
14 8+05	23	

1070 L.F.

23 GREEN STREET
HUNTINGTON, N. Y.

PEQUONNOCK RIVER BASIN

COPPER SEAL.

NO. OF. MONOLITH	STATION		LENGTH OF SEAL LF	TOTAL.
	1+10		54	
2				
	1+70		80	
3				
	2+30		103	
4				
	2+90		147	
5				
	3+50		150	
6				
	4+10		148	
7				
	4+70		133	
8				
	5+30		116	
9				
	5+90		106	
10				
	6+50		103	
11				
	7+10		85	
12				
	7+70		40	
13				
	8+20		40	
14				
	8+80		25	
15				
	9+40		15	
			1345 x 2	2690

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1, 72 REV. SKETCH# EC-S26
TRUMBULL LAKE DAM.
PEQUONNOCK RIVER BASIN, CONN

COPPER SEAL AT CONTR. JOINTS. GALLERY

LENGTH $2 \times [(8+2+2)+(6+2+2)]$ FT.

= 44 FT.

NO. OF JOINTS = 11.

TOTAL LENGTH OF SEAL = 44 x 11 = 484 L.F.

MISC. SEALS ~ 500 LF

TOTAL - 2690 LF
484 "
500 "
3674 LF

SAY 4000 LF

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1, 72 REV. SKETCH# EC-S 37

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN C.T.

INSIDE VOL. OF PUMPING STATION.

LENGTH - 49'-0"

WIDTH - 24'-0"

HEIGT - 32'-0"

VOLUME = 49'-0" x 24'-0" x 32'-0" = 37632 C.F

LESS FLOOR SLAB = 1 x 49' x 24' = 1176 C.F.

36,456 C.F.

LESS CONC. AT BASE = 3' x 9' x 24' = 648 C.F

35,808 C.F.

23 GREEN STREET
HUNTINGTON, N. Y.

ACCESS ROADS

460' x 16' = 7,350 SF — ACCESS TOP
14900 x 18' = 268,200 SF — RAIL ROAD
3600 x 20' = 72.000 SF — VALLEY ROAD

ENVIRONMENTAL CONTROL

a) WATER TURBIDITY CONTROL
METERING DEVICES & FLOCULANT DISPENSERS -- $35,000
MONTHLY OPERATION:
18 MOS @ 3,000 -- 54,000
$89,000

b) DUST CONTROL ON ROADS --- $1,000 Chemicals

c) NOISE ABATEMENT (EQUIPMENT)

Clearing & Grubbing	$9,000
EXCAV	135,000
DIVERSION	80,000
DRAGLINE & TRUCKS	162,000
AGGREGATE PLANT	490.000
MIXING PLANT	432,000
CABLEWAY	395,000
AIR TOOLS	80,000
GEN'L EQUIP	243,000
TOTAL EQUIP	2,036,000

5% EQUIP $100,000

d) Landscape Renewal
1000 Plants @ $25.00 = $25,000

Q-1-9

COST AND FEASIBILITY STUDY

ALTERNATE DESIGNS TO PERMIT USE

OF SLIP FORM AND OTHER TECHNIQUES

TO MAXIMIZE ECONOMIES

BOOK R

RAPID CONSTRUCTION UTILIZING

SLIP FORM TECHNIQUE

BOOK R - RAPID CONSTRUCTION UTILIZING SLIP FORM TECHNIQUES

<u>Drawings, Sketches, Sheets, and Tabulations</u>

FEASIBILITY

FACTORS AFFECTING CONSTRUCTION

METHODOLOGY

STREAM DIVERSION AND CONSTRUCTION SEQUENCE

The stream diversion for constructing the dam utilizing slip form techniques is essentially the same as for construction by traditional methods. The work is divided again into two phases related to the two stages of stream diversion. Placements 1 thru 37 as shown on drawing 209-R-1 will be placed during Phase I, bringing monoliths 4 thru 11 to elevation 177'-6" with the exception of monolith 5 which will be kept low for storm overflow and monoliths 10 and 11, which will be as shown to elevation 185'-0". If further study indicates that monolith 5 should be kept lower than elevation 170, this can be easily accomplished without appreciable effect on this study. Elevation 170 was selected as weir height for monolith 5 in order to provide sufficient head for good flow through the flood control and blow-off conduits during the second stage diversion. It seems necessary, however, to maintain this weir height at elevation 162'-6" in order that upstream water levels be kept down to acceptable limits. Placing the weir height at this level presents no problem and will have no significant effect on this study which is based on the 170'-0" elevation. If necessary, the concrete over the water supply gallery can be kept down to elevation 176'-0" to allow installation of piping in the open.

During Phase II (See Drawing 209-R-2) slip form and fixed form operations will be intermixed together and in the order shown on concrete demand schedule, Sketches 209-R1 thru R8, starting with placement 38 on the 38th working day; slip form operations are indicated by Roman numerals and except for monolith 5, will be continuous placement to elevation 260, working around the clock on a 24 hour basis and taking a week to

Revised

complete, including some work into the weekend. During slip form placements it is not anticipated that concrete will be placed in the 7'-6" lifts. The 7'-6" lifts have been spaced at 7 calendar days (5 working days) except in one or two instances near the top. Retaining walls and minor miscellaneous placements can be made during the same period of time without interferring with the main operation or overloading the concrete plant. Monolith number 5 will be kept low until all other slip formed monoliths are up to elevation 260, the east abutment monoliths up to elevation 237'-6" and the west abutment monoliths to 222'-6". Monolith 5 is then slipped in two operations stopping for the weekend. Work will then continue simultaneously on the abutments and top of dam to completion. Since these last placements are small, lost time may be picked up during this period if necessary.

ENVIRONMENTAL PROTECTION AND ACCESS TO SITE

Since this construction scheme will not utilize a cableway system and since concrete production is kept in the valley, work above the east and west abutments will not be required, leaving these areas untouched. Traffic from Valdamere Avenue access and activity in the populated area above the west abutment will be greatly reduced. In order to further reduce this traffic, the cement unloading station has been removed to the lower access road (SEE DRAWING 209-R-10), and all shipments will be received at this lower level.

Night operations during slip forming (a total of 8 weeks) will result in activities and noises that may be objectionable. Unloading, aggregate production, and as many other activities as possible must be accomplished during normal working hours to reduce night activities.

LABOR CONSIDERATION

The availability and attitude of labor towards shift work is extremely important to the economy of the slip form operations. Actually, a continuous 24 hour operations is not essential to this technique. The slide may be made in daily lifts based on an eight hour operation or in daily lifts of any predetermined height, say 7'-6", running into some overtime if necessary. Even with daily operations, some premium time must be paid because of the necessity of freeing the forms at the end of each day's work. This will involve a skeleton form crew for two to three hours after placing is completed. Since preliminary inquiries indicate that shifting is possible and economical in this area, and since a continuous slip will eliminate the costly horizontal joint treatment, as well as have some beneficial effect in reducing thermal shock, we have based this study on a continuous 24 hour placement except in monolith No. 5. It was elected to take a stop and horizontal joint over the weekend in lieu of the premium time involved in running monolith No. 5 through the weekend.

Shift work is generally done in one of two ways, depending on the avilability of labor and on union agreements, three 8 hour shifts or two 12 hour shifts. Three 8 hour shifts are, of course, the most economical and have the advantage of not overtiring the men by too long and grueling a day. When eight hour shifts are used, supervision is usually placed on twelve hour shifts to provide overlap across the shift changes and a better degree of continuity. The pay for three 8 hour shifts is 27 hours for 24 hours work. Sometimes the men are asked to work the half hour lunch-time in which case they are paid 30 hours for 24 hours work. It is better to give the men the lunch half hour as they will normally take it in any case and charge the double time for it anyway. The lunch periods are usually staggered by the foremen to maintain continuity. Pay for the twelve hour shifts is usually 34 or 30 hours for 24 hours work, depending on whether overtime is at double time or at time-and-a-half.

The cost impact of premium time for the various methods of shifting as compared to an eight hour day without overtime is approximately as follows:

One 8-hour shift with overtime skeleton crew to free the forms	1.25
Three 8-hour shifts	1.125
Two 12-hour shifts	1.33
One straight time shift with two shifts overtime	1.55
Sunday operation for 8-hour day	2.00

In considering labor costs, the above premium costs must be balanced against the labor savings that accrue from form reuse (height of slip divided by form height), elimination of erection and stripping of forms at each lift, reduction in form cleaning, elimination of scaffold erection handling and dismantling and tie hole patching.

Slip forming has a good impact in areas where unemployment is temporarily high as it will concentrate work for three times as many men in a short period of time. When labor supply is low and competition for men exists between projects, two twelve-hour shifts has a great appeal to the men because of the premium pay involved.

Due to the automated repetitious nature of slip forming techniques, a minimum of skill is required among the main labor force, making the use of unskilled labor (especially among minority groups) possible without loss of efficiency. The supervision and some of the skilled trades, however, must be highly skilled and an experienced technician will be needed to work with the supervision until they acquire skill in the technique. The technician will be needed during form construction and for about two slips.

CONCRETE

The mass concrete used in the construction of this dam presents problems in the use of slip forming techniques. These problems result from the low cement content, substitution of fly-ash and low temperatures of the concrete, all of which add up to an extremely low rate of hydration and strength pick-up. At tests conducted at the Waterways Experiment Station in Vicksburg, Mississippi during April and May, 1972, it was found that with concrete temperatures of 70 degrees Fahrenheit and an ambient temperature of 73 degrees, the exterior mass concrete picked up 3 degrees Fahrenheit in 12 hours and an additional 12 degrees in the next 12 hours for a total of 15 degrees in 24 hours. The low temperature pick-up in the first 12 hours is the significant item.

The tests conducted in Vicksburg indicated that this concrete placed at temperatures from 57 to 70 degrees Fahrenheit in a 73 degree environment successfully held vertical surfaces emerging from the forms at ages as low as 2 to 4 hours. SEE TABLE 209-SR-17. Using a four foot high slip form, 4 hour old concrete emerging from the form may be translated into a slide rate of 12 inches per hour.

During the tests, monoliths 3 feet by 6 feet in plan and ten feet high were slip formed at rates of 3 inches, 6 inches and 12 inches per hour respectively, without any problems, as long as the forms were kept full. Slips at 18 inches per hour were marginal. It is predictable that if the forms are allowed to run empty, the heavy vibrators used in this type of work will push the concrete out from under the form. This situation actually occurred during the test and it was necessary to stop vibration until the forms were filled to the top. With the forms running full, no problem was encountered with the use of 6 inch vibrators.

Both data and visual inspection indicate that this concrete placed at 57 to 70 degrees Fahrenheit in a mild environment of 70 to 75 degrees can be slip formed at rates considerably lower than 3 inches per hour and higher than 12 inches per hour without problems. The upstream and downstream faces of the dam are actually sloped so that the danger of "fall out" or bulging of concrete from under the form is almost nil, if the forms are kept full. It was also observed that the slip formed surfaces were in excellent condition for finishing and remained so for many hours after they were exposed.

The slow set of cement will not cause serious problems as far as slipability is concerned. The rate of slide can be kept down and the forms can be made longer than four feet if necessary. It is to be noted that because of the prolonged plasticity of the concrete, contact with the form is maintained two to three times as long as with normal structural concrete thus increasing the drag forces by an amount somewhat higher than this ratio. Test showed the drag loads per lineal foot of forms to run between 100 and 600 pounds for wood forms and 150 to 250 pounds for steel forms. Our best judgement is that drag forces must be designed at three times those used for structural concrete work. It is interesting to note, too, that although drag forces for mass concrete are much higher

Revised

than for structural concrete under normal operating conditions, they will not tend to increase to the high drag values (infinity) that structural concrete can reach when concrete sets too rapidly. This indicates that the chances of the forms binding to the concrete,(which requires dismantling and re-assembly, causes tearing of the concrete) are nil over long periods of time. During the test at the Waterways Experimentation Station, the forms were left in contact with the concrete overnight and were broken away in the morning without any damage to the forms nor to the concrete.

The major problem connected with the slow rate of hydration and low strength pick-up of cool mass concrete is the development of sufficient strength to enable anchoring of the forms (whether it be slip or fixed cantilever forms). For this reason a special type of anchor has been developed by this office having precast concrete block at the surface to give good strength at the actual insert face and a bearing plate effect for transmitting compressive and shear loadings to the low strength at the actual insert face and a bearing plate effect for transmitting compressive and shear loadings to the low strength mass concrete. This system also provides a means of spacing and holding the inserts in position relative to each other and to the concrete surface. The inserts must develop high resistance to pull-out at strengths well below the traditional value of 300 psi. The solution to this problem lies in using inserts that go deeper into the concrete (at some cost) so that the action is more like that obtained by burying deadmen deep in a granular material.

At tests conducted at Vicksburg on May 5th, three inserts were tested in 50 degree Trumbull mass concrete having an age of eight hours. It is estimated that the tensile strength of this concrete was between 1 and 2 psi. (SEE TABLE 209-SR-18). Two of the anchors tested were of the composite type described above and shown on Sketch 209-W-4 and one of the composite type utilizing a conventional anchor as shown on Sketch 209-W-5. The two "deep" anchors were pulled out at 5100# and 6000#; the standard anchor was pulled out at 2500#. It is to be noted that the depth of the test monolith (3'-0") limited the depth of embedment of the first two anchors. Actually the length of the bars may be extended as necessary in the actual construction. It is noted also that the edge distance and spacing of the three inserts did not allow full development of cone normally to be expected under such conditions. Lastly, the pipe support between inserts adds to the strength of the anchor by adding projected bearing surface and by cantilever action down to concrete of greater age.

During tests conducted on May 19th, anchors of the "deep" type were tested by pulling them up from the top of the monolith allowing the test of anchors 5'-0" long, twice as long as the ones tested May 5th. The capacity was doubled, but again monolith dimensions prevented full strength development.

It is planned to conduct additional anchor and early concrete strength tests to develop data for determining the length of anchors actually required based on age and temperature parameters. For the purpose of this cost study, ten foot long anchors were used.

A problem develops in planning the rate of placement of large size aggregates related to three parameters, maximum rate of slipping; minimum thickness of placements, maximum time between placements. It has been traditional to make the thickness of concrete placements a minimum of three times the largest aggregate size. For 6 inch aggregate such as planned for this project, the minimum placement thickness is 18 inches. Allowing two hours maximum between successive placements results in a minimum placing rate of 9 inches per hour. If the strength pick-up is not sufficient to support this rate of slide, the form must be designed higher than four feet. If this solution is not viable, then either slipforming must be abandoned or the size of aggregate must be reduced.

The minimum concrete mixing and placing capacity required in accordance with EM 1110-2-2000 is slightly under 150 yards per hour. The two 4 yard mixers provided for the purposes of this study have a rated capacity of 160 yards per hour, the same as was provided for the purposes of the conventional methods study. Although the number of days of placing is reduced, (see sketches 209-SR-1 thru SR-8), the number of shifts is increased. This will improve the plant utilization factor for the quarry and aggregate production operations but will reduce the average placement of concrete per shift to 516 yards with a plant utilization

Revised

factor of 40% arrived at by dividing total concrete in the monoliths by the number of 8 hr. shifts by a daily plant capacity of 1280 yards (160 yards per hour times 8 hours). This results in a decrease in the batch plant utilization factor of 2 percent.

Because of the strength pick-up and other qualities necessary to support a good rate of slide, a minimum cement content will be required. In order to provide this minimum cement factor we must use exterior concrete in both upstream and downstream faces of the dam, but not the transverse (inter-monolith) faces. This will result in an increase in exterior mass concrete and a decrease in interior mass concrete on 19,400 square feet of downstream face or 4300 cubic yards.

CONCRETE PLACEMENT

Concrete placement by belt conveyors offers a rapid flexible method of placing concrete on this project. Conveyors are adaptable to both the fix form and slip form operations and are capable of much higher rates of concrete delivery if other limitations were removed. Since the great majority of placements are over 200 yards and require rates of placement of over 50 yards per hour, experience indicates the conveyors are the most economical method of placing the concrete.

Belt conveyors are limited and inefficient in the vertical transport of concrete. This requires integration of another piece of concrete placing equipment to be used in conjunction with the belts for raising the concrete to the higher lifts. For the basis of this study, we selected a two-well materials hoist tower (SEE DRAWING 209-R-3) which has a capacity of 160 yards per hour plus a long history of dependability. Because the hoist tower is between two belt conveyors (continuous feed equipment) two hoisting buckets of three yd. capacity each will be needed with surge hoppers of eight yard capacity top and bottom to smooth out the delivery and feeding of the concrete. The two-well system also gives a safety margin to maintain operations in the event of a malfunction of one of the hoists. Please note that the upper surge and receiving hopper is supported on the tower and suspended in such a manner that it will be hydraulically synchronized to maintain the same level as the slip form operation. Discharge of the skip buckets into a common surge hopper is automatic. The use of other types of elevating machinery such as bucket elevators is not recommended because of problems in keeping

Revised

the equipment clean and preventing concrete build-up and fouling of the machinery.

Pumping the concrete has been considered as this placing method is capable of pumping concrete vertically as well as horizontally, eliminating the necessity of integrating the materials tower into the handling system. Since concrete pumping depends on maintaining a rich film of cement, sand and water to provide lubrication between the pipe walls and the moving concrete, the minimum cement content must be about 450 lbs/yd with a relatively high percentage of well graded fines and a slump of 2 inches or more. Mass concrete mixes now in vogue will not support concrete pumping.

The maximum size of aggregate can also be a deterrent to the use of concrete pumping. The size of the pumps and pipes are related to the size of the aggregate. Six inch maximum aggregate, which can have dimensions considerably more than 6 inches, will require pipe lines of at least 12 inches, probably more; the pumps must be sized accordingly. Equipment of this size will have capacities and weight ten times that of equipment now in use. The weight of a 12 inch pipe full of concrete will be approximately 175 lbs. per lineal foot. Pipes of this weight are acceptable for main lines and can be hydraulically hooked up to the slip form hydraulics to maintain a fixed position relative to the work. The final concrete distribution must, however, be by other means since such pipes cannot be readily handled.

Crane handling is not considered economical in this type of placing except possibly for some of the smaller placements at the top of the dam, retaining walls and miscellaneous concrete.

The conveyor operations are divided roughly into three groups:

1- A fairly typical system where trains of feeder and/or side discharge conveyors run along the ground, on the trestle runway or on the monoliths themselves and deliver concrete directly from the plant to the point of deposit.

2- An automated conveyor system supported on the slip form, fed by a meterials tower and distributing the concrete to any point on the leading monoliths.

3- An automated conveyor system supported from the slip forms and distributing the concrete to trailing monoliths.

The conveyor train system is shown on Drawings 209-R-1 and 209-R-2. A timber trestle runway has been provided as a working area for the crane and conveyors; semi-permanent conveyor rail can be mounted on this runway and feeder conveyors of 30 to 100 foot lengths may be used in various combinations to service any particular monolith. Sixteen inch belt conveyors have the capacity to meet the concrete requirements of this job. The use of six inch aggregates, however, necessitates the use of 24 inch conveyors at an equipment first cost premium of 40 to 50 percent.

Concrete is transported from the batch plant via a radially moveable feeder conveyor to either a run along the trestle to the west, a similar run to the east, or an elevated conveyor feeding directly to monolith 13 on the east abutment. Side discharge conveyors then transport the concrete to the particular monolith being placed. The side discharge conveyors are stationary; the feeder conveyors are rearranged daily, utilizing the crane to effect these movements. Actual distribution within the monolith is effected using radial spreaders or side discharge conveyors.

The conveyor system for placing the concrete in the slip formed lead monoliths consists of a main line conveyor supported on the upstream and downstream slip forms and rising with them and a distributing conveyor. A steel support bracket is provided to cater to the overhang condition that developes in the main line conveyors as the placing progresses. This conveyor is tied to the material tower and maintains a constant relation to it and the surge hopper. These conveyors are side discharge conveyors of a 160 yard per hour total capacity. The distributing conveyors are shown riding on rails supported on the transverse slip forms each serving any point in the monolith. Using the one conveyor with reversible belt and a two way plow is more economical than using two one-way conveyors. The capacities needed will almost always be considerably less than 160 yards per hour. It should be noted that jack capacities must be increased to 6 tons at points of conveyor support; actually 6 ton jacks were used throughout.

The conveyor system for the trailing monoliths as shown on Drawing 209-R-2, monolith No. 7, consists of a main line side discharge conveyor on one side of the monolith supported on a double truss which is supported on the face slip forms. A similar truss is on the other side of the monolith. The distributing conveyor capable of reaching any point in the monolith runs on rails supported from the two double trusses. The materials towers from the lead monoliths are used to feed the conveyors either by elephant trunk from the top of the monolith or directly via a suspended conveyor running directly from the suspended surge bin to the main line conveyor. Monoliths 1, 2, 3, and 11 may be placed using the lead monolith materials tower, elephant trunk and conveyor system as shown for monolith 11.

FORMING SYSTEM

The forming system envisioned in this study consists of a combination of fixed and sliding forms as required to cater to the varying conditions that occur in the different parts of the dam. Basically, the height of monoliths slip formed are those that can be formed by conventional cantilevered forms allowing for starting a level lift with room for anchoring of the strongbacks. Monoliths 1, 2 and 12 thru 16 do not have sufficient height to justify setting up a slip form operation. Monolith 3 would support a slide of 37-1/2 feet; monolith 11 would support a slide of 45 feet. These monoliths can be economically slid and may have been included in the group of monoliths we planned to slide. Actually this study is based on sliding monoliths 4 thru 10 on an alternate basis as shown on Drawing 209-R-2. This particular group was selected due to alternate arrangement of lead and trail monoliths and orientation to monolith 5, which must be kept down as last monolith slid to provide a stream overflow weir.

The forming of the areas below and on the abutment sides of the slip formed monoliths is effected by traditional forming methods, that is to say foundation forms, lift starter forms and cantilever forms. Concrete placements have been spaced at a minimum of five calendar days between placements. It is obvious that a long flat valley or a deep gorge with vertical sides would give maximum opportunity for use of slip forms.

The basic concept for the slip form system is as shown on Drawings 209-R-3 and 4. This system is capable of sliding a complete monolith with two faces and two transverse bulkheads. By mounting a double truss on each side of the monolith perpendicular to the base line, all conveyors can be supported from these trusses which are, in turn, supported on the face slip forms only (SEE MONOLITH No 7 and Detail A on Drawing 209-R-2). This latter system can be used with a lead monolith, a trail monolith, or with an end trailing monolith (one transverse bulkhead) as transverse bulkheads are not required for supporting the conveyor system.

The form is a hybrid between the conventional cantilever form and the conventional slip form having the capabilities of both (See Drawing 209-R-4). All forces parallel to the formed face are transmitted through the jack to the jack rod which can take only axial loads and no bending. All axial loads are transmitted directly to the bottom of the slide through the jack rods with the concrete preventing buckling. The jack rods run continuously from the bottom of the slide, being extended in ten foot lengths as the work progresses; the jack rod platform as shown providing a placing deck and template to hold the jack rods. A base plate may be used under the first section of jack rod if this is considered necessary to keep compressive strength on the concrete within limits. Off-the-shelf jacks in capacities up to 25 tons are available on a rental basis, higher capacities being obtainable on a special order basis if necessary.

Loads perpendicular to the formed surface are transmitted through the trailing cantilever legs and then through wheels capable of taking no loads parallel to the formed surface. Wheel support brackets are attached to the dam

Revised

on previously set inserts as the forms clear these inserts (See Sketch 209-SR-10). These brackets are composed of three pieces to allow for side erection and removal to the yoke legs; quick connection hardware and some adjustability are very desireable in these brackets. The loadings due to gravity loads, eccentricity, hydrostatic concrete pressure, form drag and wind produce overturning moment resulting in maximum pull-out forces of 18 kips. (See Calculation Sheets 209-CR-1 thru 10). Actually, this pull-out force can be substantially reduced by using counterweights or tieing the yokes to each other across the monolith. Tieing across the jack level will not directly interfere with the concrete placing system, but it does offer impediments in a general way such that it should be looked at as a low priority alternate solution. We have actually slip formed one dam in upstate New York using steel drums filled with water for counterweights. This worked very well and allowed for easy adjustment of the counterweights. Taking care of the overturning moments through the concrete anchors seems feasible and will present a minimum of interference with placing operations.

Three ton jacks are sufficient for raising and supporting these forms as shown. If counterweights are used, and in sections of form supporting conveyors, the capacity of the jacks and jack rods must be increased, probably doubled. For this reason it was conservatively decided to use 6 ton jacks throughout. The conveyors may be so supported as to decrease rather than increase the overturning moments of the forms.

The proposed form shown on Drawing 209-R-4 is a wood form composed of tongue and groove fir floor boards with 3 ply 2 x 10 wales and 2 x 6 diagonal trussing. Wood forms of this type have had a long and successful service record over many years. Because of the spaces between the boards, this form reacts very well to dimensional changes caused by varying moisture conditions. Wood forms also have a great deflection flexibility, can endure grooving from aggregate projections without serious damage, are easily repaired by replacing individual boards by driving a new one through and are very economical. Plywood forms have been used successfully, but the plys tend to tear off and there is a serious tendency to buckle. The backing for the plywood has to be heavier and removal of a damaged plywood sheet is very difficult to achieve. Finnform plywood, a very strong plywood with many more plies than are usually obtainable and a very hard plastic surface has a very good service record. It was tested at the Waterways Experimentation Station together with board and steel surfaces and gave satisfactory results. Although finnform was used for a 525 foot slide in Baltimore very successfully and without any wear problems, the large aggregate caused significant damage to the plank tested at the Experimentation Station.

Steel forms, fiberglas reinforced plastics and combinations with wood may all be used as forming material. Steel and fiberglas may turn out to be the most economical if good reuse is developed, particularly over more than one project. In addition, steel forms reduce drag forces by 50 percent as compared to board forms. It must be noted at this point that the fiberglas reinforced plastic forms have only been tested once to our knowledge on a hundred and sixty foot slide.

Platforms and scaffolds have been integrated into the slip form system to provide placing and template platforms as well as a finishing platform and a platform for removing the guide wheel brackets and patching the insert holes. Scaffolds are handrailed as necessary with ladders providing access between platforms and personnel stair towers, providing access to the ground. Lateral bracing trusses provide for longitudinal stability.

The system for forming vertical and nearly vertical surfaces is shown on Drawing 209-R-6. This system is used on the upstream face and transverse bulkheads.

Like the traditional cantilever form system, a problem exists with finding enough room for anchoring the trailing cantilever legs. This is accomplished as shown on Drawing 209-R-7 by means of an intermediate form which takes the place of the lift starter form in the conventional system. The slip form is erected with the bottom of the form 7'-6" above the first lift that has a level surface the full length of the monolith. It is supported on the bottom of the legs and shored as required.

Fixed forms may be installed to cover this 7'-6" lift using the yoke legs as strong backs and taking the hydrostatic concrete pressure by ties into hard concrete. Two lifts are shown in the drawing but the placement will probably be made in one lift. Once the concrete is up to the bottom of the slip form, filling of the slip form may commence and the forms moved upon the concrete reaching sufficient strength.

It is planned to stop the slip form at elevation 260'-0", since at this elevation a change in slope occurs on the upstream face. The bottom wheel anchor is replaced by a fixed support capable of taking loads parallel to the formed surface and the top section of the yoke is removed together with the jacking equipment. The placing platform remains in place to provide a deck for erecting vertical panel forms for casting the remainder of the work in the conventional manner using form ties. 6'-8" is then cast using the slip forms on the downstream face and fixed form on the upstream face. At the top of this placement conventional panel forms are installed on the downstream face supported on the modified slip form system and platform. In the slip form placing sequence shown on Drawing 209-R-3 alternate monoliths are placed so that the lead monolith has in effect face forms for casting the transverse dam faces. The trailing monoliths require no transverse forms as the concrete is placed directly against the previously placed monoliths. If adjacent monoliths are to be slip formed simultaneously, premolded joint fillers may be installed to maintain separation between monoliths. A modification of the slip form system may be used to accomplish this using jacks synchronized with the jacks controlling the slip form movement; panels of rigid joint filler are fed into a moving jig as the placing progresses, using little sheet metal clips to allign and hold the panels together. This method is shown on Drawing 209-R-8. On this drawing are also shown some suggestions for handling a monolith system which for one reason or another utilizes concrete filler sections placed between the monoliths after the monoliths are completed.

Drawing 209-R-9 shows some of the ways in which the interesctions between transverse and face sliding forms may be handled including corner details for both lead and trailing monoliths and intersection between face forms and premolded joints.

The slip forming system used here involves only hydraulic connections between the face forms and the transverse forms. Actually, the various face forming systems can be mechanically tied together supporting some system of platforms spanning between forms. Such a system would provide support for construction equipment, storage areas and access ways. The size, height and configuration of this dam is such that it is felt that such a "space platform" is not required and that there is some advantage to the flexibility obtained with the system shown.

Copper water stops may be placed as shown on Sketch 209-RS-15 utilizing a continuous keyway guided by the slip form and a bend-out leg.

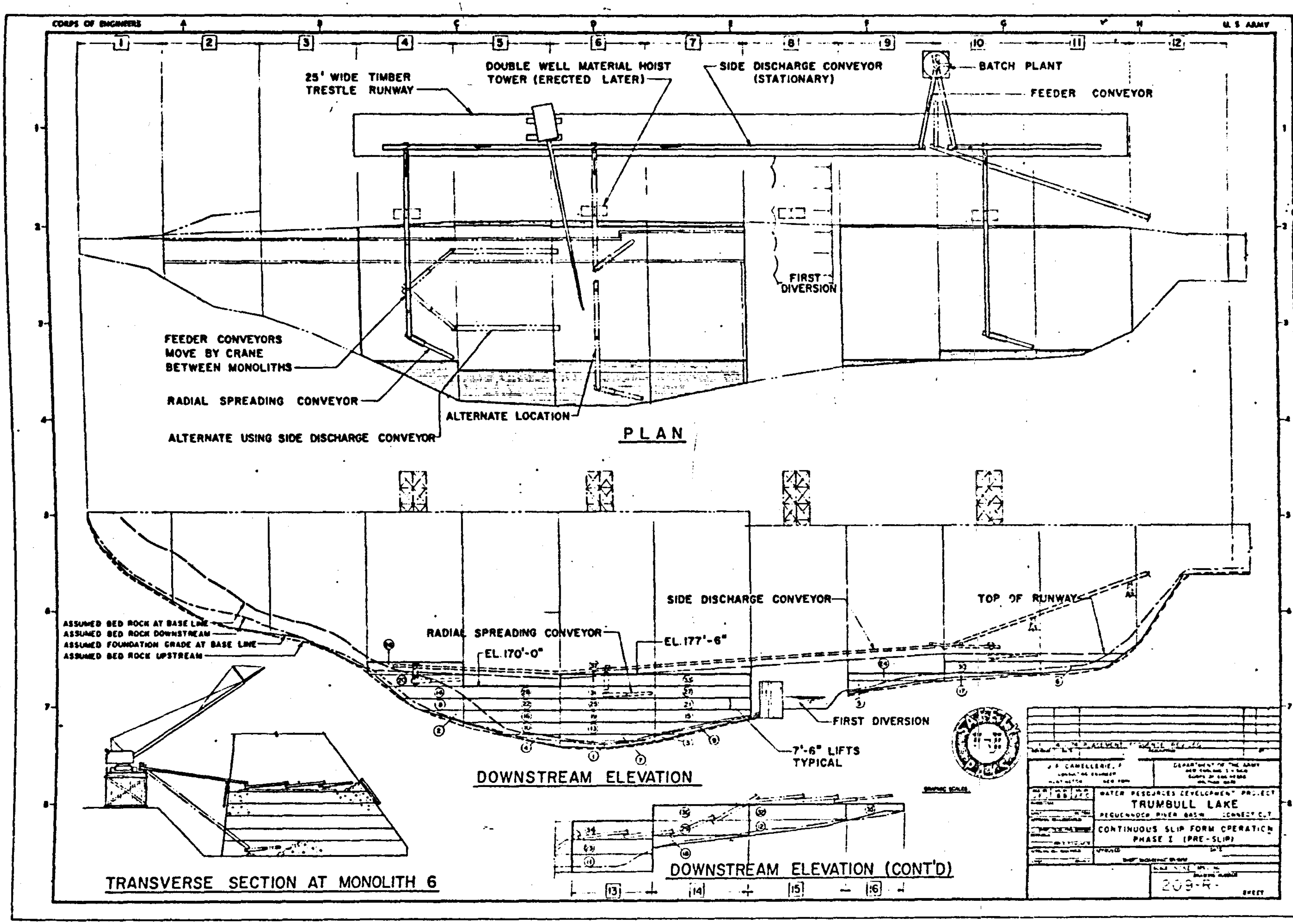
The drain wells at the transverse joints may be slip formed in two halves as shown on drawing Sketch 209-SR-16.

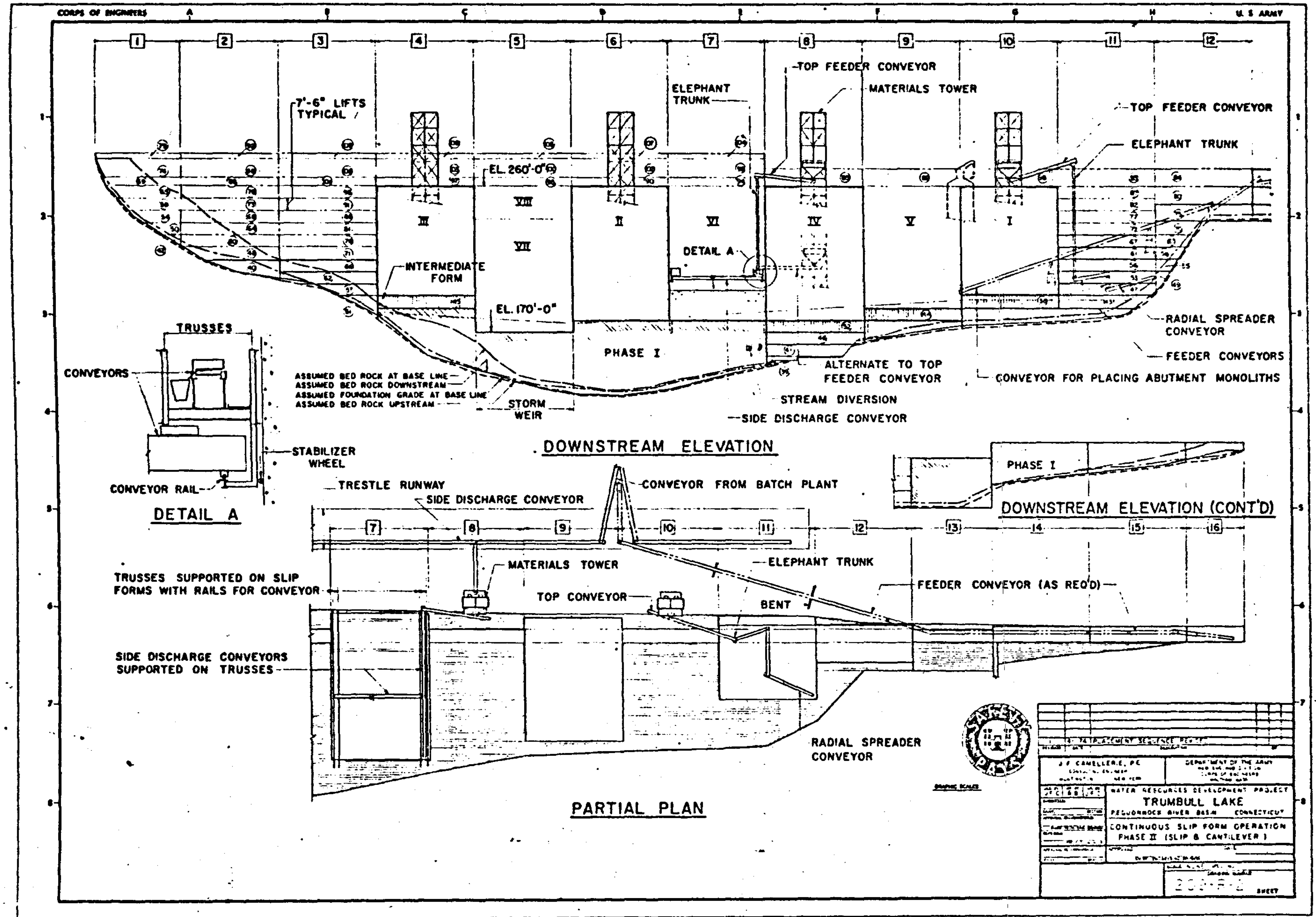
The transverse bulkheads will slide past the fixed form gallery forms with no problems.

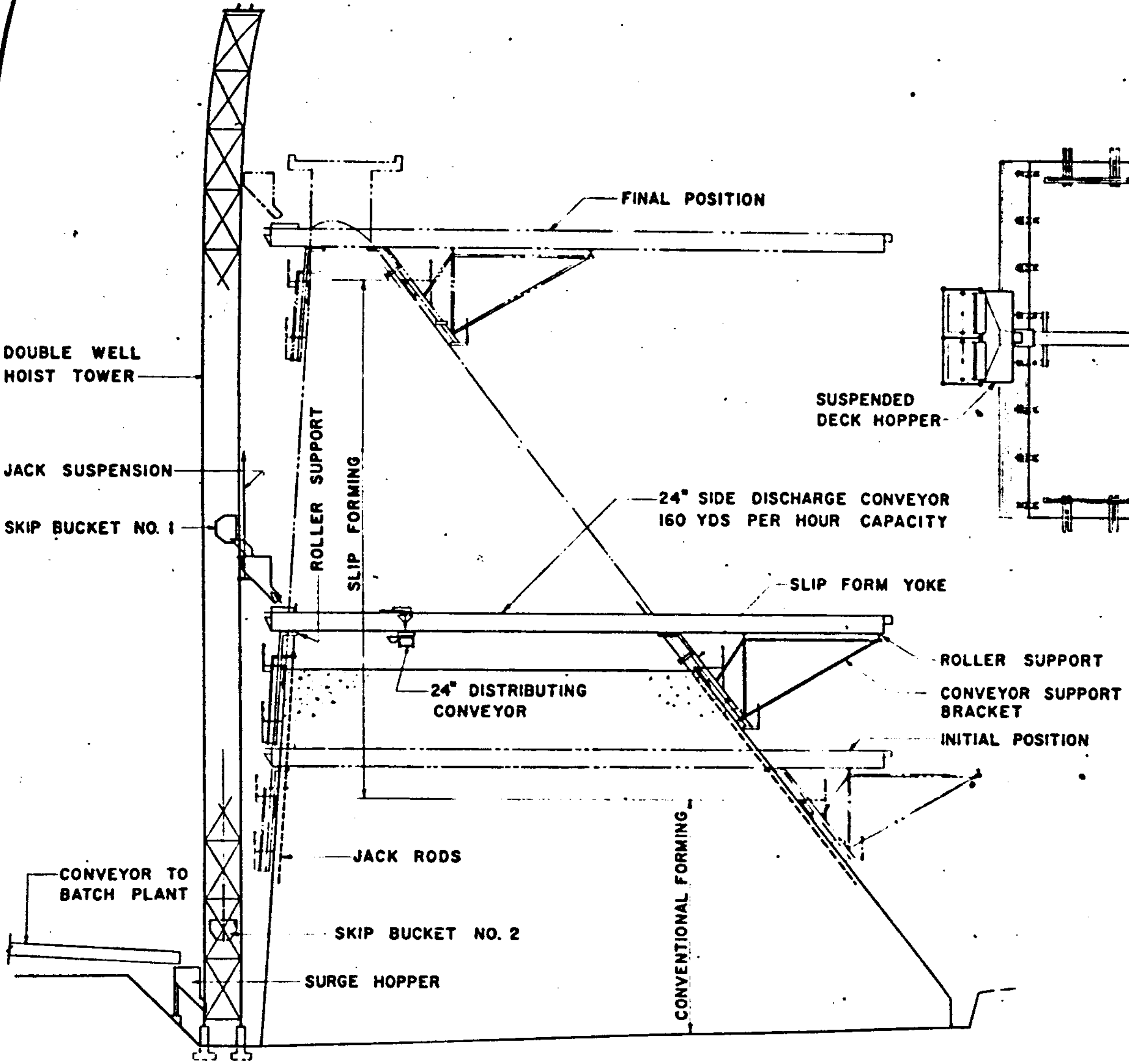
CONSTRUCTION SCHEDULE

The construction schedule for this work is shown on Sketch 209-SR-12. The schedule is based on work starting in the fall of 1972 with Phase I of concrete placing being completed late in the summer of 1973. Phase II of concrete placing is completed during the prime time of the construction season.

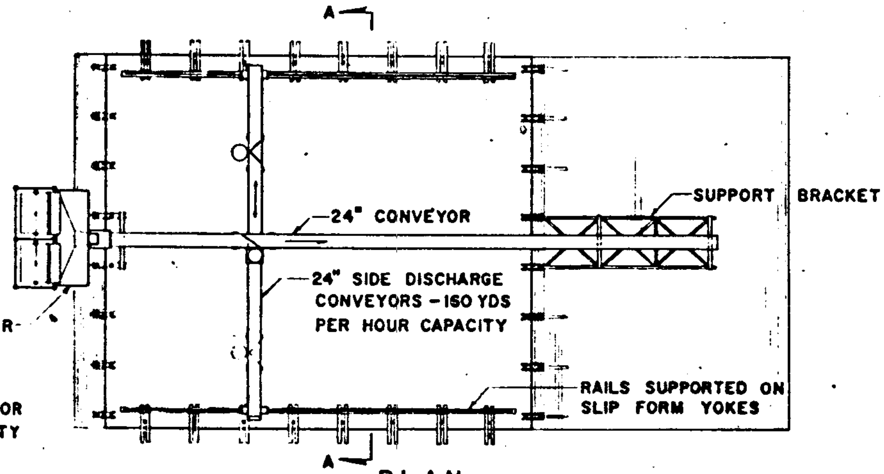
If work is delayed until the beginning of 1973, (SEE SKETCH 209-SR-13), concreting Phase I will be pushed into the late fall of 1973 but placing of Phase II will not be effected and completion by the end of 1974 will be adhered to.


CORPS OF ENGINEERS
U. S. ARMY
25' WIDE TIMBER TRESTLE RUNWAY
DOUBLE WELL MATERIAL HOIST TOWER (ERECTED LATER)
SIDE DISCHARGE CONVEYOR (STATIONARY)
BATCH PLANT
FEEDER CONVEYOR
FIRST DIVERSION
FEEDER CONVEYORS MOVE BY CRANE BETWEEN MONOLITHS
RADIAL SPREADING CONVEYOR
ALTERNATE LOCATION
ALTERNATE USING SIDE DISCHARGE CONVEYOR
PLAN
SIDE DISCHARGE CONVEYOR
TOP OF RUNWAY
ASSUMED BED ROCK AT BASE LINE
ASSUMED BED ROCK DOWNSTREAM
ASSUMED FOUNDATION GRADE AT BASE LINE
ASSUMED BED ROCK UPSTREAM
RADIAL SPREADING CONVEYOR
EL. 170'-0"
EL. 177'-6"
FIRST DIVERSION
7'-6" LIFTS TYPICAL
DOWNSTREAM ELEVATION
TRANSVERSE SECTION AT MONOLITH 6
DOWNSTREAM ELEVATION (CONT'D)
DEPARTMENT OF THE ARMY
WATER RESOURCES DEVELOPMENT PROJECT
TRUMBULL LAKE
PEQUONNOCK RIVER BASIN CONNECTICUT
CONTINUOUS SLIP FORM OPERATION
PHASE I (PRE-SLIP)
209-R-

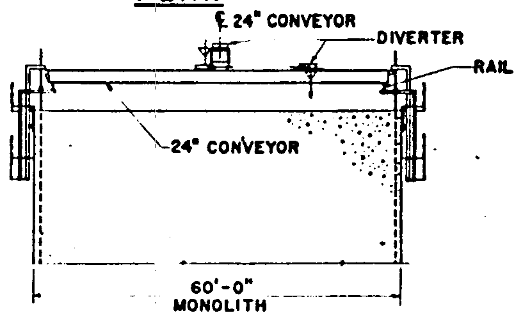

CORPS OF ENGINEERS
U. S. ARMY
7'-6" LIFTS TYPICAL
ELEPHANT TRUNK
TOP FEEDER CONVEYOR
MATERIALS TOWER
TOP FEEDER CONVEYOR
ELEPHANT TRUNK
EL. 260'-0"
DETAIL A
INTERMEDIATE FORM
EL. 170'-0"
PHASE I
RADIAL SPREADER CONVEYOR
FEEDER CONVEYORS
ALTERNATE TO TOP FEEDER CONVEYOR
CONVEYOR FOR PLACING ABUTMENT MONOLITHS
ASSUMED BED ROCK AT BASE LINE
ASSUMED BED ROCK DOWNSTREAM
ASSUMED FOUNDATION GRADE AT BASE LINE
ASSUMED BED ROCK UPSTREAM
STORM WEIR
STREAM DIVERSION
SIDE DISCHARGE CONVEYOR
TRUSSES
CONVEYORS
STABILIZER WHEEL
CONVEYOR RAIL
DETAIL A
DOWNSTREAM ELEVATION
PHASE I
DOWNSTREAM ELEVATION (CONT'D)
TRESTLE RUNWAY
SIDE DISCHARGE CONVEYOR
CONVEYOR FROM BATCH PLANT
TRUSSES SUPPORTED ON SLIP FORMS WITH RAILS FOR CONVEYOR
MATERIALS TOWER
ELEPHANT TRUNK
TOP CONVEYOR
BENT
FEEDER CONVEYOR (AS REQ'D)
SIDE DISCHARGE CONVEYORS SUPPORTED ON TRUSSES
RADIAL SPREADER CONVEYOR
PARTIAL PLAN
DEPARTMENT OF THE ARMY
WATER RESOURCES DEVELOPMENT PROJECT
TRUMBULL LAKE
PEQUONNOCK RIVER BASIN CONNECTICUT
CONTINUOUS SLIP FORM OPERATION
PHASE II (SLIP & CANTILEVER)



SECTION THRU MONOLITH NO. 6



PLAN



SECTION A-A

J. F. CAMELLERIE, P.E.

DEPARTMENT OF THE ARMY

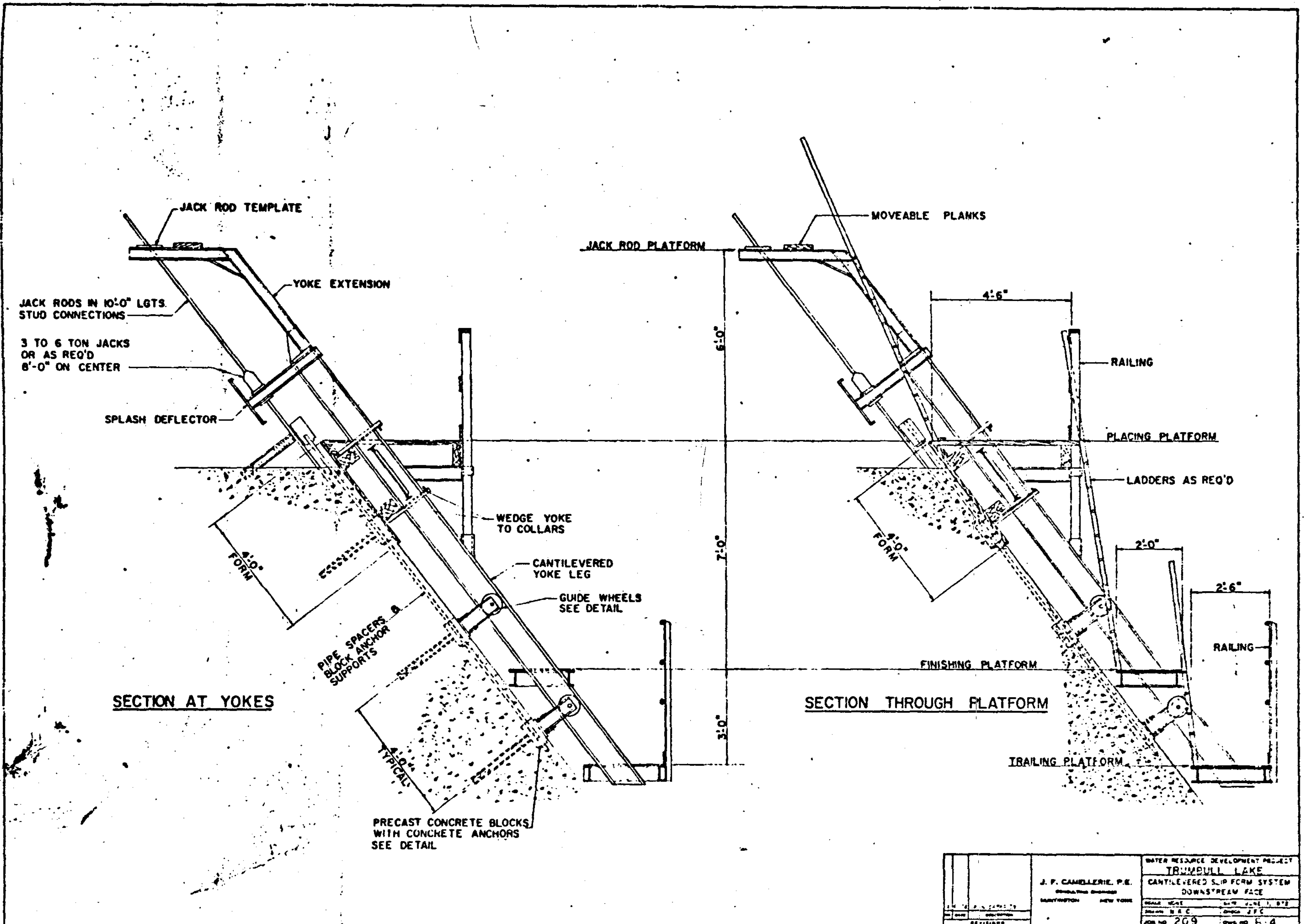
JFC	BB	JFC

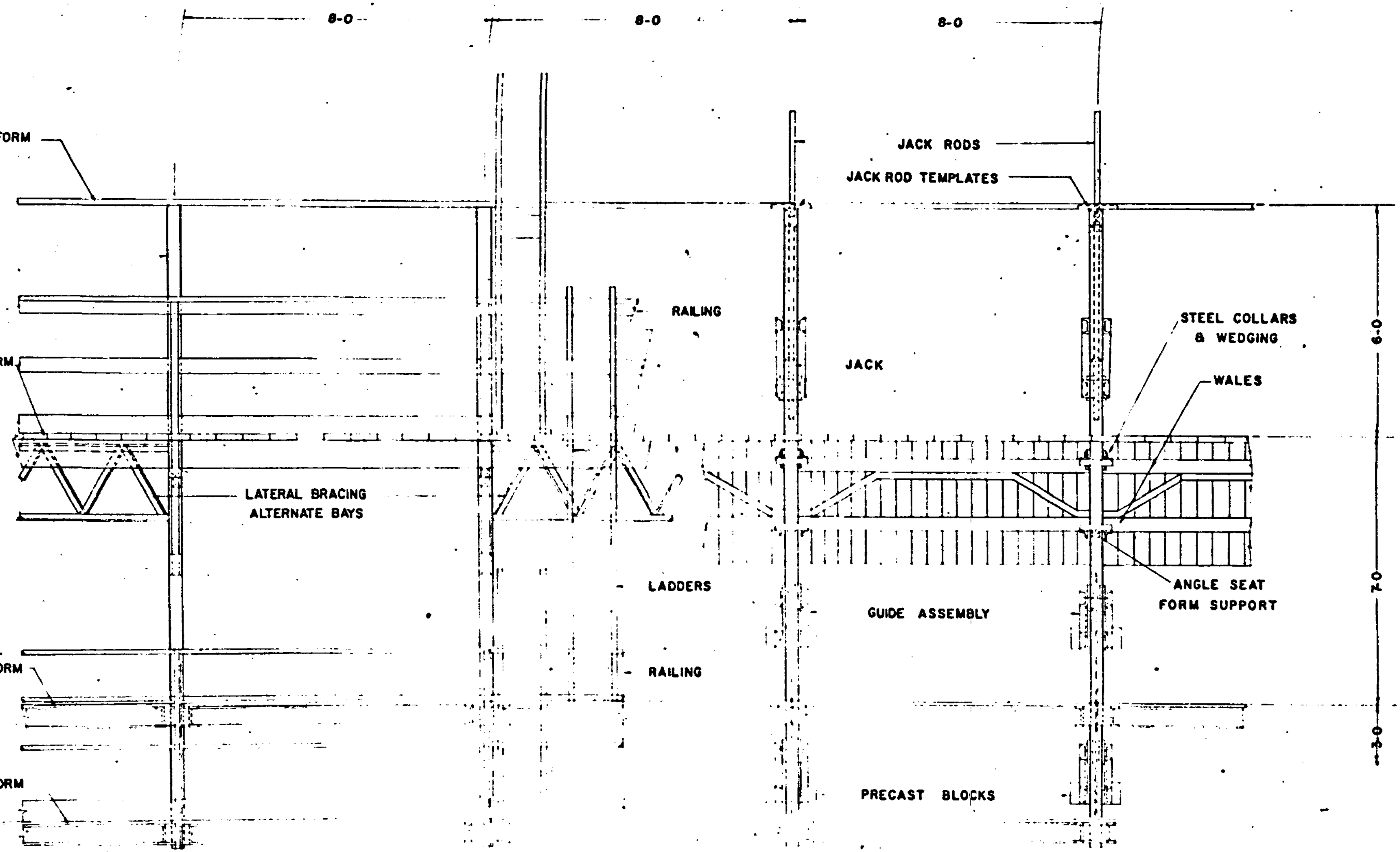
WATER RESOURCES DEVELOPMENT PROJECT
TRUMBULL LAKE
PEQUONNOCK RIVER BASIN CONNECTICUT

CONTINUOUS SLIP FORM OPERATION
CONCRETE DISTRIBUTING SYSTEM

SCALE NONE

209-R-3

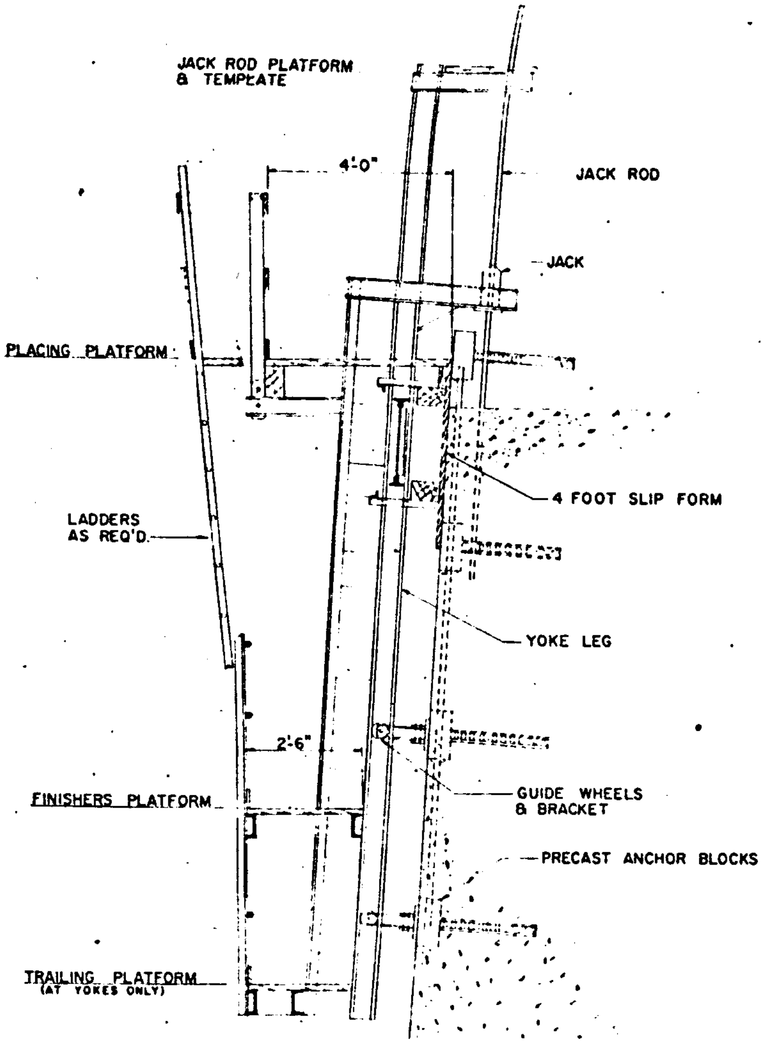

JACK ROD TEMPLATE
YOKE EXTENSION
JACK RODS IN 10'-0" LGTS.
STUD CONNECTIONS
3 TO 6 TON JACKS
OR AS REQ'D
8'-0" ON CENTER
SPLASH DEFLECTOR
WEDGE YOKE
TO COLLARS
4'-0" FORM
CANTILEVERED
YOKE LEG
GUIDE WHEELS
SEE DETAIL
PIPE SPACERS &
BLOCK ANCHOR
SUPPORTS
4'-0" TYPICAL
PRECAST CONCRETE BLOCKS
WITH CONCRETE ANCHORS
SEE DETAIL
SECTION AT YOKES
MOVEABLE PLANKS
JACK ROD PLATFORM
4'-6"
6'-0"
RAILING
PLACING PLATFORM
LADDERS AS REQ'D
4'-0" FORM
7'-0"
2'-0"
2'-6"
RAILING
FINISHING PLATFORM
3'-0"
SECTION THROUGH PLATFORM
TRAILING PLATFORM
J. F. CAMELLERIE, P.E.
NEW YORK
WATER RESOURCE DEVELOPMENT PROJECT
TRUMBULL LAKE
CANTILEVERED SLIP FORM SYSTEM
DOWNSTREAM FACE
JOB NO 209
DWG NO R-4



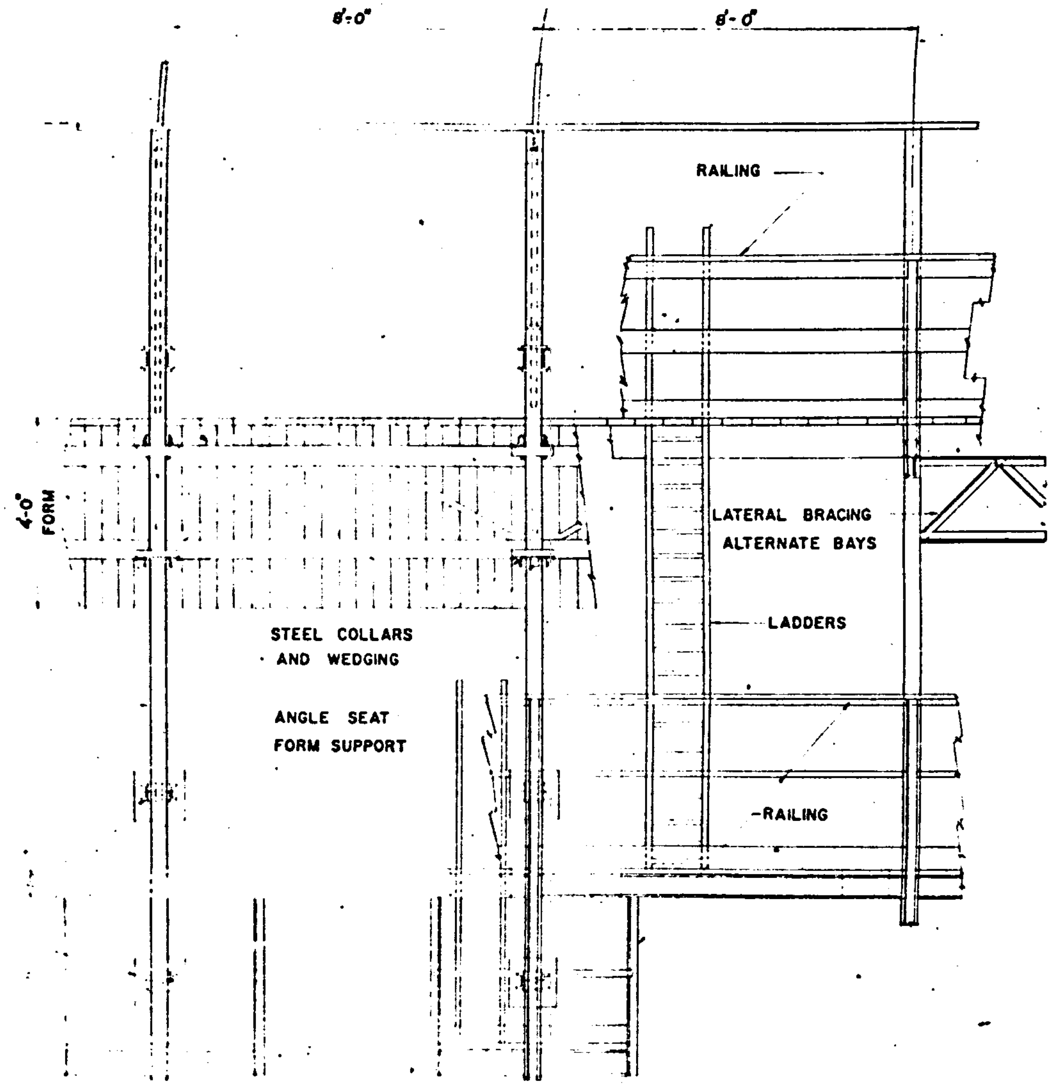
FRONT VIEW OF SLIPFORM & SCAFFOLDING

DOWNSTREAM FACE

REVISIONS	J. F. CAMELLERIE, P.E.
WATER RESOURCES DEVELOPMENT PROJECT	TRUMBULL LAKE
CANTILEVERED SLIP FORM SYSTEM DOWNSTREAM FACE	
SCALE NONE	DATE JUNE 1 197[illegible]
DRAWN H.E.C.	CHECKED J.F.C.
JOB NO. 209	DWG NO. R-5

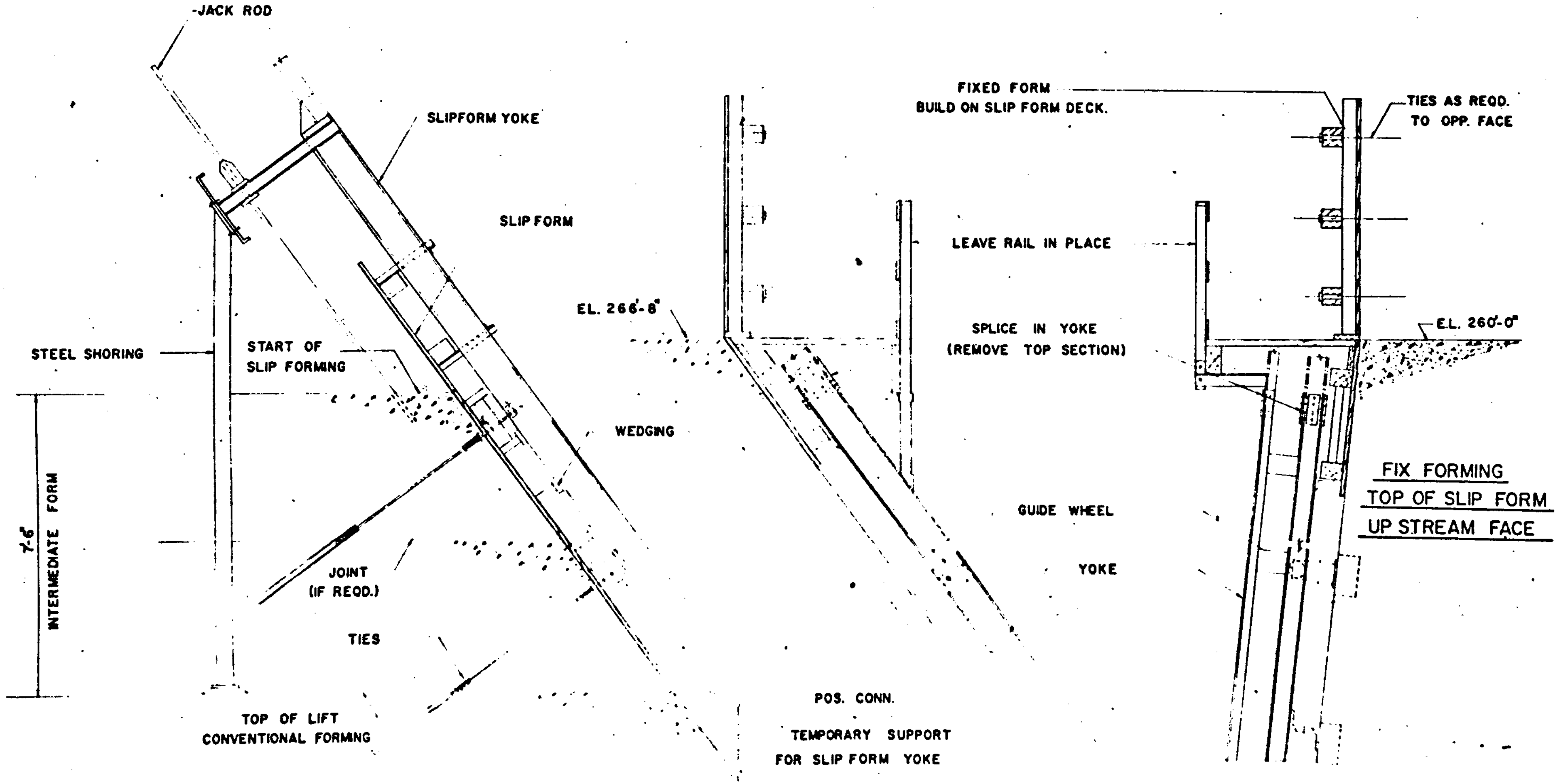


SECTION THROUGH FORM



FRONT ELEVATION

J. F. CAMELLERIE, P.E.	WATER RESOURCES DEVELOPMENT PROJECT TRUMBULL LAKE
	CANTILEVERED SLIP FORM SYSTEM UPSTREAM FACE
	SCALE: NONE / DATE: JUNE 1, 1976
	DRAWN: N K
REVISIONS	JOB NO. 209

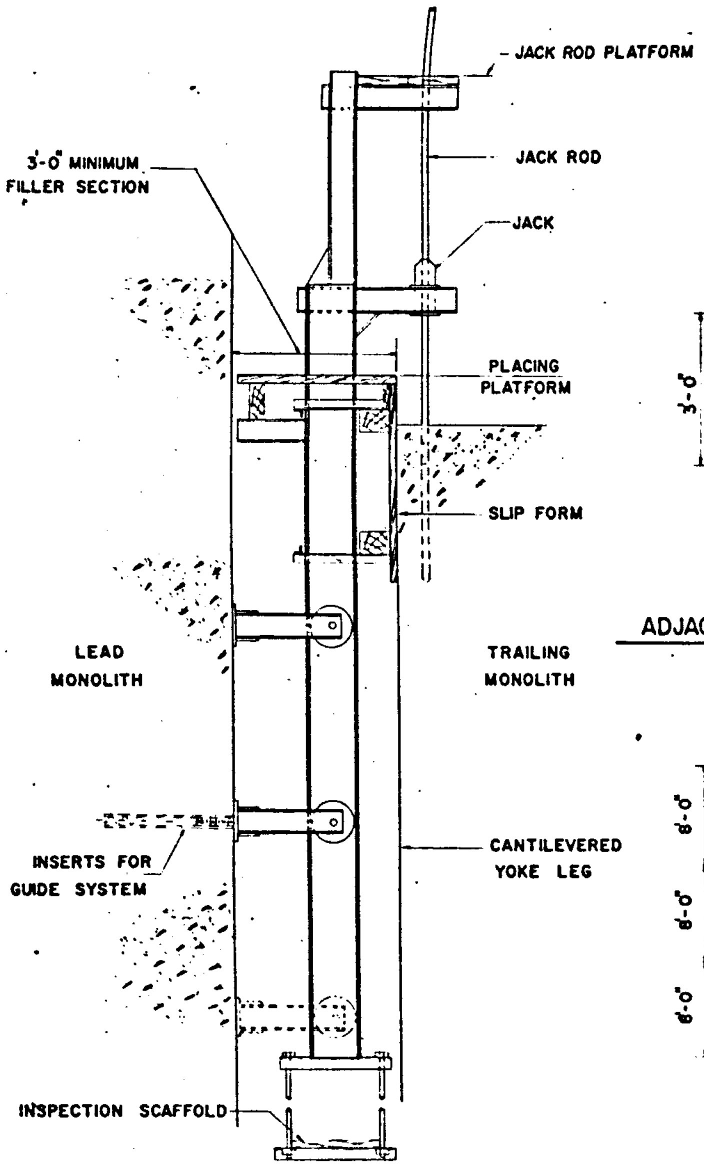


INTERMEDIATE FORMING
DOWNSTREAM FACE
UPSTREAM FACE SIMILAR

FIX FORMING
TOP OF SLIP FORM
DOWNSTREAM FACE

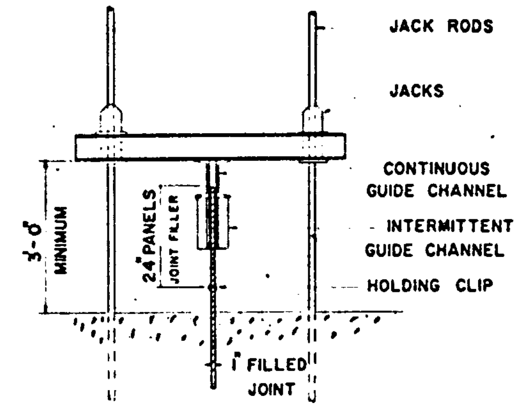
FIX FORMING
TOP OF SLIP FORM
UP STREAM FACE

J. F. CAMELLERIE, P.E.	WATER RESOURCES DEVELOPMENT PROJECT TRUMBULL LAKE
	CANTILEVERED SLIP FORM SYSTEM START & TOP
REVISIONS	SCALE NONE — DATE JUNE 1, 197
	DRAWN N K C — CHECKED J F C
	JOB NO. 209 — DWG NO. R-7



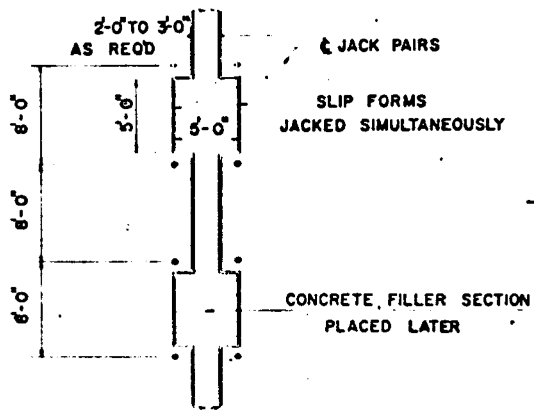
TRANSVERSE JOINTS WITH FILLER SECTION

MONOLITHS NOT PLACED CONCURRENTLY



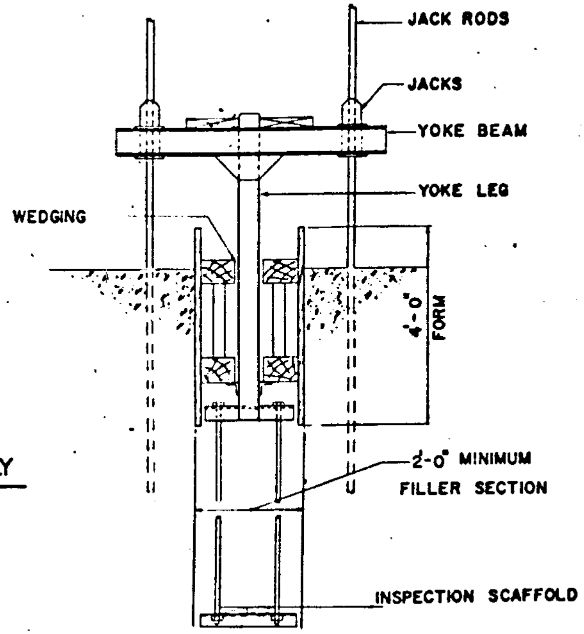
PREMOULDED JOINT FILLER

ADJACENT MONOLITHS PLACED CONCURRENTLY



PLAN.

TYPICAL FILLER SECTIONS BETWEEN MONOLITHS



TRANSVERSE JOINT WITH FILLER SECTION

ADJACENT MONOLITHS PLACED CONCURRENTLY

SAFETY PAYS

J. F. CAMELLERIE, P.E.

DEPARTMENT OF THE ARMY

JFC NKC JFC

WATER RESOURCES DEVELOPMENT PROJECT

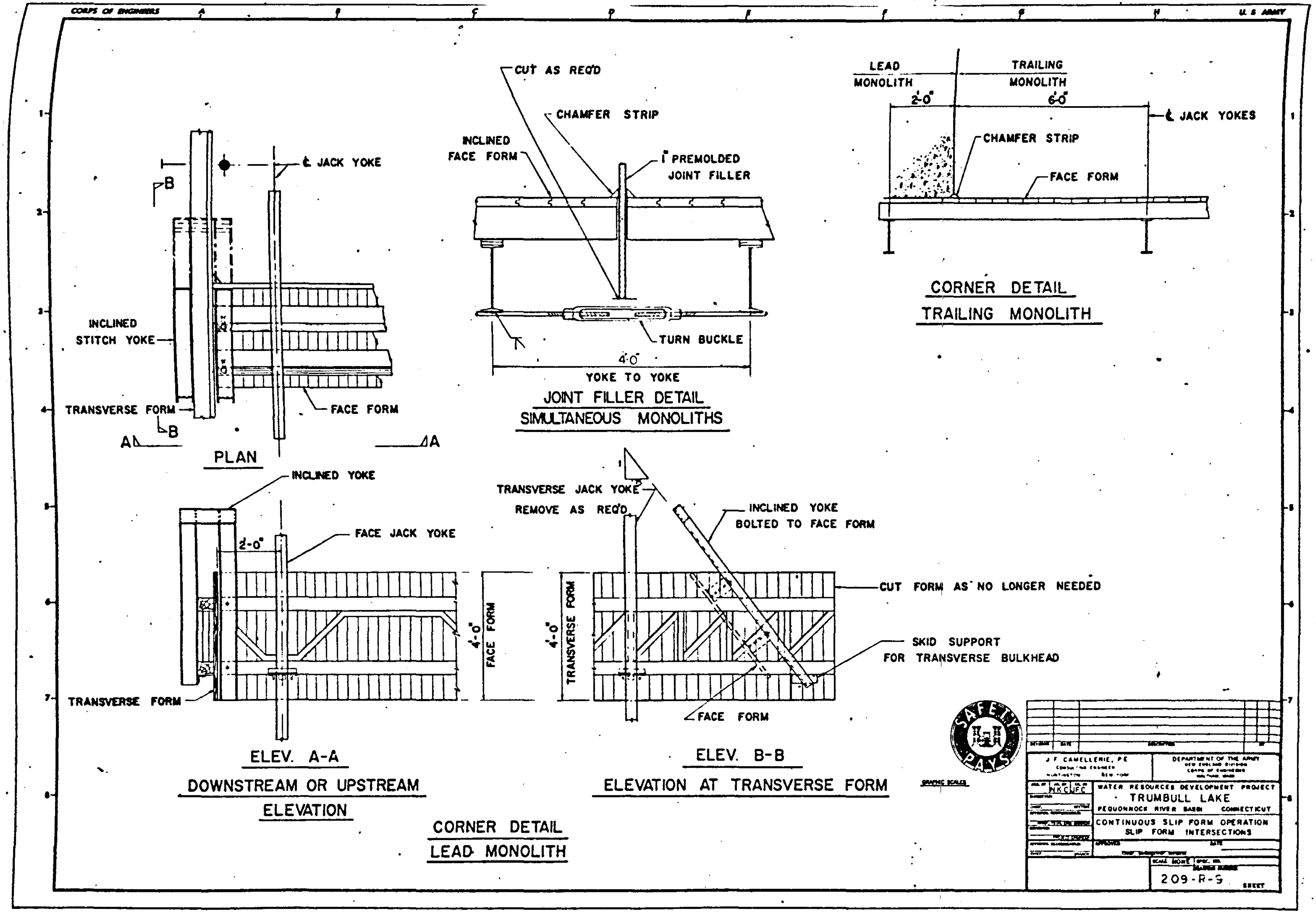
TRUMBULL LAKE

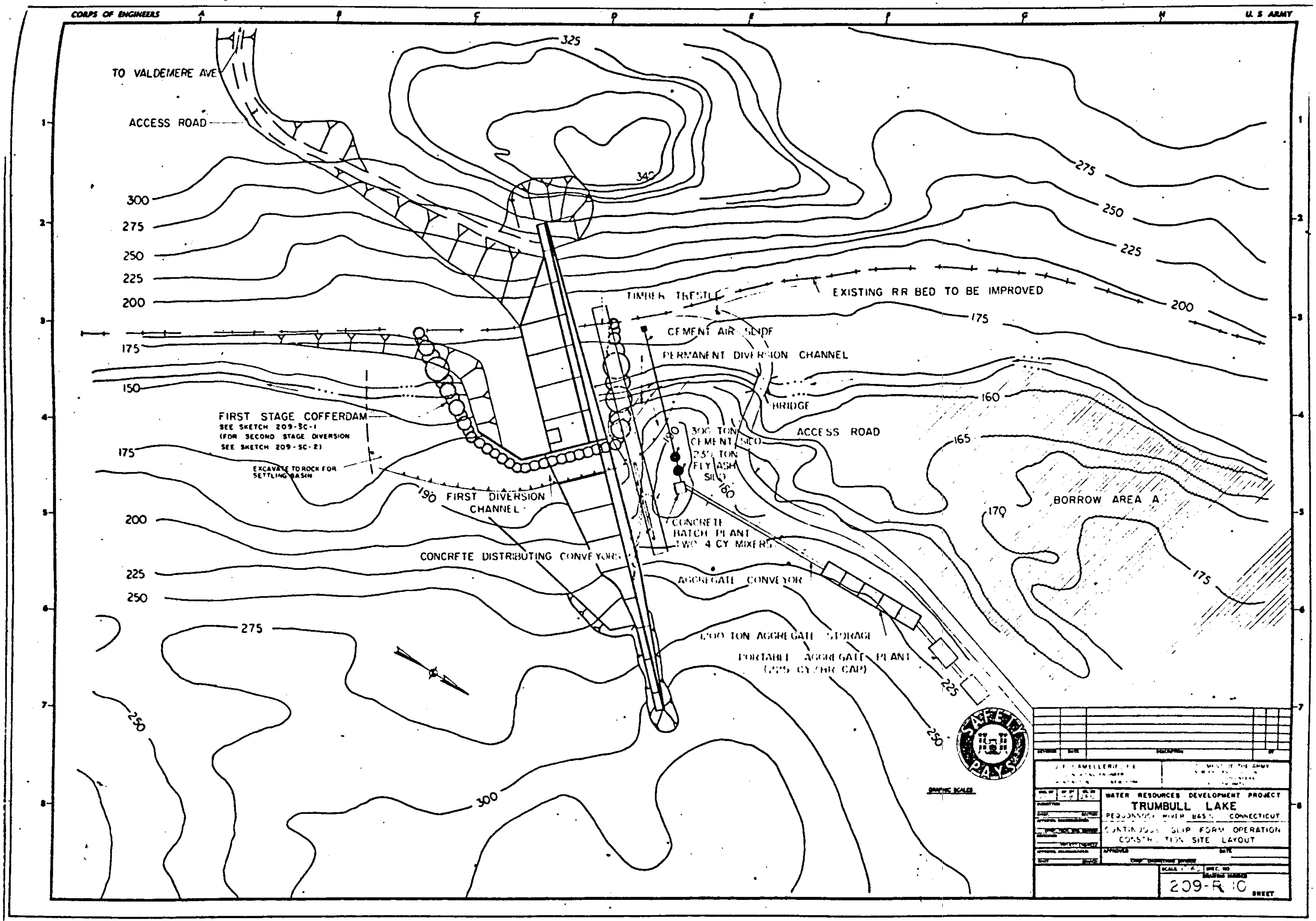
PEQUONNOCK RIVER BASIN CONNECTICUT

CONTINUOUS SLIP FORM OPERATION

TRANSVERSE JOINTS

209-R-8


CORPS OF ENGINEERS
U S ARMY
℄ JACK YOKE
B
INCLINED
STITCH YOKE
TRANSVERSE FORM
FACE FORM
B
A
A
PLAN
CUT AS REQ'D
CHAMFER STRIP
INCLINED
FACE FORM
1" PREMOLDED
JOINT FILLER
TURN BUCKLE
4'-0"
YOKE TO YOKE
JOINT FILLER DETAIL
SIMULTANEOUS MONOLITHS
LEAD
MONOLITH
TRAILING
MONOLITH
2'-0"
6'-0"
℄ JACK YOKES
CHAMFER STRIP
FACE FORM
CORNER DETAIL
TRAILING MONOLITH
INCLINED YOKE
FACE JACK YOKE
2'-0"
4'-0"
FACE FORM
TRANSVERSE FORM
ELEV. A-A
DOWNSTREAM OR UPSTREAM
ELEVATION
TRANSVERSE JACK YOKE
REMOVE AS REQ'D
INCLINED YOKE
BOLTED TO FACE FORM
CUT FORM AS NO LONGER NEEDED
TRANSVERSE FORM
4'-0"
SKID SUPPORT
FOR TRANSVERSE BULKHEAD
FACE FORM
ELEV. B-B
ELEVATION AT TRANSVERSE FORM
CORNER DETAIL
LEAD MONOLITH
SAFETY PAYS
J F CAMELLERIE, P E
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
NKC
JFC
WATER RESOURCES DEVELOPMENT PROJECT
TRUMBULL LAKE
PEQUONNOCK RIVER BASIN CONNECTICUT
CONTINUOUS SLIP FORM OPERATION
SLIP FORM INTERSECTIONS
SCALE NONE
209-R-S
SHEET



CORPS OF ENGINEERS
U S ARMY
TO VALDEMERE AVE
ACCESS ROAD
325
340
300
275
250
225
200
175
150
TIMBER TRESTLE
EXISTING RR BED TO BE IMPROVED
CEMENT AIR SLIDE
PERMANENT DIVERSION CHANNEL
BRIDGE
160
ACCESS ROAD
165
FIRST STAGE COFFERDAM
SEE SKETCH 209-SC-1
(FOR SECOND STAGE DIVERSION
SEE SKETCH 209-SC-2)
EXCAVATE TO ROCK FOR SETTLING BASIN
190 FIRST DIVERSION CHANNEL
180
FLY ASH SILO
CONCRETE BATCH PLANT
BORROW AREA A
170
CONCRETE DISTRIBUTING CONVEYORS
AGGREGATE CONVEYOR
AGGREGATE STORAGE
PORTABLE AGGREGATE PLANT
SAFETY PAYS
GRAPHIC SCALES
WATER RESOURCES DEVELOPMENT PROJECT
TRUMBULL LAKE
CONNECTICUT
209-R 10

CONSTRUCTION COSTS

AND ANALYSIS

R 19

CONSTRUCTION COSTS

The cost of constructing the dam at Trumbull Pond using slip forms and belt conveyors and applying the same rates and pricing methods as used for conventional construction is $6,830,000 - slightly less than that for conventional construction. Actually, the difference is about $185,000 or 2-1/2 percent of the total dam cost.

SEE Cost and Summary Sheets ER-S and ER-1 thru ER-4.

Cost Analysis Sheets ECR-1 thru ECR-10 give a rearranged breakdown of the costs according to work groupings with payroll taxes and insurance included. These cost analysis sheets show both conventional and rapid construction costs and breakdown of direct costs by percentages.

Revised

	J. F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JUN 1'72 PRICED BY	SHEET NO. ER-S
		PROJECT: TRUMBULL LAKE DAM	
		ARCHITECT: NEW ENGLAND DIV., CORPS/ENGRS	

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
SUMMARY RAPID CONSTRUCTION						
SHEET ER-1				2,303,900		691,600
" ER-2				239,500		304,000
" ER-3				694,000		83,200
" ER-4				800,500		586,500
				4,037,900		1,647,300
ESCALATION THRU 1974			2%	80,800	11%	181,200
				4,118,700		1,828,500
PAYROLL, TAXES & INSURANCE					14%	256,000
						2,084,500
						4,118,700
TOTAL COST TO CONTRACTOR						6,203,200
O'HD, PROFIT & CONTINGENCY					8%	496,300
						6,699,500
BID BOND					3/4%	50,500
TOTAL CONTRACT PRICE						6,750,000
VISTA AREA						80,000
TOTAL ITEM 04						6,830,000

SP 10196A

	J. F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JUN 1, '72 PRICED BY		SHEET NO. ER-1		
		PROJECT: TRUMBULL LAKE DAM				
		ARCHITECT: NEW ENGLAND DIV., CORPS/ENGR.				

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
ITEM 04 DAM						
CLEARING & GRUBBING	360,000	S.F.	.05	18,000	-	SUB
DISPOSAL	250,000	S.F.	.03	7,500	-	SUB
EXCAV. UNCLASS.	36,000	CY	2.00	72,000	-	SUB
EXCAV. ROCK	10,000	CY	10.00	100,000	-	SUB
EXCAV. TALUS	14,000	CY	3.00	42,000	-	SUB
HAND CLEANING	70,000	S.F.	.75	52,500	-	SUB
CULVERT PIPE	-	LF	4.50	-	1.50	-
CHAIN LINK FENCE	850	LF	3.50	3,000	2.00	1,700
FOUNDATION GROUTING	50,000	S.F.	.90	45,000	-	-
DIVERSION	-	L.S.		714,000	-	SUB
CEMENT	10,840	TONS	27.20	294,800	-	-
FLY ASH	6,055	TONS	9.00	54,500	-	-
BORROW OPERATION	240,000	TONS	.30	72,000	.29	69,500
AGGREGATE PRODUCTION	231,000	TONS	.53	128,000	.34	78,500
BATCH PLANT OPERATION	127,000	CY	3.44	437,360	1.65	209,000
CONC. PLACING (EXCEPT SLIP FORM)	68,600	CY	1.82	125,000	.71	48,700
VIBRATION "	68,600	CY	.38	26,100	.46	31,600
HOR. JOINT TREATMENT	235,650	S.F.	.05	11,800	.15	35,400
FINISHING (EXCEPT SLIP FORM)	72,000	S.F.	.05	3,600	.28	20,200
CURING "	308,000	S.F.	.01	3,100	.01	3,100
FIXED FORMS: FDN	18,300	SF CA	.80	14,640	3.00	55,000
LIFT STARTERS	5,100	"	.95	4,800	1.17	6,000
CANTILEVER	33,300	"	.95	31,600	1.17	39,000
TRANSV. BULKHEAD	21,600	"	.95	20,500	1.17	25,300
STAIR TOWER	2,300	"	1.50	3,450	3.50	8,050
INTERMEDIATE	7,750	"	.25	1,900	1.00	7,800
SPRAY WALL	800	"	.30	240	1.50	1,200
SLAB (PUMP HSE)	2,470	"	.75	1,850	1.00	2,470
SLAB (TOP)	2,350	"	.25	590	.75	1,760
PUMP HSE. WALLS	7,080	"	.75	5,310	2.00	14,160
PUMP HSE. SHORING	35,800	CU.FT.	.06	2,150	.06	2,150
VERT. SURF. TOP DAM	12,400	SF CA	.25	3,100	1.50	18,600
RETAINING WALLS	7,450	"	.25	1,860	1.00	7,450
TOP CURBS	3,300	"	.50	1,650	1.50	4,950
SP 10196A	R	-22-		2,303,900		691,600

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE Jun 1, 1972 PRICED BY

SHEET NO. EP-2

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. CORPS/ENGR

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
SLIP FORM OPERATION						
SLIDING FORMS	1520	L.F.	7.–	10,600	10.53	16,000
YOKES	192	EA.	210.–	40,300	135.–	26000
JACK RODS 6T.	14,000	L.F.	2.50	35,000	.13	1,800
PLATFORM DECKS	1650	L.F	1.50	2,500	4.–	6,600
RAILING & LADDERS	1650	L.F	4.50	7,500	2.50	4,100
FORM DESIGN	—	—	—	10,000	—	—
SLIDE CREW				—		140,000
FINISHING	74,000	◻'	.05	3,700		IN SLIDE CREW
CURING	74,000	◻'	.01	700		IN SLIDE CREW
FIELD ASSIST ENG	15	DAYS	200	3,000	—	—
FIELD TECHNICIAN	30	DAYS	150	4,500	—	SUB
STRIP FORMS	—	—	—	—	—	26,000
HYDRAULIC PIPING	4000	LF	–	INCL.	.80	3,200
CONVEYORS	58,400	YD	.21	12,500	.12	7,000
MATERIALS TOWERS	4 x 6	MOS	1200	28,800		34,000
CONV. SUPT. BRKT.	7	EA	—	1,300	—	2,300
PRECAST INSERTS	3500	EA	12.50	44,000		IN SLIDE CREW
CONVEYOR SUPPORT TRUSS	6	EA	–	8,500	–	6,500
ELEPHANT TRUNK				500		—
GUIDE WHEEL BRKTS	230	EA	65.00	15,000		IN SLIDE CREW
GALLERIES (FORMED)						
FORMWORK	16,500	◻'CA	.65	10,720	1.75	28,875
STAIRS	1,300	◻'CA	.30	390	1.25	1,625
		R 23		239,500		304,000

SP 10196A

J. F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JUN 1, 1972 PRICED BY SHEET NO. ER-3 PROJECT: TRUMBULL LAKE DAM ARCHITECT: NEW ENGLAND DIV. CORPS/ENGR

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
GENERAL ITEMS						
HYDRAULIC PACKAGE	1	L.S.	–	303.680	–	–
EXTENSION 36" BLOW-OFF	1	L.S.	–	5.000	–	2.000
3½" φ STEEL PIPE	1,160	LF	3.50	4,060	5.50	6,380
2½" φ " "	2,150	LF	1.75	3,760	3.50	7,530
3" DRAINAGE HOLES	2,880	LF	8.10	23,300	-	SUB
1½" GROUT HOLES	9,240	LF	8.00	73,920	—	SUB
6" DRAINS	2,770	LF	1.70	4,720	–	SUB
8" WELLS	1,070	LF	2.25	2,410	–	SUB
PLUMBLINE SHAFT	120	LF	3.00	360	2.50	300
REINF. STEEL	100,000	LB	.15	15,000	.09	9,000
BACKFILL	12,000	C.Y.	–	–	2.00	24,000
ROCK SLOPE PROT	800	C.Y.	3–	2,400	10–	8,000
ROAD GRAVEL	1,200	C.Y.	4.50	5,400	2.50	3,000
BIT. CONC. PAVING	1,200	S.Y.	5–	6,000	–	SUB
ALUM. HAND RAIL	1,000	L.F.	10–	10,000	3–	3,000
COPPER WATER STOP	4,000	L.F.	3.50	14,000	4.50	18,000
ENVIRONMENTAL WORK						
TURBIDITY CONTROL			–	80,000	–	SUB
DUST CONTROL			–	1,000	–	–
NOISE CONT. (EQUIP)			–	80,000	–	–
LANDSCAPE RENEWAL				5,000		2,000
R.R. BED "	270,000	SQ.FT.	.20	54,000	–	SUB
SP 10196A		R 24		694,010		83,210

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE Jun 1, 1972 REV. SKETCH# ER-3A

TRUMBULL LAKE DAM

NEW ENGLAND DIVISION CORPS OF ENGINEERS

HYDRAULIC PACKAGE

Description	Quantity	Unit	Unit Price	Estimated Amount
Gate Valves 16" Manual	2	Ea	$1,000	2,000.00
Gate Valves 16" Automatic	4	Ea	1,600	6,400.00
Gate Valves 24" Manual	4	Ea	3,600	14,400.00
Gate Valves 24" Automatic	4	Ea	4,800	19,200.00
Gate Valves 36" Automatic	1	Ea	6,700	6,700.00
Water Supply Pipe 16"	225	LF	18.00	4,050.00
Water Supply Pipe 24"	200	LF	26.00	5,200.00
Water Supply Pipe 36"	600	LF	48.00	28,800.00
Blow Off Pipe 36"	90	LF	50.00	4,500.00
Double 3' x 4' Gates	1	Job	LS	70,000.00
Intake Screen, 24"	4	Ea	2,000.00	8,800.00
Bulkhead Gate	1	Ea	5,000.00	5,000.00
Gate Vent System	1	Job	LS	5,000.00
Float Well & Accessories	1	Job	LS	3,000.00
Heating & Vent. System	1	Job	LS	5,000.00
Crane & Hoist	1	Job	LS	7,140.00
Diesel Engine	1	Job	LS	10,000.00
Sump Pumps	1	Job	LS	5,000.00
Electric Systems	1	Job	LS	30,000.00
Grounding System	1	Job	LS	4,000.00
Tile Gage	1	Job	LS	4,000.00
Log Boom	1	Job	LS	10,000.00
Water Quality Control	1	Job	LS	3,300.00
Instrumentation	1	Job	LS	15,000.00
Downstream Measuring Weir	1	Job	LS	10,000.00
TOTAL COST - 1971				286,490.00
ESCALATION to 1972 @ 6%				17,189.40
COST IN 1972				303,679.40

R 25

	J. F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JUN 1, 1972 PRICED BY	SHEET NO. ER 4
		PROJECT: TRUMBULL LAKE DAM	
		ARCHITECT: NEW ENGLAND DIV., CORPS/ENGR.	

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
EQUIPMENT						
TIMBER TRESTLE	480	L.F	73⁻	35,000	37⁻	17,800
YARD CRANE	1×12	MOS	4,500	54,300	1500 1200	32,500
CONVEYOR SYSTEM	—	"		INCLUDED IN CONC PLAC		INCLUDED IN CONC. PLACING
HYDRAULIC BOOM CRANES	2×7	"	1500	21,000	1400	19,600
COMPRESSORS	2×7	"	1100	15,400	1300	18,200
UTILITY TRUCKS	2×15	"	800	24,000	940	28,200
PERSONNEL STAIR TOWERS	3×10	"	80	2,400	—	2,000
DOZER	1×15	"	1200	18,000	1330	20,000
	(SUB TOTAL)			(170,100)		(138,300)
FIELD OVERHEAD						
BRIDGE	1	EA.		1,000		5000
IMPROVE R.R. BED	268,000	□'	1.50	402,000		SUB
ACCESS ROAD, VALLEY	72,000	□'	1.00	72,000		SUB
FIELD OFFICES, SHOPS, STORAGE				27,000		3,000
HARDWARE & TOOLS				45,000		—
FUEL & OIL				12,000		—
START-UP & LAYOUT				—		5,000
MIX DESIGNS				1,000		—
CONCRETE TESTING				25,000		SUB
TEMPORARY LIGHTING				3,000		10,000
SANITARY FACILITIES				5,400		SUB
CLEAN-UP				—		20,000
HEATING				20,000		—
PROJECT MANAGER	1 × 117	WKS		—	500	58,500
SUPERINTENDANT	1 × 90	"		—	400	36,000
PROJECT ENGINEER	1 × 80	"		—	400	32,000
CLERKS	2 × 80	"		—	200	32,000
SURVEYORS	4 × 80	"		—	250	80,000
UTILITY MECHANICS	6 × 52	"		—	300	93,600
WATCH MEN	3 × 117	"		—	100	35,100
WINTER PROTECTION				2000		5,000
COMMUNICATIONS				5000		5,000
POWER DISTRIBUTION				10,000		10,000
SP 10196A TOTAL FOR PAGE				800,500		568,500

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE 6.1.72 REV. SKETCH ECR-1

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONNECTICUT

COST ANALYSIS

TOTAL DIRECT COSTS

ITEMS	CONVENTIONAL CONSTRUCTION		RAPID CONSTRUCTION	
	Total Cost	% Direct Cost	Total Cost	% Direct Cost
Cementatious Mat'ls	347,000	9.9	349,300	10.1
Plant & Plant Oper.	1,699,608	48.8	1,607,805	46.6
Cooling	100,600	2.9	100,600	2.9
Conc.Placing & Vib.	134,634	3.8	107,730	3.2
Jnt.Treat.,Finish., & Curing	207,364	6.0	159,108	4.6
Forms	535,658	15.4	659,630	19.1
Misc. Inserts	460,418	13.2	464,678	13.5
TOTAL DIRECT COSTS	3,485,282	100.0	3,448,851	100.0
Site Work	1,614,758		1,603,758	
Environment	281,400		222,280	
Field Overhead	690,960		640,128	
TOTAL COST TO CONTRACTOR - 1972	6,072,400		5,915,017	
Escalation thru 1974	302,320		287,400	
Overhead Profit & Contingency	510,000		496,300	
Bid Bond	52,000		50,500	
TOTAL CONTRACT PRICE	6,936,720		6,749,200	

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONNECTICUT

COST ANALYSIS

CEMENTATIOUS MATERIALS

ITEMS	CONVENTIONAL CONSTRUCTION		RAPID CONSTRUCTION	
	Material	Labor	Material	Labor
Cement	292,000		294,800	
Fly Ash	55,000		54,500	
TOTAL	347,000		349,300	

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE 6.1.72 REV. SKETCH# ECR-3

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONNECTICUT

COST ANALYSIS

PLANT & PLANT OPERATION

ITEM	CONVENTIONAL CONSTRUCTION		RAPID CONSTRUCTION	
	Material	Labor	Material	Labor
Borrow Operation	72,000	69,500	72,000	69,500
Aggregate Prod.	128,000	78,500	128,000	78,500
Batch.Plant Oper.	437,360	222,300	437,360	209,000
SUB-TOTAL	637,360	370,300	637,360	357,000
Cableway	254,000	77,470	-0-	-0-
Concrete Placing	8,000	-0-	125,000	24,300
Vibration	44,400	-0-	26,100	-0-
Slide Crew	-0-	-0-	-0-	36,500
Field Eng.(Slipform	-0-	-0-	3,000	-0-
Field Tech. (")	-0-	-0-	4,500	-0-
Conveyors (")	-0-	-0-	12,500	7,000
Mat'ls Towers (")	-0-	-0-	28,800	34,000
Conv. Sup. Brkt	-0-	-0-	1,300	2,300
Conv. Sup. Truss	-0-	-0-	8,500	6,500
Elephant Trunk	-0-	-0-	500	-0-
SUB-TOTAL	306,400	77,470	210,200	110,600
Equipment	172,800	151,900	170,100	138,300
TOTAL	1,116,560	599,670	1,017,660	605,900
Less Cooling	47,000	47,000	47,000	47,000
TOTAL	1,069,560	552,670	970,660	558,900
Payroll tx & Ins(14%)		77,378		78,246
Labor & Mat. Total		1,699,608		1,607,805

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE 5.1.72 REV. SKETCH# ECR-4

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONNECTICUT

COST ANALYSIS

CONCRETE PLACEMENT & VIBRATION

ITEM	CONVENTIONAL CONSTRUCTION		RAPID CONSTRUCTION	
	Material	Labor	Material	Labor
Concrete Placing		66,000		24,400
Vibration		52,100		31,600
Slide Crew				38,500
TOTAL		118,100		94,500
Payroll tx & Ins (14%)		16,534		13,230
TOTAL		134,634		107,730

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONNECTICUT

COST ANALYSIS

JOINT TREATMENT, FINISHING & CURING

ITEMS	CONVENTIONAL CONSTRUCTION		RAPID CONSTRUCTION	
	Material	Labor	Material	Labor
Horizontal Jnt Treatment	22,000	63,850	11,800	35,400
Finishing	7,300	41,000	3,600	20,200
Curing	4,300	4,300	3,100	3,100
Weekend Over Time	-0-	15,000	-0-	-0-
Slide Crew	-0-	-0-	-0-	30,500
Finishing (Slipform)	-0-	-0-	3,700	-0-
Curing (")	-0-	-0-	700	-0-
Copper Water Stops	14,000	16,000	14,000	18,000
TOTAL	47,600	140,150	36,900	107,200
Payroll tx & Ins (14%)	-0-	19,614	-0-	15,008
LABOR & MATERIAL TOTAL....		207,364		159,108

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONNECTICUT

COST ANALYSIS

FORMS

	CONVENTIONAL CONSTRUCTION		RAPID CONSTRUCTION	
	Material	Labor	Material	Labor
Foundation	14,640	55,000	14,640	55,000
Lift Starters	5,520	15,000	4,800	6,000
Intermediate	-0-	-0-	1,900	7,800
SUB-TOTAL	20,160	70,000	21,340	68,800
Cantilever	46,200	125,600	31,600	39,000
Transv. Blkhead	22,200	60,400	20,500	25,300
Sliding Forms	-0-	-0-	10,600	16,000
Yokes	-0-	-0-	40,300	26,000
Jack Rods	-0-	-0-	35,000	1,800
Hydraulic Piping	-0-	-0-	-0-	3,200
Platform Decks	-0-	-0-	2,500	6,600
Railing & Ladders	-0-	-0-	7,500	4,100
Strip Forms	-0-	-0-	-0-	26,000
Form Design	-0-	-0-	10,000	-0-
Guide Wheel Brakts	-0-	-0-	15,000	-0-
Precast Inserts	-0-	-0-	44,000	-0-
Slide Crew	-0-	-0-	-0-	34,000
SUB-TOTAL	71,860	200,400	217,000	182,000

continued on following page.......

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONNECTICUT

COST ANALYSIS

FORMS - continued

ITEM	CONVENTIONAL CONSTRUCTION		RAPID CONSTRUCTION	
	Material	Labor	Material	Labor
balance forward...	71,860	200,400	238,340	250,800
Spray Wall	240	1,200	240	1,200
Pump House Slab	1,850	2,470	1,850	2,470
Top Slab	590	1,760	590	1,760
Pump House Walls	5,310	14,160	5,310	14,160
Pump House Shoring	2,150	2,150	2,150	2,150
Top Dam	3,100	18,600	3,100	18,600
Ret. Walls	1,860	7,450	1,860	7,450
Top Curbs	1,650	4,950	1,650	4,950
Gallery & Stairs	11,110	30,500	11,110	30,500
Stair Tower	3,450	8,050	3,450	8,050
SUB-TOTAL	31,310	91,290	31,310	91,290
TOTAL	123,330	361,690	269,640	342,090
Payroll tx & Ins (14%)		50,638		47,890
TOTAL Labor & Material......		535,658		659,630

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE 6.1.72 REV. SKETCH # ECR-7

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONNECTICUT

COST ANALYSIS

MISCELLANEOUS INSERTS

ITEM	CONVENTIONAL CONSTRUCTION		RAPID CONSTRUCTION	
	Material	Labor	Material	Labor
Hydraulic Package	303,680	-0-	303,680	-0-
Ext. 36" Blow-Off	5,000	2,000	5,000	2,000
3-1/2" Steel Pipe	4,060	6,380	4.060	6,380
2-1/2" Steel Pipe	3,760	7,530	3,760	7,530
3" Drain Holes	20,750	-0-	23,300	-0-
1-1/2" Grout Holes	73,920	-0-	73,920	-0-
6" Drains	4,150	-0-	4,720	-0-
8" Wells	2,140	-0-	2,140	-0-
Plumb Line Shaft	360	[illegible],300	360	300
Reinforcing Steel	15,000	8,000	15,000	9,000
TOTAL	432,820	24,210	435,940	25,210
Payroll tx & ins. (14%)		3,388		3,528
TOTAL Labor & Material........		460,418		464,678

R 34

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE 6.1.72 REV. SKETCH# ECR-8

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONNECTICUT

COST ANALYSIS

SITE COSTS

ITEM	CONVENTIONAL CONSTRUCTION		RAPID CONSTRUCTION	
	Material	Labor	Material	Labor
Clearing & Grubbing	18,000	-0-	18,000	-0-
Disposal	7,500	-0-	7,500	-0-
Excavation, Unclass.	72,000	-0-	72,000	-0-
Excavation, Rock	100,000	-0-	100,000	-0-
Excavation, Talus	42,000	-0-	42,000	-0-
Hand Cleaning	52,500	-0-	52,500	-0-
Chain Link Fence	3,000	1,700	3,000	1,700
Foundation Grouting	45,000	-0-	45,000	-0-
Diversion	714,000	-0-	714,000	-0-
Backfill	-0-	24,000	-0-	24,000
Rock Slope Prot.	2,400	8,000	2,400	8,000
Road Gravel	5,400	3,000	5,400	3,000
Bit. Conc. Pave.	6,000	-0-	6,000	-0-
Hand Rail	10,000	3,000	10,000	3,000
Bridge	1,000	5,000	1,000	5,000
Improve R.R. Bed	402,000	-0-	402,000	-0-
Access Road, Top	11,000	-0-	-0-	-0-
Access Road, Valley	72,000	-0-	72,000	-0-
TOTAL	1,563,800	44,700	1,552,800	44,700
Payroll Tx & Ins (14%)		6,258		6,258
LABOR & MATERIAL TOTAL		1,614,758		1,603,758

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE 6.1.72 REV. SKETCH # ECR -9

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONNECTICUT
COST ANALYSIS

ENVIRONMENT

ITEMS	CONVENTIONAL CONSTRUCTION		RAPID CONSTRUCTION	
	Material	Labor	Material	Labor
Turbidity Control	90,000	-0-	80,000	-0-
Dust Control (Rds)	1,000	-0-	1,000	-0-
Noise Control	100,000	-0-	80,000	-0-
Landscape Renewal	25,000	10,000	5,000	2,000
Railroad Beds	54,000	-0-	54,000	-0-
TOTAL	270,000	10,000	220,000	2,000
Payroll tx & Ins (14%)		1,400		280
TOTAL LABOR & MAT.......		281,400		222,280

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE 6.1.72 REV. SKETCH# ECR-10

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONNECTICUT

COST ANALYSIS

FIELD OVERHEAD

ITEM	CONVENTIONAL CONSTRUCTION		RAPID CONSTRUCTION	
	Material	Labor	Material	Labor
From Cost Sheet	820,800	620,900	800,500	568,500
Less Items in Site Work	486,000	5,000	475,000	5,000
TOTAL	334,800	615,900	325,500	563,500
Less Equipment	172,800	151,900	170,100	138,300
TOTAL	162,000	464,000	155,400	425,200
Payroll tx & Ins (14%)		64,960		59,528
TOTAL Labor & Material		690,960		640,128

COST ANALYSIS

ANALYSIS OF CONSTRUCTION COSTS

As the savings in plant, placing, vibration and joint treatment are balanced by the increased cost of the forming system, the savings in direct costs is of a minor nature. The increased cost of the forming is brought about by the fact that in effect two completely different forming systems come into play reducing the reuse factors of both conventional cantilever and slip forms.

The savings in the system resulted from reduction of indirect costs such as Field Overhead, Environmental Control and Escalation costs as a result of reducing the construction time. Using Rapid Construction methods, that is to say, the combination of slip forms and belt conveyors, reduces concrete placing time by about 40 working days or just about two calendar months.

COST IMPACT OF DAM AND SITE CONDITIONS

It is interesting to note that such construction cost items as aggregate production, foundation treatment, foundation, abutment and starter forms, accessory structures, "plumbing", site work, excavation, access and stream diversion are captive to the site and basic design and cannot be influenced by innovations in construction technology. In the case of Trumbull Dam, these items amounted to 50 percent of the cost. When one considers that the two and one-half percent savings in total cost is really 5 percent of the area vulnerable to cost reduction the prospects seem brighter for larger dams where the ratio to "untouchables" is better.

COST OF FORMING SYSTEM

As discussed in "Analysis of Cost" above, the reuse factors are rather low for this dam. Actually, only half of the formed surface lends itself to a repetative systemized forming system such as slip forming. The reuse factor for this expensive equipment is only 3-1/2 and the height to be slipped is limited, which means high erection and dismantling costs. In order to explore this idea further a study was made to determine the effect on form costs if

Revised

the contact area lending itself to this system were twice as large and again three times as large. We checked the effect of vertical increase, which saves in both material and erection cost, and horizontal increase which saves only in material cost. The results were as follows (SEE SKETCH ER-A1 thru ER-A11):

	CONVENTIONAL FORMS	SLIP FORMS
Trumbull Pond Cost	$ 2.94/ф'	$ 4.66/ф'
Twice Hor. Increase	2.86	4.00
Thrice Hor. Increase	2.74	3.80
Twice Vert. Increase	2.92	3.26
Thrice Vert. Increase	2.74	2.79

IMPACT OF FORMING SYSTEM ON PLANT AND EQUIPMENT

The cost savings that accrue from the slip form operation do not show up in the forming item but rather in plant and overhead items. Conveyor costs are improved by reducing repositioning of conveyors; batch plant utilization is improved; equipment rentals and field supervision salaries are of shorter duration. Sheets ER-A11 thru ER-A21 study the effects of doubling and tripling the areas lending themselves to slip forming. The results are summarized on sheets 209-SR-18A thru 20 together with forming costs based on cubic yards of concrete formed.

The curves indicate that with increase in height the combined forming-plant-overhead costs favor slip forming at a 60 percent increase in height. With horizontal increase in formed surface, slip forming gains at a very low rate.

Revised

IMPACT OF REDUCED CONSTRUCTION TIME

As a result of the additional 2 months required by the conventional methods the concreting operations are very tightly scheduled with work into November during both 1973 and 1974 and over-run time going into cold weather. The Rapid Construction allows concrete operations to be completed by September or October, both years with over-runs running into October. This capability to better schedule concrete operations ~~relative to climatic~~ conditions has a cost advantage which was not numerically evaluated in this report.

If start of construction is delayed until the beginning of 1973, this Rapid Construction may be able to pick up savings over Conventional Construction similarly delayed as follows:

50% of labor in 1973 at 8% escalation 4.0%

50% of labor in 1974 at 14% escalation 7.0%

TOTAL 11.0%

75% of Purchases in 1973 at 8% escalation........ 6.0%

25% of Purchases in 1974 at 12% escalation........3.0%

TOTAL 9.0%

The equivalent escalation for conventional construction going into 1975 is 13 and 10 percent respectively -(SEE conventional construction report).

This represents a saving of:

2% labor at $2,000,000	$40,000
1% material at $4,000,000	40,000
	$80,000

Construction cost will be increased over a 1972 letting by 7% x $4,000,000 or $280,000.

 Revised

COST OF CONVEYOR SYSTEM

The use of conveyors including the material hoist towers and slip form supports costs $300,800 including payroll taxes and insurance. The cable way operation runs $350,000 or $50,000 more than the conveyors. The 24 inch conveyor sizing is based on 6 inch aggregate. If the maximum aggregate size were reduced to four inches, sixteen inch conveyors may be used to furnish the required capacity of 160 yards per hour. This would reduce conveyor cost by 30 percent of equipment cost or $137,500 x .3 or $41,000. Including escalation, overhead and profit the savings are $43,000, using the 24 inch conveyors with an additional $45,000, if four inch aggregate were used.

The use of four inch aggregate would increase the amount of portland cement required by, say - 5 percent or approximately $20,000, leaving the savings of going to four inch aggregate at $25,000. There are additional advantages that accrue from lighter weight equipment which we assigned no monetary value to.

COST OF CEMENTATIOUS MATERIALS

Savings in this area can be effected only by design and mix changes. Generally speaking, a thin layer of very high cement content concrete on the upstream face with the rest of the concrete at extremely low cement content and maximum flyash substitution is a direction for saving.

PLANT AND PLANT OPERATION

The plant cost for aggregate production, batching and placing (nearly half the total direct costs) is captive between the volume of concrete on one hand and the construction schedule on the other. The use of conveyors, compression of construction schedule and improved utilization did effect a savings of $95,000 in this area but this is only a cost reduction of 5-1/2 percent. In order to make more significant cost reductions in this important area, the volume of concrete placed must be reduced. This militates against gravity dams. The use of prestressed rock anchors may have merits in this area.

CONCRETE PLACING AND VIBRATION

A savings of 20 percent was made in this area due to the better spreading abilities of the conveyor system, especially in the slip form placements. Actually, the savings was greater but some of the man hour savings went into premium time for shift work.

HORIZONTAL JOINT TREATMENT

The use of slip forming has reduced the number of horizontal joints and therefore the cost of joint treatment significantly. With other valley cross-sections this decrease can be much greater. The reduction in difficulties and "agony" connected with this work cannot be assigned a numerical value.

MISCELLANEOUS INSERTS

These ran slightly higher because of premium pay during slip operation.

Revised

SUMMARY, RECOMMENDATIONS

AND

DISCUSSION OF ADDITIONAL MODIFICATIONS

SUMMARY

The most effective application of rapid, economical construction methods to the dam at Trumbull lies in the combined use of slip forming and conveyor systems. This results in a time savings of two months and a minimum cost saving of $185,000. Because of the size of this dam and the configuration of the valley, the application of innovative construction techniques was limited.

Tests at the Water Experiment Station in Vicksburg, Mississippi indicate no serious problems in the use of slip forms with mass concrete.

The equipment and skills required for constructing this dam by the methods recommended are readily available in the industry.

Revised

REVISIONS REQUIRED TO SPECIFICATIONS TO ALLOW USE OF THE SYSTEM DESCRIBED

1- In order to meet slip form requirements, exterior mass concrete will be required on both upstream and downstream faces of the dam but not on the monolith interfaces.

2- Permit concrete placement of full height of monoliths without horizontal joints.

3- Delete maximum height difference requirement between adjacent monoliths. Insulation as specified in Paragraph 16 "Special Protection", page 73 of guide specification CE-1401.01 may be required in project specifications.

4- Permit conveying of 6 inch aggregate by conveyors.

Revised

RECOMMENDATIONS

1- It is recommended that the use of 4 inch maximum size aggregate be given careful consideration as the use of six inch aggregate required placements of eighteen inches in depth. Allowing two hours between successive placements obtains a minimum placing rate of nine inches per hour. Considering the low strength gain of the mass concrete maintaining such a rate may be impossible in cold weather using the slip form system. In addition, the small aggregate will reduce problems and possibly sizing in all handling equipment as well as number of sizes stored.

2- The extension and gating of the overflow conduit is recommended to enable inclusion in stream diversion scheme.

3- It is highly desirable to implement a research and development program to develop a set regulated shrinkage retarded cement of medium early strength to be used as exterior mass concrete to allow more rapid construction and at the same time reduce shrinkage and thermal problems.

4- American contractors are traditionally conservative. It is recommended, therefore, that a promotional program be implemented to increase contractor enthusiasm and to allay fear of innovations.

5- The following design modifications are suggested as a means of achieving additional savings:

a- The gallery layouts be oriented in elevation to the horizontal joints so that the support system can be simplified and systematized.

b- That all sloped sections of the gallery be at one slope to enable reuse of forms and systematizing in general. Drawing 209-RM-1 shows two such layouts related to the jointing and using 45 degrees for all inclined sections. NOTE the horizontal to inclined transition sections become standardized.

c- It is suggested that the transition from sloped surfaces to the vertical surfaces at the top of the dam be made at the same elevation on both faces of the dam and related to lift modules.

d- The five foot vertical section at the bottom of the downstream face is extremely difficult to form. If possible this vertical section should be eliminated.

e- Minimizing or eliminating the overhang of the roadway at the top of the dam (at the expense of additional concrete if necessary) will reduce cost in this area.

f- An alternate for precasting the spray wall may be desirable as it will allow the unbroken use of the standard cantilevered forms.

DISCUSSION OF ADDITIONAL

MODIFICATIONS TO PRESENT

DESIGN TO IMPROVE ECONOMICS

R 49

CONTINUOUS CONSTRUCTION

Continuous construction, that is to say the partial or complete elimination of vertical bulkheads dividing the dam into monoliths has often been suggested by knowledgable people in this field. The slip form system suggested for use at Trumbull Lake is one of the several arrangements possible and was not intended to rule out any other sequence or monolith combination. If the requirement for subdivision into monoliths is removed, it is possible to slip form large sections of the dam at one time using the slip form - belt conveyor combination. In order to study this possibility we decided to determine the cost of slip forming on a continuous basis a section of the dam comprising monoliths 4 thru 10 (420 lineal feet) starting at elevation 185'-0". In doing this, we neglected stream diversion problems and planned on placing concrete at a rate of 4 inches per hour (half the rate used in the original study). This slow rate keeps the required plant size down to a 160 yard/hour capacity, and is better suited to the slow strength pick-up of the concrete, making the use of less expensive anchors possible.

The cost of this construction is $6,616,000 as shown on cost sheets EM-S and EM-1 thru 4. This represents a savings of $134,000 from slip forming by monoliths and $321,000 from conventional construction. This saving accrues from elimination of bulkhead forming and a four week reduction in construction time. This saving was reduced by the added plant cost of forms and conveyors to do the work in one operation. A variation of this alternate may be doing two or three monoliths at a time resulting in intermediate savings. Naturally, the inclusion of stream diversion by keeping down monolith 5 will reduce the savings very seriously while on higher dams the savings would be enhanced.

IMPACT OF NO-SLUMP CONCRETE

Continuous construction utilizing no-slump concrete is a possibility worthy of consideration. Drawing 209-RM-4 shows such a construction with the exterior mass concrete as normal slump concrete. The normal slump concrete is required at the faces because of the difficulty of compacting the no-slump concrete with hand vibrators.

Revised

In tests conducted by the Tennessee Valley Authority under the direction of R. W. Cannon, a mix having a slump of under one-half inch was successfully placed and compacted using trucks and a vibratory roller. The mix consisted of 94 lbs of Portland Cement, 130 lbs of fly ash, 3 inch maximum size crushed limestone and water reducing and air entraining admixtures.

On the Trumbull Site, truck hauling is not feasible, but the conveyor system devised is entirely adequate and spreads very uniformly. Vibratory rollers may be used in the 420 foot long section without problems. The no-slump concrete is placed in convenient stable layers and the areas between the no-slump concrete and the forms is then filled with normal concrete before placing the next layer of no-slump.

The only cost areas effected by this procedure as compared to continuous placing using low slump concrete are cementatious materials and vibration. These savings, as worked out on our cost sheet EM-S-5 is as follows for this particular situation:

Cementatious Material......	$48,500
Vibration	9,500
TOTAL	$ 58,000

The switching back and forth between no-slump and low-slump concrete will create some hardship on the batch plant and conveying operations but it is felt that our plant is capable of absorbing the difficulties without cost increases.

CONTINUOUS MIXER PLANT

The yardage and rate of placing requirements for this particular project do not warrant consideration of a continuous type of mixer plant. The use of two 4 yard mixers is not only adequate, it provides the capability of continuing operations with one mixer if the other mixer temporarily breaks down. An important consideration in using a continuous type mixing plant is the lead time for design and procurement.

PLANT PLACED ON MONOLITH

Placing a plant directly on the monoliths presents some problems and in this particular situation no advantages. Conveying materials to the moving plant presents a problem because of the constantly changing elevation, but this problem is not too serious as dry aggregates can be raised in bucket elecators when conveyor inclines become too steep and dry aerated cement can be pumped vertically. The conveying systems must of course, have flexibility designed into the layout. A hydraulically activated support tower will also have to be incorporated into the plant. On the positive side, the materials hoist towers can be eliminated; raising dry materials is always more desirable and less expensive than raising wet concrete.

The two serious impediments are those which occur at the base and at the top of the dam construction. Initially, a concrete supply is required before sufficient structure is available to support the plant on the monoliths. It is possible to set the plant on a tower supported directly on rock with a pick-up arrangement as the work progresses. This can be done when conditions warrant the expense and possibly delay involved and when the well, left to be filled in later, is not objectionable.

At the top, the dimension of the dam is greatly reduced, in this case to ten feet. The small depth of the dam as well as the constantly changing dimension offer physical problems to the support of the plant as well as to distribution.

It is conceivable that for larger dams of a different design a plant can be mounted on the monoliths. Gravity dams do not present much hope in this direction.

PRECAST, LEAVE-IN-PLACE, CONCRETE FORMS

This type of form has been used in Europe and some success was claimed for this type of forming. Leave-in-place forms offer two major advantages: saving of stripping time and a guaranteed good surface. They are at least as difficult to place as wood or steel cantilever forms and require high capacity cranes on a continuous basis. In addition, a precast yard must be set up on the site and a handling system must be designed to transport the forms from the casting yard to the crane pickup point. As an alternate, these forms may be obtained from an established precast yard and transported at some cost in trucking and annoyance to nearby communities.

The most important concept that must be kept in mind is that only a relatively small number of steel forms need be brought to the monoliths from their point of fabrication. After their first installation the movements are mostly vertical by hand, davits, jacks or very light duty jacks; there is a minimum of horizontal movement. The form weight is half the weight of the precast panels. On the other hand, each and every precast form panel, that is to say, a very large number of precast panels must be transported from their point of fabrication to the point of installation. This incolves expensive horizontal logistics.

In addition, precast panels have the same anchor problems related to hydrostatic pressures from concrete that all other forms have; this pressure militates in favor of heavier sections, heavy reinforcement to take cantilever stresses from anchors in the lift below and reinforcement for handling stresses during transport. Add to this the cost of lifting inserts and adjustment devices and you have a fairly expensive form. Again, you do save stripping.

Light weight concrete is often used to reduce weight and thermal stresses. The handling savings accrued from using lightweight concrete will probably be more than offset by the complications resulting from handling a different family of aggregates than are being batched for the in-situ concrete.

Two systems of precast concrete forms were considered as part of this study; one a checker-board system spanning laterally and vertically and well suited to continuous operations; the other a typical cantilever system. These systems are shown on sheets EM-F1, EM-F2 and EM-S17 thru EM-S22.

The cost of implementing these systems at Trumbull are $295,000 and $335,000 respectively. The cost of using standard cantilever forms is $172,000.

PRECAST GALLERIES

The relative economy of precast concrete galleries versus forming the galleries in place was investigated for this particular dam. Two arrangements were used as shown on Drawings 209-RM-1 & RM-2.

Arrangement A envisions channel sections with pouring ports in the roof which rest on support beams blocked or shimmed on the top of a concrete lift. The trough is formed by separate rectangular beams also resting on the support beams.

Arrangement B is oriented to have the top of the support beam at the top of a concrete lift to act as a screed and be in position to receive the channel section forming the roof and walls of the gallery which will be placed in the next lift. This arrangement requires support to the top of the next lower lift and a full precast trough. As an alternate to using the precast columns, steel trestles may be used to support the support beam to exact elevation.

In both cases standardization of sections and simplicity of forming was given serious consideration. A casting yard was assumed to the northeast of the batch plant with a small crane and a flat bed trailer for handling the sections. Erection was assumed to be handled by the three cranes included in the general equipment item and not picked up here.

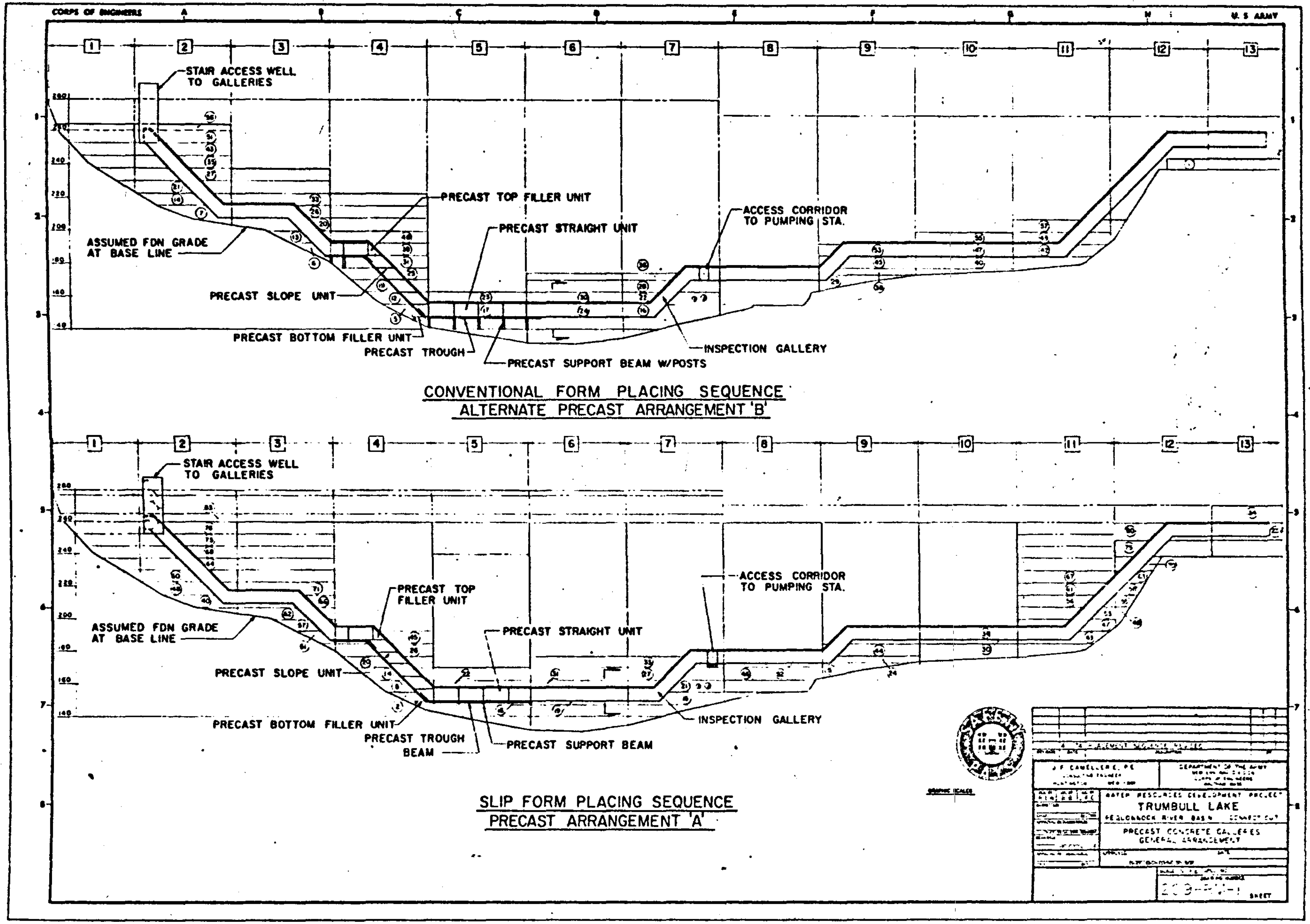
The total cost for casting and erecting the galleries in precast sections as shown on cost sheets EM-G, EM-S6 thru S17 is $59,400 not including pertinent percentages. The cost of forming the galleries is $41,600.

SUMMARY

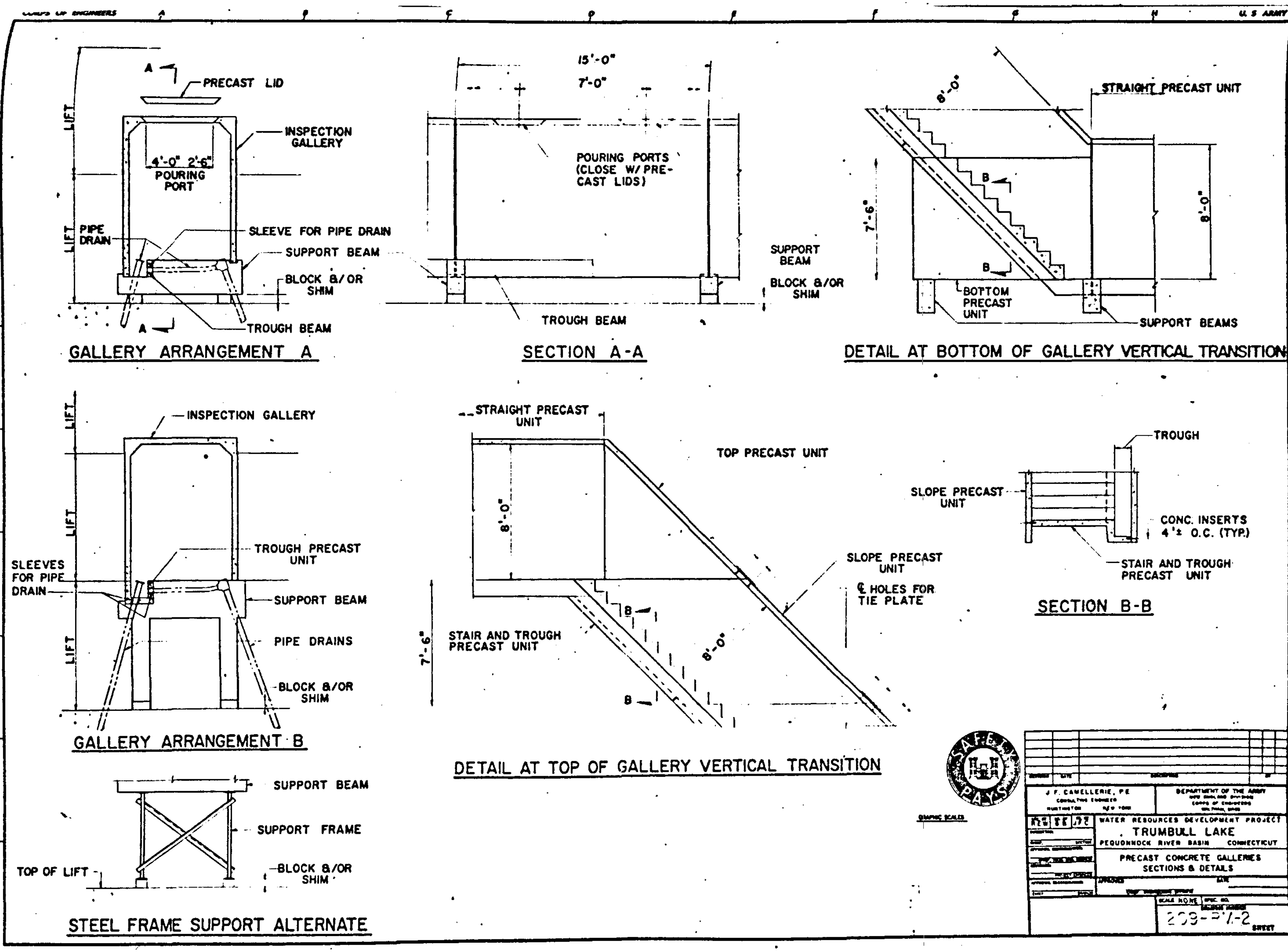
The amount of money that may be saved by applying advance construction techniques to the building of a small gravity dam such is the one at Trumbull Lake, is limited by design and site conditions to less than ten percent.

By using slip form construction omitting vertical joints to the extent possible, substituting belt conveyors for a cableway, reducing aggregate size and using no-slump concrete about $400,000 may be saved. This represents approximately 6 percent of the total cost.

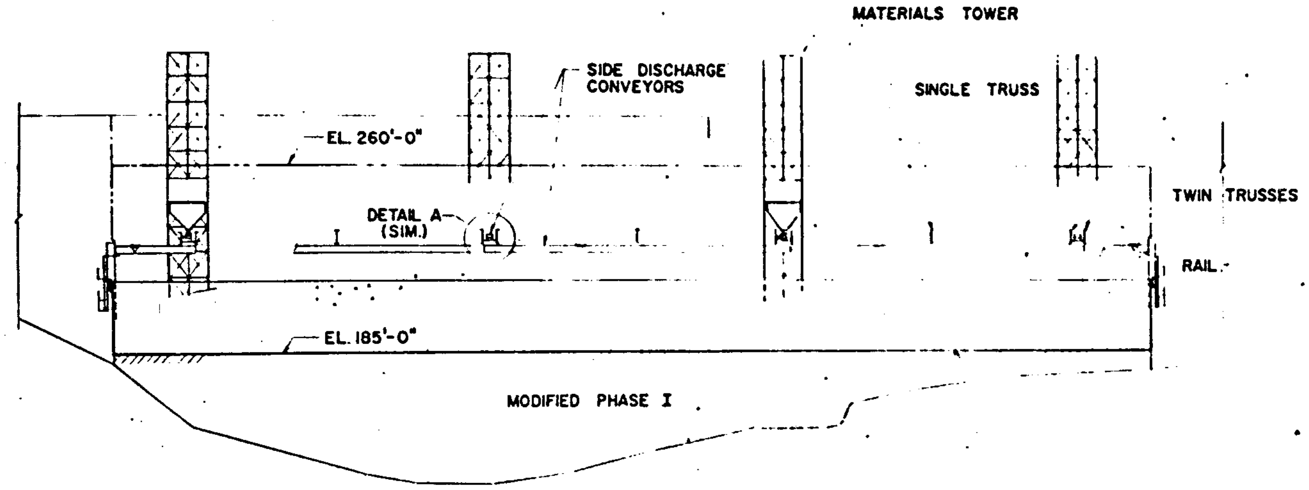
The opportunity for savings would obviously be greater on larger dams and in some instances dams having different configurations. To effect savings beyond ten or fifteen percent, radical design changes must be considered using structural concrete with or without low cement fills.



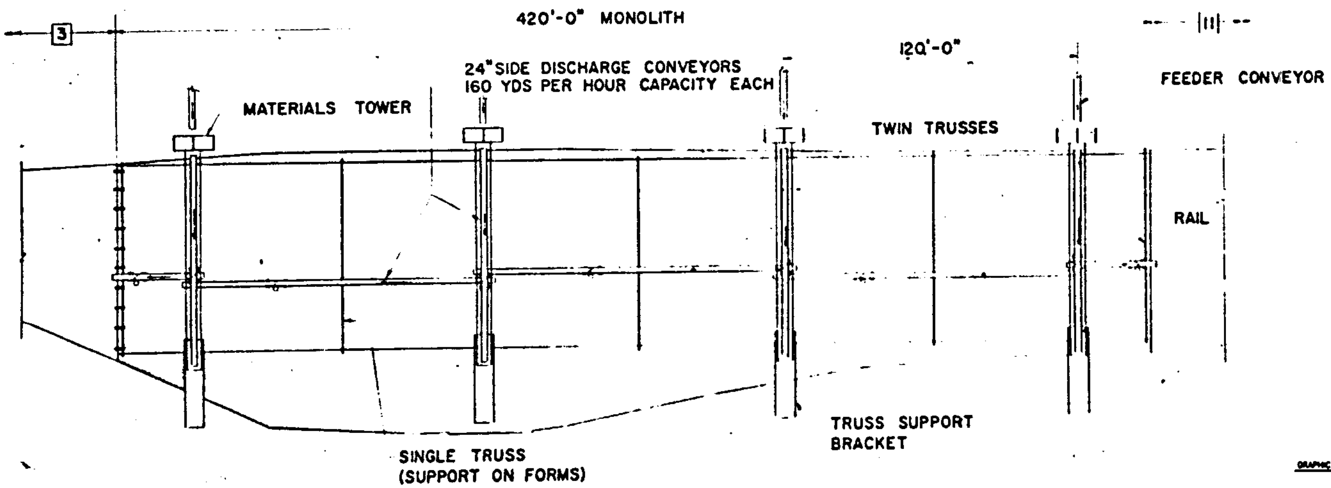
CORPS OF ENGINEERS
U.S. ARMY
STAIR ACCESS WELL TO GALLERIES
PRECAST TOP FILLER UNIT
PRECAST STRAIGHT UNIT
ACCESS CORRIDOR TO PUMPING STA.
ASSUMED FDN GRADE AT BASE LINE
PRECAST SLOPE UNIT
PRECAST BOTTOM FILLER UNIT
PRECAST TROUGH
PRECAST SUPPORT BEAM W/POSTS
INSPECTION GALLERY
CONVENTIONAL FORM PLACING SEQUENCE
ALTERNATE PRECAST ARRANGEMENT 'B'
STAIR ACCESS WELL TO GALLERIES
PRECAST TOP FILLER UNIT
PRECAST STRAIGHT UNIT
ACCESS CORRIDOR TO PUMPING STA.
ASSUMED FDN GRADE AT BASE LINE
PRECAST SLOPE UNIT
PRECAST BOTTOM FILLER UNIT
PRECAST TROUGH BEAM
PRECAST SUPPORT BEAM
INSPECTION GALLERY
SLIP FORM PLACING SEQUENCE
PRECAST ARRANGEMENT 'A'
DEPARTMENT OF THE ARMY
TRUMBULL LAKE
PRECAST CONCRETE GALLERIES
GENERAL ARRANGEMENT
SHEET


U S ARMY
PRECAST LID
INSPECTION GALLERY
4'-0" 2'-6"
POURING PORT
LIFT
PIPE DRAIN
SLEEVE FOR PIPE DRAIN
SUPPORT BEAM
BLOCK &/OR SHIM
TROUGH BEAM
GALLERY ARRANGEMENT A
15'-0"
7'-0"
POURING PORTS (CLOSE W/ PRE-CAST LIDS)
SUPPORT BEAM
BLOCK &/OR SHIM
TROUGH BEAM
SECTION A-A
8'-0"
STRAIGHT PRECAST UNIT
7'-6"
BOTTOM PRECAST UNIT
SUPPORT BEAMS
DETAIL AT BOTTOM OF GALLERY VERTICAL TRANSITION
INSPECTION GALLERY
TROUGH PRECAST UNIT
SLEEVES FOR PIPE DRAIN
SUPPORT BEAM
PIPE DRAINS
BLOCK &/OR SHIM
GALLERY ARRANGEMENT B
STRAIGHT PRECAST UNIT
TOP PRECAST UNIT
SLOPE PRECAST UNIT
℄ HOLES FOR TIE PLATE
STAIR AND TROUGH PRECAST UNIT
DETAIL AT TOP OF GALLERY VERTICAL TRANSITION
TROUGH
SLOPE PRECAST UNIT
CONC. INSERTS 4'± O.C. (TYP.)
STAIR AND TROUGH PRECAST UNIT
SECTION B-B
SUPPORT BEAM
SUPPORT FRAME
TOP OF LIFT
BLOCK &/OR SHIM
STEEL FRAME SUPPORT ALTERNATE
SAFETY PAYS
J. F. CAMELLERIE, P.E.
CONSULTING ENGINEER
HUNTINGTON NEW YORK
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
WATER RESOURCES DEVELOPMENT PROJECT
TRUMBULL LAKE
PEQUONNOCK RIVER BASIN CONNECTICUT
PRECAST CONCRETE GALLERIES
SECTIONS & DETAILS
SCALE NONE
SHEET

CORPS OF ENGINEERS — U. S. ARMY



DOWNSTREAM ELEVATION



PLAN

NOTE: FOR CONVEYOR SUPPORT DETAILS SEE DWG RM-4.

SAFETY PAYS

J F CAMELLERIE, PE
CONSULTING ENGINEER
HUNTINGTON NEW YORK

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS

J F C | B B | J F C

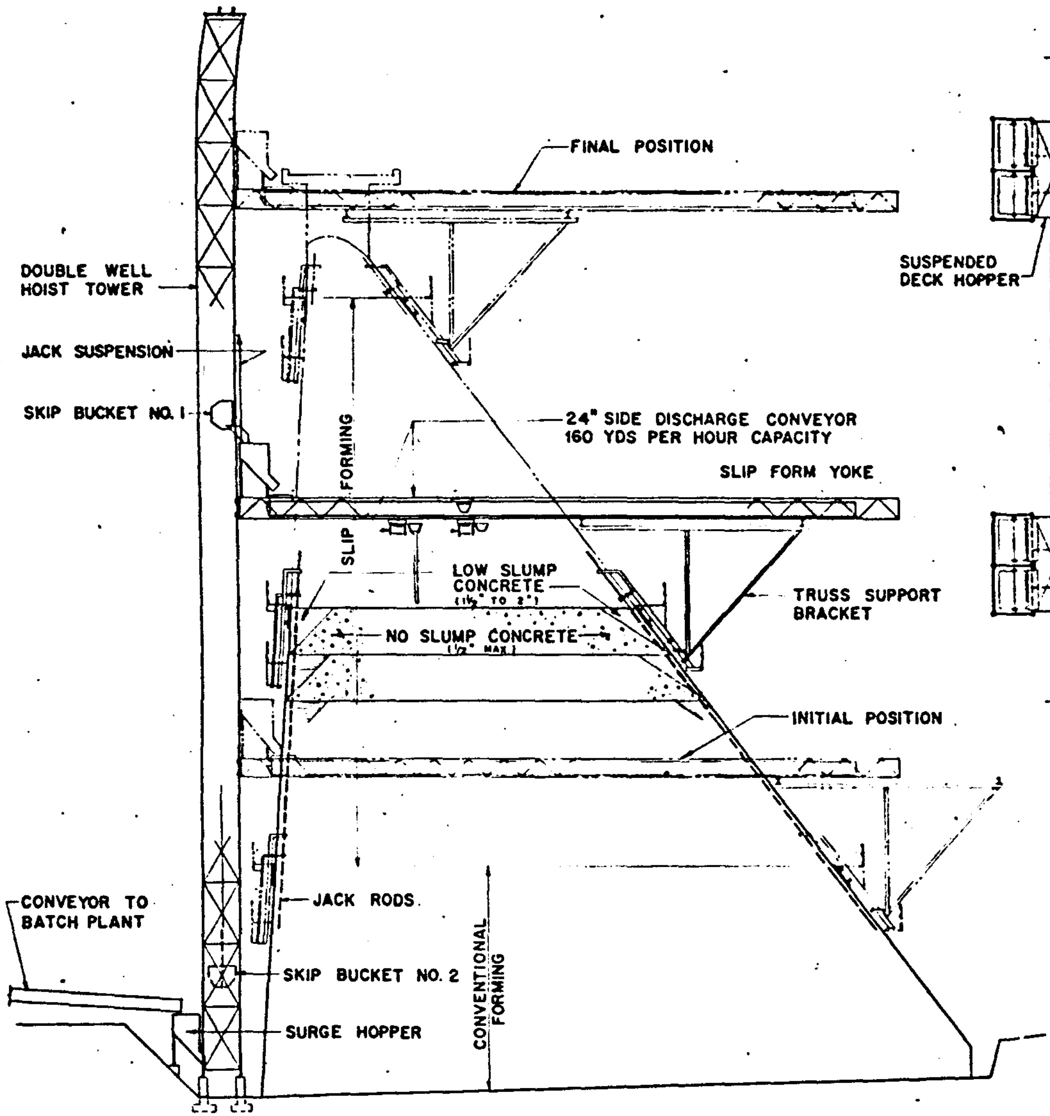
WATER RESOURCES DEVELOPMENT PROJECT
TRUMBULL LAKE
PEQUONNOCK RIVER BASIN CONNECTICUT

CONTINUOUS SLIP FORM OPERATION WITH TRANSVERSE JOINTS ELMINATED

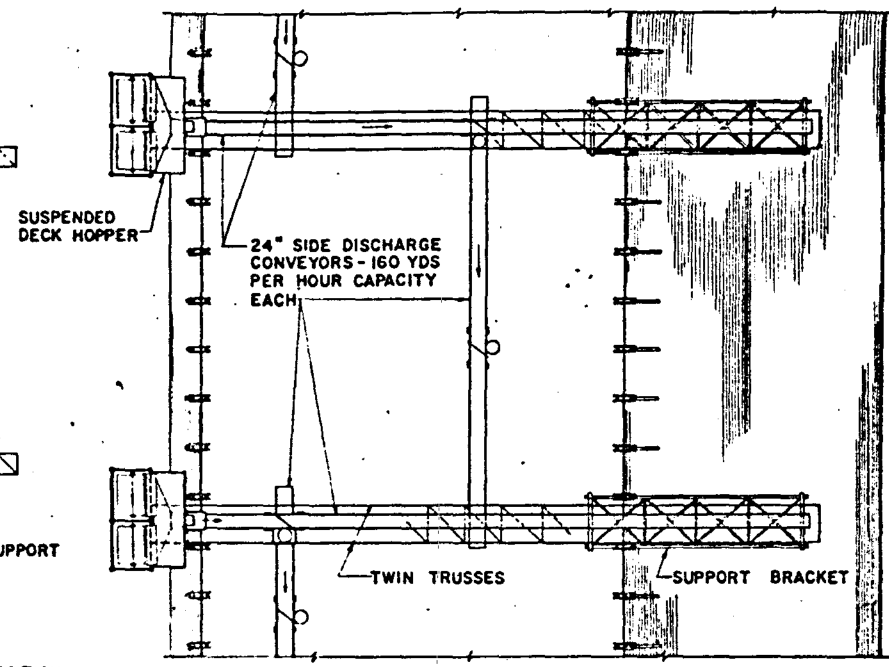
SCALE NONE

2?9-RM-3 SHEET

CORPS OF ENGINEERS



SECTION THRU MONOLITH NO. 6



PLAN

J. F. CAMELLERIE, P.E.

DEPARTMENT OF THE ARMY

WATER RESOURCES DEVELOPMENT PROJECT

TRUMBULL LAKE

PEQUONNOCK RIVER BASIN CONNECTICUT

CONTINUOUS SLIP FORM OPERATION UTILIZING NO SLUMP CONCRETE

SCALE NONE

209-PM-4

COST AND FEASIBILITY STUDY

ALTERNATE DESIGNS TO PERMIT USE

OF SLIP FORM AND OTHER TECHNIQUES

TO MAXIMIZE ECONOMIES

BOOK RA

RAPID CONSTRUCTION UTILIZING SLIP FORM TECHNIQUE

APPENDIX: ILLUSTRATIONS AND CALCULATIONS

BOOK RA - RAPID CONSTRUCTION UTILIZING SLIP FORM TECHNIQUE

APPENDIX: ILLUSTRATIONS AND CALCULATIONS

1 Schedule 209-SR-1 through SR-20

2 Sketches 209-W-4 and W-5

3 Sketches 209-CR-1 through CR-14

ILLUSTRATIONS

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1, 1972 REV. SKETCH# SK-I

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

SLIP FORM CONSTRUCTION

CONCRETE DEMAND SCHEDULE

MONTH-

WORKING DAY	PLACEMENT DESIGNATION	CONCRETE DEMAND (Yds)	PLACING RATE Yds/HR	REMARKS
1	1	660	110	
2	2	530	90	
3	3	115	20	
4	4	530	90	
5	5	440	75	
6	6	960	160	
7	7	1000	160	
8	8	750	125	
9	9	1090	160	
10 × 2	10	1860	155	
11	11	540	90	
12	12	314	50	
13 × 2	13	1870	155	
14 × 2	14	1120	95	
15 × 2	15	1180	100	
16 × 2	16	1650	135	
17	17	340	60	
18	18	160	15	
19 × 2	19	1710	140	
20 × 2	20	1350	115	
21 × 2	21	1430	120	
22 × 2	22	1650	135	

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1 1972 REV. SKETCH# [illegible]

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

SLIP FORM CONSTRUCTION

CONCRETE DEMAND SCHEDULE

MONTH -

WORKING DAY	PLACEMENT DESIGNATION	CONCRETE DEMAND (Yds)	PLACING RATE Yds/HR	REMARKS
23	23	315	50	
24	24	695	115	
25 x 2	25	1730	145	
26	26	610	100	
27 x 2	27	1485	125	
28 x 2	28	1550	130	
29	29	320	55	
30 x 2	30	1340	110	
31 x 2	31	1500	125	
32	32	225	40	
33 x 2	33	1330	110	
34	34	65	10	
35	35	425	70	
36	36	225	40	
37 x 2	37	1270	105	
	END OF PHASE "I"			

34,334

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1 1972 REV. SKETCH# S.R

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN

SLIP FORM CONSTRUCTION

CONCRETE DEMAND SCHEDULE

MONTH -

WORKING DAY	PLACEMENT DESIGNATION	CONCRETE DEMAND (Yds)	PLACING RATE Yds/HR	REMARKS
38 × 2	38	1240	105	START PHASE II
39	39	200	35	
40	40	385	65	
41 × 2	I	158/FT MAX	92 @ 7"	
42 × 3		33/FT MIN.	25 @ 9"	
43 × 3		96/FT AVER.	64 @ 8"	
44 × 3		67.5 FT		
45 × 2		6,485 TOTAL		
46	41	1020	160	
47	42	60	10	
48	43	935	155	
49 × 2	44	1280	105	
50 × 2	45	1200	100	
51 × 2	II	186/FT MAX.	108 @ 7"	
52 × 3		33/FT MIN.	25 @ 9"	
53 × 3		110/FT AVER.	73 @ 8"	
54 × 3		82.5 FT		
55 × 5		9,065 TOTAL		
56 × 2	46	1440	120	
57	47	1040	160	
58	48	620	105	
59	49	90	15	

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1 1972 REV. SKETCH# SK-4

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
SLIP FORM CONSTRUCTION

CONCRETE DEMAND SCHEDULE

MONTH-

WORKING DAY	PLACEMENT DESIGNATION	CONCRETE DEMAND (Yds)	PLACING RATE Yds/HR	REMARKS
60	50	175	30	
61×2	III	158/FT MAX.	92@7"	
62×3		33/FT MIN.	25@9"	
63×3		96/FT AVER.	64@8"	
64×3		67.5 FT		
65×2		6,485 TOTAL		
66	51	350	60	
67×2	52	1360	115	
68	53	1030	160	
69	54	300	5	
70	55	135	25	
71×2	IV	186/FT MAX.	108@7"	
72×3		33/FT MIN.	25@9"	
73×3		110/FT AVER.	73@8"	
74×3		82.5 FT		
75×5		9,065 TOTAL		
76	56	980	160	
77	57	615	105	
78	58	200	35	
79	59	290	50	
80	60	705	120	

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN
SLIP FORM CONSTRUCTION

CONCRETE DEMAND SCHEDULE

MONTH -

WORKING DAY	PLACEMENT DESIGNATION	CONCRETE DEMAND (Yds)	PLACING RATE Yds/HR	REMARKS
81 x 2		186/FT MAX.	108@7"	
82 x 3		33/FT MIN.	25@9"	
83 x 3	VI	110/FT AVER.	73@8"	
84 x 3		82.5 FT		
85 x 5		9,065 TOTAL		
86	61	830	140	
87	62	800	135	
88	63	260	45	
89	64	595	100	
90	65	205	35	
91 x 2		172/FT MAX.	100@7"	
92 x 3		33/FT MIN.	25@9"	
93 x 3	V	103/FT AVER.	67@8"	
94 x 3		75 FT		
95 x 3		7,700 TOTAL		
96	66	800	135	
97	67	720	120	
98	68	490	80	
99	69	135	25	
100	70	325	55	

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1 1972 REV. SKETCH

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
SLIP FORM CONSTRUCTION

CONCRETE DEMAND SCHEDULE

MONTH-

WORKING DAY	PLACEMENT DESIGNATION	CONCRETE DEMAND (Yds)	PLACING RATE Yds/HR	REMARKS
101 x 2	VII	200/FT MAX.	117@7"	
102 x 3		76/FT MIN.	67@9"	
103 x 3		138/FT AVER.	92@8"	
104 x 3		70.0 FT		
105 x 2		9500 TOTAL		
106 x 2	VIII	20 FT	33@8'	
107 x 2		1,000 TOTAL		
108	71	800	135	
109	72	615	105	
110	73	670	110	
111	74	250	40	
112	75	610	100	
113	76	690	115	
114	77	510	85	
115	78	480	80	
116	79	30	5	
117	80	610	100	
118	81	615	105	
119	82	405	70	
120	83	190	30	
121	84	190	30	
122	85	190	30	

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE·1·1972 REV. SKETCH# SK-7

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

SLIP FORM CONSTRUCTION

CONCRETE DEMAND SCHEDULE

MONTH-

WORKING DAY	PLACEMENT DESIGNATION	CONCRETE DEMAND (Yds)	PLACING RATE Yds/HR	REMARKS
123	86	510	85	
124	87	300	50	
125	88	300	50	
126	89	190	30	
127	90	185	30	
128	91	405	70	
129	92	40	5	
130	93	190	30	
131	94	185	30	
132	95	185	30	
133	96	300	50	
134	97	185	30	
135	98	190	30	
136	99	295	50	
137	100	295	50	
138	101	185	30	
139	102	295	50	
140	103	295	50	
141	104	40	5	
142	105	40	5	
143	106	295	50	
144	107	40	5	

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE·1·1972 REV. SKETCH# SR-8

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
SLIP FORM CONSTRUCTION

CONCRETE DEMAND SCHEDULE

MONTH-

WORKING DAY	PLACEMENT DESIGNATION	CONCRETE DEMAND (Yds)	PLACING RATE Yds/HR	REMARKS
145	108	40	5	
146	109	40	5	
(235 SHIFTS)		(254 PAY SHIFTS)		

TOTAL PLACEMENT 125,389 CY
CONCRETE PER DAY : 860 cy AVER.
CONCRETE PER SHIFT = 535 CY AVER.
CONCRETE PER PAY SHIFT = 495 CY AVER
PLANT UTILIZATION = 515/1280 = 40% AV.

Revised

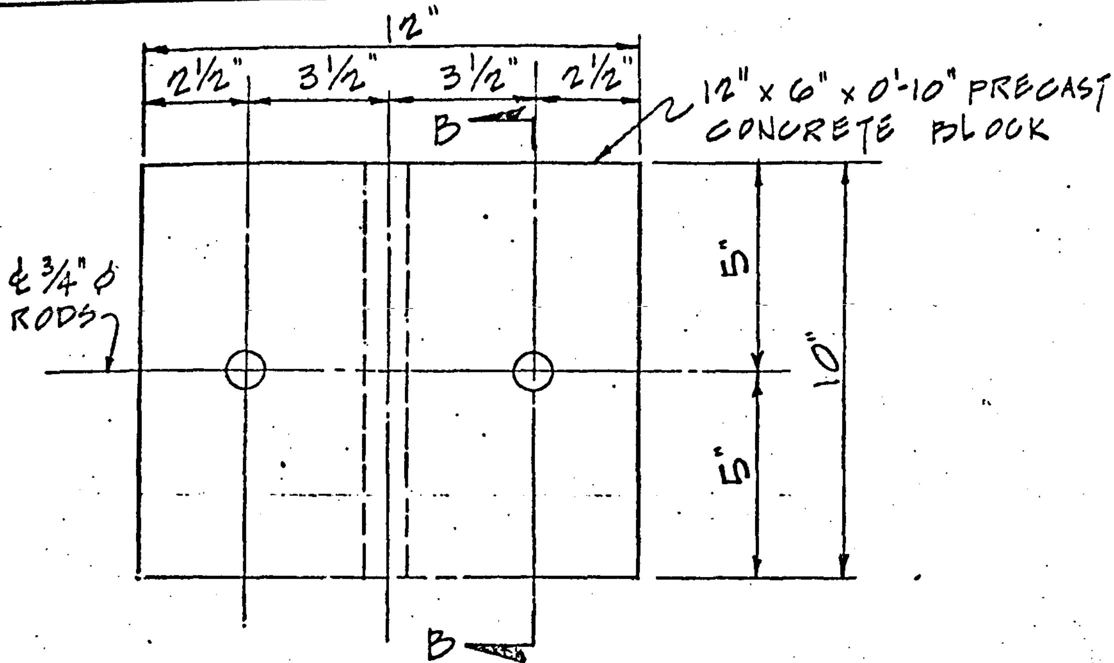
J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUN 1, 1972 REV. SKETCH# 209-SE-Y

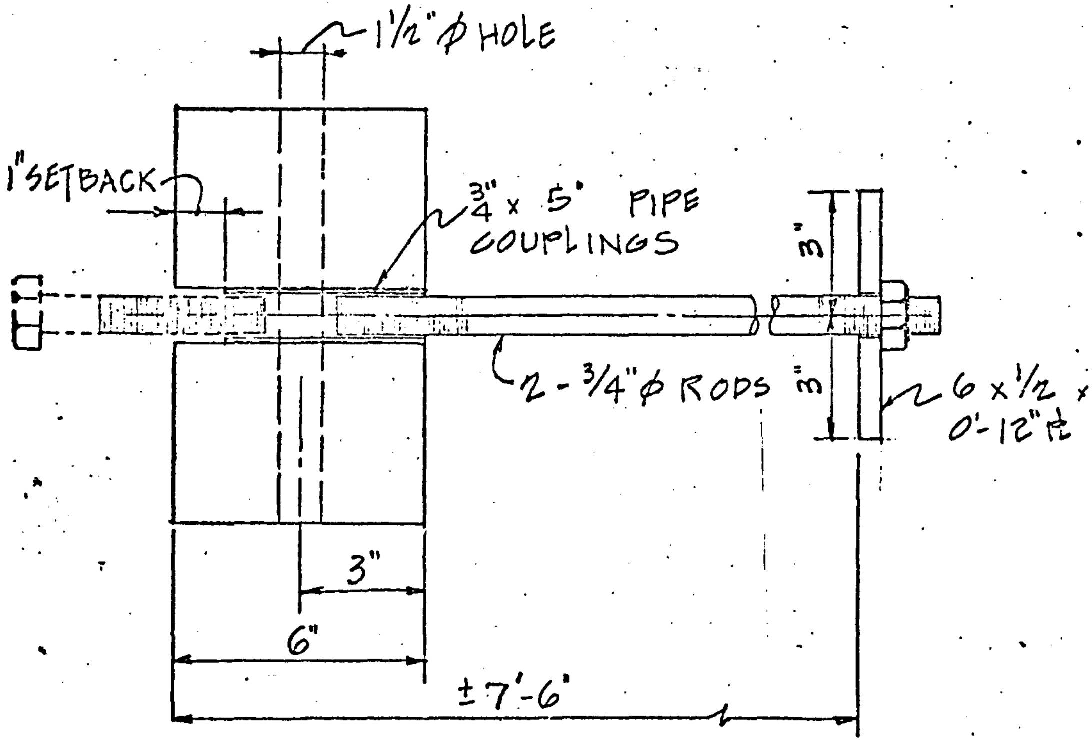
TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN

CANTLIVER SLIP FORM - PRECAST INSERTS



FRONT FACE ELEVATION

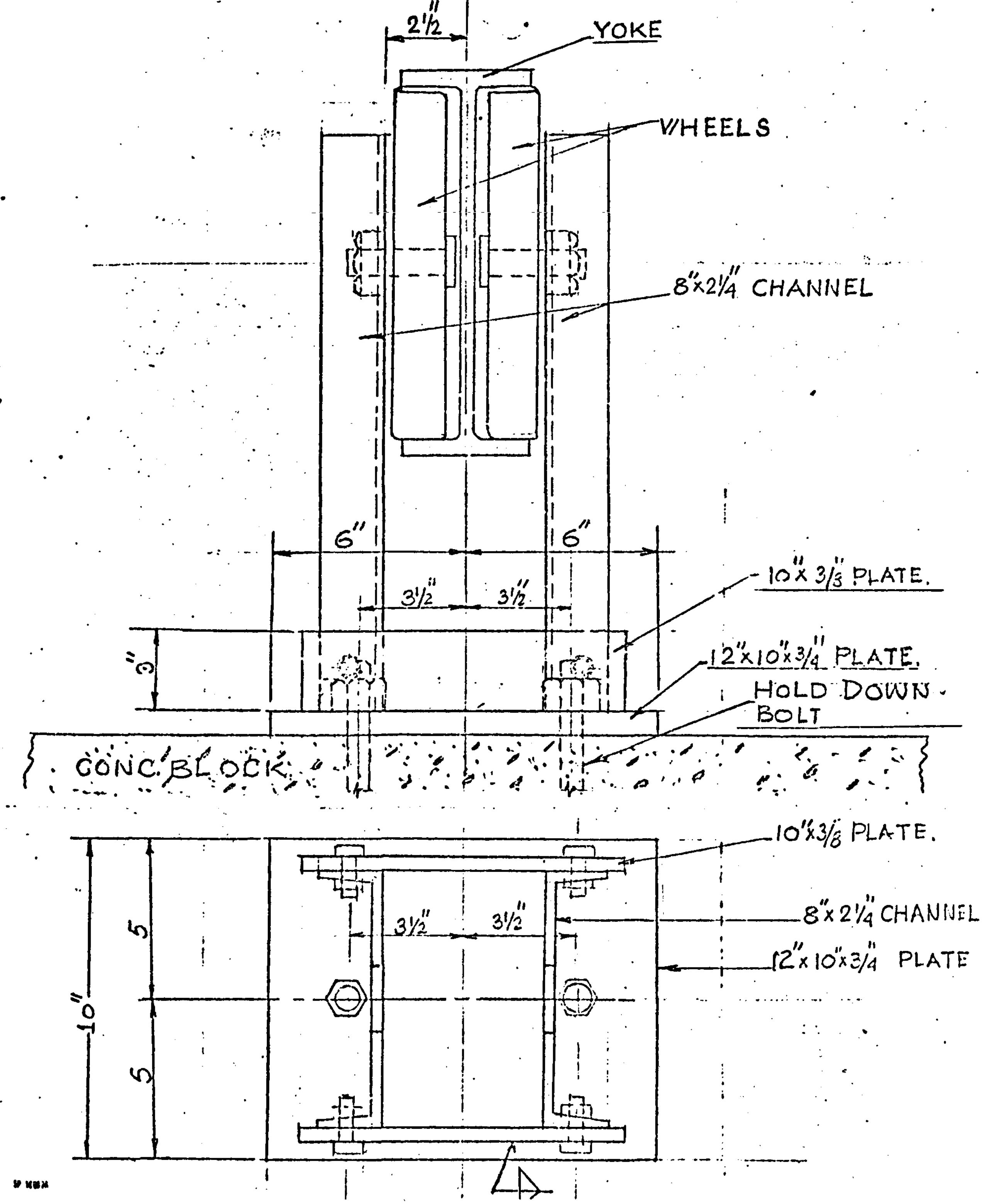


SECTION B-B

J. F. CAMELLERIE, P.E.
GREEN STREET
NTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN
CANT. SLIP FORM - WHEEL BRACKETS

WHEEL-BRACKET



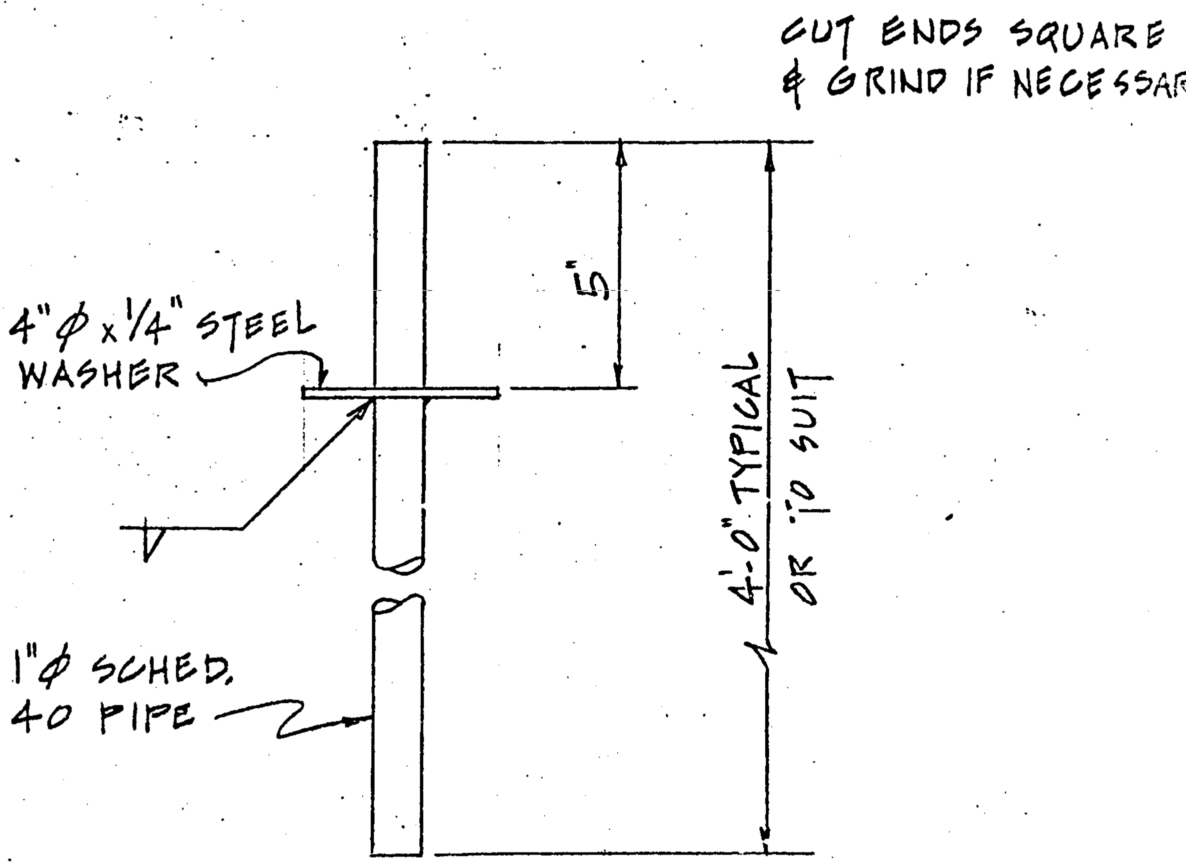
J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUN. 1, 1972 REV. SKETCH# 209-SR-

TRUMBULL LAKE DAM

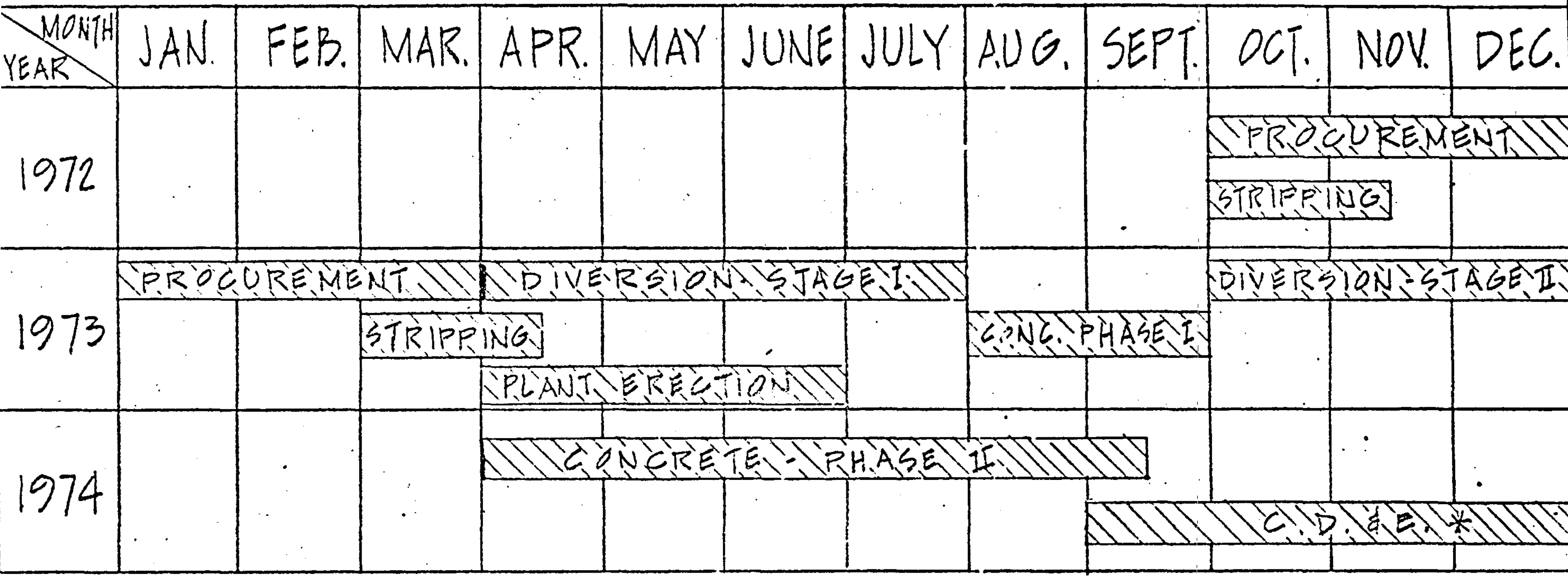
PEQUONNOCK RIVER BASIN, CONN

CANTILEVER SLIP FORM - INSERT SUPPO



VERTICAL PIPE SUPPORT
FOR PRECAST CONCRETE BLOCK

CONSTRUCTION SCHEDULE · RAPID CONSTRUCTION



* CLEAN UP, DEMOBILIZATION & ENVIRONMENT

CONTRACTURAL COMPLETION DATE DEC 31, 1974

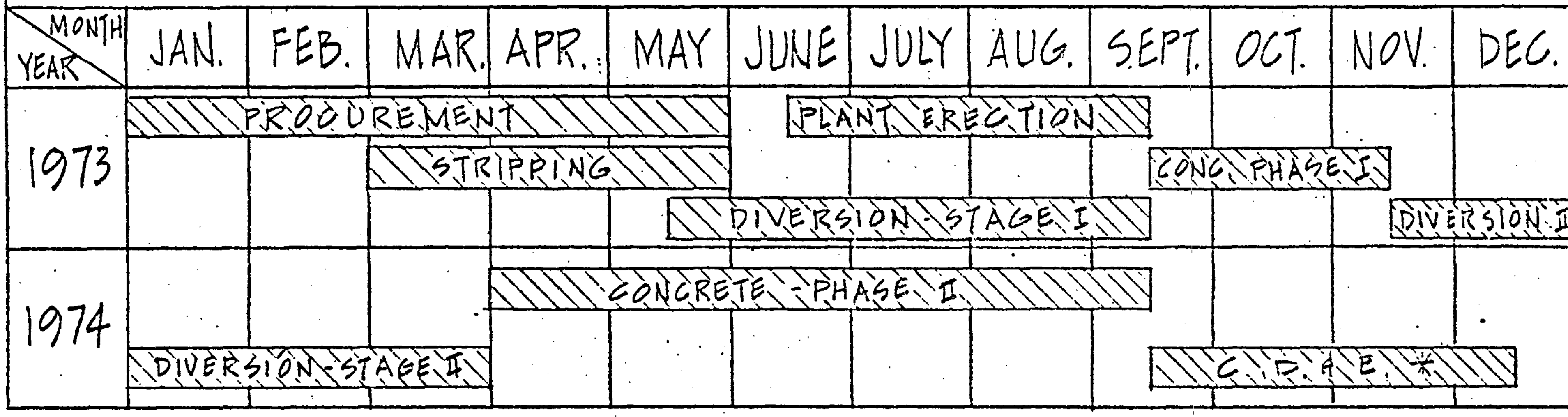
J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
CONSTRUCTION SCHED.-RAPID CONSTR

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER, BASIN, CONN.
RAPID CONSTRUCTION SCHED. - DELAYED CONST. ST

RAPID CONSTRUCTION SCHEDULE - DELAYED CONSTRUCTION START



* CLEAN UP, DEMOBILIZATION & ENVIRONMENT

CONTRACTURAL COMPLETION DATE DEC.15, ~~1972~~ — 1974

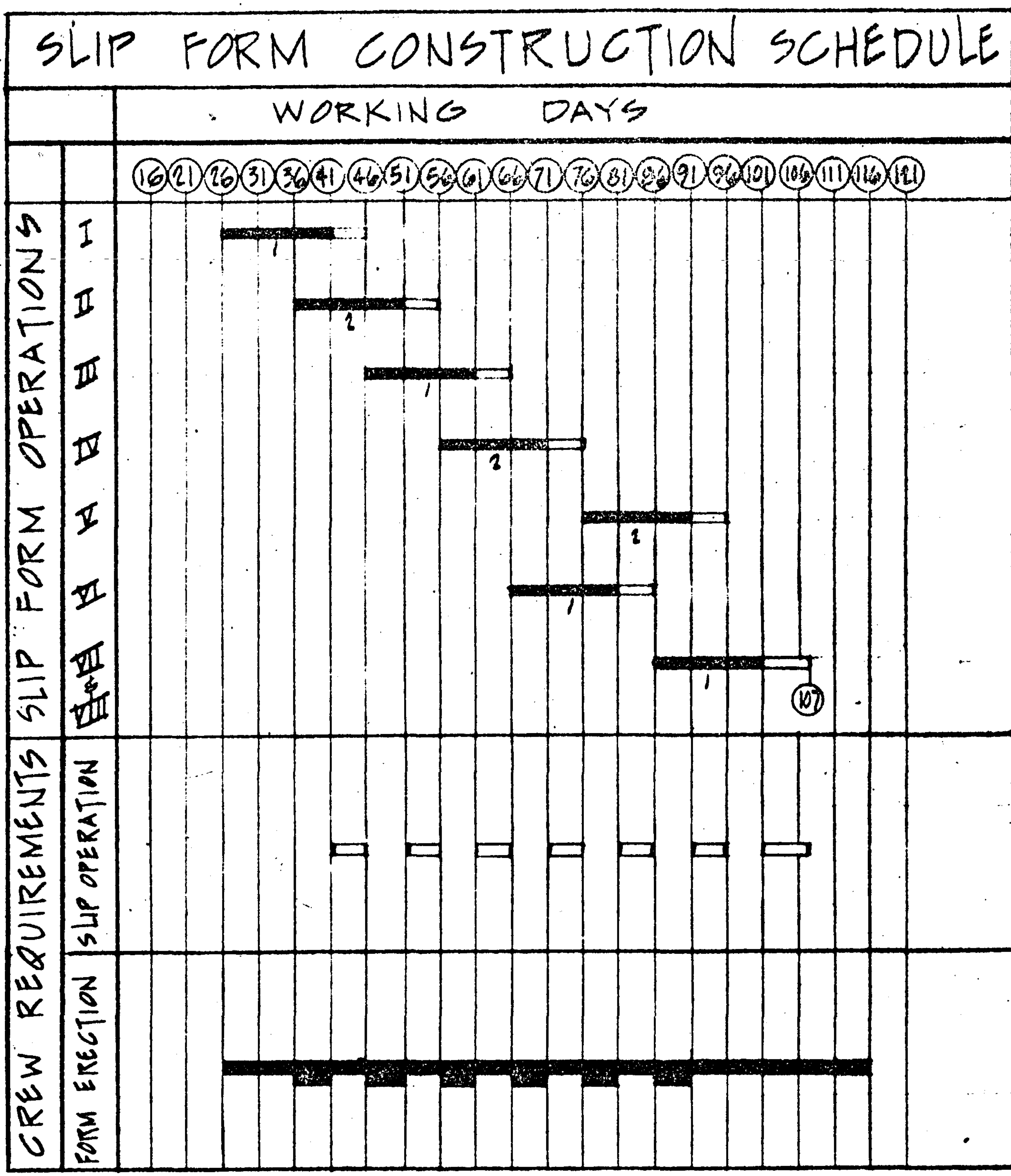
J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUN. 1, 1972 REV. APR. 1, 1974 SKETCH# 209-SR-14

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

SLIP FORM SCHEDULES



Revised

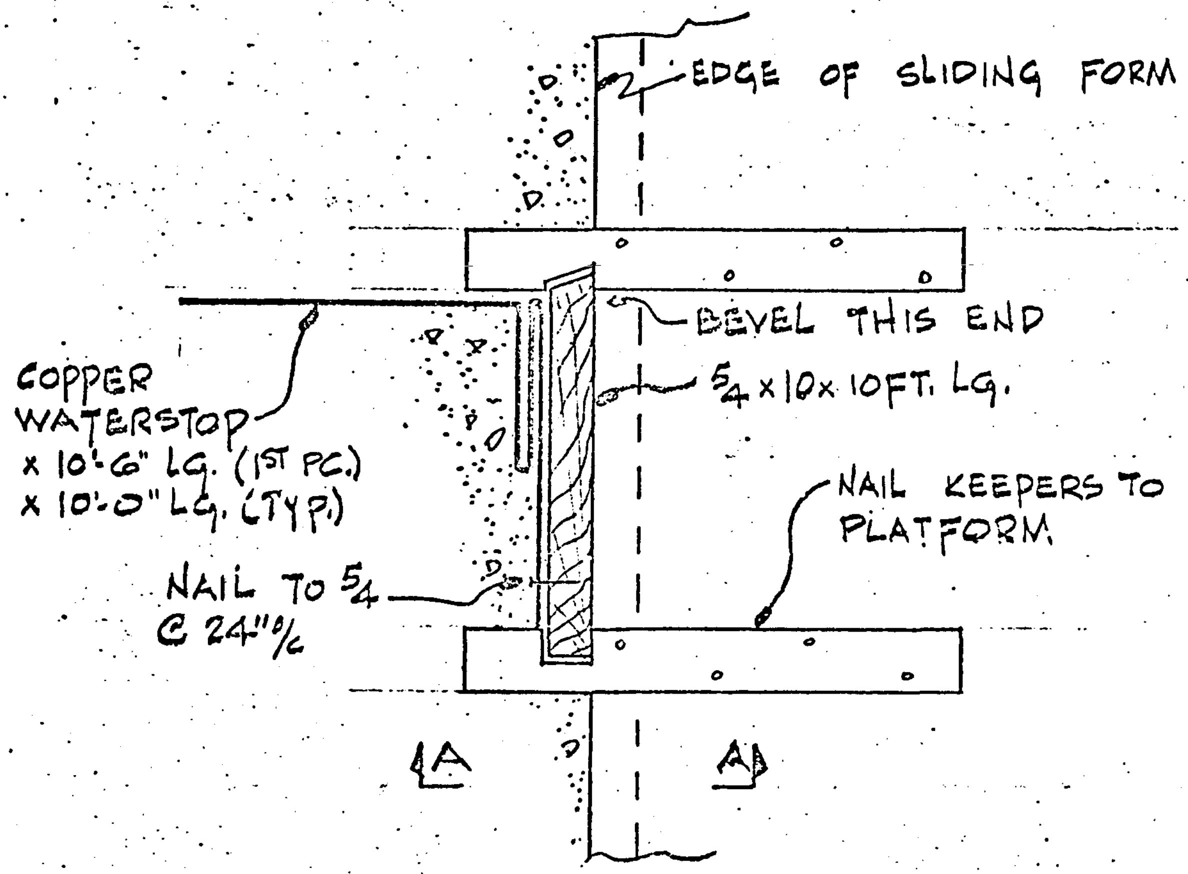
J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 9, '72 REV. SKETCH# 209-SR-15

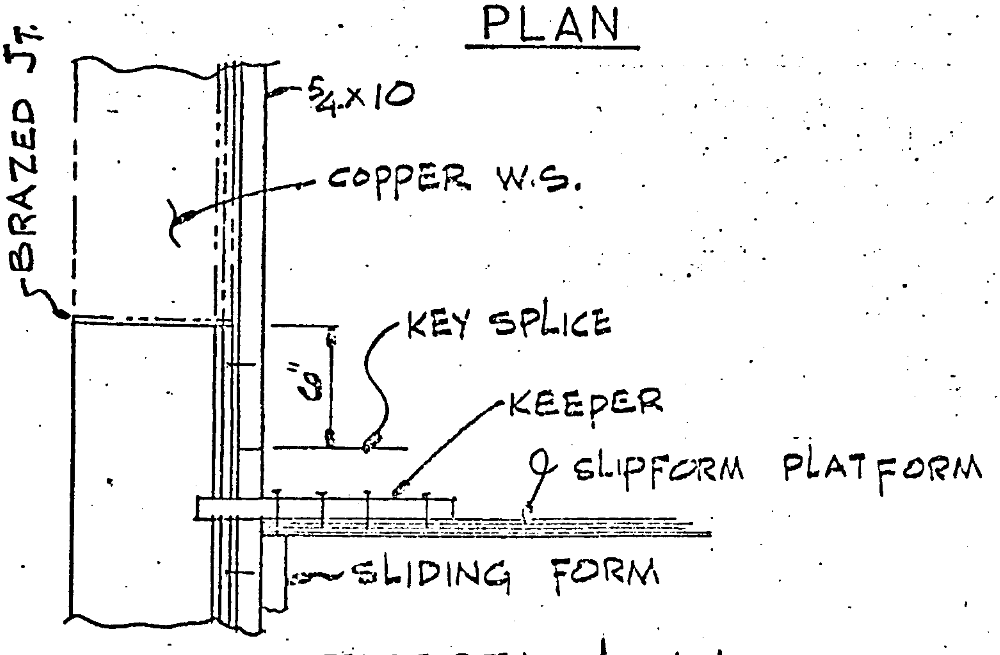
TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN - CONN.

COPPER WATERSTOP PLACING DET.



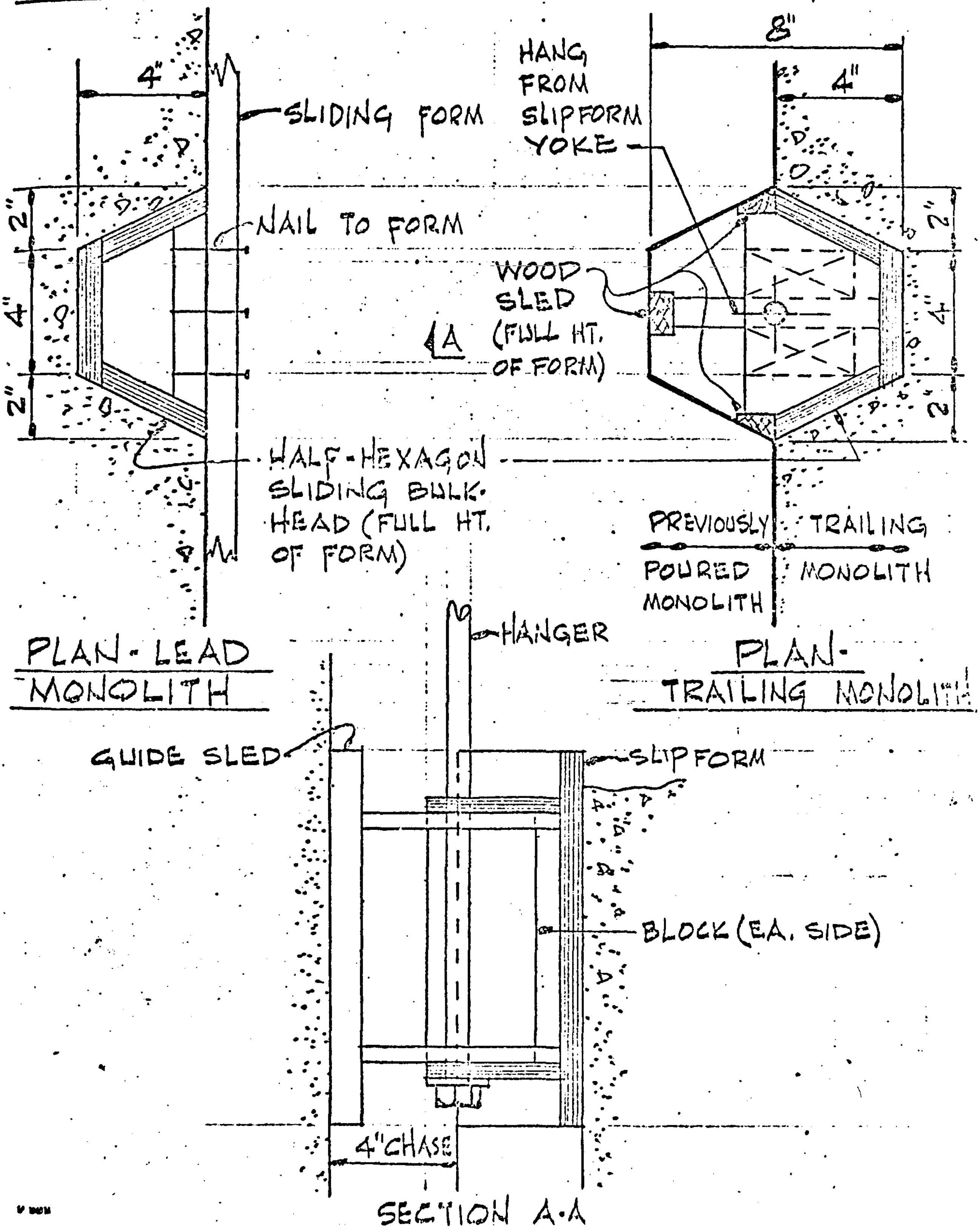
PLAN



SECTION A-A

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN - CONN
DRAIN WELL FORMING



ANCHOR PULL OUT SUMMARY

TEST RESULTS - WATER EXPERIMENTATION STATION

AGGREGATE	DISCHARGE TEMPERATURE	TEMPERATURE IN FORM	AGE IN FORM	COMPRESSION STRESS	TENSILE STRESS	TYPE OF ANCHOR	ANCHOR EMBEDMENT	PULL OUT STRENGTH	REMARKS
"TRUMBULL POND	51°F	59°F	8 hr.	—	1.2 psi	II	2'-6"	2,500#	
"	51°	59°	8	—	2.1	I	2'-6"	5,100#	
"	51°	59°	8	—	1.4	I	2'-6"	6,000#	
" CRUSHED LIMESTONE	47°	57°	8	24 psi	3.2	I	5'-0"	12,300#	
" CRUSHED LIMESTONE	47°	57°	12	56 psi	9.1	1	5'-0"	*14,300#	

1. CEMENT FACTOR 2.61 CWT WITH 35 PERCENT FLY ASH SUBSTITUTION
2. AMBIENT TEMPERATURE = 73°

* CRACKING OF MONOLITH INDICATED THAT PULL OUT STRENGTH WAS NOT FULLY DEVELOPED DUE TO SIZE OF MONOLITH

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1, 1972 REV.
TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
FORM ANCHOR TESTING

SKETCH# 209-SR-16

CONCRETE SET & STRENGTH GAIN SUMMARY

TEST RESULTS - WATER EXPERIMENTATION STATION

AGGREGATE	DISCHARGE TEMPERATURE	TEMPERATURE IN FORM	AGE OUT OF FORM	COMPRESSION STRENGTH	TENSILE STRENGTH	AGE AT 500psi PENETRATION	JACKING LOAD LB/FT FORM	REMARKS
3" CRUSHED LIMESTONE	70°F	70°F	2 TO 3 HRS			5 TO 6 HRS	WOOD 100 TO 300	
6" CRUSHED LIMESTONE	70°	70°	5 TO 8 HRS			5 TO 6 HRS	WOOD 200 TO 400	
6" TRUMBULL POND	51°	59°	4 TO 6 HRS		1.2 TO 2.1 psi @ 8 HRS	7 TO 8 HRS	WOOD 400 TO 600	
6" TRUMBULL POND	51°	59°	3 TO 4 HRS		1.2 TO 2.1 psi @ 8 HRS	7 TO 8 HRS	WOOD 400 TO 600	
6" CRUSHED LIMESTONE	47°	57°	2 TO 4 HRS	24 psi @ 8 HRS	3.2 psi @ 8 HRS	8 TO 9 HRS	STEEL 150 TO 250	
6" CRUSHED LIMESTONE	47°	57°	3 TO 4 HRS	56 psi @ 12 HRS	9.1 psi @ 12 HRS	8 TO 9 HRS	STEEL 150 TO 250	

1. CEMENT FACTOR 2.61 CWT PER YARD WITH 35% FLY ASH SUBSTITUTION.
2. AMBIENT TEMPERATURE = 73°

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1, 1972 REV.

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

CONCRETE STRENGTH GAIN.

SKETCH# 209-SE-1

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUN. 1, 72 REV. APR. 1, 1974 SKETCH# 209.SR
TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN
COMPARISON SHEET

AREAS CAPABLE OF BEING SLIPPED

		CONV. COST/YD.	RAPID COST/YD.	DIFF.
AS IS	FORMS	3.72	5.91	+2.19
	PLANT + OPER.	3.52	3.24	-0.28
		7.24	9.15	+1.91
TWICE AS LONG	FORMS	3.62	5.10	+1.48
	PLANT + OPER.	2.74	2.75	+0.01
		6.36	7.85	+1.49
3 X. AS LONG	FORMS	3.45	4.80	+1.35
	PLANT + OPER.	2.42	2.50	+0.08
		5.87	7.30	+1.43
TWICE AS HIGH	FORMS	3.70	4.16	+0.46
	PLANT + OPER.	2.74	1.15	-1.59
		6.44	5.31	-1.13
3 x AS HIGH	FORMS	3.45	3.52	+0.07
	PLANT + OPER.	2.40	0.65	-1.75
		5.85	4.17	-1.68

Revised

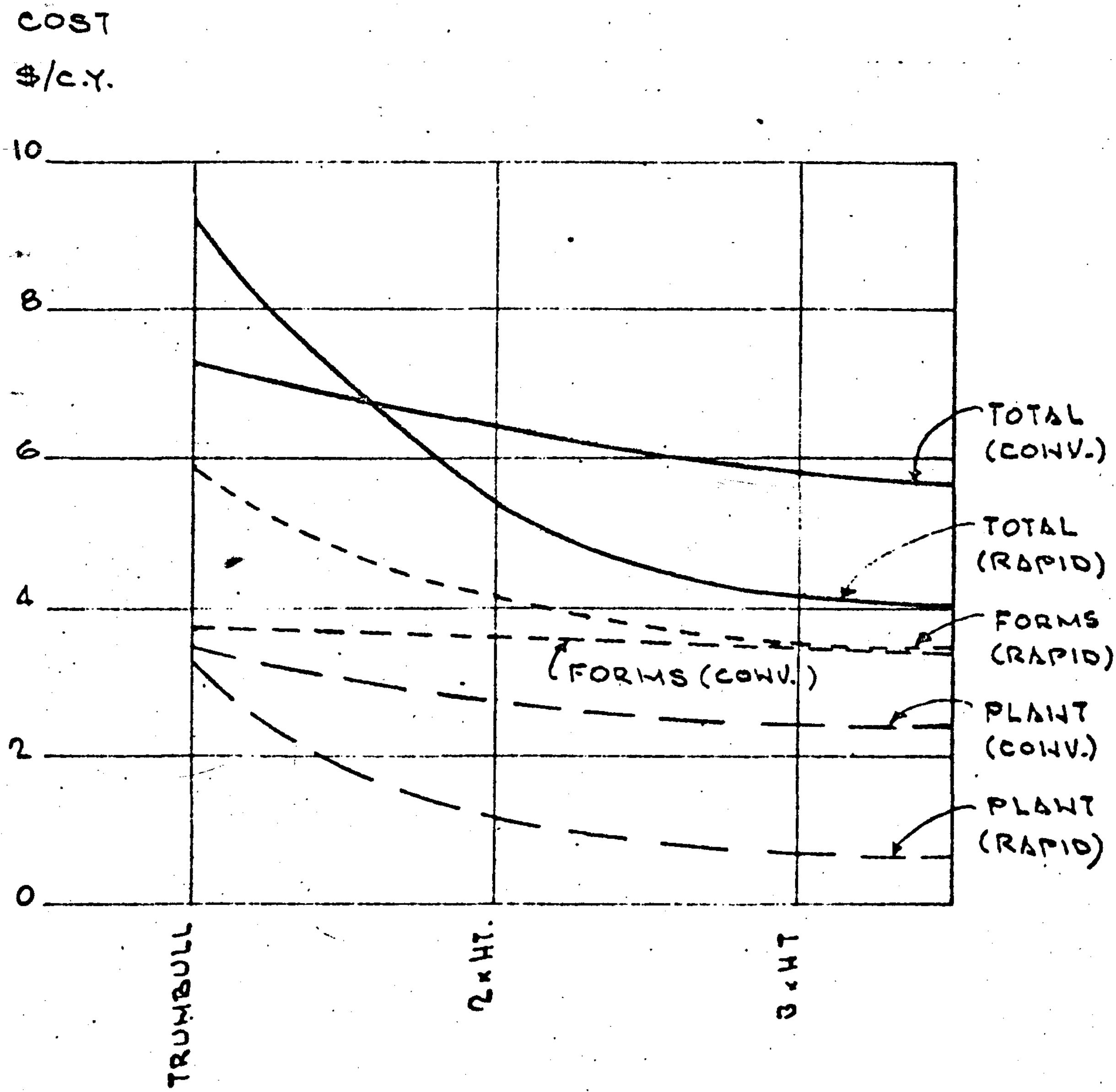
J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUN 1, '72 REV APR. 1, 1974 SKETCH # 209-SR-19

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

COMPARISON



FORM & PLANT COST VARIATION BY DAM HEIGHT

Revised

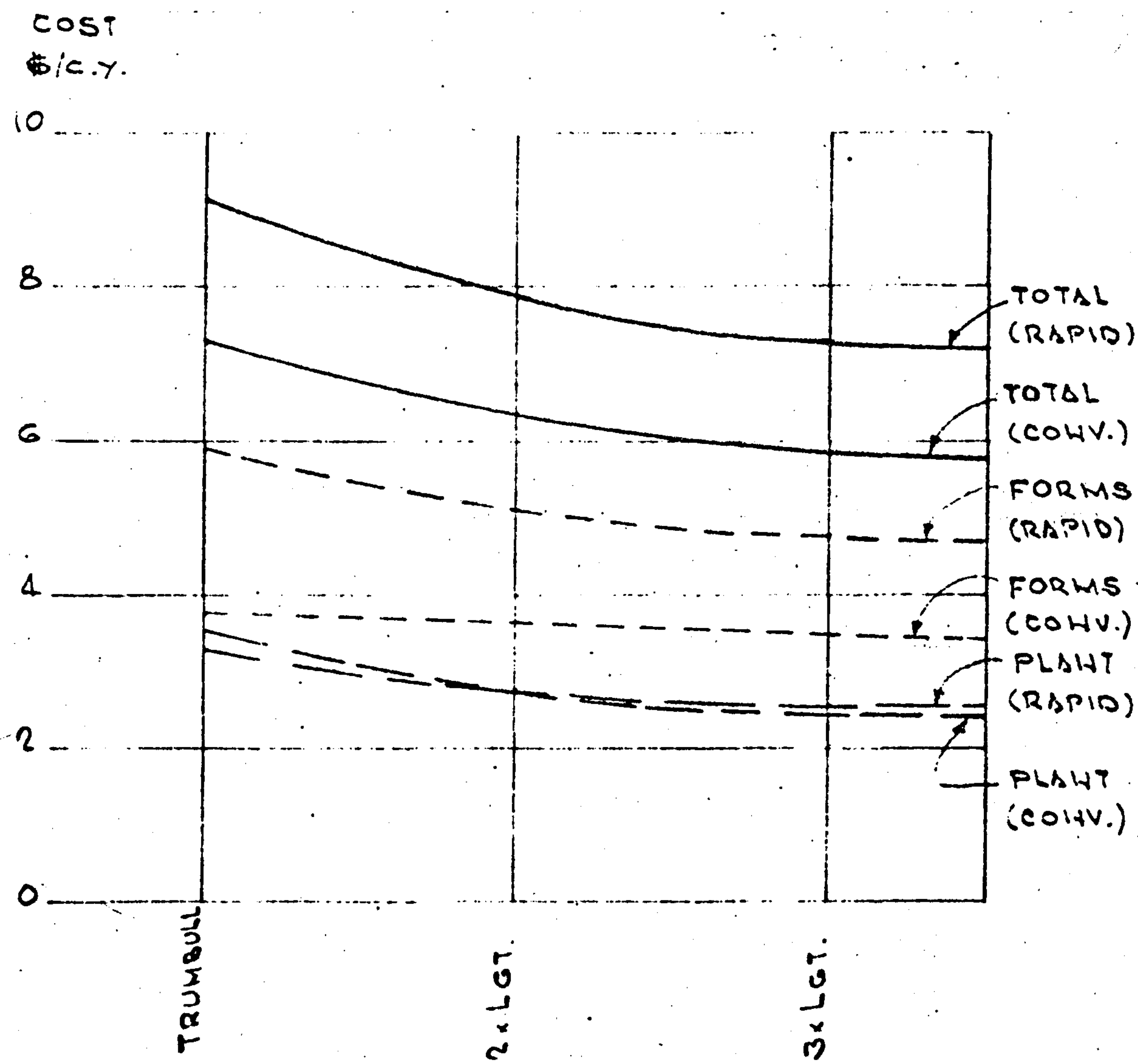
J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUN 1, '72 REV APR. 1, 1974 SKETCH # 209-SR-20

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

COMPARISON



FORM & PLANT COST VARIATION BY DAM LENGTH

Revised

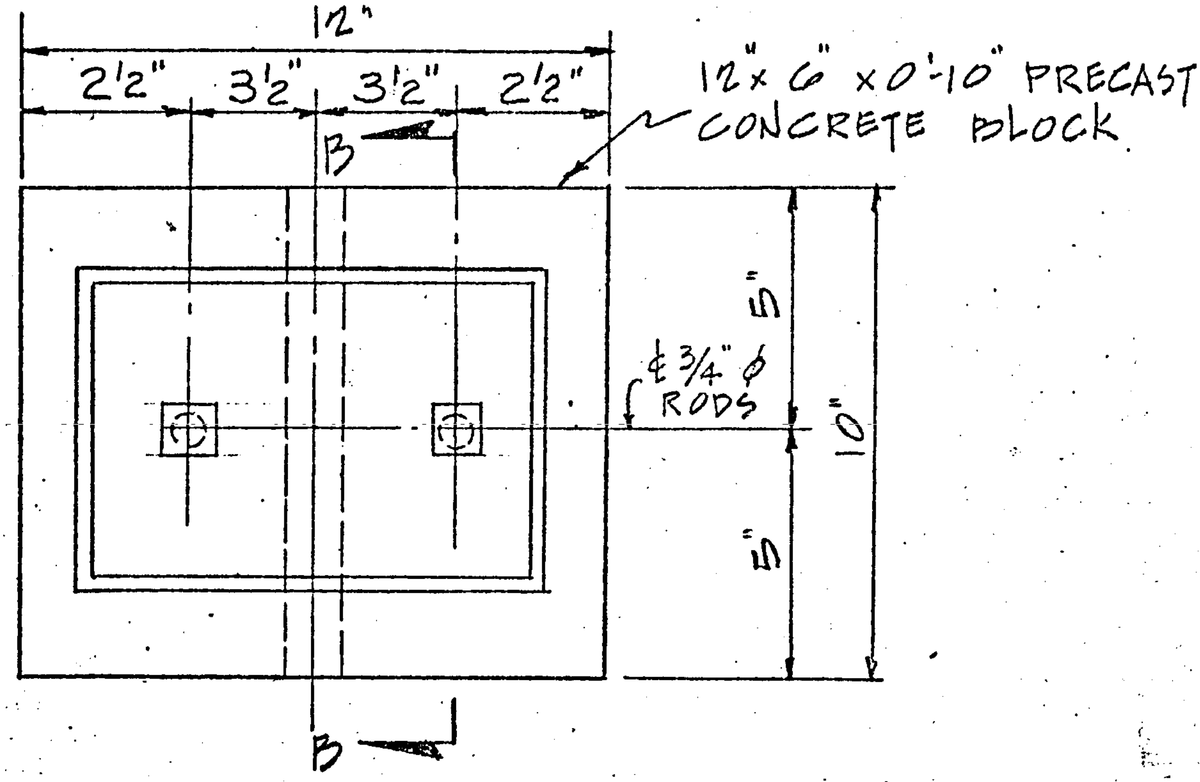
J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE Jun 1, 1972 REV. SKETCH #209-W-4

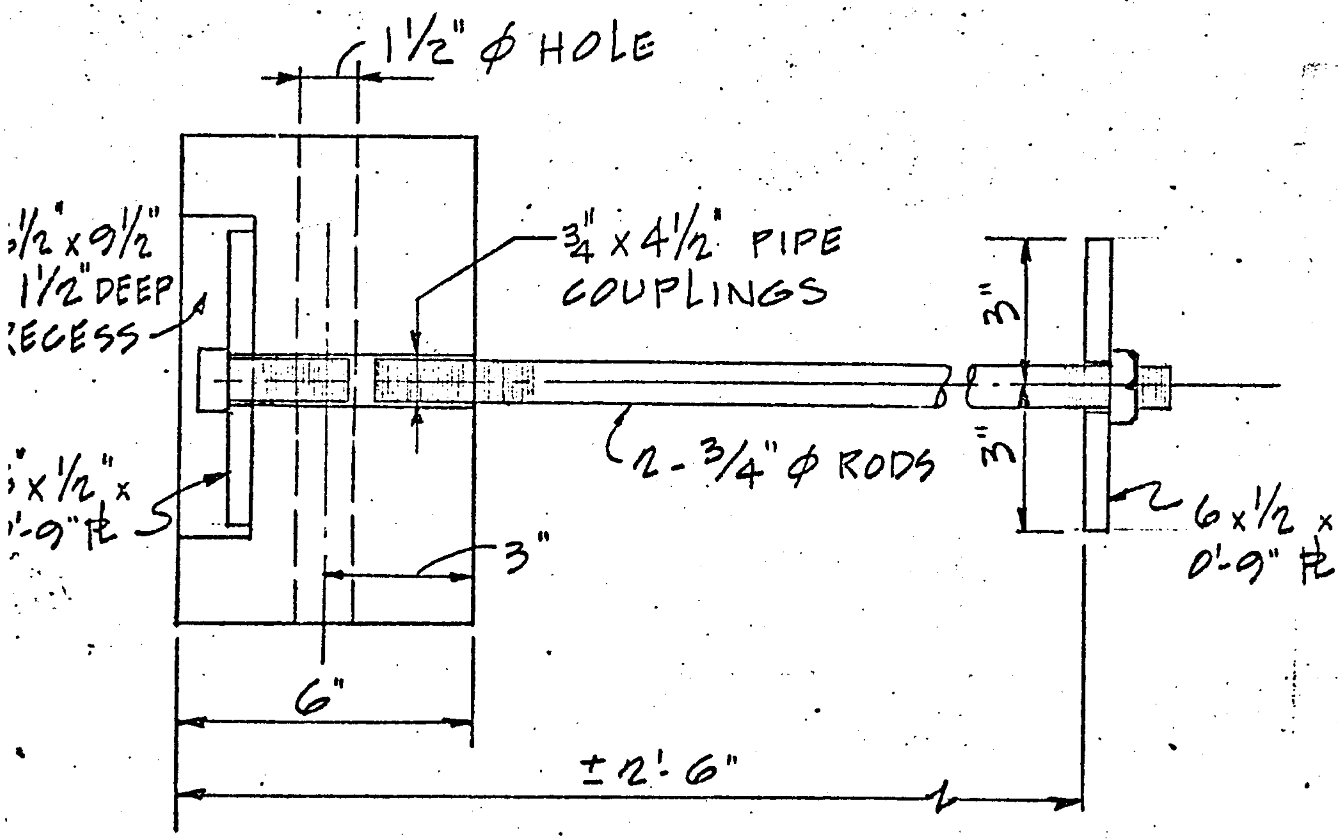
TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

SUGGESTED TEST PROCEDURES, BLOCK II



FRONT FACE ELEVATION



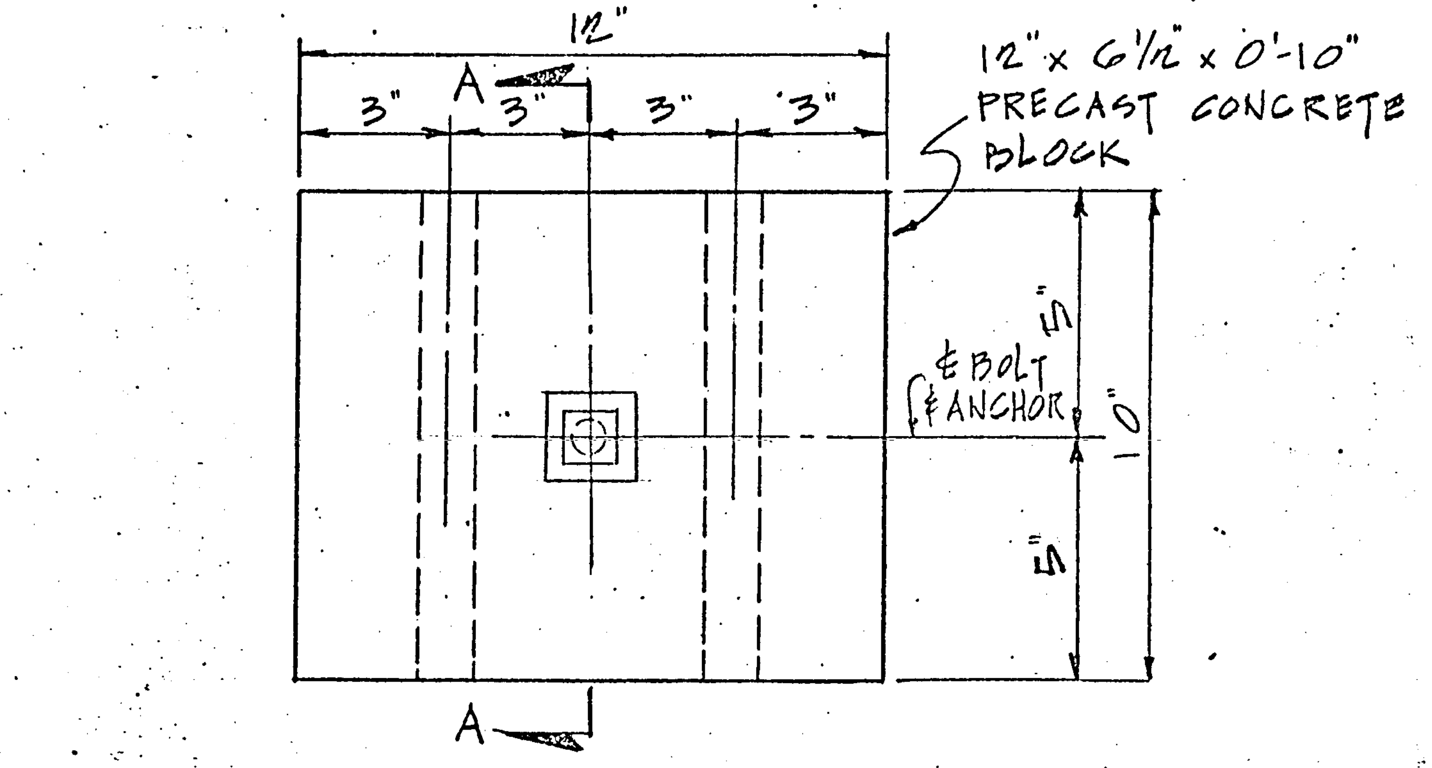
SECTION B-B

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

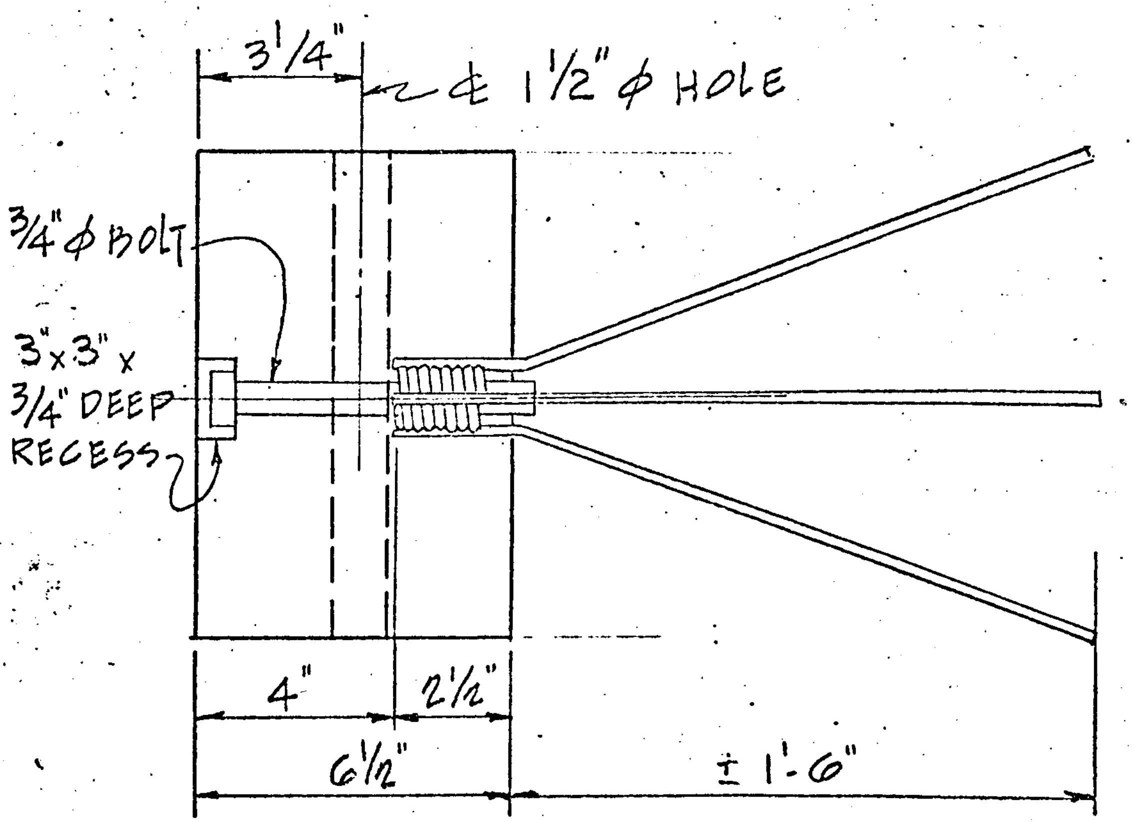
TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN

SUGGESTED TEST PROCEDURES, BLOCK II



FRONT FACE ELEVATION



SECTION A-A

CALCULATIONS

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE June 1, 1972 REV. SKETCH# 204-CK-T

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN CONN.

SLIP FORMING SYSTEM, DOWN STREAM, Fc.

GRAVITY LOADING

ITEM		WT.	M.A.	MOMENT +	MOMENT −
YOKE BEAM	39 X 16.67	654 #	0		
YOKE EXTN.	8 x 7.4	59.2 #	6.25		370
YOKE EXTN (WITH PLATFORM)	8 x 10	80	8.5		680
MAIN PLATFORM	36 x 5	180	2		360
FINISH PLATFORM					
(1) PLYWOOD	32x2 = 64				
[ ]	16x10.5 = 168	232	3.6	835	
(2) PLYWOOD	40 x 2 = 80				
[ ]	16x10.5 = 168	248	5	1240	
RAILING	9.8x4.5x2 = 89				
	2x40 = 80	169	6.5	1100	
LADDER					
1)	4.5x18	81	3.6	290	
2)	8x18	144	1	144	
3)	8x18	144	5.8		835
		1991		3609	2245

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1 '72 REV. SKETCH# 209-CR-2

TRUMBULL LAKE DAM.

PEQUONNOCK RIVER BASIN, CONN.

SLIP FORMING SYSTEM. DOWN STREAM FC

ITEM		WT.	M.A.	MOMENT +	MOMENT −
		1991		3609	2245
WOODEN PLATFORM SUPPORT.	1·75×7·5×2	30	1		30
PROP. −	3·5×7×2	49	0	-	-
PORTAL FRAME	56×11·8	672	2·25		1490
WOODEN WALES	3×36 = 108		3·2		337
FORM SHEATHING	32×2 = 64; 172	172	3·25		557
SPLASH GUARD	2×3×7·4 = 45; 1·6×8×2 = 25; 70	70	6·0		420
JACK ROD WITH JACK		40	7		280
		3024		3609	5359

$C.G = \frac{(5359-3609)}{3024} = .58'$ INBOARD OF TOP ANCHOR AT FACE OF DAM

TRAVEL = 2.0' EACH WAY

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

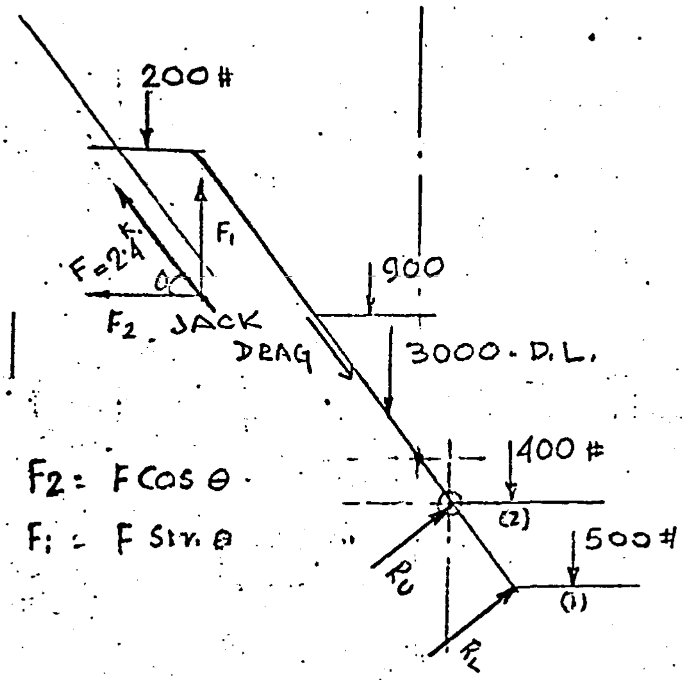
DATE JUNE 1, 1972

TRUMBULL LAKE DAM.

PEQUONNOCK RIVER BASIN, CONN.

SLIP FORMING SYSTEM, DOWN STREAM Fc.

WEIGHT & FORCE STUDY



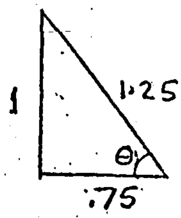
$F_2 = F \cos\theta$

$F_1 = F \sin\theta$

DRAG = 300 #/LF × 8 = 2400#

L.L. = 25 #/□
= 25(8) = 200#/FT WIDTH

HYDRO PRES = 225#/□ × 3 = 675#/
675 × 8' = 5400#/YOKE



cos θ = .6
SIN θ = .8
TAN θ = 1.33

CASE - 1 CONSIDERING THE WORST CASE, WHEN THE WHEEL IS AT THE LOWER LEVEL, $R_U - R_K$ POSITION.

D.L + PART. L.L. ; JACK LOAD = 4100 (.8) = 3280^K

	WT.	M.A	+	−
L.L. ON FINISHING PL. 1 -	(500)	3.0	(1500)	
L.L. ON FINISHING P.L. 2.	(400)	1.6	(640)	
L.L. ON MAIN PL.	900	4.00		3600
L.L. ON TOP PL.	200	10.5		2100
JACK	↑ −3280	.67	2200	
D.L.	3000	2.58		7740
	1480		2200	13,440

$R_L = \frac{(13{,}440 - 2200)}{4} = 2.8^k$ T

$R_U = (.60)(3280) + (.8)(2800) = 5.3^k$ C

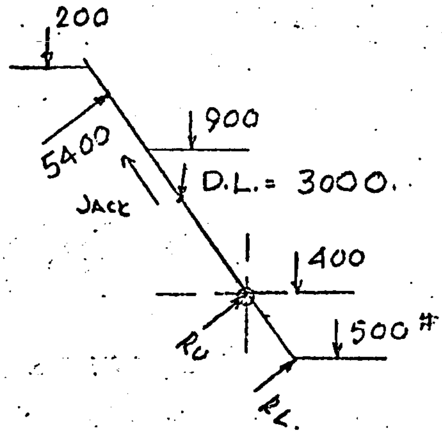
J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

CASE II

D.L. + HYDROSTATIC + PARTIAL L.L. (WHEEL AT LOWEST POS)

JACK LOAD:

400 (.8)(500)
320 (.8)(400)
2400 (.8)(3000)
0 (0)(5400)
2400 (1.0)(2400)
5520



	W.T.	M.A.	+	-
L.L. ON FINISIHING PL. 1.	500	3.0	1500	
L.L. ON FINISHING PL. 2.	400	1.6	640	
L.L. ON TOP PL.	(200)	10.5		(2100)
L.L. ON MAIN PL.	(900)	4.0		(3600)
D. L	3000	2.58		7740
HYDROSTATIC	↗ (5400)	11.5	62000	
DRAG	↘ 2400	0		
JACK	↑ 5520	.67	3,680	
	↑ 1840		67,820	7740

$R_L = \frac{(67,820 - 7,740)}{4} = 15.0\ C$

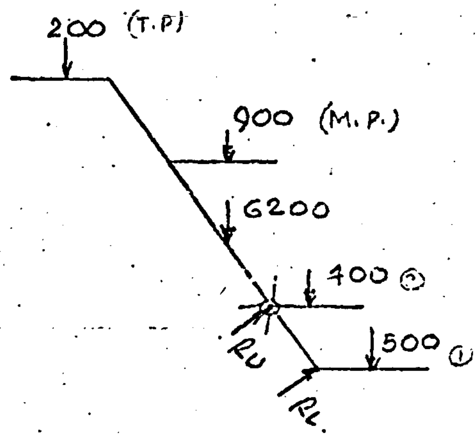
$\overleftarrow{R_U} = .6(5520) + .6(2400) - (.8)(5400) - .8(15,000) = 17,7..$

$R_U = 14,450/.8 = 18.1^k\ T$

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

CASE - III

ALL LOADING INCLUDED
WHEEL @ HIGHEST POSITION



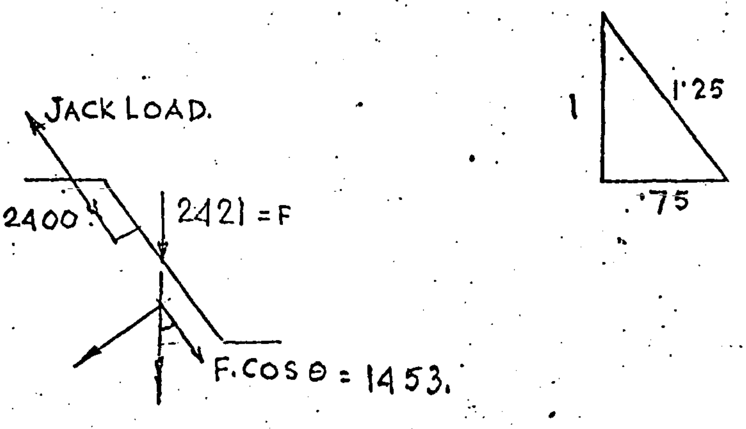
	WT	M.A.	+	-
L.L. ON FINISHING PL. 1 -	500	7.0	3500	
L.L. ON FINISHING PL. 2 -	400	5.6	2240	
L.L. ON MAIN PL.	900	0.0		
L.L. ON TOP PL.	200	6.5		1300
D. L.	3000	1.42	4260	
	5000		10,000	1,300
DRAG (2400)(.8)	1920		–	–
	6920		10,000	1,300
JACK	↖ 6400	.67	4,300	
			14,300	1,300
HYDRO STATIC	↗ 5400	7.5	40,500	
	↑ 1440		54,800	1,300

$R_L = 13.4^k C$

$R_U = (5.4+13.4)(.8)+(2.4-6.4)(.6) = 15.7^k T$

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

JACK LOAD.



JACK LOAD = 4000# DL + L.L. (5000)(.8)
2400# DRAG (2400)
6400# AXIAL

USE 3 TON JACK

LOADING SUMMARY

JACK	6.4^k	
Rupper	18.1^k	TENSION (PULL OUT)
	5.3^k	COMPRESSION
RLOWER	15.0^k	COMPRESSION
	2.8^k	TENSION (PULL OUT)

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 7/72 REV. SKETCH# 209-CK-1

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
SLIP FORM SYSTEM, VERT. FORMS

UPSTREAM SLIPFORM

WEIGHT OF MEMBERS & C.G.

			DIST.		MOMENTS +		MOMENTS −	
		WEIGHT	1:12	VERT	1:12	VERT	1:12	VERT
YOKE BEAM	20×22"	440"	0'-5"+	0-0	185	0		
JACK ROD PLATF.	8×2×5"	80"	2'-6"+	1-3+	200	100		
	2,5×6"	21"	2-0+	1-0+	42	21		
JACK ROD + JACK	10×2,5"	25"	2-9+	1-9+	69	44		
WITH BRACKET		25"	2-6+	1-9+	63	44		
	7×10"	70"	1-3+	0-6+	88	35		
FORM BRACKETS	3×7"	21"	1-0+	0-3+	21	5		
	3×7"	21"	0-9+	0-3+	16	6		
PLACING PLATF.	3×7	21"	0-6+	0-3-	11			5
2,5×8×5"		100"	0-6+	0-3-	50			25
24×3"		72"	0-9-	1-6-			54	110
8×12"		96"	1-0-	1-6-			96	144
FORM WALES	16×12"	192"	1-3+	0-8+	240	127		
FINISHERS PLATFORM		100"	1-6-	1-6-			150	150
8×10"×2		160"	1-6-	1-6-			240	240
		20"	1-6-	1-6-			30	30
		72"	2-9-	2-8-			200	190
8×8"		64"	3-0-	2-10-			192	180
TRAILING PLATF.		80"	2-3-	2-0-			180	160
4×2,5×5		50"	1-9-	1-6-			88	75
YOKE L	16×5	80"	1-0-	0-9-			80	60
FILLERS		40"	0-9-	0-9-			30	30
TOTAL		1850"	1:12		985		1340	
			VERT.			382		1399

1399 − 382 = 1017/1850 = 0,55' ≈ 6½"

1340 − 985 = 355/1850 = 0,19' ≈ 2¼"

TOTAL WEIGHT 1850"/8 FT SECTION

C.G. { 1:12 2¼" { OUTBOARD OF TOP WHEEL

[illegible] POSITION)

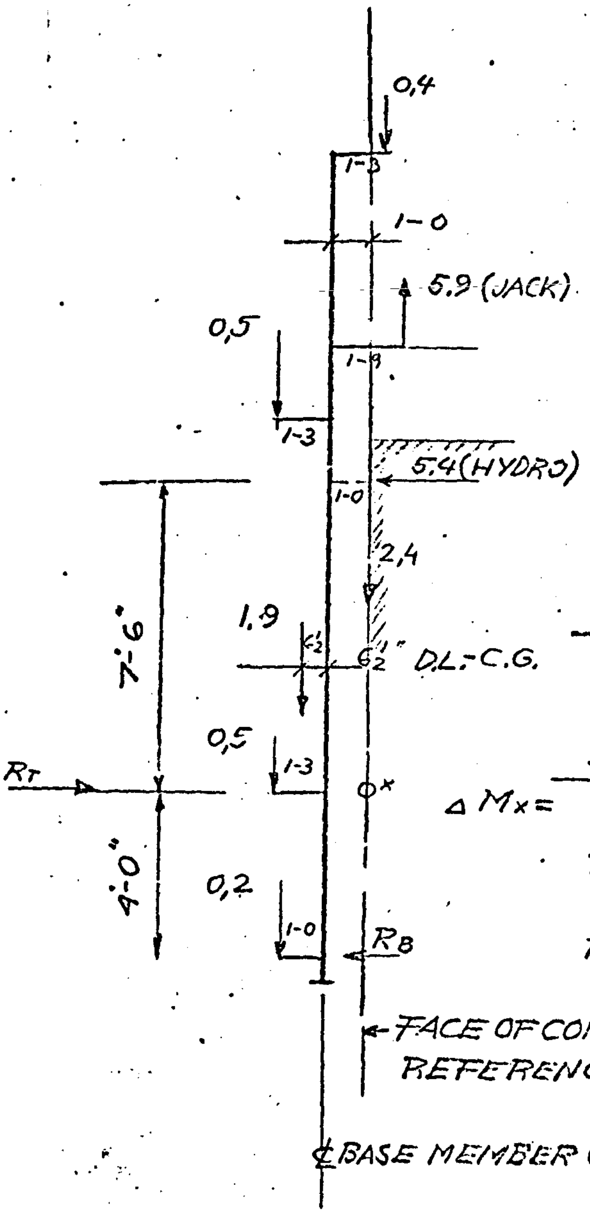
J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1/72 REV. SKETCH# 209-CE-[illegible]

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN

SLIP FORMING SYSTEM, VERT FORMS



JACK LOAD

1,9
0,4 K
0,5
2,4
0,5
0,2

5.9 K

$+M_x$	$-M_x$
	5,9 × 0,75 = 4,40
0,4 × 0,25 = 0,1	5,4 × 7,5 = 40,50
	0,5 × 2,25 = 1,12
	0,5 × 2,25 = 1,13
	0,2 × 2,0 = 0,40
	1,9 × 1,55 = 2,94
+ 0,1	− 50,49

50,49
+ 0,10

$\Delta M_x =$ 50,39

$R_B = \frac{50,39}{4} = 12,6$ COMP

$R_T = 18,0^K$ PULL-OUT

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

AGE OF CONCRETE
RATE OF SPEED = 9"/HR MAX
DISTANCE BELOW FORM 6" TO 24"
MAKE TOP WHEEL OPERATIVE AT 24"
TOTAL AGE OF CONCRETE = 72"/9" = 8 HOURS

CONCRETE STRENGTH

TESTS AT WES USING CONCRETE AT 70° INDICATE STRENGTHS ABOVE 1000 psi @ 8 hrs & STRENGTHS ABOVE 100 PSI @ 5 hours.

A STRENGTH OF 100 PSI WILL BE USED AS SLIPPING WILL NOT PROCEED AT STRENGTHS LOWER THAN THIS

ALLOWABLE STRESSES:

TENSION = 50 psi
COMPRESSION = 100 PSI

LOADING: 18 KIPS PULLOUT
6 KIPS BEARING

BEARING AREA REQUIRED

$$6{,}000/100 = 60\,\square''$$

12 x 10 PRECAST BLOCKS ARE ADEQUATE

BEARING AREA FOR PULL-OUT

$$18000/100 = 180\,\square''$$

USE 10 x 18" PLATE
5/8" THK

$$M = \tfrac{1}{2}(100)(5)^2 = 1250\,''\#$$

$$S_{req} = \frac{1250}{24{,}000} = .052/\text{INCH}$$

Fm. 5/8" ф $S = \frac{1}{6}(\frac{5}{8})^2 = .065/\text{INCH}$

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JAN 1, 1972 REV. SKETCH# 209-CR-10

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN

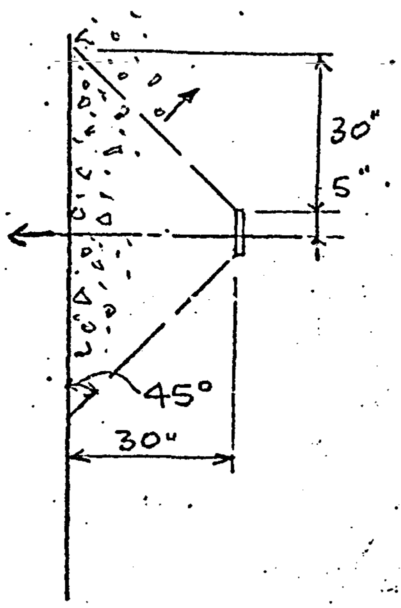
SLIP FORM SYSTEM, ANCHOR DESIGN

DESIGN OF RODS

LOAD PER ROD = 9^k

USE 5/8" φ H.S. RODS (= A325)

DESIGN OF CONCRETE.



PULL ON CONCRETE

$18^k \times 1.41 = 25,300^{\#}$

AREA OF CONCRETE

$A = [(35 \times 35) - 25]1.41$

AREA = 1200 □"(1.41) = 1690□"

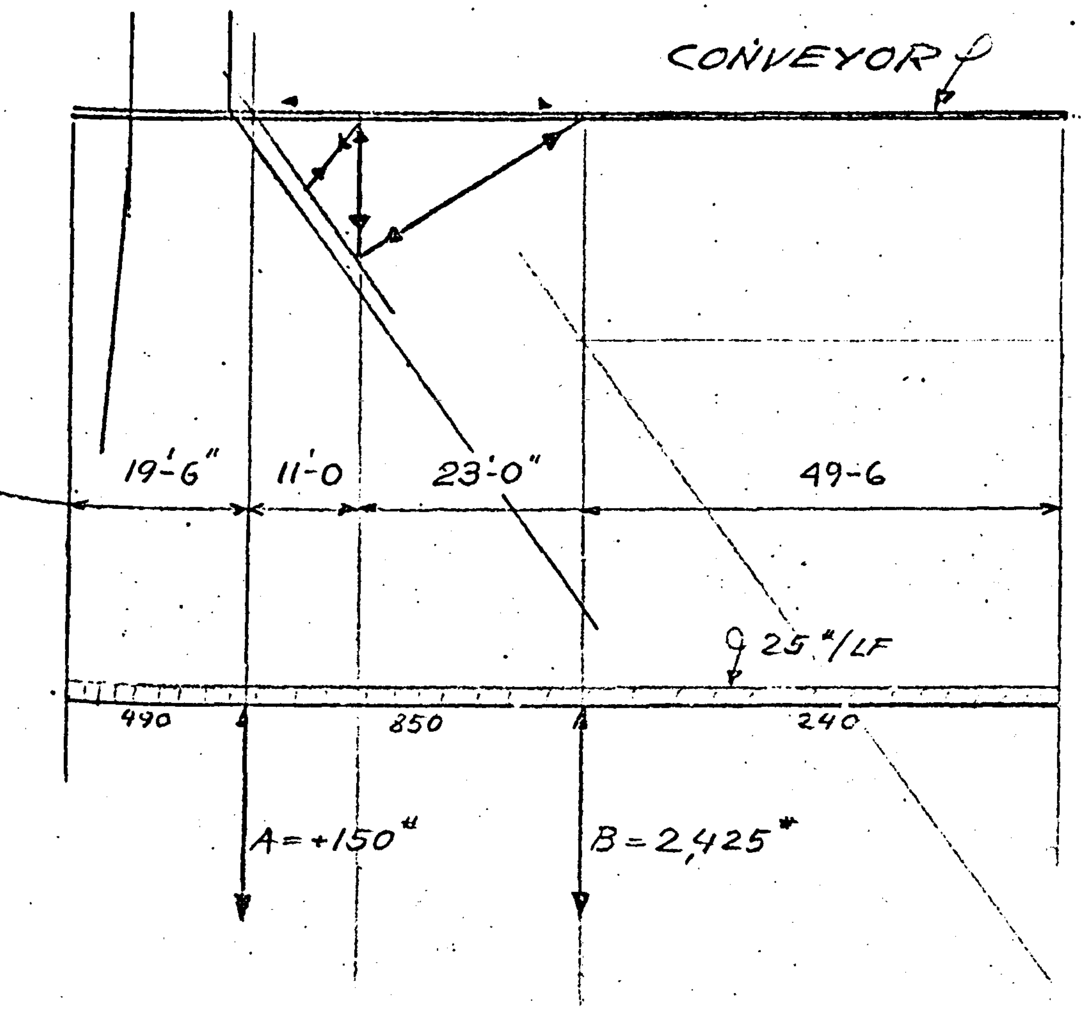
STRESS = $\frac{25,300}{1690}$ = 15 psi < 50

OK.

SP 10132

23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN
SLIP FORM STUDY - CONVEYORS



WEIGHT OF CONV. 25 #/LF
W. OF CONC. 100 "
TOTAL 125 #/LF

$\frac{1240 \times 49.5}{2 \times 34}$ = −900 #

$\frac{850}{2}$ = +425 #

$25 \times \left(19.5 + \frac{19.5^2}{68}\right)$ = +625 #

+ 150 #

2575
150

+ 2425 # / 2 = 1212 #/BRACKET

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUN.1, 1972 REV. SKETCH# 209

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN
SLIP FORM STUDY - CONVEYOR

UNSUPPORTED L OF (A) = 13'-0"
K = 1

TRY DOUBLE L 3x2x 5/16 A = 2,93 □" 10#/LF

$KL/r = \frac{1 \times 13 \times 12}{0,9} = 173$

$F_a = 5000^{\#}$

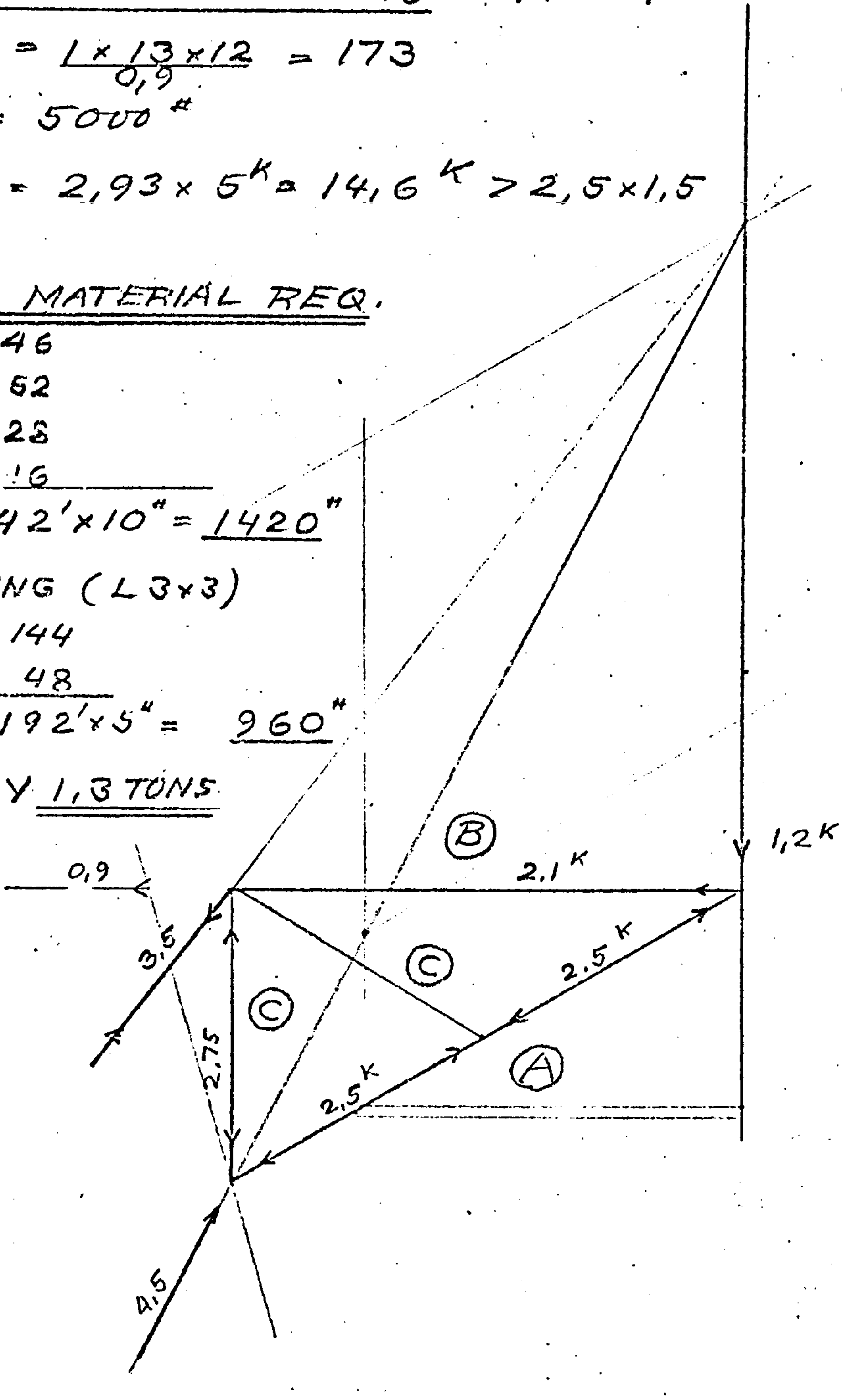
All. P = $2,93 \times 5^K = 14,6^K > 2,5 \times 1,5$

TOTAL MATERIAL REQ.

23'x2 = 46
26'x2 = 52
14'x2 = 28
8'x2 = 16
142'x10" = 1420#

BRACING (L3x3)
12x6x2 = 144
3x3x2 = 48
192'x5" = 960#

TOTAL: SAY 1,3 TONS



J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

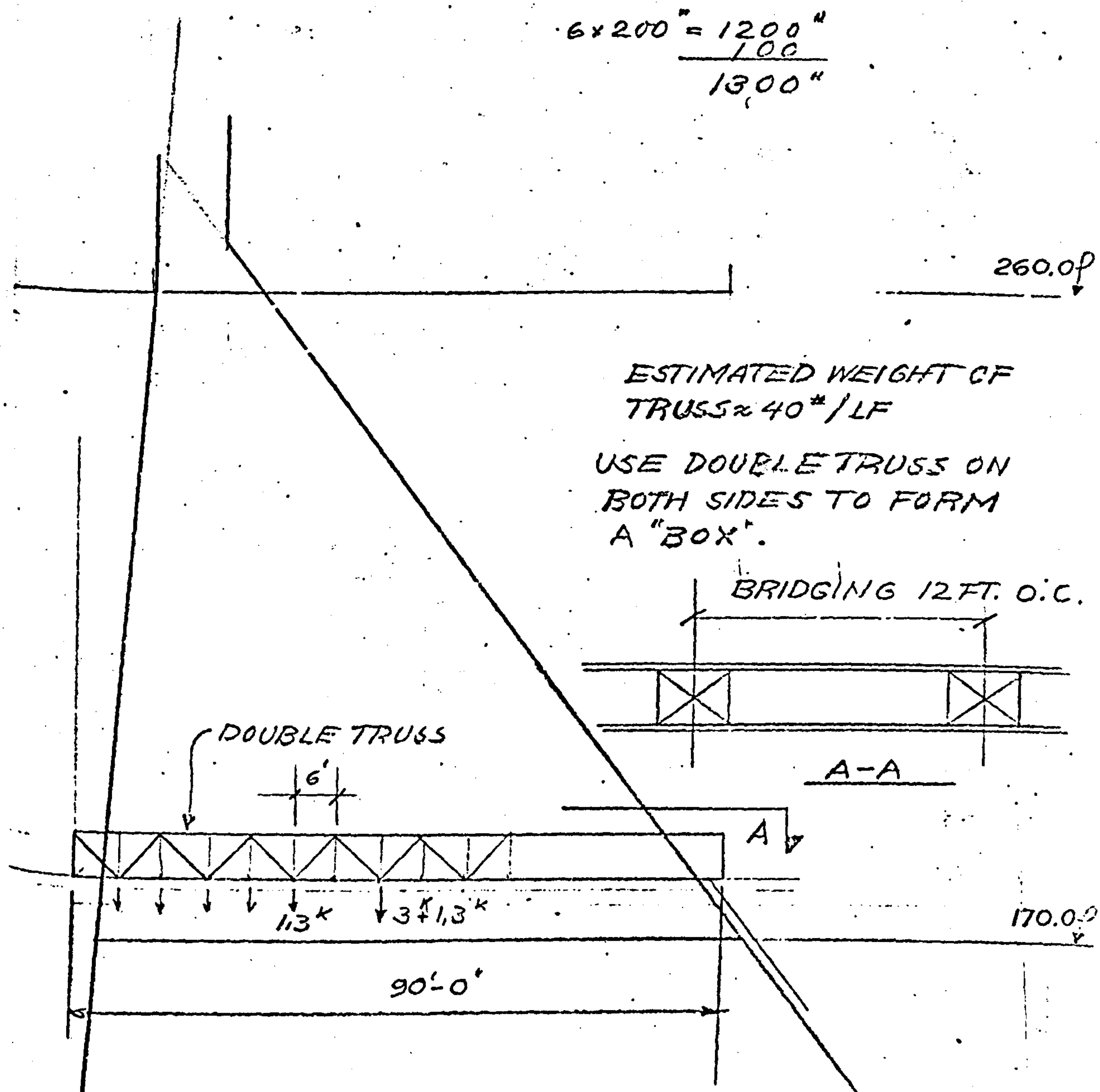
TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN
SLIPFORM STUDY – CONVEYOR TRUSS

LOADS: EMPTY CONV. = 25 #/LF
FULL CONV. + L.L. = 200 #/LF
DL. STEEL = 100#/6FT

6 × 200# = 1200#
100
1300#

ESTIMATED WEIGHT OF TRUSS ≈ 40#/LF

USE DOUBLE TRUSS ON BOTH SIDES TO FORM A "BOX".



TOTAL WEIGHT PER DOUBLE TRUSS (2 REQ.)
200' × 40# = 8000#
MISC. STEEL = 500#
TOTAL = 8500#

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRESTLE ON UPSTREAM SIDE OF DAM

ASSUMED TRESTE WIDTH = 20 FT - 2 LANES
CRANE LOAD 160 TONS
USE 8 POSTS
UNSUPPORTED LENGTH = 20 FT
SPAN = 15 FT.

GROSS WEIGT OF VEHICLE = 300,000# FOR AN APROX. LENGTH OF 22 FT

$\frac{300,000 \times 15}{22}$ = 200,000 PER 15 FT SPAN

TRY WOOD STRINGERS (20")

$\frac{200,000}{2800 \times 8}$ = 9 REQ.

STEEL STRINGERS

$\frac{200,000}{28,000}$ = 7 REQ (15" DEPTH)

$\frac{200,000}{42,000}$ = 5 REQ (18" DEPTH)

2 TONS/LANE/BAY

TRESTLE BENTS, POSTS

TOTAL L.L.	= 100 TONS
IMPACT	= 50 "
D.L.	= 5 "
	155 TONS

USE 10×10 POSTS - All. LOAD = 25 TONS

$\frac{155}{25}$ = 6 EA. /10 FT WIDTH.

10×10, 20 FT LONG, 6 EA
167 × 6 = 1002 BOARD FEET/BENT

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

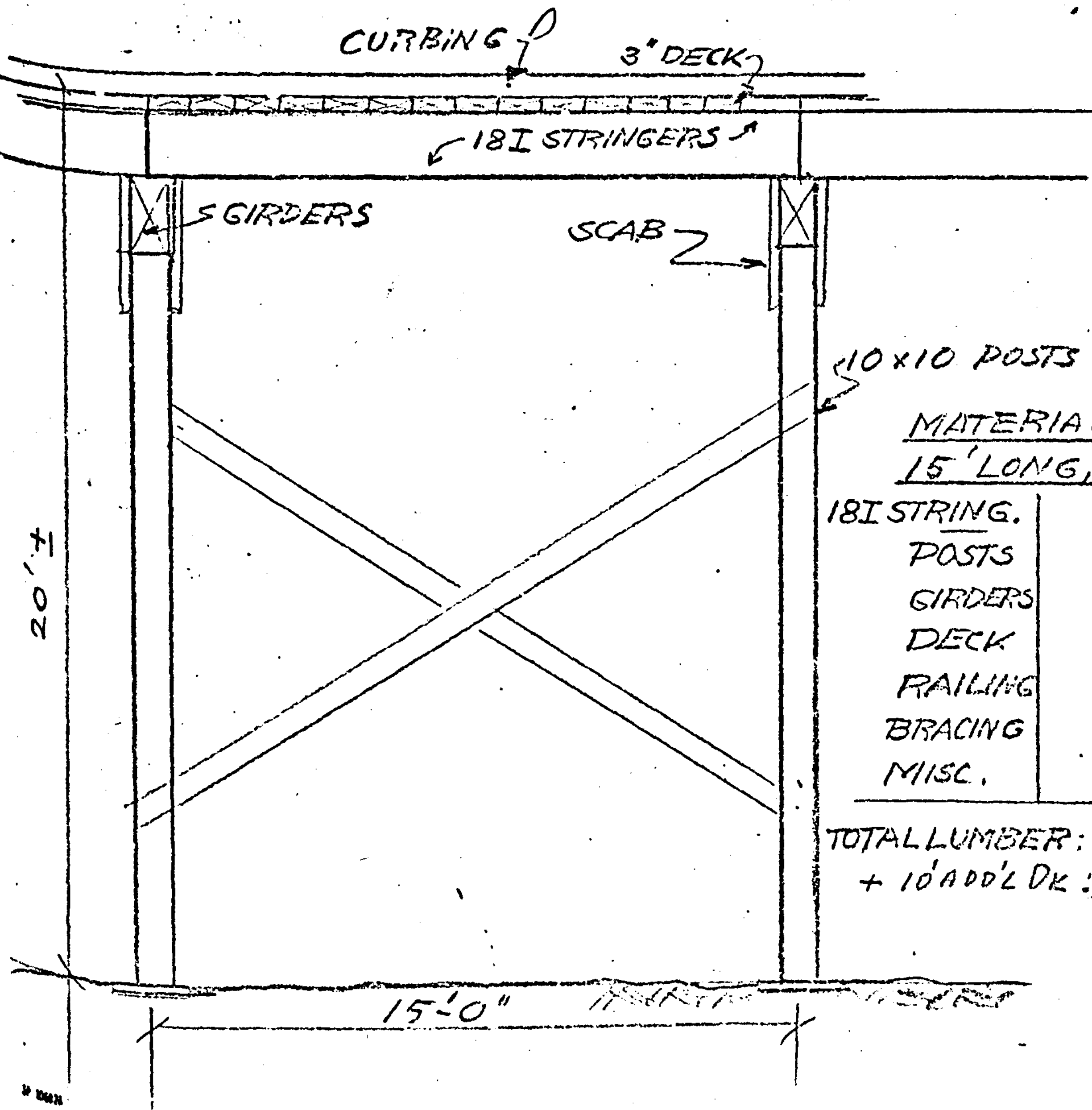
TIMBER FLOORING.

CLEAR DISTANCE BETWEEN 18 I-BEAMS = 18"

1,5 × 1,5 = 2,25 SAY 3" DEEP

3 × 12 × 20' LG. = 45 BOARD FEET

FOR ONE LANE 10' × 45 = 450 B.F./LANE/BAY



MATERIAL FOR 1 LANE
15' LONG, 10' WIDE

18I STRING.	2 TONS
POSTS	1000 BF
GIRDERS	230 "
DECK	500 "
RAILING	150 "
BRACING	100 "
MISC.	100 "

TOTAL LUMBER: 2,080 BF
+ 10' ADD'L DK: 920 BF
3,000 BF

COST AND FEASIBILITY STUDY

ALTERNATE DESIGNS TO PERMIT USE

OF SLIP FORM AND OTHER TECHNIQUES

TO MAXIMIZE ECONOMIES

BOOK RC

RAPID CONSTRUCTION UTILIZING SLIP FORM TECHNIQUES

APPENDIX: COST STUDY SHEETS

BOOK RC - RAPID CONSTRUCTION UTILIZING SLIP FORM TECHNIQUE

APPENDIX: COST STUDY SHEETS

1 Sheets ER-A1 through -A21

2 Sketches ER-S1 through -S22

3 Sheets EM-S, EM-1 through EM-4

4 Sheets EM-G, $-F_1$, $-F_2$

5 Sketches EM-S-1 through -S-22

COST STUDY SHEETS

SLIP FORMING

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE: Jun 1, '72
PRICED BY:
SHEET NO. ER-A1

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV.-CORPS./ENGR.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
COST OF FORMING OF THOSE AREAS CAPABLE OF BEING SLIPPED:						
AREAS AS USED IN COST STUDY:	(CONVENTIONAL FORMS)					
CANTILEVER	74,000	CA	.43	31,800	1.17	86,600
TRANSV. BULKHEADS	30,000	CA	.43	12,900	1.17	35,200
				44,700		121,800
ESCALATION THRU 1974			2%	890	11%	13,400
				45,590		135,200
PAYROLL, TAXES & INSURANCE					14%	18,900
						154,100
				→		45,600
TOTAL COST TO CONTR.						199,700
O'HD, PROFIT & CONTINGENCY					8%	16,000
						215,700
BID BOND					3/4%	1,600
TOTAL CONTRACT PRICE						217,300

TOTAL YDS. - 58,400 C.Y.
TOTAL CONTACT AREA - 74,000

COST/C.Y. - 217,300/58,400 + $3.72/C.Y.

COST/S.F. 217,300/74,000 + $2.94

10196A

J.F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JUN 1, '72 PRICED BY SHEET NO. ER-A2

PROJECT: TRUMBULL LAKE DAME

ARCHITECT: NEW ENGLAND DIV.-CORPS/ENG'R.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
COST OF FORMING OF THOSE AREAS CAPABLE OF BEING SLIPPED:						
AREAS AS USED IN COST STUDY:	(RAPID CONSTR.)					
SLIDING FORMS	1,520	LF	7.00	10,600	10.50	16,000
YOKES	192	EA.	210.	40,300	135.	26,000
JACK RODS (6T)	14,000	LF	2.50	35,000	.13	1,800
HYDRAULIC PIPING	4,000	LF	-	INCL.	.80	3,200
PLATFORM DECKS	1,650	LF	1.50	2,500	4.00	6,600
RAILING & LADDERS	1,650	LF	4.50	7,500	2.50	4,100
STRIP FORMS	-	-	-	-	-	26,000
FORM DESIGN	-	-	-	10,000	-	-
GUIDE WHEEL BRACKETS	230	EA.	65.	15,000	-	INCL.
PRECAST INSERTS	3,500	EA.	12.50	44,000	-	INCL.
SLIDE CREW	-	-	-	-	-	34,000
				164,900		117,700
ESCALATION THRU 1974			2%	3,300	11%	12,900
				168,200		130,600
PAYROLL TAXES & INSURANCE					14%	18,300
						148,900
					→	168,200
TOTAL COST TO CONTRACTOR						317,100
O'HD, PROFIT & CONTINGENCY					8%	25,400
						342,500
BID BOND					3/4%	2,600
TOTAL CONTRACT PRICE						345,100
COST/C.Y. - 345,100/58,400 -	$5.91/C.Y.					
COST/S.F. - 345,100/74,000 -	$4.66					

SP 10196A

	J. F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743

DATE JUN 1, '72 PRICED BY SHEET NO. ER-A3

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV.-CORPS/ENG'R.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
ALTERNATE COST MONOLITHS TWICE AS HIGH: (CONVENTIONAL)						
CANTILEVER FORMS	148,000	CA	.38	56,200	1.17	173,000
TRANSV. BULKHEADS	60,000	CA	.38	22,800	1.17	70,000
				79,000		243,000
ESCALATION THRU 1974			2%	1,580	11%	34,000
				80,580		277,000
PAYROLL, TAXES & INSURANCE					14%	38,800
						315,800
						80,580
TOTAL COST TO CONTR.						396,380
O'HD, PROFIT & CONTINGENCY					8%	31,700
						428,080
BID BOND					3/4%	3,200
TOTAL CONTRACT PRICE						431,280

TOTAL YDS - 116,800 YDS.

TOTAL CONTACT AREA - 148,000 S.F.

COST/S.F. 431,280/148,000 - $2.92/S.F.

COST/C.Y. 431,280/116,800 - $3.70/C.Y.

SP 10196A

	DATE JUN 1, '72 PRICED BY	SHEET NO. ER-A4
J. F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	PROJECT: TRUMBULL LAKE DAM	
	ARCHITECT: NEW ENGLAND DIV.-CORPS/ENG'R.	

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
ALTERNATE COST MONOLITHS TWICE AS HIGH: (RAPID)						
SLIDING FORMS	1,520	L.F.	7.00	10,600	10.50	16,000
YOKES	192	EA.	210.	40,300	135.	26,000
JACK RODS	28,000	L.F.	2.50	70,000	.13	3,600
HYDRAULIC PIPING	4,000	L.F.	-	INCL.	.80	3,200
PLATFORM DECKS	1,650	L.F.	1.50	2,500	4.00	6,600
RAILING & LADDERS	1,650	L.F.	4.50	7,500	2.50	4,100
STRIP FORMS	-	-	-	-	-	26,000
FORM DESIGN	-	-	-	10,000	-	-
GUIDE WHEEL B'KT	230	EA.	65.	15,000	-	INCL.
PRECAST INSERTS	7,000	EA.	12.50	88,000	-	INCL.
SLIDE CREW	-	-	-	-	-	68,000
				243,900		153,500
ESCALATION THRU 1974			2%	4,900	11%	16,900
				248,800		170,400
PAYROLL, TAXES & INSURANCE					14%	23,800
						194,200
				→		248,800
TOTAL COST TO CONTRACTOR						443,000
O'HD, PROFIT & CONTINGENCY					8%	35,500
						478,500
BID BOND					3/4%	3,600
TOTAL CONTRACT PRICE						482,100
COST/C.Y. 482,100/116,000 =	$4.16/C.Y.					
COST/S.F. 482,100/148,000 =	$3.26/S.F.					

SP 10196A

	J.F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JUN 1, '72 PRICED BY SHEET NO. ER-A5 PROJECT: TRUMBULL LAKE DAM ARCHITECT: NEW ENGLAND DIV.-CORPS/ENG'R.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
ALTERNATE COSTS, TWICE AS MANY MONOLITHS: (CONVENTIONAL)						
CANTILEVER FORMS	148,000	C.A.	.38	56,200	1.17	173,000
TRANSV. BULKHEADS	60,000	C.A.	.38	22,800	1.17	70,000
				79,000		243,000
ESCALATION THRU 1974			2%	1,580	11%	26,800
				80,580		269,800
PAYROLL, TAXES & INSURANCE					14%	37,800
						307,600
				→		80,580
TOTAL COST TO CONTRACTOR						388,180
O'HD, PROFIT & CONTINGENCY					8%	31,000
						419,180
BID BOND					3/4%	3,150
TOTAL CONTRACT PRICE						422,330

COST/S.F. - 422,330/148,000 - $2.86/S.F.

COST/C.Y. - 422,330/116,800 - $3.62/C.Y.

SF 10196A

	J. F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JUN 1, '72 PRICED BY	SHEET NO. ER-A6
		PROJECT: TRUMBULL LAKE DAM	
		ARCHITECT: NEW ENGLAND DIV.-CORPS/ENG'R	

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
ALTERNATE COST, TWICE AS MANY MONOLITHS: (RAPID)						
SLIDING FORMS:	1,520	L.F.	7.00	10,600	21.	32,000
YOKES	192	EA.	210.	40,300	270.	52,000
JACK RODS	28,000	L.F.	2.50	70,000	.13	3,600
HYDRAULIC PIPING	8,000	L.F.	-	INCL.	.80	6,400
PLATFORM DECKS	1,650	L.F.	1.50	2,500	8.00	13,200
RAILINGS & LADDERS	1,650	L.F.	4.50	7,500	5.00	8,200
STRIP FORMS	-	-	-	-	-	52,000
FORM DESIGN	-	-	-	10,000	-	-
GUIDE WHEEL B'KT	230	EA.	65.	15,000	-	INCL.
PRECAST INSERTS	7,000	EA.	12.50	88,000	-	INCL.
SLIDE CREW	-	-	-	-	-	68,000
				243,900		235,400
ESCALATION THRU 1974			2%	4,900	11%	25,900
				248,800		261,300
PAYROLL, TAXES & INSURANCE					14%	36,600
						297,900
				→		248,800
TOTAL COST TO CONTRACTOR						546,700
O'HD, PROFIT & CONTINGENCY					8%	43,800
						590,500
BID BOND					3/4%	4,450
TOTAL CONTRACT PRICE						594,950

COST/S.F. - 594,950/148,000 - $4.00/S.F.

COST/C.Y. - 594,950/116,800 - $5.10/C.Y.

SF 10196A

J. F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JUN 1, '72 PRICED BY SHEET NO. ER-A7 PROJECT: TRUMBULL LAKE DAM ARCHITECT: NEW ENGLAND DIV.-CORPS/ENG'R.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
COST OF FORMING OF THOSE AREAS CAPABLE OF BEING SLIPPED:						
ALTERNATE COST - MONOLITHS 3K AS HIGH: (CONV.)						
CANTILEVER FORMS	222,000	C.A.	.30	66,700	1.17	260,000
TRANSV. BULKHEAD	90,000	C.A.	.30	27,000	1.17	105,000
				93,700		365,000
ESCALATION THRU 1974			2%	1,870	11%	40,200
				95,570		405,200
PAYROLL, TAXES & INSURANCE					14%	56,800
						462,000
				→		95,570
TOTAL COST TO CONTRACTOR						557,570
O'HD, PROFIT & CONT.					8%	44,600
						602,170
BID BOND					3/4%	4,500
TOTAL CONTRACT PRICE						606,670

COST/S.F. - 606,670/222,000 - $2.74/S.F.

COST/YD - 606,670/176,000 - $3.45/C.Y.

SP 10190A

J.F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE June 1, '72 PRICED BY	SHEET NO. ER-A8
	PROJECT: TRUMBULL LAKE DAM	
	ARCHITECT: NEW ENGLAND DIV.-CORPS/ENG'R.	

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
COST OF FORMING OF THOSE AREAS CAPABLE OF BEING SLIPPED:						
ALTERNATE COST - MONOLITHS 3X AS HIGH (RAPID)						
SLIDING FORMS	1,520	LF	7.00	10,600	10.50	16,000
YOKES	192	EA.	210.	40,300	135.	26,000
JACK RODS	42,000	LF	2.50	105,000	.13	5,400
HYDRAULIC PIPING	4,000	LF	-	INCL.	.80	3,200
PLATFORM DECKS	1,650	LF	1.50	2,500	4.00	6,600
RAILINGS & LADDERS	1,650	LF	4.50	7,500	2.50	4,100
STRIP FORMS	-	-	-	-	-	26,000
FORM DESIGN	-	-	-	10,000	-	-
GUIDE WHEEL BKT.	230	EA	65.	15,000	-	INCL.
PRECAST INSERTS	10,500	EA	12.50	132,000	-	INCL.
SLIDE CREW	-	-	-	-	-	102,000
				322,900		189,300
ESCALATION THRU 1974			2%	6,450	11%	20,800
				329,350		210,100
PAYROLL, TAXES & INSURANCE					14%	29,400
						239,500
						329,350
TOTAL COST TO CONTR.						568,850
O'HD, PROFIT & CONT.					8%	45,500
						614,350
BID BOND					3/4%	4,600
						618,950
COST/C.Y. 618,950/176,000 -	$3.52/C.Y.					
COST/S.F. 618,950/222,000 -	$2.79/S.F.					

SP 10196A

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE Jun 1, '72 PRICED BY SHEET NO. ER-A9

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV.-CORPS/ENG'R.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
COST OF FORMING THOSE AREAS CAPABLE OF BEING SLIPPED:						
ALTERNATE COST, 3X AS MANY MONOLITHS: (CONV.)						
CANTILEVER FORMS	222,000	CA	.30	66,700	1.17	260,000
TRANSV. BULKHEADS	90,000	CA	.30	27,000	1.17	105,000
				93,700		365,000
ESCALATION THRU 1974			2%	1,850	11%	40,200
				95,550		405,200
PAYROLL, TAXES & INSURANCE					14%	56,700
						461,900
						95,550
TOTAL COST TO CONTR.						557,450
O'HD, PROFIT & CONT.					8%	44,600
						602,050
BID BOND					3/4%	4,500
TOTAL CONTRACT PRICE						606,550

COST/S.F. - 606,550/222,000 - $2.74/S.F.

COST/C.Y. - 606,550/176,000 - $3.45/C.Y.

SP 10190A

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE Jun 1, '72 PRICED BY SHEET NO. ER-A10
PROJECT: TRUMBULL LAKE DAM
ARCHITECT: NEW ENGLAND DIV.-CORPS/ENG'R.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
COST OF FORMING THOSE AREAS CAPABLE OF BEING SLIPPED						
ALTERNATE COST - 3X AS MANY MONOLITHS: (RAPID)						
SLIDING FORMS	1,520	LF	7.00	10,600	31.50	48,000
YOKES	192	EA	210.	40,300	405.	78,000
JACK RODS (6T)	42,000	LF	2.50	105,000	.13	5,400
HYDRAULIC PIPING	12,000	LF	-	INCL.	.80	9,600
PLATFORM DECKS	1,650	LF	1.50	2,500	12.00	19,800
RAILINGS & LADDERS	1,650	LF	4.50	7,500	7.50	12,400
STRIP FORMS	-	-	-	-	-	78,000
FORM DESIGN	-	-	-	10,000	-	-
GUIDE WHEEL BRKT.	230	EA	65.	15,000	-	INCL.
PRECAST INSERTS	10,500	EA	12.50	132,000	-	INCL.
SLIDE CREW	-	-	-	-	-	102,000
				322,900		353,200
ESCALATION THRU 1974			2%	6,450	11%	38,800
				329,350		392,000
PAYROLL, TAXES & INSURANCE					14%	55,000
						447,000
				→		329,350
TOTAL COST TO CONTR.						776,350
O'HD, PROFIT & CONT.					8%	62,100
						838,450
BID BOND					3/4%	6,300
TOTAL CONTRACT PRICE						844,750
COST/S.F. -844,750/222,000 -	$3.80/S.F.					
COST/C.Y. -844,750/176,000 -	$4.80/C.Y.					

SP 10190A

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. – CORPS. / ENG'R

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
COST OF PLANT & OPERATION FOR THOSE AREAS CAPABLE OF SLIDING:						
CONCRETE HANDLING PLANT (CONV)						
CABLEWAY	58,365	C.Y.	2⁻	117,000	.61	35,600
CONCRETE PLACING	58,365	C.Y.	.06	3,500	—	—
VIBRATION	58,365	C.Y	.35	20,400	—	—
				140,900		35,600
ESCALATION THRU 1974			2%	2,800	11%	3,900
				143,700		39,500
PAYROLL TAXES + INSURANCE					14%	5,500
						45,000
				→		143,700
TOTAL COST TO CONTRACTOR						188,700
O'HD, PROFIT & CONTINGENCY					8%	15,300
						204,000
BID BOND					¾%	1,500
TOTAL CONTRACT PRICE						205,500

COST / C.Y. 205,500 / 58,365 = 3.52/CY

SP 10196A

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JUN. 1, '72 PRICED BY SHEET NO. ER-A12

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. — CORPS. / ENG'R

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
CONCRETE HANDLING PLANT (RAPID)						
CONCRETE PLACING	—	—	—	73,000	—	—
VIBRATION	58,365	C.Y.	.35	20,400	—	—
SLIDE CREW	—	—	—	—	—	36,500
FIELD ASSIST. ENG.	15	DAYS	200	3,000	—	—
FIELD TECHNICIAN	30	DAYS	150	4,500	—	SUB
CONVEYORS	58,400	C.Y.	.21	12,500	.12	7,000
MATERIAL TOWERS	4x6	MOS.	1200	28,800	—	34,000
CONV. SUPP. BRKT.	7	EA.	—	1,300	—	2,300
CONV. SUPP. TRUSS	6	EA.	—	8500	—	6,500
ELEPHANT TRUNKS	—	—	—	500	—	—
	(SUB-TOTAL)			152,500		86,300
EQUIP. SAVINGS (ON JOB 3 MONTHS LESS) (CONVENTIONAL LESS RAPID)						
YARD CRANES	1 x 3	MOS.	4500	13,500	—	8,200
HYDRAULIC BOOM CRANES	2 x 3	"	1500	9,000	1400	8,400
COMPRESSORS	2x3	"	1100	6,600	1300	7,800
UTILITY TRUCKS	2x3	"	800	4,800	940	5,700
PERSONNEL STAIR	3x3	"	80	720	—	—
DOZER	1x3	"	1200	3600	1330	4000
	(SUB-TOTAL)			38,220		34,100
FIELD OVERHEAD (ON JOB 3 MONTHS LESS)						
PROJECT MANAGER	12	WKS	—	—	500	6000
SUPERINTENDENT	12	"	—	—	400	4800
PROJECT ENG'R	12	"	—	—	400	4800
CLERKS	2x12	"	—	—	200	4800
SURVEYORS	4x12	"	—	—	250	12,000
UTILITY MECHANICS	6x12	"	—	—	300	21,600
WATCHMEN	3x12	"	—	—	100	3,600
	(SUB-TOTAL)					57,600
EQUP. + FIELD O'HD SAVINGS				38,220		91,700
TIMBER TRESTLE (ADD'L)	480	LF	73⁻	35,000	37⁻	17,800
TEMPORARY LIGHTING (ADD'L)			—	1,000	—	4,000
SP 10196A				36,000		21,800

J. F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE Jun. 1 '72 PRICED BY	SHEET NO. ER-A13
	PROJECT: Trumbull Lake Dam	
	ARCHITECT: New England Div. - Corps/Eng'r.	

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
Concrete Handling Plant - Cont. (Ck'd)						
Conc. Handling Plant				152,500		86,300
Less Equip. + Field O'hd Savings				-38,220		-91,700
				114,280		-5,400
Plus Add'l Trestle & Temp. Light.				+36,000		+21,800
				150,280		16,400
Escalation Thru 1974			2%	3,020	11%	1,800
				153,300		18,200
Payroll Taxes + Insurance					14%	2,500
						20,700
					→	153,300
Total Cost To Contractor						174,000
O'hd, Profit + Contingency					8%	14,000
						188,000
[illegible] Bond					[illegible]%	1,400
Total Contract Price						189,400

Cost/c.y. = 189,400 / 58,365 = $3.[illegible]/c.y.

J.F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. - CORPS./ ENG'R.

COST OF PLANT & OPERATION - CONCRETE HANDLING PLANT

ALTERNATE COST - MONOLITHS TWICE AS HIGH: (CONVENTIONAL)

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
CABLEWAY	116,730	C.Y.	1.35	156,000	.61	71,200
CONCRETE PLACING	116,730	C.Y.	.03	3,500	—	—
VIBRATION	116,730	C.Y	.35	40,800	—	—
				200,300		71,200
ESCALATION THRU 1974			2%	4,000	11%	7,800
				204,300		79,000
PAYROLL TAXES + INSURANCE					14%	11,000
						90,000
						204,300
TOTAL COST TO CONTRACTOR						294,300
O'HD PROFIT + CONTINGENCY					8%	23,400
						317,700
BID BOND					3/4%	2,400
TOTAL CONTRACT PRICE						320,100

COST /C.Y. = 320,100 / 116,730 = $2.74/C.Y.

SP 10196A

J.F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. - CORPS. / ENG'R.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
COST OF PLANT + OPERATION - CONCRETE HANDLING PLANT						
ALTERNATE COST - MONOLITHS TWICE AS HIGH : (RAPID)						
CONCRETE PLACING	116,730	CY	—	73,000	—	—
VIBRATION	116,730	C.Y.	.35	40,800	—	—
SLIDE CREW	—	—	—	—	—	73,000
FIELD ASS'T ENG'R	15	DAYS	200	3,000	—	—
FIELD TECHNICIAN	30	DAYS	150	4,500	—	SUB.
CONVEYORS	116,730	C.Y.	.21	12,300	.12	14,000
MATERIAL TOWERS	—	—	—	35,200	—	51,000
CONV. SUPP. BRKT.	7	EA.	—	1,300	—	2,300
CONV. SUPP. TRUSS	6	EA.	—	8500	—	6500
ELEPHANT TRUNKS	—	—	-	500	—	—
	(SUB-TOTAL)			179,100		146,800
LESS EQUIP. + FIELD O'HD SAVINGS			—	-74,500	-	-183,400
				103,600		-36,600
PLUS TIMBER TRESTLE +	480	LF	73⁻	35,000	37⁻	17,800
TEMP. LIGHT ADD'L.			—	1,000	-	4,000
				139,600		-14,800
ESCALATION THRU 1974			2%	2,800	11%	- 1,600
			+	142,400		-16,400
PAYROLL TAXES + INSURANCE					14%	- 2,300
						-18,700
				→		+142,400
TOTAL COST TO CONTRACTOR						+123,700
O'HD, PROFIT + CONTINGENCY					8%	9,900
						133,60
BID BOND					3/4%	1,000
TOTAL CONTRACT PRICE						134,60

COST/C.Y. = 134,600 / 116,730 = $1.15/C.Y.

SP 10196A

J.F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

PROJECT: TRUMBULL LAKE DAM
ARCHITECT: NEW ENGLAND DIV. - CORPS / ENG'R

COST OF PLANT + OPERATION - CONCRETE HANDLING PLANT
ALTERNATE COST - TWICE AS MANY MONOLITHS (CONV.)

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
CABLEWAY	116,730	C.Y.	1.35	156,000	.61	71,200
CONCRETE PLACING	116,730	C.Y.	.03	3,500	—	—
VIBRATION	116,730	C.Y.	.35	40,800	—	—
				200,300		71,200
ESCALATION THRU 1974			2%	4,000	11%	7,800
				204,300		79,000
PAYROLL TAXES + INSURANCE					14%	11,000
						90,000
				→	→	204,300
TOTAL COST TO CONTRACTOR						294,300
O'HD, PROFIT + CONTINGENCY					8%	23,500
						317,800
BID BOND					3/4%	2,400
TOTAL CONTRACT PRICE						320,200

COST/C.Y. = 320,200 / 116,730 = $2.74/C.Y.

SP 10196A

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. – CORPS/ENG'R

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
COST OF PLANT + OPERATION – CONCRETE HANDLING PLANT						
ALTERNATE COST – TWICE AS MANY MONOLITHS (RAPID)						
CONCRETE PLACING	116,730	C.Y.		138,000	—	—
VIBRATION	116,730	C.Y.	.35	40,800	—	—
SLIDE CREW	—	–	—	–	–	73,000
FIELD ASS'T ENG'R	15	DAYS	200	3000	—	—
FIELD TECHNICIAN	30	DAYS	150	4500	—	SUB.
CONVEYORS	116,730	C.Y.	.21	17,000	.12	14,000
MATERIAL TOWERS	4 x 8	MOS.	1200	38,400	—	68,000
CONVEYOR SUPP. BRKT	7	EA.	—	1,300	—	4,600
CONV. SUPP. TRUSS	6	EA.	—	8,600	—	13,000
ELEPHANT TRUNKS	—	–	–	500	—	–
	(SUB-TOTAL)			252,100		172,600
LESS EQUIP + FIELD O'HD SAVINGS				-74,500		-183,400
			+	177,600		-10,800
PLUS TIMBER TRESTLE	960	L.F.	73–	+70,000	37–	+35,600
				247,600		+24,800
PLUS ADD'L TEMP. LIGHTING				1,000		8000
				248,600		+32,800
ESCALATION THRU 1974			2%	5,000	11%	3,600
				253,600		36,400
PAYROLL TAXES + INSURANCE					14%	5,100
						41,500
				→		253,600
TOTAL COST TO CONTRACTOR						295,100
O'HD, PROFIT + CONTINGENCY					8%	23,600
						318,700
BID BOND					¾%	2,400
TOTAL CONTRACT PRICE						321,100

COST/C.Y. = 321,100 / 116,730 = $2.75/C.Y.

SP 10196A

J.T. CAMILLERI ...
23 GREEN STREET
HUNTINGTON, N.Y. 11743

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. — CORPS. / ENG'R.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
...T OF PLANT & OPERATION FOR THOSE AREAS CAPABLE OF SLIPPING:						
...NC. HANDLING PLANT: 3X AS HIGH (CONV.)						
CABLEWAY	175,100	C.Y.	1.04	183,000	.61	107,000
CONCRETE PLACING	175,100	C.Y.	—	3,500	—	—
VIBRATION	175,100	C.Y.	.35	61,200	—	—
				247,700		107,000
ESCALATION THRU 1974			2%	5,000	11%	11,800
				252,700		118,800
PAYROLL TAXES + INSURANCE					14%	16,600
						135,400
				→	→	252,700
TOTAL COST TO CONTR.						388,100
O'HD, PROFIT + CONST.					8%	31,100
						419,200
BID BOND					3/4%	3,200
TOTAL CONTRACT PRICE						422,400

COST/C.Y. = 422,400 / 176,000 = $2.40/C.Y.

SP 10196A

J.F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JUN. 1, '72 PRICED BY SHEET NO. ER-A 19

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. – CORPS/ENG'R

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
COST OF PLANT & OPERATION FOR THOSE AREAS CAPABLE OF SLIDING:						
CONC. HANDLING PLANT: 3X AS HIGH: (RAPID)						
CONCRETE PLACING	–	–	–	73,000	–	–
VIBRATION	176,000	C.Y.	.35	61,600	–	–
SLIDE CREW	–	–	–	–	–	109,500
FIELD ASSIST. ENG'R	15	DAYS	200	3,000	–	–
FIELD TECH.	30	DAYS	150	4,500	–	SUB
CONVEYORS	175,200	C.Y.	.21	37,500	.12	21,000
MATERIAL TOWERS	–	–	–	48,000	–	68,000
CONV. SUPP. BRKT.	7	EA.	–	1,300	–	2,300
CONV. SUPP. TRUSS	6	EA.	–	8,500	–	6,500
ELEPHANT TRUNKS	–	–	–	500	–	–
	(SUB-TOTAL)			237,900		207,300
LESS EQUIP. + FIELD O'HD SAVINGS				-114,600		-275,100
				+123,300		-67,800
PLUS TIMBER TRESTLE	480	L.F.	73–	+35,000	37–	+17,800
				158,300		-50,000
PLUS ADD'L TEMP. LIGHTING				+1,000		+4,000
				159,300		-46,000
ESCALATION THRU 1974			2%	3,200	11%	-5,100
				162,500		-51,100
PAYROLL TAXES + INSURANCE					14%	-7,100
						-58,200
				→		+162,500
TOTAL COST TO CONTR.						104,300
O'HD, PROFIT + CONT.					8%	8,300
						112,600
BID BOND					3/4%	900
TOTAL CONTRACT PRICE						113,500

COST/C.Y. 113,500/176,000 = $.65/C.Y.

SP 10196A

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JUN. 1, '72 PRICED BY SHEET NO. CK-A-20

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. - CORPS/ENG'R

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
COST OF PLANT & OPERATION FOR THOSE AREAS CAPABLE OF SLIDING:						
CONCRETE HANDLING PLANT - 3x AS MANY MONOLITHS (CONT.)						
CABLEWAY	176,000	C.Y.	1.04	184,000	.61	108,000
CONCRETE PLACING	176,000	C.Y.	.015	3,500	—	—
VIBRATION	176,000	C.Y.	.35	61,500	—	—
				249,000		108,000
ESCALATION THRU 1974			2%	5,000	11%	11,900
				254,000		119,900
PAYROLL TAXES + INSURANCE					14%	16,800
						136,700
						254,000
TOTAL COST TO CONTRACTOR						390,700
OHD, PROFIT + CONT.					8%	31,300
						422,000
BID BOND					¾%	3,200
TOTAL CONTRACT PRICE						425,200

COST / C.Y. = 425,200 / 176,000 = $2.42 / C.Y.

SP 10196A

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE Jun. 1, '72 PRICED BY SHEET NO. ER-A21

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. – CORPS / ENG'R.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
COST OF PLANT & OPERATION – CONCRETE HANDLING PLANT						
ALTERNATE COST – 3X AS MANY MONOLITHS (RAPID)						
CONCRETE PLACING	176,000	C.Y.	—	204,000	—	—
VIBRATION	176,000	C.Y.	.35	61,600	—	—
SLIDE CREW	—	—	—	—	—	109,500
FIELD ASS'T ENG'R	15	DAYS	200	3,000	—	—
FIELD TECH.	30	DAYS	150	4,500	—	—
CONVEYORS	176,000	C.Y.	.07	12,500	.12	21,000
MATERIAL TOWERS	4 x 10	MOS.	1200	48,000	—	102,000
CONV. SUPP. BR'KT	7	EA.	—	1,300	—	6,900
CONV. SUPP. TRUSS	6	EA.	—	8,600		19,500
ELEPHANT TRUNKS	—	—	—	500	—	—
	(SUB-TOTAL)			344,000		258,900
LESS EQUIP. + FIELD OHD SAVINGS				-114,600	—	275,100
				+229,400		-16,200
PLUS TIMBER TRESTLE	1440	LF	73	105,000	37	+53,400
				334,000		+37,200
PLUS ADD'L TEMP. LIGHTING				+1,000		+12,000
				335,000		49,200
ESCALATION THRU 1974			2%	6,700	11%	5,400
				341,700		54,600
PAYROLL TAXES + INSURANCE					14%	7,600
						62,200
				→		341,700
TOTAL COST TO CONTR.						403,900
OHD, PROFIT + CONT.					8%	32,300
						436,200
BID BOND					3/4%	3,300
TOTAL CONTRACT PRICE						439,500

COST/C.Y. = 439,500 / 176,000 = $2.50/C.Y.

SP 10196A

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1/72 REV. SKETCH# [illegible]

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
CONCRETE ESTIMATE

	CY	CEMENT	FLYASH
INT. CONC.	88.700	×1,40 = 124,200 CWT /376 = 33.000 bbl	×1,10 = 97,500 CWT /286 = 34.000 bbl
EXT. CONC.	30.300	×1,83 = 55000 CWT /376 = 14,600 bbl	×0.78 = 23,600 CWT /286 = 8.250 bbl
3000 PSI 4000 PSI	8,000	×4,7 37.600 CWT ×1,25 bbl = 10.000 bbl	
		57,600 bbl	42,250 bbl
		216.800 CWT	121.100 CWT

TOTAL bbl

CEMENT	57.600
FLYASH	42.250
	99.850 bbl

CEMENT 216.800/20 = 10 840 TONS

FLYASH 121.100/20 = 6,065 "

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUN. 1, 1972 REV. APR 1, 1974 SKETCH# ER-S2
TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN
BATCH PLANT OPERATION

COST PER SHIFT $461.10 LAB + $190.00

SEE CONVENTIONAL CONSTR. REPORT SHEET No. EC-S4

NO OF DAYS OPERATION (SEE CONC DEMAND SCHEDULE 209-SR1 THRU SR8

No. OF WORKING DAYS (146-37	109 days
ADD'L SHIFTS 21 x 1.125	24 days
WEEK DAY SHIFT DAYS 96 x 1.125 =	108 days
SAT. MORNING SHIFT (II, IV VI) (V) 4 x 2	8 days
STRAIGHT TIME SHIFTS (I, III, V VII VIII) 5 x 1	5 days
PAY	254 days

TOTAL LABOR COST = 254 (461) = $117,000
" SUPPLIES " = 235 (190) = 44,500
" LABOR (COOLING) = 254 (117) = 29,500
" SUPPLIES (") = 235 (85) = 20,000
$211,100

UNIT COST = $\frac{211,000}{127,000}$ = $1.66

PLUS ADMIX .02
$1.68/yd

SAY $1.65

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

NON SLIP FORMED CONCRETE

SLIP FORMED CONC

SLIP	I	=	6485 CY.
"	II	=	9065 CY
"	III	=	6485 CY
"	IV	=	9065 CY
"	V	=	7700 CY
"	VI	=	9065 CY
"	VII	=	9500 CY
"	VIII	=	1000 CY
			58365 CY TOTAL

127,000 LESS 58,400 = 68,600 CY NON SLIP

CREW

SPREADING 3 MEN
FOREMAN 1 MAN

4 MEN @ $5.60 = 22.40
+.50 FOREMAN - .50
$22.90/hr.

COST PER DAY = $22.90 × 8 = $183.20/day

TOTAL SHIFTS WORKED 133

TOTAL LABOR COST = 133 (183) = $24,000

COST PER YD = $24,000 / 68,600 = .35¢ (PLUS CONV. OPERATORS)

VIBRATION

4 MEN @ $5.60 = 22.40
COMP. OPER. = 7.40
$29.80 × 8 = $238/DAY

EQUIPMENT — — — $200/DAY

TOTAL COST = 133 (238) = $31,600

COST PER YD = .46 LAB

133 (200) = $26,600

COST PER YD = .38 MTL.

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DURING CANTILEVER FORM OPERATION

OPERATORS

FEEDER CONV. (STATIONARY) PLANT TO TRESTLE	1
SIDE DISCHARGE CONVEYOR ON TRESTLE	1
RADIAL OR SIDE DISC. CONV ON MONOLITH	1
	3

CREW
3 OPERATORS @ $7.75 = $23.25
3 LABORS (MOVING) @ 5.60 = 16.80
$40.05/hr

CRANE OPER & OILER ELSEWHERE

COST PER DAY = 8 × $40.05 = $320.40

COST PER YD = 320.40 × 133 days / 68,600 yd = $.62

COMBINE WITH PLACING CREW

3 OPERATORS @ 7.75 = 23.25
3 LABORERS (MOVE & SPREAD) 16.80
1 FOREMAN 6.10
$46.15/hr

COST PER DAY = 8 × 46.15 = $369.20/day

COST PER YD = 369.20 × 133 / 68,600 = $0.71/yd.

CONVEYOR REQUIREMENTS

BATCH PLANT TO TRESTLE	50 L.F
DISTRIBUTOR CONVEYORS	430 L.F
ABUTMENT CONVEYOR	200 L.F
PLACING CONVEYORS	150 LF
RADIAL CONVEYOR	30 LF
	860 LF

860 L.F @ $150 =	$129,000
RAIL & ACCESS @ 10%	13,000.
SIDE DISCHARGE	1,000
RADIAL CONV.	2,000
	$145,000
SAY	70,000 SALVAGE
	$75,000

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

CONVEYOR EQUIPMENT COST
TOTAL USE 160 days.
COST PER DAY = $\frac{\$75,000}{160}$ = \$470.00/day

CHECK ON RENTAL BASIS
860 LF @ 1.25 = \$1075/day
USE \$750/day

COST PER YARD:

$\frac{750 \times 160}{68,600}$ = \$1.75

CONVEYOR ERECTION (INITIAL)

5 MEN @ 8.00 = \$40/hr
x 2 WKS = \$3200/WK ERECT
x 1 WK 1600/WK DISMANTLE
\$4800 TOTAL

COST PER YD = $\frac{\$4,800}{68,600}$ = .07
SAY .07/YD.

TOTAL EQUIPMENT COST PER YARD

RENTAL	1.75
ERECT.	.07
	\$ 1.82

DURING SLIPFORM OPERATION

OPERATORS

FEEDER CONV (STATIONARY) TO TRESTLE 1
(TAKES CARE OF SIDE DISCHARGE & CONVEYOR TO MATERIALS HOIST TOWER. ALL INTERCONNECTED)
FEEDER CONVEYOR @ TOP (HOIST TOWER TO SIDE DISCHARGE CONVEYOR AND SID DISCHARGE CONVEYOR, INTERCONN) 1
SPREADER CONVEYOR 1

3

CREW 3 OPERATORS @ $7.75 = $23.75/hr.
INCLUDE IN SLIDE CREW

CONVEYOR REQUIREMENTS
ADD'L TO GENERAL SYSTEM

MATERIAL TOWER TO FEEDER	40 LF
DISTRIBUTER CONVEYOR	90 LF
SPREADING CONVEYOR	60 LF
	190 LF

190 LF @ $150 =	28,500
RAIL & ACC	3,000
SIDE DISCH	1,500
	$33,000
SAY	16,000 SALVAGE
	$17,000

CONVEYOR EQUIPMENT COST
TOTAL USE 41 days
COST PER DAY = 17,000/41 = $415
RENTAL PER DAY = 190 @1.25 = $240 USE $300
COST PER YD = 300 x 41 / 58,400 = .21

CONVEYOR ERECTION 5 MEN @ $8.00 x 2 days x 7 Hrs.
= $4,480
+ DISMANTLE = 2240 $6,720 TOTAL

COST PER YD = 6,720 / 58,400 = $.12 TOTAL = .21 + .12 = $.33

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUN 1, 1972 REV. A11 SKETCH# ER-57

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
CONCRETE PLACING

FINISHING

TOTAL AREA = 146,000 ☐'

SLIP FORMED AREAS

SLIP I	67.5'
II	82.5'
III	67.5
IV	82.5
V	75.0'
VI	82.5'
VII	70.0'
VIII	20.0'
	547.5' × 60' × 2.25 = 74,000 ☐'

NON-SLIP-FORMED AREA = 72,000 ☐'

HORIZONTAL JOINTS

ELIMINATED BY SLIP FORMING

EL. 177'-6"	1 ×	83.75	=	83.75
	4 ×	77.50	=	310.00
	5 ×	71.25	=	356.25
	7 ×	65.00	=	455.00
	7 ×	58.75	=	411.25
	7 ×	52.50	=	367.50
	7 ×	46.25	=	323.75
	7 ×	40.00	=	280.00
	7 ×	33.75	=	236.25
	7 ×	27.50	=	192.50
	7 ×	21.25	=	148.75
				3,165.00 × 60 = 190,000

TOTAL AREA = 425,650
JOINTS ELIM. = 190,000
JOINTS REMAINING = 235,650 ☐'

LIFT STARTER FORMS

REPLACED BY INTERMEDIATE FORMS:

SLIDE I, III, IV, V } 4 x 60' x 2.25 = 540 ф'

SIDE = I	2 x 77.5 =	155 ф'
III		155 ф'
IV	2 x 90.0	180 ф
		1030 ф'

TOTAL AREA REPLACED = 7.5(1030) = 7750
TOTAL " CONVENTIONAL 12,850
AREA REMAINING 5,100

CANTILEVER FORMS

AREA REPLACED BY SLIP FORMS = 74,000 ф'
TOTAL CANTILEVER FORM = 107,300 ф'
REMAINING CANTILEVER FORM = 33,300 ф'

TRANSVERSE BULKHEADS

ELIMINATED BY SLIP FORM

EL. 170'-0" to 177'-6"	1 x 86.88 =	86.88
	4 x 80.63 =	322.52
	5 x 74.38 =	371.90
	7 x 68.13 =	476.91
	7 x 61.88 =	433.16
	7 x 55.63 =	389.41
	7 x 49.38 =	345.66
	7 x 43.13 =	301.91
	7 x 36.88 =	257.16
	7 x 30.63 =	214.41
	7 x 24.38 =	170.66
	7 x 18.13 =	126.91
		3,497.49

AREA ELIMINATED = (3497)(7.5)8/7 = 30,000 ф'

TOTAL = 51,600
LESS 30,000 ... 21,600 ф'

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

COST FOR CANTILEVERED FORM

FORMS USED FOR

LIFT STARTERS	5,100 SF
FACE FORMS	33,300 SF
TRANSV BLKHD	21,600 SF
	60,000 SF

COST OF FORMS = 9,600 ¢' × $7.20 = $69,000
LESS SALVAGE = 24,000
$45,000
PLUS ANCHORS = 12,000
$57,000

COST PER ¢' = $\frac{\$57,000}{60,000}$ = .95¢

Revised

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

SLIDING FORMS

2 SETS REQUIRED (SEE SCHEDULE 209-SR-11)

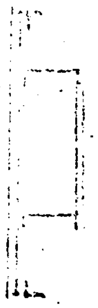
2 SETS CONSISTS OF
- 120 LF DOWNSTREAM FACE FORMS
- 120 LF UPSTREAM FACE FORMS
- 340 LF TRANSV. BULKHEAD FORMS (END [illegible])

TOTAL LINEAL FOOT OF SLIP FORM REQ'D.

420 LF	DOWN STREAM FACE FORMS
420 "	UP STREAM " "
680 "	TRANSV BLKHD FORMS (8×85FT)
1520 LF	

DOWNSTREAM & UPSTREAM FORMS MAY BE MADE IN 2 SETS USING STEEL & [illegible]

COST PER 8'-0" × 4'-0" PANEL



STEEL PLATE	32 [illegible] × 8[illegible] =	2[illegible] #
∠S	16 [illegible] 3.2 =	[illegible] #
WALES	16 [illegible] =	1[illegible] #
LIFT POINT	4 [illegible] × 8.5 =	[illegible] #
		4[illegible]
	+ 10%	[illegible]
		5[illegible].6

COST PER ft² = [illegible]# × 1.30 / 32 = $5.00

REUSE = 7/2 = 3.5

COST PER ft² = 5.0 × 1.25 / 3.5 = 1.80/ft²

COST PER LF = $1.80 × 4 = 7.20/LF

23 GREEN STREET
HUNTINGTON, N. Y.

SLIDING FORMS

USING WOOD FORMS W/ NO REUSE (4'x 8' PANEL)

1x4 T&G BOARDS 32 ф' x 1.25 x .30 =	$12.00
12 x 10 WALES 10 bd ft x 8' x 1.2 x .17 =	16.30
2x6 TRUSSING 1 bd ft x 14' x .17 =	1.40
HARDWARE	2.00
	$31.70

COST PER SQ FT $1.00 MATERIAL
MAKE-UP .40 (51 bd ft / 32) = .64
$1.64 / ф'
$6.60 / LF

AVERAGE COST PER L.F.
(ASSUME WOOD BULKHEAD FORMS, STEEL FACE FORMS)

840 F.F x $7.20 = 6,050
680 B.F x 6.60 = 4,500
1520 — 10,550

AV COST = $7.00

J. F. CAMILLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL [illegible]
[illegible] , CONN.
[illegible]

[illegible] FORM YOKES

REQUIREMENTS PER SET, 2 SETS REQ'D

8 DOWNSTREAM YOKES
8 UPSTREAM " } SIMILIAR
20 TRANSVERSE "

TOTAL REQUIREMENTS TO MAKE

16 DOWNSTREAM YOKES
56 UPSTREAM YOKES

TOTAL REQUIREMENTS TO ERECT

8x7 = 56 DOWNSTREAM YOKES
8x7 = 56 UPSTREAM "
10x8 = 80 TRANSVERSE "
192 TOTAL

[illegible] STREAM YOKES
[illegible] COMP [illegible]

YOKE BEAM	654#
YOKE EXTENSION	59#
JACK PLAT [illegible]	80#
FIN BAT SUPPORT	336#
MAIN " "	79#
PORTAL FRAME	612#
SPLASH GUARD	70#
	1890#

COST PER YOKE = 2000# x [illegible] = [illegible].00

[illegible]STREAM YOKES (COMP SHEET [illegible])

YOKE BEAM	440#
JACK ROD PLAT ARM	101#
JACK ROD BRKT	70#
PLATFORM SUPPORT	289#
FIN PLAT	64#
TRAILING PLAT	80#
MISC	170#
PORTAL FR	612
	1826#

23 GREEN STREET
HUNTINGTON, N. Y.

SLIP FORM YOKES (CONT)

TOTAL COST

16 DOWNSTREAM × $600 =		$ 9,600
56 UPSTREAM × $550 =		30,800
		$40,400

COST PER UNIT = $40400 / 192 ≈ $210

FORM ERECTION

YARD CRANE AVAILABLE (SEE EQUIPMENT SHEET ER4)
4 PER DAY

CREW	5 IRON WORKERS @ 10.20 =	$51.00/hr
	FOREMAN	10.70/hr
		$61.70/HR
		$493.60/DAY
	SHORES & RIGGING	45.00
		$538.60

ERECTION PER YOKE = $135.

JACK RODS

SLIDE No			
I	8 × 2.25 × 67.5 =	1210	
	8 × 2.0 × 67.5 × .6 =	650	1860
II	8 × 2.25 × 82.5 =	1490	
	11 × 2.0 × 82.5 × .6 =	1080	2570
III			1860
IV			2570
V	8 × 2.25 × 75 =	1350	
	~~10 × 2.0 × 75 × .6 =~~	~~900~~	1350
VI			1490
VII & VIII	8 × 2.25 × 90 =	1620	
	~~12 × 2.0 × 90 × .6~~	~~1300~~	1620
		TOT =	13,320

SAY, 14,000 LF

PLATFORM DECKS

DOWNSTREAM FORMS

LUMBER = $5' \times \frac{10}{9.5} \times 2$ = 10.5 bd ft/ft

3x10 stringer 2.5 x 1.1 = 2.8 " "

TOP PLANK 2 - 2x10 x 1.1 = 2.7 " "

2x10 STRINGER 1.33 x 1.1 = 1.5 " "

17.5 bd ft/ft

PLYWOOD $4.5 \times \frac{5}{4.5}$ = 5 ☐'/FT

COST PER FT = 17.5 x .175 = $ 3.05
5.0 x .265 = $ 1.32
HARDWARE .10

$ 4.47/FT

REUSE = $\frac{4.47}{3.5} \times 1.25$ = 1.60

PLACING .020 (9)(22.5) = 4.05/FT.

LGT OF DECKING = 7 x 60 = 420 L.F

UPSTREAM & BULKHEAD FORMS

MAIN DECK, LUMBER
4' x 1 x 2' = 8.0 BD. FT.
STRINGERS = 4.3 " "
TOP PLANK 2.7 " "

15.0 @ .175 = 2.60

PLYWOOD 1.32
HARDWARE .10

$ 4.02

$\$ \frac{4.02}{3.5} \times 1.25$ = 1.44/LF

USE $1.50

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
SLIP FORM OPERATION

RAILING & LADDERS

DOWNSTREAM FACE
WOOD
PLACING PLATFORM RAILING
POSTS 8' x 1bdft x 1/8 = 1.00bdft/L.F
TOP RAIL 1 x .67bf. x 9/8 = .75 "
SIDE RAILS 3 x .5bf x 9/8 = 1.75 "
3.50 bf/LF.

COST = 3.50 x 175 = 0.61¢/LF
w/REUSE = .61x1.25 / 3.5 = .25¢/LF

ERECTION = .020(9)(3.5) = .65¢/LF

STEEL RAILING
MATERIAL (3.5 USES) = $3.00 LF
PLACING 1.50/LF
LADDERS $40 EA RENTAL

TOTAL COST PER FT	MTL.	LAB
WOOD RAILING	.25	.65
STEEL "	3.00	1.50
LADDERS $2x3x40 / 60 x 1/7	.57	—
	$3.82	$2.15/LF

UPSTREAM FACE
PLACING PLATFORM RAILING
POST 5' x 1bdft x 1/8 = .63 bf/LF
RAILS 2.50
3.13 bf/LF

COST MTL = .20¢ INSTALL = .55¢/LF

TOTAL COST PER FT	MTL.	LAB
WOOD RAILING	.20	.55
STEEL RAILING	4.50	2.00
LADDERS	.38	—
	$5.08	$2.55

USE AVERAGE COSTS: MTL: $4.50
INSTALL: 2.50

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

PRECAST INSERTS

		$
PRECAST BLOCK		.50
COUPLER	2 @ .75	1.50
RODS	2 @ 3.00	6.00
BEARING PLATE		2.00
PIPE SUPPORT	4 x .40	1.60
WASHER		1.00
		$ 12.60 EA.

SAY 12.50

NO OF INSERTS REQ'D:
L.F. JACK ROD = 14,000 LF
INSERT SPACING = 4'

N^o REQ'D = $\frac{14,000}{4}$ = 3,500 EA.

GUIDE WHEEL BRACKETS

WEIGHT EACH	12 x 10 x 3/4 =	25.5#
	2 EA 10 x 3 x 3/8 =	6.4#
	2 EA	37.4#
	WHEELS	43.6#
		112.9#
	+ 10% =	11.3
		124.2# (FOR PRICING ONLY)

COST = 125# x .50¢ = $62.5 / ASSMBLY
SAY $65.00

NO REQ'D (2 SETS OF FORMS)
72 LOCATIONS x 3 = 216 SAY 230

FORM DESIGN

APPROX. FORM COST $200,000
DESIGN = 10% = $20,000/2 = $10,000

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUN 1, 1972 REV. SKETCH# CR-511

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN

SLIP FORM OPERATION

STRIP SLIP FORMS

SAY 50% ERECTION

ERECT FORMS	16,000
" YOKES	26,000
" DECKS	6,600
" RAILINGS	4,100
	$52,700 (.50) = $26,000

HYDRAULIC PIPING

L.F. FORMS	1520 LF
192 Jacks x 10'	1920 LF
7 x 85' ACROSS	585 LF
	4025 LF

SAY 4000 LF

CONVEYOR SUPPORT BRACKETS

(SEE COMP SHEETS 209-CR-11 & 12)

EST. WEIGHT PER BRACKET = 1.3 TONS

2 REQ'D AT 1.3 = 2.6 TONS FAB

@ $500/TON = $1,300

7 REQ'D TO ERECT = 9.1 TONS.

@ $250/TON = $2,300

CONVEYOR SUPPORT TRUSSES

(SEE COMP SHEET 209-CR-13

ESTIM WEIGHT PER TRUSS = 4.25 TONS

4 REQ'D @ 4.25 = 17 TONS FAB

@ $500/TON = $8,500

6 REQ'D TO ERECT = 25.5 TONS

@ $250/TON = $6,500

J. T. CAVALLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN
SLIDE CREW 5/8

CLASSIFICATION		HOURLY RATE INCL. FRINGE BENEFITS	COST PER SHIFT: NORMAL RATE 8 HR. WORK 8 HR PAY	COST PER SHIFT: WEEKDAY SHIFT RATE 8 HR. WORK 9 HR. PAY	COST PER SHIFT: WEEKEND RATE 8 HR. WORK 16 HR. PAY
CONVEYOR OPER	3	7.75	$ 186	$ 209	$ 372
HOIST ENGINEER	1	8.60	69	78	138
JACK OPERATOR	1	8.00	64	72	128
CARPENTERS	3*	9.00	216	243	432
ELECTRICIAN	2/3**	8.28	44	50	88
FINISHER FOREMAN	1	9.37	75	84	150
FINISHER	1	8.87	71	80	142
FINISHER HELPER	1	7.15	57	64	114
LABORERS					
FOREMAN 1		6.10	49	55	98
PLACING	3				
VIBRATION	3				
CURING	1				
	7	5.60	314	353	628
TOTAL PER SHIFT	19 2/3		$1,145	$1,288	$2,290

* 4 ON LEAD MONOLITHS 2 ON TRAIL MONOLITHS
** 1 Shift in Field OVERHEAD

DIVISION BY ITEMS : PLANT 26.1%
FORMS 24.4%
PLACE & VIB 27.8%
FIN & CURE 21.7%

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN
SLIDE CREW

SLIDE Nº	NORMAL SHIFT	DOUBLE TIME SHIFT	STRAIGHT TIME SHIFT	TOTAL SHIFTS
I	12		1	13
II	15	1		16
III	12		1	13
IV	15	1		16
V	12	1	1	14
VI	15	1		16
VII	12		1	13
VIII	3		1	4
TOTAL	96	4	5	105

TOTAL COST

96 Shifts @ $1,288 ----- $123,700
4 " @ 2,290 ----- 9,200
5 " @ 1,145 ----- 5,700

TOTAL $138,600

SAY $140,000

DIVISION BY WORK:

PLANT ---------- $36,500
FORMS ---------- 34,000
PLACE & VIB ---------- 39,000

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUN 1, 1972 REV. SKETCH# ER-S2
TRUMBULL DAM
PEQUONNOCK RIVER BASIN, CONN
ENVIORNMENT CONTROL

ENVIORNMENT PROTECTION

a) WATER TURBIDITY

METERING DIVICES, FLOCULATION		$35,000
MONTHLY OPERATION: 15 MOS @ $3,000		45,000
		$80,000

b) Noise Abatement

	$
CLEARING & GRUBBING	9,000
EXCAV	135,000
DRAGLINE & TRUCKS	162,000
AGGREGATE PLANT	490,000
MIXING PLANT	432,000
DIVERSION	80,000
AIR TOOLS	80,000
GEN'L EQUIP	215,000
	1,603,000

5% EQUIP $80,000

c) LANSCAPE RENEWAL

	$
200 Plants @ 25.00	= 5000
PLANTING @ 40%	= 2000
	$7,000

TRESTLE (SEE COMP SHEETS 209-CR14 & 15)

LUMBER PER FOOT $\frac{3000 \text{ fbm}}{15}$ = 200 bf/ft

STRUCT STL PER FOOT $\frac{2 \text{ TON}}{15'}$ .13 T/FT

COST PER FT	MATERIAL		LABOR
200 bd ft x .20	$40.00	(.12)	$24.00
.13 TON x (250)	33.00	(100)	13.00
	$73.00		$37.00

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

CANTILEVER FORMS (REUSE PRICE FOR 2X HT. MONOLITHS)

REUSE INCREASES 146,000 ф'
+ 74,000 ф'
220,000 ф ≈ 33% INCREASE

COST OF MAT'L 45,000 FORMS LESS SALVAGE
28,860 ANCHORS
9,620 33% ADD'L ANCHORS
#83,480 / 220,000 ф' = .38¢/ф'

CONVEYOR EQUIP.: BATCH PLANT TO TRESTLE 50 L.F.
DIST. CONV. 430 LF
480 L.F.

480 LF @ #150/, = 72000
RAILS & ACCES. = 7000
SIDE DISCHARGE = 1000
#80,000 - SALVAGE + ERECTI[illegible]

TOTAL COST, ERECTION
125,000 + 5,000 = 130,000 X 480/860 = 73,000

CABLEWAY REUSE: 127,000
58,365
185,365
253,000 / 185,365 = #1.35

MATERIAL TOWERS 160' HT. X 5/FT = 800
4 Towers X 2 MOS. X 800 = 6,400
4 " X 6 " = 28,800
35,200

CONV. EQUIP: (TWICE AS LONG) 50
430
430
910
125,000 + 5,000 = 130,000 X 910/860 = 138,000

(3X AS LG) 910
430
130,000 X 1340/860
= 204,000

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUN. 1, '72 REV. SKETCH# ER-52

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
ALTERNATE COSTS

CANTILEVER FORMS (REUSE FOR 3X HT)

146,000 ϕ'
+ 74,000
+ 74,000
294,000 ≈ 50% INC.

COST OF MAT'L

45,000 FORMS LESS SALVAGE
28,860 ANCHORS
14,430 ADD'L (50%) ANCHORS
88,290

88,290 / 294,000 = .30¢/ϕ'

CABLEWAY REUSE

127,000
58,365
58,365
243,730

$258,000 / 243,730 = $1.04

MAT'L TOWERS

240' HT x 5 $/1 = 1200
4 TOWERS x 4 MOS x 1200 = 19,200
4 " x 6 " = 28,800
48,000

COST STUDY SHEETS

MODIFIED DESIGN

RC-46

J.F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JUN 1, '72 SHEET NO. EM-S

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV.-CORPS/ENG'R

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
SUMMARY						
SHEET EM-1				2,314,890		659,240
" EM-2				284,100		246,940
" EM-3				685,900		78,100
" EM-4				787,500		538,200
				4,072,390		1,522,340
ESCALATION THRU 1974			2%	81,450	11%	167,460
				4,153,840		1,689,800
PAYROLL, TAXES & INSURANCE					14%	236,570
						1,926,370
				→		4,153,840
TOTAL COST TO CONTRACTOR						6,080,210
O'HD, PROFIT & CONT.					8%	486,420
						6,566,630
BID BOND					3/4%	49,370
TOTAL CONTRACT PRICE						6,616,000

J.F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JUN 1, '72 PRICED BY SHEET NO. EM-1 PROJECT: TRUMBULL LAKE DAM ARCHITECT: NEW ENGLAND DIV.-CORPS./ENG'R.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
DAM-SLIP ALL MONOLITHS SIMULTANEOUSLY						
CLEARING & GRUBBING	360,000	S.F.	.05	18,000	-	SUB
DISPOSAL	250,000	S.F.	.03	7,500	-	SUB
EXCAV. UNCLASS.	36,000	C.Y.	2.00	72,000	-	SUB
EXCAV. ROCK	10,000	C.Y.	10.00	100,000	-	SUB
EXCAV. TALUS	14,000	C.Y.	3.00	42,000	-	SUB
HAND CLEANING	70,000	S.F.	.75	52,500	-	SUB
CULVERT PIPE	-	L.F.	4.50	-	1.50	-
CHAIN LINK FENCE	850	L.F.	3.50	3,000	2.00	1,700
FOUNDATION GROUTING	50,000	S.F.	.90	45,000	-	-
DIVERSION	-	L.S.		714,000	-	SUB
CEMENT	10,840	TONS	27.20	294,800	-	-
FLY ASH	6,055	TONS	9.00	54,500	-	-
BORROW OPER.	240,000	TONS	.30	72,000	.29	69,500
AGGREGATE PROD.	231,000	TONS	.53	128,000	.34	78,500
BATCH PLANT OPER.	127,000	C.Y.	3.44	437,360	1.30	166,000
CONC. PLACING (EXCEPT SLIP FORM)	72,700	C.Y.	1.82	132,000	.71	51,600
VIBRATION (")	72,700	C.Y.	.38	27,600	.46	33,400
HORIZ. JT. TREATMENT	250,650	S.F.	.05	12,600	.15	37,600
FINISHING (EXCEPT SLIP FORM)	75,000	S.F.	.05	3,750	.28	21,000
CURING (")	308,800	S.F.	.01	3,100	.01	3,100
FIX FORMS: FDN	18,300	SF CA	.80	14,640	3.00	55,000
LIFT STARTERS	5,100	SF CA	.95	4,800	1.17	6,000
CANTILEVER	34,300	SF CA	.95	32,600	1.17	40,000
TRANSV. BULKHEAD	21,600	SF CA	.95	20,500	1.17	25,300
STAIR TOWER	2,300	SF CA	1.50	3,450	3.50	8,050
INTERMEDIATE	9,750	SF CA	.25	2,440	1.00	9,750
SPRAY WALL	800	"	.30	240	1.50	1,200
SLAB (PUMP HOUSE)	2,470	"	.75	1,850	1.00	2,470
SLAB (TOP)	2,350	"	.25	590	.75	1,760
PUMP HSE WALLS	7,080	"	.75	5,310	2.00	14,160
PUMP HSE SHORING	35,800	CU.FT.	.06	2,150	.06	2,150
VERT. SURF. TOP DAM	12,400	SF CA	.25	3,100	1.50	18,600
RETAINING WALLS	7,450	SF CA	.25	1,860	1.00	7,450
TOP CURBS	3,300	"	.50	1,650	1.50	4,950
SF 10196A SHEET TOTAL				2,314,890		659,[illegible]

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE July 1, '72 PRICED BY SHEET NO. EM-2

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. - CORPS/ENG'R.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
SLIP FORM OPERATION						
SLIDING FORMS	1000	L.F.	7-	7,000	10^{50}	10,500
YOKES	122	EA.	210-	25,600	135-	16,500
JACK RODS (6T).	10,000	L.F.	2^{50}	25,000	.13	1,300
PLATFORM DECKS	1,000	L.F.	1^{50}	1,500	4-	4,000
RAILINGS + LADDERS	1,000	L.F.	4^{50}	4,500	2^{50}	2,500
FORM DESIGN	—	—	—	10,000	—	—
SLIDE CREW				—		108,000
FINISHING	71,000	◻'	.05	3,600		IN SLIDE CREW
CURING	71,000	◻'	.01	700		IN SLIDE CREW
FIELD ASSIST. ENG'R	15	DAYS	200	3,000	—	—
FIELD TECHNICIAN	30	DAYS	150	4,500	—	SUB
STRIP FORMS	—	—	-	—	-	16,500
HYDRAULIC PIPING	2400	L.F.	—	—	.80	1,900
CONVEYORS	54,300	C.Y.	1^{55}	82,000	.12	6,500
MATERIAL TOWERS	4 x 4½	MOS.	1200	21,700	—	34,000
CONV. SUPP. BKT	14	EA.	650-	9,100	325-	4,700
PRECAST INSERTS	2500	EA	12^{50}	31,300	—	IN CREW
CONV. SUPP. TRUSS	9	EA.	2150-	19,400	1100-	9,900
ELEPHANT TRUNKS				—		—
GUIDE WHEEL BKT.	370	EA	65-	24,100	—	IN CREW
GALLERIES (FORMED)						
FORMWORK	16,500	◻'CA	.65	10,720	1^{75}	28,875
STAIRS	1,300	◻'CA	.30	390	1^{25}	1,625
SHEET TOTAL				281,100		246,800

SP 10196A

	J. F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743

DATE July 1, '72 PRICED BY SHEET NO. EM-3

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. – CORPS / ENG'R

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
GENERAL ITEMS						
HYDRAULIC PACKAGE	1	L.S.	—	303,680	—	—
EXTENSION 36" BLOW-OFF	1	L.S.	—	5,000	—	2,000
3½"Φ ST'L PIPE	1,160	LF	3.50	4,060	5.50	6,380
2½"Φ " "	2,150	LF	1.75	3760	3.50	7530
3" DRAINAGE HOLES	2,880	LF	8.10	23,300	—	SUB
1½" GROUT HOLES	9,240	LF	8.—	73,920	—	SUB
6" DRAINS	2770	LF	1.70	4,720	—	SUB
8" WELLS	600	LF	2.25	1,350	—	SUB
PLUMBLINE SHAFT	120	LF	3.—	360	2.50	300
REINF. STEEL	100,000	LBS.	.15	15,000	.09	9000
BACKFILL	12,000	C.Y.	—	—	2.—	24,000
ROCK SLOPE PROT.	800	C.Y.	3.—	2400	10.—	8000
ROCK GRAVEL	1200	C.Y.	4.50	5400	2.50	3000
BIT. CONC. PAVING	1200	S.Y.	5.—	6,000	—	SUB
ALUM. HAND RAIL	1000	LF	10.—	10,000	3.—	3000
COPPER WATERSTOP	2874	LF	3.50	10,000	4.50	12,900
ENVIRONMENTAL WORK						
TURBIDITY CONTROL			—	77,000	—	SUB
DUST CONTROL			—	1,000	—	—
NOISE CONTROL (EQUIP)			—	80,000	—	—
LANDSCAPE RENEWAL			—	5,000	—	2,000
R.R. BED	270,000	Φ'	.20	54,000	—	SUB
SHEET TOTALS				685,900		78,100

SP 10196A

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE July, 1, '72 PRICED BY SHEET NO. EM-4

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. - CORPS/ENG'R

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
EQUIPMENT						
TIMBER TRESTLE	480	L.F.	73—	35,000	37—	17,800
YARD CRANE	1 X 11	MOS.	4500—	49,500	—	29,800
CONVEYOR SYSTEM	—	-	—	IN CONC. PLACING	-	IN CONC. PLACING
HYDRAULIC BOOM CRANES	2 x 6	MOS.	1500	18,000	1400	16,800
COMPRESSORS	2 x 6	"	1100	13,200	1300	15,600
UTILITY TRUCKS	2 x 14	"	850	22,400	940	26,300
PERSONNEL STAIR TOWER	3 x 9	"	80	2,200	—	2,000
DOZER	1 x 14	"	1200	16,800	1330	18,700
	(SUB-TOTAL)			157,100		127,000
FIELD OVERHEAD						
BRIDGE	1	EA.		1,000		5,000
IMPROVE R.R. BED	268,000	□'	1.50	402,000		SUB
ACCESS ROAD, VALLEY	72,000	□'	1—	72,000		SUB
FIELD OFFICE, SHOPS, STORAGE				27,000		3,000
HARDWARE + TOOLS				45,000		—
FUEL & OIL				12,000		—
START-UP + LAYOUT				—		5,000
MIX DESIGN				1,000		—
CONCRETE TESTING				25,000		SUB
TEMPORARY LIGHTING				3,000		10,000
SANITARY FACILITIES				5,400		SUB
CLEAN-UP				—		20,000
HEATING				20,000		—
PROJECT MANAGER	1 X 113	WKS		—	500	56,500
SUPERINTENDENT	1 X 86	WKS		—	400	34,400
PROJECT ENGINEER	1 X 76	WKS		—	400	30,400
CLERKS	2 X 76	"		—	200	30,400
SURVEYORS	4 X 76	"		—	250	76,000
UTILITY MECHANICS	6 x 48	"		—	300	86,500
WATCHMEN	3 x 113	"		—	100	34,000
WINTER PROTECTION				2000		5,000
COMMUNICATIONS				5000		5000
POWER DISTRIBUTION				10,000		10,000
(SHEET TOTAL)				787,500		538,200

SP 10196A

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JUNE 1/72 PRICED BY TK SHEET NO. EM-9

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGL. DIV. - CORPS/ENG'R

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
PRECAST GALLERIES						
CASTING PLANT						
EXCAV.	40	CY	3.00	120		SUB
CASTING BEDS, CONC.	18	CY	18.00	324	7.00	126
" " REINF.	1000	SF	.10	100	.05	50
" " FORMS	150	SF	.25	40	.75	110
GRAVEL BASE	500	SF	1.00	500	—	SUB
MISC. INSERTS	—	—	—	50	—	-
FORMS						
1 CHANNEL STEEL FORM	756	SF	8.75	6,600	—	SUB
1 TROUGH " "	100	SF	4.00	400	—	"
1 STAIR " "	150	SF	4.00	600	—	"
2 LEE BEAMS + MISC. RAILS	100	SF	4.00	400	—	"
LABOR FOR 172 UNITS	60 PRODUCTION DAYS					
FOREMAN	1 × 60	DAYS	—	—	81.60	4,900
LABORERS	3 × 60	"	—	—	44.80	8,060
MASONS	1 × 60	"	—	—	71.20	4,270
LATHERS	2 × 60	"	—	—	81.60	9,800
CONV. OPERATOR	1 × 60	"	—	—	62.00	3,720
MATERIALS						
CONC. BY SITE PLANT		—	—	—	—	—
REINF.	20	TONS	200.00	4,000	—	—
MISC.	—	—	—	200	—	—
ERECTION CREW						
FOREMAN	1 × 40	DAYS			76.00	3,040
LABORERS	2 × 40	"			44.80	3,590
CRANE OPER	1 × 40	"			68.80	2,750
TRUCK DRIVER	1 × 40	"			42.80	1,720
CRANE	2	MOS	1000	2,000		
FLAT BED	2	"	1000	2,000		
	TOTAL			17,300		42,100

SP 10196A

	J. F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JUNE 1/72 PRICED BY LK SHEET NO. EM-F1
		PROJECT: TRUMBULL LAKE DAM
		ARCHITECT: NEW ENGL. DIV. - CORPS / ENG'D

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
PRECAST FACE FORM	SECTIONS		SCHEME		"1	
CASTING PLANT						
EXCAV. & GRAVEL BASE	—	—	—	—	—	—
CHARGED TO GENERAL						
EQUIPMENT COST						
FORMS						
20 STEEL FORMS	1,780	SF	5.50	9,800	—	SUB
LABOR FOR 1250 UNITS	65 PRODUCTION DAYS					
FOREMAN	1 × 65	DAYS	—	—	81.50	5,300
LABORERS	12 × 65	"	—	—	44.80	35,000
MASONS	2 × 65	"	—	—	71.20	9,250
LATHERS	8 × 65	"	—	—	81.60	42,450
CONC TRUCK OPERATOR	1 × 65	"	—	—	42.80	2,780
YARD CRANE OP.	1 × 65	"	—	—	55.00	4,470
MATERIAL						
CONC. BY SITE PLANT	—	—	—	—	—	—
REINF.	156	TONS	200.00	31,200	—	—
MISC. INSERTS, ETC.	—	—	—	4,500	—	—
EQUIPMENT						
1 YARD CRANE	3	MOS	1000	3,000	—	—
1 CONC. TRUCK	3	MOS	800	2,400		
ERECTION	10 ERECTION DAYS (2 TEAMS)					
LABOR						
FOREMAN	1 × 10	DAYS	—	—	275.00	2,750
LATHERS (2 CREWS)	4 × 10	DAYS	—	—	275.00	11,000
ERECTION CRANE OPER.	3 × 10	DAYS	—	—	232.00	6,960
TRANSPORTATION TO ERECTION SITE BY						
90 TON CRANE & CABLEWAY						
MATERIAL						
ANCHORS	2500	EA.	9.50	24,000	4.00	10,000
				74,900		129,960
				→		74,900
						204,860
$204,860 × 107,000/74,000 = $295,000						
SP 10196A (STEEL FORMS = $171,800)						

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JUNE 1/72 PRICED BY LR SHEET NO. EM-F2

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGL. DIV.-CORPS/ENG.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
PRECAST FACE FORMS SCHEME # 2						
CASTING PLANT						
EXCAV. & GRAVEL BASE						
CHARGED TO GENERAL						
EQUIPMENT COST						
FORMS						
20 STEEL FORMS	3800	SF	6.50	24,700	—	SUB
LABOR FOR 1430 UNITS		88 PRODUCTION DAYS				
FOREMAN	1×88	DAYS	—	—	81.60	7,190
LABORERS	16×88	"	—	—	44.80	63,000
MASONS	2×88	"	—	—	71.20	12,520
LATHERS	8×88	"	—	—	81.60	57,400
CRANE OPER. (YARD)	2×88	"	—	—	68.80	12,100
CONC. TRUCK OP.	2×88	"	—	—	42.80	7,550
MATERIAL						
CONC. BY SITE PLANT	—	—	—	—	—	—
REINF.	286	TONS	200.00	57,200	—	—
MISC. INSERTS	11600	EA	1.00	11,600	—	—
EQUIPMENT						
2 YARD CRANES	4	MOS	1000.00	4,000	—	—
2 CONC. TRUCKS	4	MOS	800.00	3,200	—	—
ERECTION						
LABOR						
FOREMAN	1×200	DAYS	—	—	81.60	16,320
LATHERS	1×200	"	—	—	81.60	16,320
LABORERS	2×200	"	—	—	44.80	17,920
CRANE OPERATORS	1×200	"	—	—	68.80	13,760
MATERIAL						
CONC. ANCHORS	5800	EA.	1.62	9400	—	—
TRANSPORTATION TO ERECTION SITE				110,100		224,080
BY 90 TON CRANE & CABLEWAY				→		110,100
						334,180

SP 10196A (STEEL FORMS = 171,800)

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

BATCH PLANT OPERATION:

NO. OF DAYS OPERATION (209-SR1 THRU SR8) —— 160 DAYS
LESS SLIP DAYS FOR 1 MONOLITH @ A TIME —— -37

123 DAYS

SPEED = 4"/HR. AVERAGE 75' HIGH SLIP

75' / .33'/HR = 228 HRS. SLIPPING.

3 SHIFTS/DAY = 24x5 = 120 HRS/WK

9 DAYS x 3 SHIFTS/DAY = 27 SHIFTS x 9/8 = 30.5
2 SHIFT x 9/8 = 2.25

29 SHIFTS
x8
232 HRS

32.75 —— 33 DAY

PAY 156 DAY

LABOR COST 156 (461) = 72,000
SUPPLIES " = 44,500
LABOR (COOLING) = 28,600 } SH. ER.
SUPPLIES " = 20,000

\# 165,100 / 127,000 = #1.30/YD

CONC. PLACING (EXCEPT SLIP FORM) 68,600 C.Y.

MONO. I -1240
II +1340
III -1240
IV +1340
V
IV +1340
IIV & IIIV +1340
+1240

72,720 C.Y.

SAY 72,700 C.Y. RC-55

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM — EM S-2
PEQUONNOCK RIVER BASIN, CONN.
DAM - SLIP ALL MONOLITHS SIMUL.

HORIZ. JT. TREATMENT 235,650 $'

MONOLITH	I	-4,300	—
	II	—	+4,650
	III	-4,300	—
	IV	—	+4,650
	V	—	—
	VI	—	+4650
	VII	—	+9650 ← 4650 + 5000

250,650 $'

FINISHING (EXCEPT SLIP FORM) 72,000 $'

MONOLITH	I	-7.5
	II	+7.5
	III	-7.5
	IV	+7.5
	V	0
	VI	+7.5
	VII	+15

22.5 × 60 × 2.25 = 3,040 $'

75,000 $'

CURING (EXCEPT SLIP FORM) 308,000 $'

TRANSV. = 560 × 4 = 2,240

+ UP & DOWN STREAM FACE = + 3,040 $'
− 2,240
308,800

CANT. FORM
+1
33,300 $' CA
+ 1,000
34,300

INT. FORM
+2
7,750 $' CA
+ 2,000
9,750

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

PEQUONNOCK RIVER BASIN, CONN.
DAM- SLIP ALL MONOLITHS SIMUL.

SLIDING FORMS: 60 x 7 = 420 L.F. DOWNSTREAM
420 L.F. UPSTREAM
80 } TRANSV.
80
1000 LF.

YOKES 420' − 4' = 416'/8 = 52 SPA. SAY 53 YOKES DOWNSTREAM
53 UP
8 } ENDS
8
122

SLIDE CREW CLASSIFICATION		HR. RATE INCL. FRINGE BENIFITS	COST/SHIFT WEEKDAY SHIFT RATE 8 HR. WORK / 9 HR. PAY
CONV. OPERATOR	6	7.75	$ 418
HOIST ENG'R	4	8.60	310
JACK OPER.	2	8.00	144
CARPENTERS	10	9.00	810
ELECTRICIAN	2/3	8.28	50
FINISH FOREMAN	1	9.37	84
FINISHER	7	8.87	560
FINISH HELPER	2	7.15	129
LABORERS:			
FOREMAN	1	6.10	55
PLACING	10	5.60	} 1160
VIBRATION	10	5.60	
CURING	3	5.60	
			$ 3,720

29 SHIFTS @ $ 3720 = $ 108,000

FINISHING: 75' x 420' x 2.25 = 71,000 ϕ'

STRIP FORMS: 50% ERECTION : FORMS 10,500
YOKES 16,500
DECKS 4000
RAILS 2,500 / 33,500 x 50% = 16,750

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM EM 64
PEQUONNOCK RIVER BASIN, CONN.
DAM - SLIP ALL MONOLITHS SIMUL.

CONVEYORS: (ADD'L)

MAT'L TOWER TO FEEDER	40' x 4 =	160'
DIST. CONV.	90' x 4 =	360'
SPREADING CONV.	60' x 6 =	360'
	30' x 2 =	60'
		940'

940' x 150#/' =	141,000
RAIL + ACC.	14 000
SIDE DISCH.	8,000
	163,000 LESS 50% SALVAGE = #82,000

COST/DAY = 82,000/14 DAYS = #5,850/DAY

COST/YD = 82 000/53,500 = #1.58

LABOR: ERECTION 35 MEN @ 8 x 2 DAYS = #4480
DISMANTLE 2240
#6720

COST/YD = 6720/54,300 = .12

PRECAST INSERTS: L.F. JACKROD = 10,000' SPA = 4'

10,000/4 = 2500 EA.

GUIDE WHEEL BKT: 122 LOCATIONS x 3 = 366
SAY 370

COPPER WATERSTOPS: (SH. EC-535)

147	2,690
150	-800
148	1890
133	+ 484
116	500
106	2874 L.F.
800	

J. F. CAMILLERI, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM ER-5-5
PEQUONNOCK RIVER BASIN, CONN.
- NO-SLUMP CONCRETE

CEMENT REQUIREMENT

INT. MASS CONCRETE
CEMENT 94 lb x 93,000 = 8750000 lb
= 4400 TONS
FLY ASH 130 lbs x 93,000 = 12100000 lb
= 6050 TONS

DECREASE IN PORTLAND CEMENT:
6500 LESS 4400 = 2100 TONS
INCREASE IN FLY ASH
6050 LESS 5100 = 950 TONS

COST DIFFERENTIAL
2100 ($27.20) = $57,120
- 950 ($9.00) = 8,550
$48,570

VIBRATION
CA-25 DYNAPAC COMPACTOR
$ 30,000
1,000 (200 x $4 shipping)
$ 31,000
15,000 SALVAGE
$ 16,000 x 2 ROLLERS = $32,000
SAVINGS IN AIR COMPRESSOR & VIBRATORS
= $26,000
ADD'L COST $ 6,000

CREW 2 MEN @ $5.60 = $11.20
VIB. OPER @ $7.80 = 7.80
$19.00 x 8 = $152.00

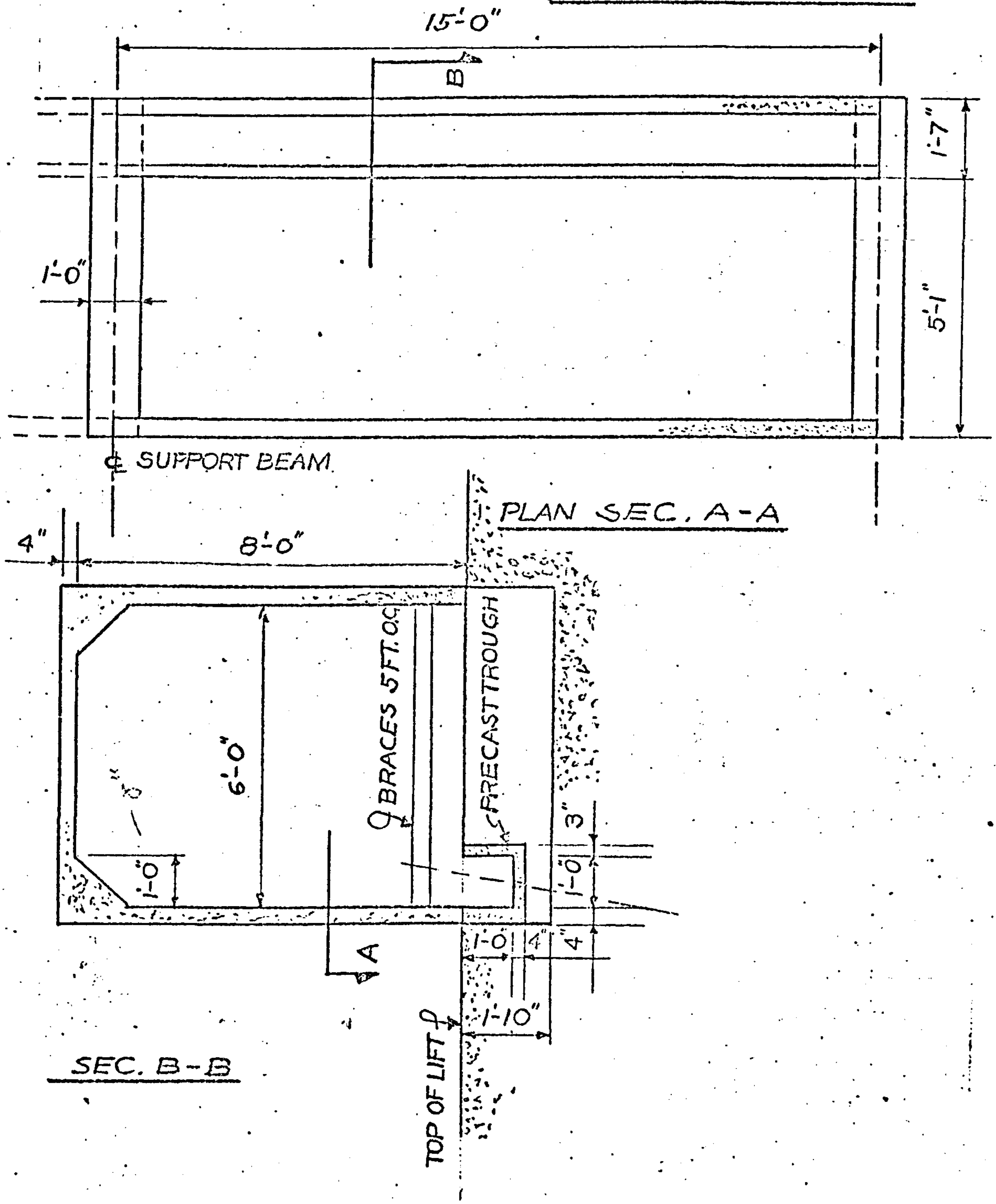
TOTAL COST = $152 (103 days) = $15,700
SAVINGS = 31,200 LESS 15,700 = $ 15,500

TOTAL SAVINGS IN VIBRATION = $15,500 - 6,000
= $9,500

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1/72 REV. SKETCH # EM-5-6

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
PRECAST INSPECTION GALLERY
TENTATIVE LAYOUT



RC-60

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

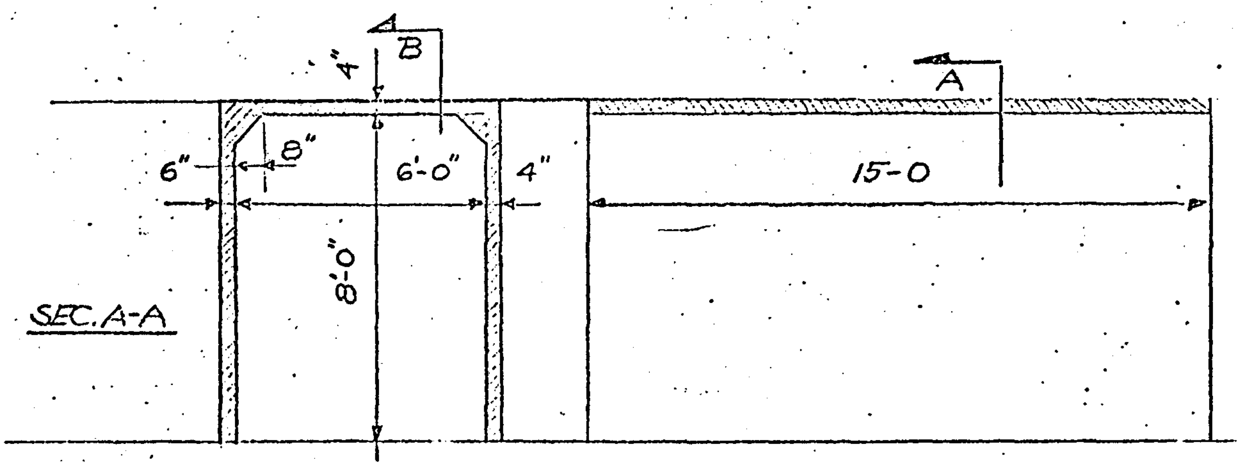
DATE JUNE 1/72 REV. SKETCH# EM-S-7

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
PRECAST INSPECTION GALLERY

PRECAST SECTIONS

			SF/UNIT
1) STRAIGHT UNITS	33	EA.	350
2) SLOPE UNITS	23	EA.	250
3) TOP FILLERS	5	EA.	170
4) BOTT. FILLERS	2× 6	EA.	90
5) LEVELLING BEAMS	38	EA.	—
6) DRAIN TROUGHS	33	EA.	—
7) STAIR SLABS	28	EA.	—

STRAIGHT UNITS



SEC. B-B

CONC. VOLUME
(2 × 8' + 6.7 + 1.33) × 0.33' × 15' = 8.0 × 15 = 120 CF = 4.5 CY EA.

REINFORCING = 500# EA.

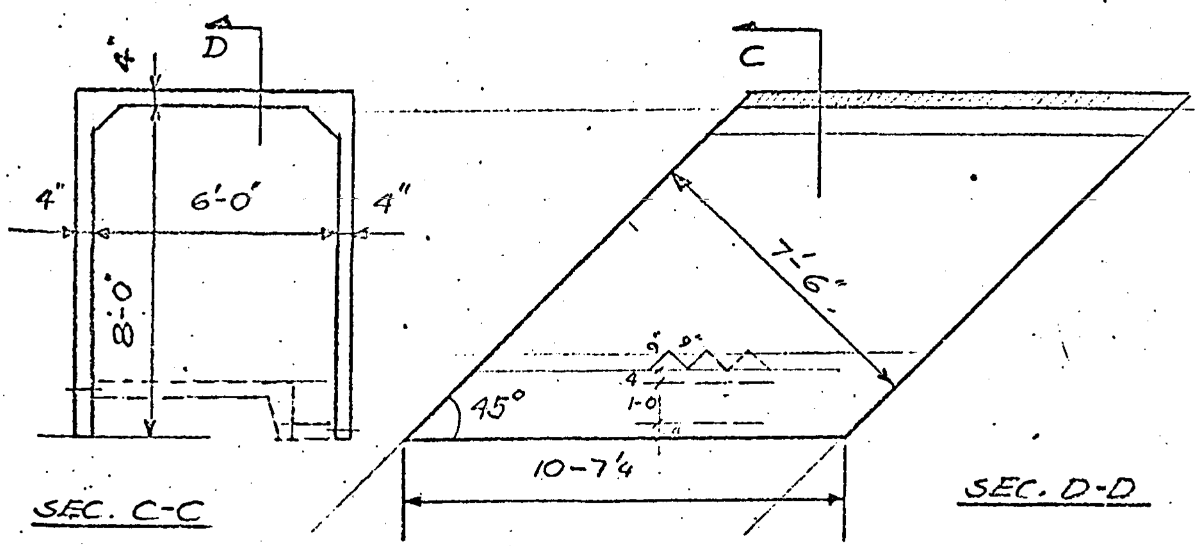
FORM CONTACT AREA
(2 × 8,33 + 2 × 7,33 + 2 + 4,67) × 15 + 48 × 0,33 = 586 SF
570 16

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1/72 REV. SKETCH # EM-S-5

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
PRECAST INSPECTION GALLERY

SLOPE UNITS



CONC. VOLUME

(2 × 8.0 + 6.7' + 1.33') × 0.33' × 10.6 = 8 × 10.6 = 85 CF = 3.2 CY EA.

REINF. = 350# EA.

CONTACT AREA : 38 × 11 + 20 = 440 SF

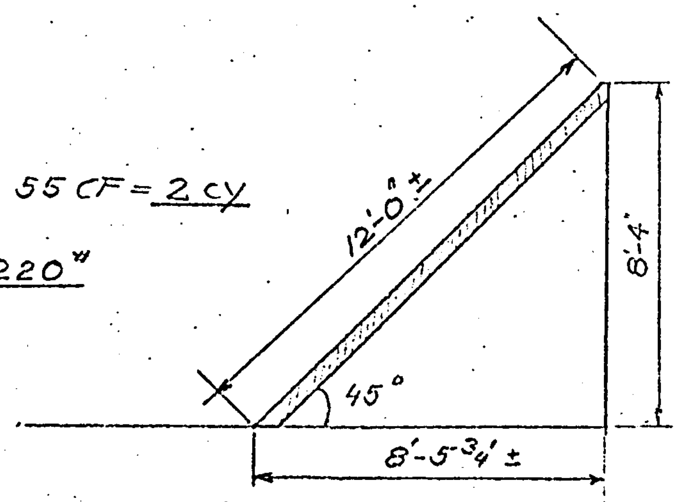
TOP FILLERS

CONC. VOLUME

$(8.48^2 + 12 \times 8.0) \times 0.33 = 55$ CF = 2 CY

72 96

REINF. = 220#



6.67
1.33
8.00

2

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1/72 REV. SKETCH# EM-S-9

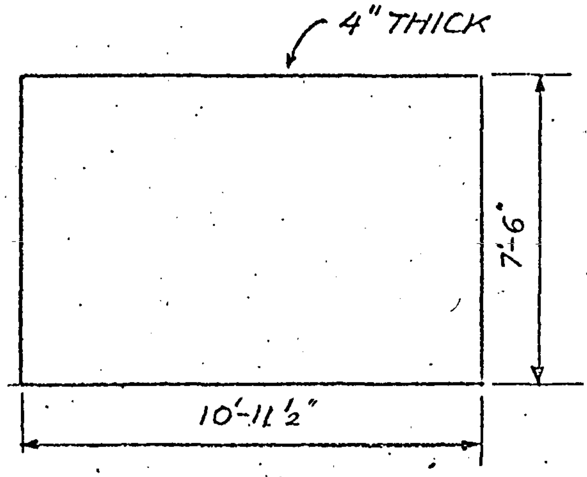
TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
PRECAST INSPECTION GALLERY

BOTT. FILLERS

CONC. VOL.

90 x 0,33 = 30CF = 1,1 CY

REINF. = 100#



FORM-SF + CONC. VOL.

		NO	CY	SF-CONTACT AREA	
1/	STR. UNITS	33 EA	x4,5 = 149	586	USE 24'x10'x1' CONC. BED FOR BASE ~9CY
2/	SLOPE UNITS	23 EA	x3,2 = 74	440	
3/	TOP FILLERS	5 EA	x 2 = 10	225	
4/	BOTT. FILLERS	12 EA	x1,1 = 14	13 (RAILS)	
	TOTAL	73	247 CY		

USE ONE STEEL FORM (INTERIOR COLLAPSIBLE) TO POUR No 1, 2) & 3)
REQ. CONTACT AREA = 38 x 19,5 + 20 = 756 SF
∴ BULKHEAD UNITS TO BE FIELD ADJUSTED FOR ASKEW & VERTICAL USE.

5/ LEVELLING BEAMS	38 EA	x 1 = 38	40 (RAILS)	24'x10'x1' CONC. BED FOR BASE
6/ DRAIN UNITS	33 EA	x.75 = 25	100	
7/ STAIR SLABS	28 EA	x1,1 = 31	150	
TOTAL	99	94 CY		

4

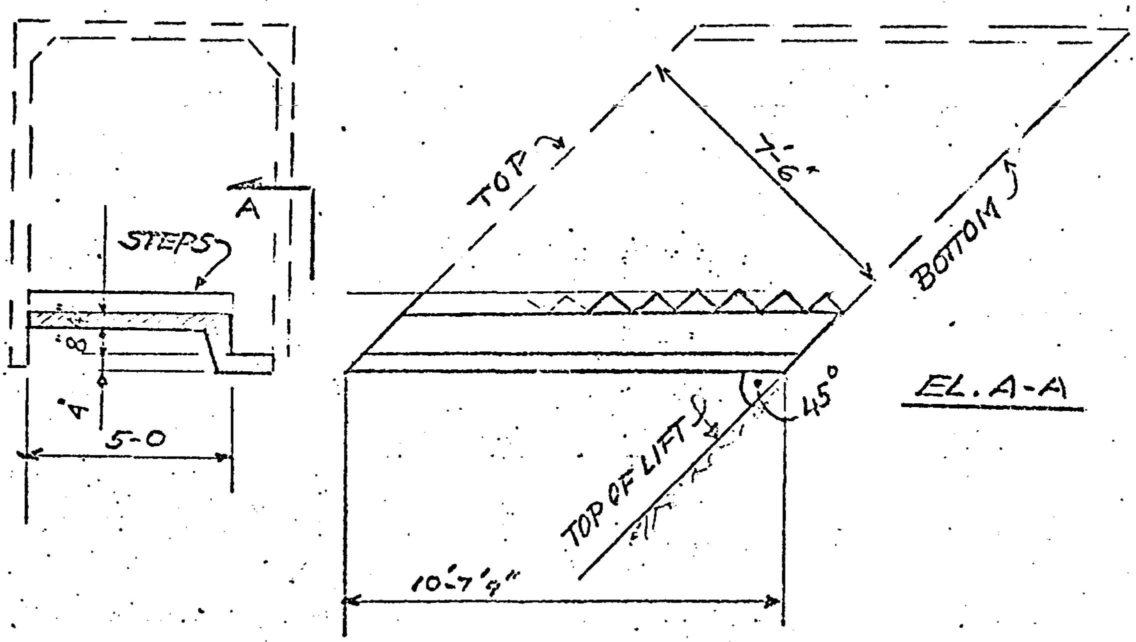
J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1/72 REV. SKETCH# EM-S-11

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
PRECAST INSPECTION GALLERY

STAIR SLAB FOR SLOPE UNITS

28 REQ.



CONC. VOL.

10,66 × (6×0,33 + 0,66×0,5 + 5×0,27) ≈ 40 CF = 1,5 CY

0,33 1,35

RE. = 180#

CONTACT AREA

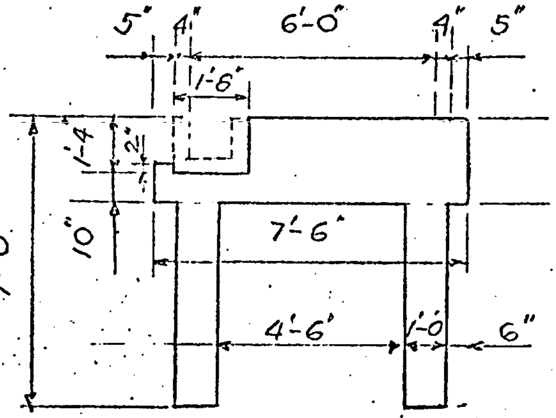
75 + 11 + 50 + 15 = 151 SF

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1/72 REV. SKETCH# EM-S-11
TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
PRECAST INSPECTION GALLERY

LEVELLING BEAMS FOR STRAIGHT UNITS.

38 EA. REQ.



WIDTH = 1'-0"

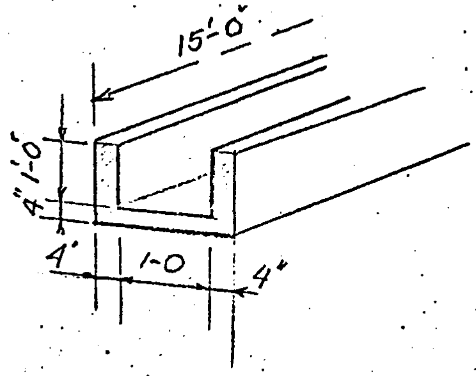
CONC. VOL. $7,5 \times 2,17 + 4,83 \times 2 - 1,67^2 = 24\ CF \sim 1\ CY$

16,3 9,7 2,5

RE. = 120#

DRAIN TROUGHS

33 REQ.



CONC. VOL.

$3.66 \times 0,33 \times 15 = 18 CF$

$\sim 0,75\ CY$

RE. = 100#

28 Stairs.

J. F. CAMELLERIE, P.E. 23 GREEN STREET HUNTINGTON, N. Y.	DATE JUNE 1/72 REV. SKETCH# EM-S-12 TRUMBULL LAKE DAM PEQUONNOCK RIVER BASIN, CONN. PRECAST INSPECTION GALLERY

PRECAST OPERATION

A) FORMS

		PRICE/SF DELIVERED	
1) 1 STEEL FORM FOR U SECTIONS	756 SF	8^{75}	6600.00
2) 1 FORM FOR TROUGHS	100 SF	4^{00}	400.00
3) 1 FORM FOR STAIR SLABS	150 SF	4^{00}	600.00
4) MISC. RAILS FOR BOTT. FILLERS & LEVELLING BEAMS	100 SF	4^{00}	400.00
TOTAL		$	8,000.00

CONC. BEDS

1) CONC. COST (MAT. 18^{00}, LABOR 7^{00})
   $2 \times 24 \times 10 \times 1 = 480$ CF = 18 CY × 25^{00} — 450.00
2) RE. MESH 960 SF (LAB + MAT.) — 150.00
3) EXCAV. OR GRADE (3^{00}/CY) 40 CY × 3^{00} — 120.00
4) GRAVEL BASE, COMPACTED (1^{00}/SF) 500 SF — 500.00
   1220.00
5) MISC. FORMS (LAB + MAT.) — 150.00

TOTAL COST FOR FORMS

8000.00
1220.00
150.00
$ 9370.00

PRECAST PRODUCTION STUDY

I	II	III
33 STR. UNITS	2 × 19 LEV. B.	12 BOTT. FILL.
23 + 5 SLOPE + TOPF.	28 STAIRS	33 DRAINS
56 DAYS	47 DAYS	45 DAYS

ITEM	I + 2-LEVELBEAMS	+ 1 BOTT. FILLER	1ST PRODUCTION CYCLE	
"	I + 2- "	+ 1 DRAIN	2ND " "	
"	I + 1- STAIR	+ 1 DRAIN	3RD " "	
CY	4,5 + 2	+ 1,1	= 7,6 CY	
"	4,5 + 1,1	+ 0,75	= 6,4 CY	
"	5,2 + 1,1	+ 0,75	= 7,1 CY	
SEC'S	1 EA + 2	+ 1	= 4	
"	1 + 1	+ 1	= 3	
"	2 + 1	+ 1	= 4	

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN CO
PRECAST INSPECTION GALLERY

B) LABOR

MAX. No OF POURS = 4
" CY OF CONC. = 7.6

CHANNEL SECTIONS

OPERATION	MEN	HRS	TOTAL
SET	4	1	4
POUR	4	1½	6
FINISH	1	2	2
STRIP & CLEAN	4	1½	6
REINF.	2	4	8
PRODUCTION TIME =		4 HR'S	26 MH'S EA.

CONVEYOR FOR CONC. DISTRIBUTION REQUIRES ONE FULLTIME OPERATOR

SCHEDULED LEVELLING BEAMS, FILLERS, DRAINS & STAIRS WILL REQUIRE AN APPROX. PRODUCTION TIME OF 4 HR'S

TOTAL CREW FOR PRECAST OPERATION

1 FOREMAN	10.20	10.20
3 LABORERS	5.60	16.80
1 MASON	8.90	8.90
2 LATHERS	10.20	20.40
1 CONV. OPER.	7.75	7.75
		64.05/HR × 8 = 512.40/SHIFT

ASSUME 60 WORKING DAYS

60 × 512.40 = 30,744.00

CRANE & CRANE OPERATOR FOR YARD: SEE SUMMARY SHEET "EM-6"

9

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

C) REINFORCING SUMMARY

1/ 33 × 500# = 16,500#
2/ 23 × 350# = 8,050
3/ 5 × 220# = 1,100
4/ 12 × 100# = 1,200
5/ 38 × 120# = 4,560
6/ 33 × 100# = 3,300
7/ 28 × 180# = 5,040

39,750# ≈ 20 TONS

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1/72 REV. SKETCH # EM-5

TRUMBULL LAKE DAM

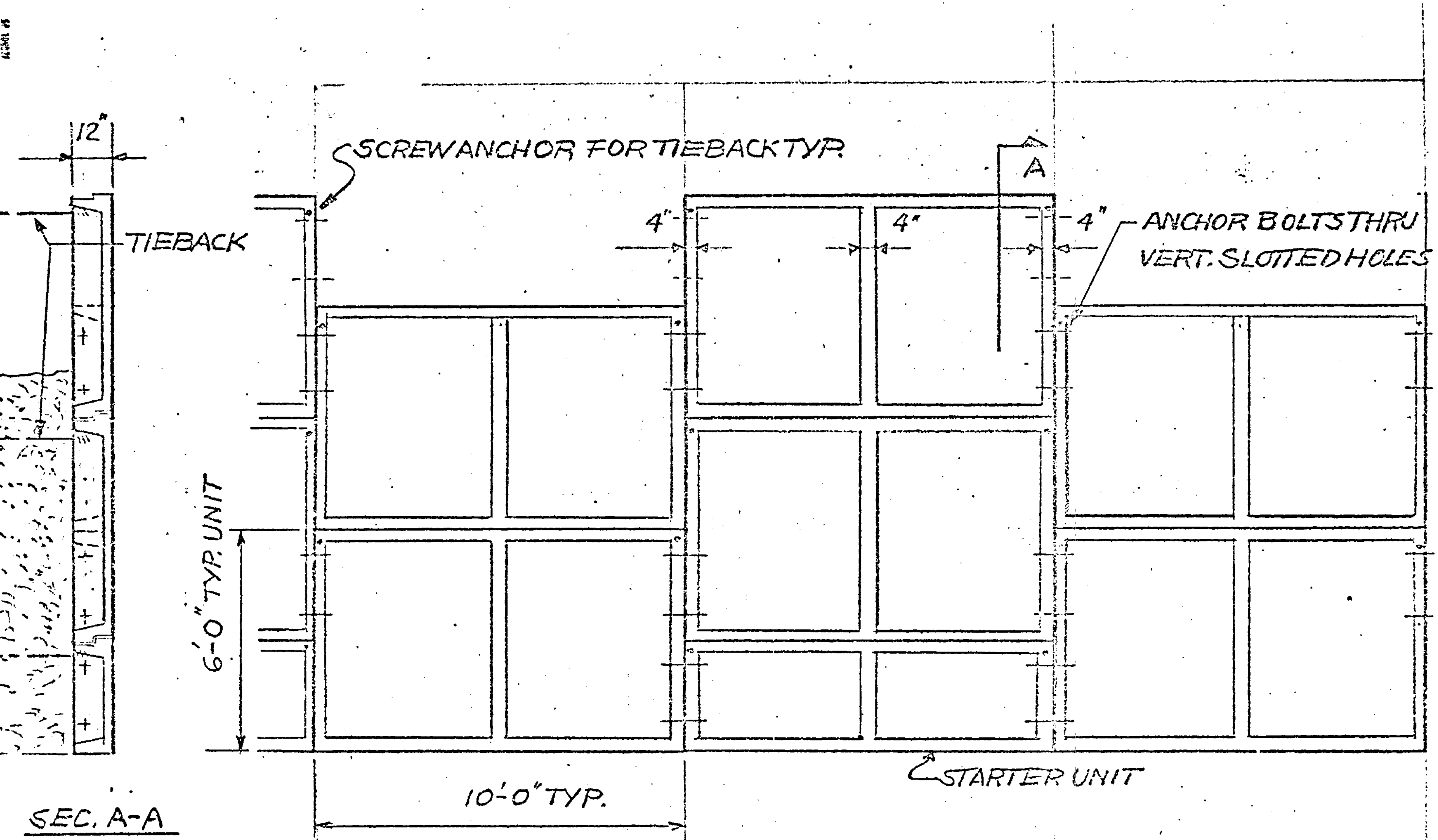
PEQUONNOCK RIVER BASIN, CONN.

PRECAST INSPECTION GALLERY

TOTAL PRECAST COST.

1/ SITE PREPARATION & CONC. BEDS	1,420
2/ FORMS	8,000
3/ LABOR	30,750
4/ REINF + MISC.	4,200
TOTAL	$ 44,370

FOR ERECTION COST SEE SUMMARY SHEET "EM-6"



EL. OF PRECAST FORMS (VIEW FROM INSIDE DAM)
CONC. LIFTS NOT SHOWN

"CANTILIVER" FORMS FOR CONT. POURING OPERATION.

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
PRECAST DAM FORMS, SCHEM

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
PRECAST FACEFORM SECTIONS

SCHEME #1

MISC.

CONC. VOLUME FOR ONE PRECAST SECTION

SLAB = 10' × 6' × 0,33' = 20.0 CF
RIBS = (2×10' + 3 × 6') × 0,66 × 0,5 = 12,5 CF
38
32,5 CF = 1,2 CY EA.

REINFORCING ~200#/UNIT

FORM CONTACT AREA

60 SF + 44' × 0,66' = 89 SF × 20 REQ = 1780 SF

NO OF SECTIONS REQUIRED = 1250 EA.

ASSUMED PRODUCTION RATE PER DAY = 20 EA.
1250 / 20 = 63 WORKING DAYS, APPROX. 3 MONTH.

REQ. CONC. VOL. PER DAY = 20 × 1,2 = 36 CY

PRECAST OPERATION

A) LABOR

LABOR	MEN	HR'S	TOTAL
SET	2	1/2	1
POUR	3	1/2	1 1/2
FINISH	1	3/4	3/4
STRIP & CLEAN	2	1/2	1
REINF.	2	1 1/2	3.
PRODUCTION TIME		1 1/2	

5 × 1 1/2 = 7 1/2 EACH CREW POURS 5 SLABS PER DAY

MANPOWER REQ. FOR 20 UNITS PER DAY

FOREMAN	1	10.20	10,20
LABOR	12	5.60	67.20
MASON	2	8.90	17.80
LATHERS	8	10.20	81.60
CRANE OP.	1	8.60	8.60
TRUCK OP.	1	5.35	5.35

PER SHIFT

TOTAL PER HR 131.75 × 8 = 1054.00

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1/72 REV. SKETCH # EM-S 19

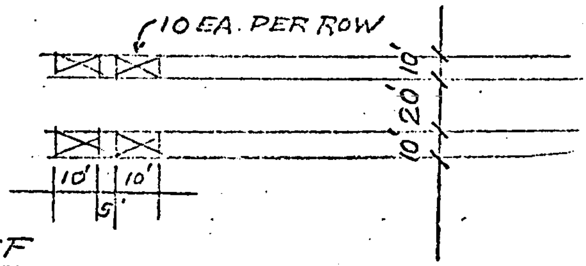
TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
PRECAST FACE FORM SECTIONS
SCHEME #1

B/ FORMS

COST PER SF. DELIVERED = 5.50

TOTAL SF REQ. = 1780 SF × 5.50 = 9,800.00

CONC. BEDS



GRAVEL BASE
155' × 40' × 1' = 6200 SF
+ 1000 "
7200 SF OR CF

GRADING & EXCAVATING
APPROX 3000 CY

FOR COST SEE "GENERAL EQUIPMENT"

C/ REINFORCING.

1250 UNITS × 250# = 312K = 156 TONS

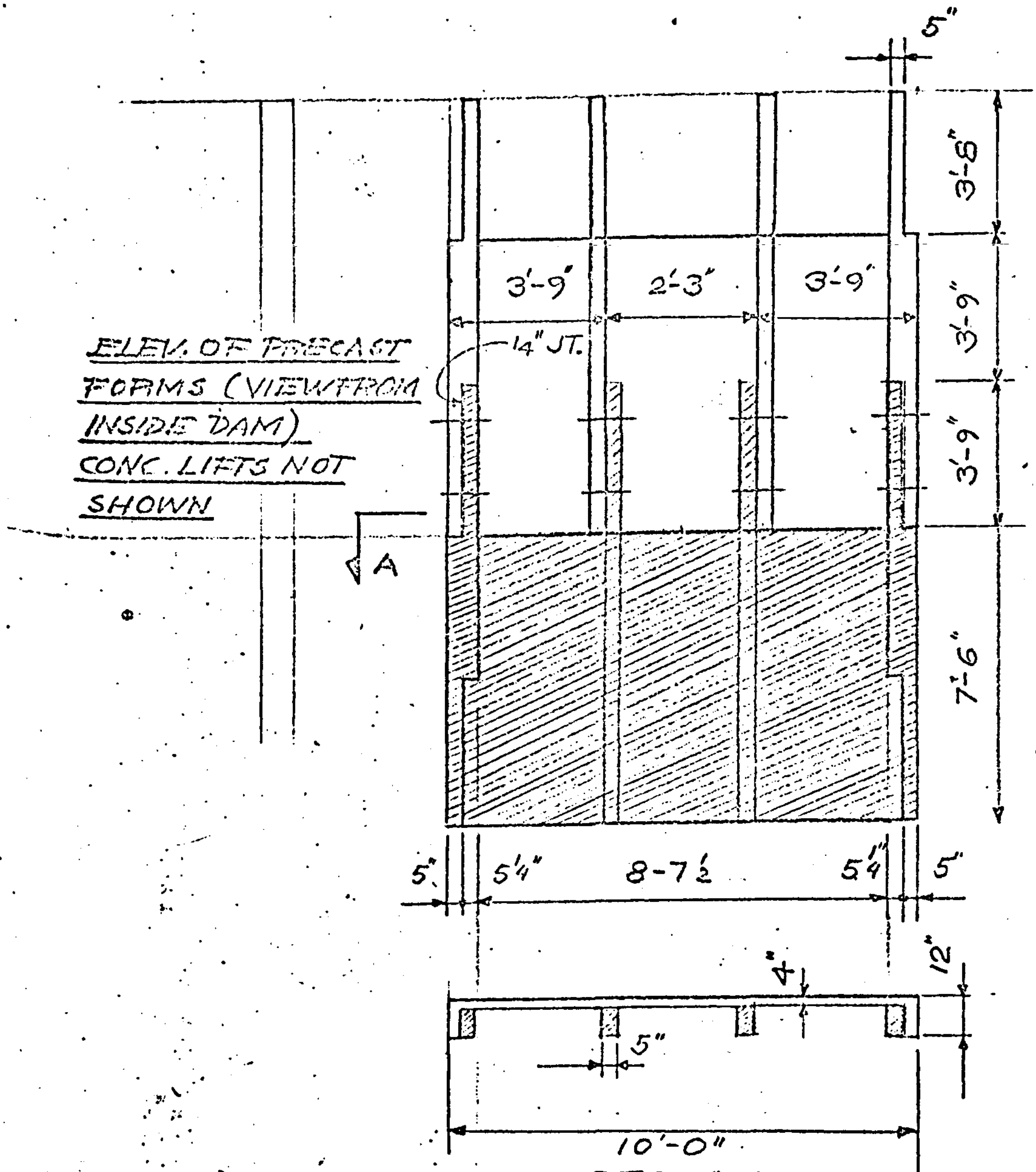
J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1 /72 REV. SKETCH# EM-5 2 0

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

PRECAST FACE FORMS, SCHEME "2



SEC. A-A

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

MISC.

CONC. VOL. FOR ONE TYP. PRECAST SECTION

10'×7,5'×0,33 + 11,25'×0,33'×0,66'×4 + 3,75'×0,33'×0,66'×2
25 13 2,7 = 41CF=1,5CY

REINFORCING

~400# / UNIT

FORM CONTACT AREA

190 SF / UNIT

No OF SECTIONS REQUIRED

$\frac{107,270 \text{ SF}}{75 \text{ SF}}$ = 1430 EA.

PROJECTED PRODUCTION RATE PER DAY.

20 UNITS PER DAY REQ. $\frac{1430}{20}$ = 72 PRODUCTION DAYS

ASSUME 88 DAYS OR 4 MONTHS

PRECAST OPERATION

A/ LABOR

	MEN	HRS	TOTAL
SET	2	1	2
POUR	3	3/4	2 1/4
FINISH	1	3/4	3/4
STRIP & CLEAN	2	1	2
REINF.	2	2	4

PRODUCTION TIME 2 3/4

1 CREW POURS 3 UNITS PER DAY

7 CREWS / 20 UNITS

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

MANPOWER REQ. TO POUR 20 SECTIONS PER DAY

FOREMAN	1	10.20/HR	81 60/DAY
LABOR	16	5.60	44 80
MASON	2	8.90	71 20
LATHERS	8	10.20	81 60
CRANE OP.	2	8.60	68 80
TRUCK OP.	2	5.35	42 80

B) FORMS

TOTAL SF. REQ. = 20 × 190 SF = 3800 SF

$3800 \times 6^{50} = \underline{24,700.00}$

POURING BEDS

CHARGED TO "GENERAL EQUIPMENT"

C) REINFORCING

1430 UNITS × 400# = 572K = 286 TONS

D) ANCHORS

SPECIAL PERMANENT ANCHORS MAY BE REQUIRED TO MAKE THE PRECAST PANELS RESIST POSSIBLE HYDROSTATIC OR ICE PRESSURE IN THE JOINT BETWEEN PRECAST SECTIONS & POURED-IN-PLACE CONCRETE.

THIS COST STUDY INCLUDES CONVENTIONAL CANTILEVER FORM ANCHORS.

COST AND FEASIBILITY STUDY

ALTERNATE DESIGNS TO PERMIT USE

OF SLIP FORM AND OTHER TECHNIQUES

TO MAXIMIZE ECONOMIES

BOOK A

STUDY OUTLINE

ALTERNATE DAM DESIGN TO

PERMIT USE OF SLIP FORM AND OTHER

TECHNIQUES TO MAXIMIZE ECONOMICS

BOOK A - STUDY OUTLINE - ALTERNATE DAM DESIGN TO PERMIT

USE OF SLIP FORM AND OTHER TECHNIQUES TO MAXIMIZE ECONOMY

Drawings and Sheets

1 Drawings 209-AD-1, AD-1A, AD-2, AD-3, AD-3A, and AD-4

2 Sheets AD-1S, AD-11 through AD-16

3 Sheets AD-2A, AD-2B1, and AD-2B2

4 Sheets AD-2S, AD-21 through AD-25

5 Sheets AD-2C, AD-S1 through 7 (Book AC-2)

6 Sheets AD-2CS, AD-2C-1 through C-5

7 Sheets AD-3S, -31 through -35

8 Sheets AD-4A, AD-4S

9 Sheets AD-11 through AD-16

10 Sheets AD-41 through AD-46

11 Sheets AD-S-108 through -113 (Book AC-1)

12 Sheets AD-S-201 through -227 (Book AC-2)

13 Sheets AD-S-401 through -414 (Book AC-4)

14 Sheet AD-EC-S

15 Sheets AD-EC-S1 through -S3 (Book AC-2)

16 Sheets AD-EC-1 through -3

17 Sheets AR-401 through -411 (Book AC-4)

18 Sheets AR-200 through -217 (Book AC-2)

PURPOSE AND LIMITS OF STUDY

The purpose of this study is to explore the possibility of applying slip form and other construction techniques to alternate designs for the dam at Trumbull Lake that are substantially different from the gravity dam as presently designed. Although time requirements will not justify redesign of this dam, the information gained will be useful for other dam sites yet to be designed. Topography, geology, dam size and many other factors will reduce the quantitative value of the comparative cost figures obtained. Nevertheless, the overall cost trends will be valuable in indicating potentially fruitful design and construction methods to be investigated for future dams.

Four different dam designs are considered for the purpose of this study:

1. A composite dam utilizing slip formed structural concrete, no-slump fill concrete and precast concrete blocks.

2. A slip formed Massive Head Buttress Dam.

3. An Ambursen Dam with slip formed buttresses.

4. A cellular type dam.

Actual alternate designs of the dam are obviously beyond the scope of this report. By rational extension of the basic design, some educated assumptions and a minimal amount of stability and soil pressure calculations, proportions and quantities were obtained which are probably correct within the limitation to accuracy that results from physical characteristic variations of different dam sites.

Although possibly the most promising alternate design to be investigated, arch dams have not been studied in this report due to their sensitivity to design and site conditions as well as the range of possible configurations. The results obtained in the studies on massive head and cellular dams do have some application to arch dams and these results are discussed relative to arch dams under Conclusions and Comments.

The discussion relative to the use of slip form techniques to implement the basic design applies here to diversion, construction sequence, environmental impact, access, escalation, and labor considerations.

Cost figures are developed for each of these alternate designs for comparison with the basic design and with each other. Some variations in design and construction procedures as well as increase in size are also analyzed.

COST AND FEASIBILITY STUDY

COMPOSITE DAM

GENERAL DESCRIPTION

This alternate (shown on drawing 209-AD-1) is essentially identical in concept and design with the Trumbull Lake Dam as designed, but differs in materials and construction process used. This combination of structural, precast and mass concrete fill was proposed and successfully implemented in the construction of two small dams by V.M. Wallingford of Hydro-Quebec.

The basic concept of this design is the provision of an impermeable structural concrete wall upstream, a serviceable precast surface downstream and an economical low cement fill in between. The savings accrue from elimination of downstream and transverse forming, elimination of horizontal joints, immunity to temperature cracking and overall low cement requirement.

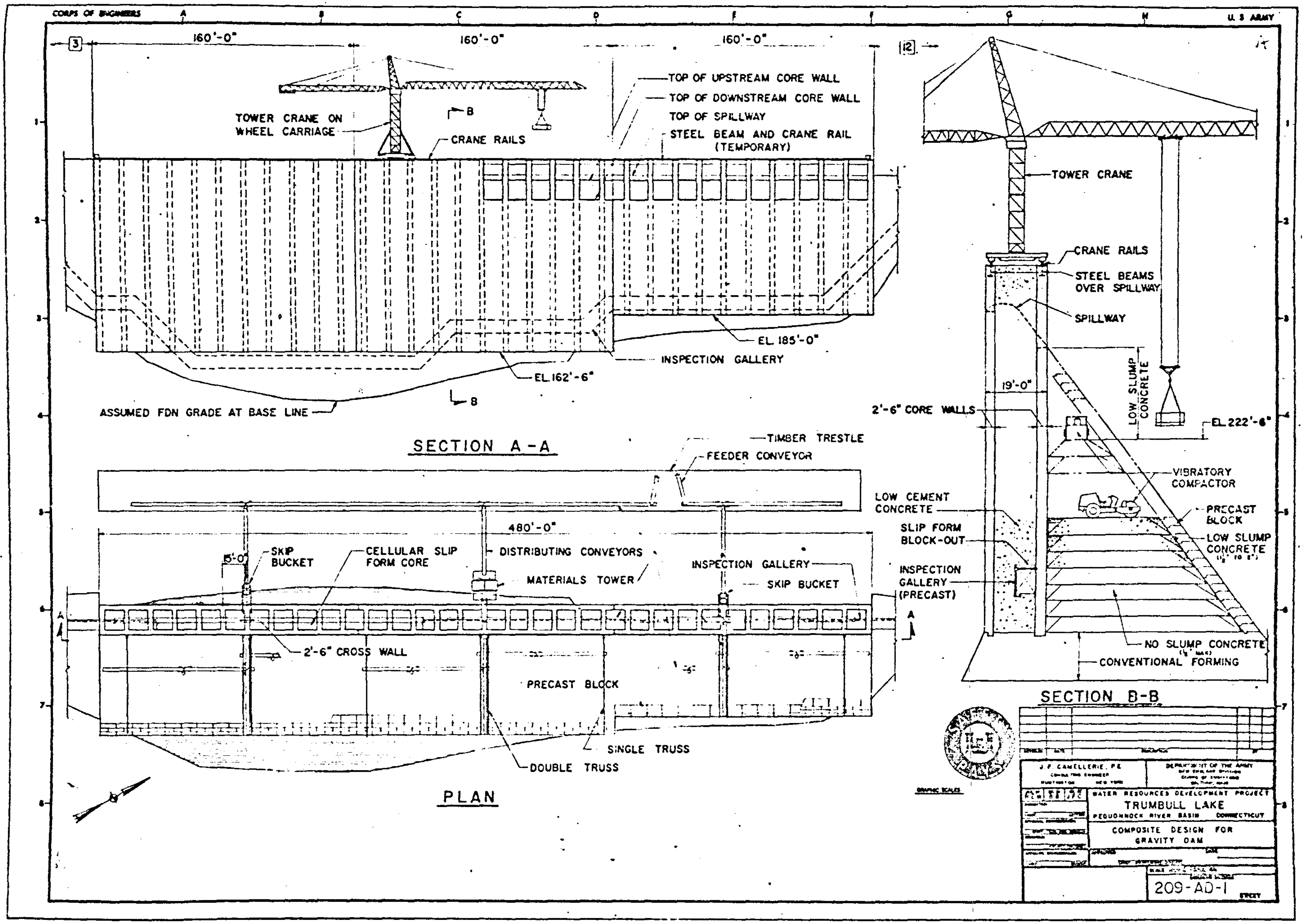
This study includes two modifications from Mr. Wallingford's proposal. One is the substitution of a cellular upstream face in lieu of a heavy monolithic wall. This has the advantage of completely eliminating dangers of thermal stresses that may exist in the more massive wall, reduces the amount of concrete to be handled during the slip and provides a good platform at the top for carrying construction equipment such as cranes. The second modification is in the configuration of the precast blocks. In order to facilitate placing of the fill concrete, these are designed without overhang on the concrete side. A flush rather than stepped downstream face is also achieved by this block configuration.

The no-slump concrete used is described under the heading "Impact of No-Slump Concrete" in the "Discussion of Additional Modifications" section of the preceding report on utilization of slip form techniques.

The cells on the upstream face may be filled with low cement concrete or a granular fill. Although lighter in weight, the granular fill would have certain drainage advantages.

CONSTRUCTION METHODS

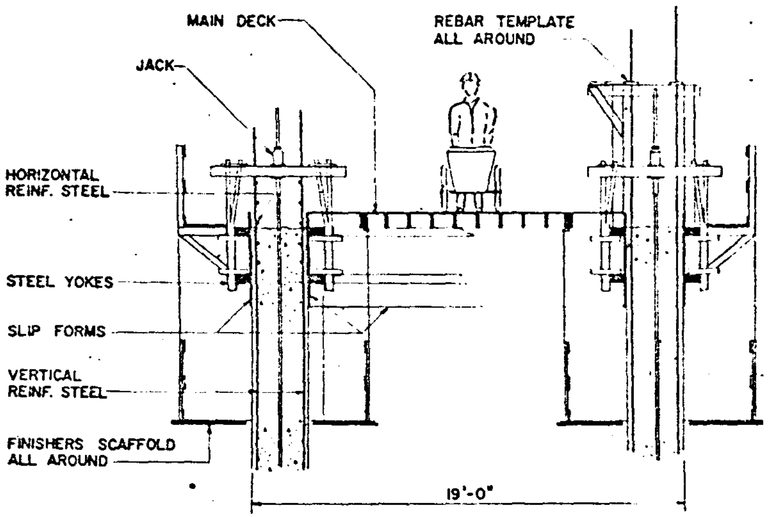
Using structural concrete, slip forming may proceed at rates upward of twelve inches per hour thereby obtaining very good economy. The cost of forming out the cells is minimal in view of the advantages obtained. Drawing



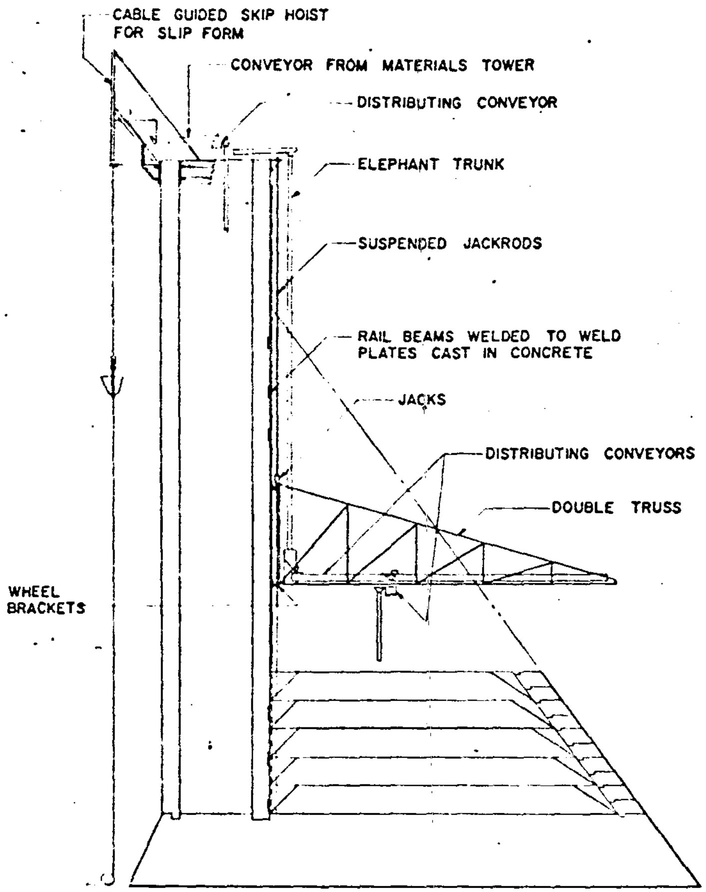
CORPS OF ENGINEERS
U. S. ARMY
160'-0"
160'-0"
160'-0"
TOP OF UPSTREAM CORE WALL
TOP OF DOWNSTREAM CORE WALL
TOP OF SPILLWAY
STEEL BEAM AND CRANE RAIL (TEMPORARY)
TOWER CRANE ON WHEEL CARRIAGE
CRANE RAILS
EL. 185'-0"
INSPECTION GALLERY
EL. 162'-6"
ASSUMED FDN GRADE AT BASE LINE
SECTION A-A
TIMBER TRESTLE
FEEDER CONVEYOR
480'-0"
15'-0"
SKIP BUCKET
CELLULAR SLIP FORM CORE
DISTRIBUTING CONVEYORS
MATERIALS TOWER
INSPECTION GALLERY
SKIP BUCKET
2'-6" CROSS WALL
PRECAST BLOCK
SINGLE TRUSS
DOUBLE TRUSS
PLAN
TOWER CRANE
CRANE RAILS
STEEL BEAMS OVER SPILLWAY
SPILLWAY
LOW SLUMP CONCRETE
19'-0"
2'-6" CORE WALLS
EL. 222'-6"
VIBRATORY COMPACTOR
LOW CEMENT CONCRETE
SLIP FORM BLOCK-OUT
INSPECTION GALLERY (PRECAST)
PRECAST BLOCK
LOW SLUMP CONCRETE
NO SLUMP CONCRETE
CONVENTIONAL FORMING
SECTION B-B
J. F. CAMELLERIE, P.E.
WATER RESOURCES DEVELOPMENT PROJECT
TRUMBULL LAKE
PEQUONNOCK RIVER BASIN CONNECTICUT
COMPOSITE DESIGN FOR GRAVITY DAM
209-AD-1

CORPS OF ENGINEERS | U. S. ARMY

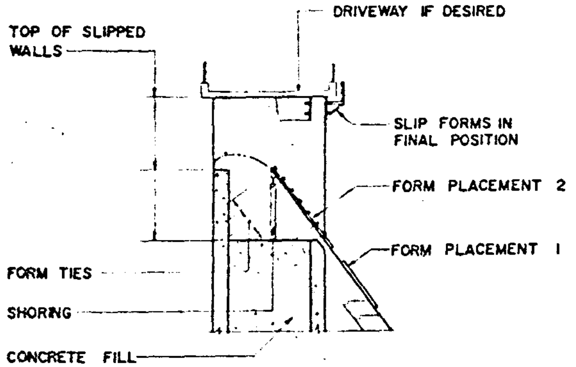
A



SLIP FORM SYSTEM



CONCRETE DISTRIBUTION SYSTEM



SECTION THROUGH SPILLWAY

J. F. CAMELLERIE, P.E.
CONSULTING ENGINEER

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS

WATER RESOURCES DEVELOPMENT PROJECT
TRUMBULL LAKE
PEQUONNOCK RIVER BASIN CONNECTICUT

COMPOSITE DESIGN FOR GRAVITY DAM

209-AD-1A

209-AD-1A shows the slip form system which is the "common garden variety" in general use on silo construction. Concrete is brought up to the placing deck by means of a cable guided skip hoist supported on the slip form system and automatically emptying into a deck hopper. Concrete may be distributed laterally by buggy, conveyor, monorail, or a combination. Pumping directly into the forms is difficult but pumping vertically (in lieu of hoist) and laterally to distribution points is entirely feasible. The slip is made in three sections of 160 feet each.

In the area of the spillway, the longitudinal walls are stopped below the level of transverse walls as shown on section thru spillway. Fix formed panels are required to place the fill above this point and to continue the concrete surface to meet the highest precast block. The slip form deck which is continued to the top may be used to cast the roadway deck and as a working platform for forming the curb and overhang.

Temporary steel beams are provided over the spillway to allow use of a crane for placing the precast blocks.

The keyed concrete blocks resist the hydrostatic pressure from the fill concrete by gravity and need no cantilever system for support. Their height is 2'-6" coordinated with the fill lifts of 5'-0" and their length 10'-0" to keep the weight down below 10 tons. These blocks may be cast on the site or purchased from a nearby casting yard. Rate of production used is 21 blocks per day; setting varies from 16 per day at bottom to 32 per day at the top to keep pace with placement of fill.

The no-slump concrete fill is placed by a conveyor system suspended from the previously slipped upstream cells. The trusses supporting the distributing conveyors run on a rail system and are hydraulically supported and raised by hydraulic jacks as the work progresses. This system allows headroom for the placing crew and the vibratory compactor. At elevation 222'-6" insufficient room remains for using the vibratory compactor; low slump concrete capable of being vibrated by hand tools must be used above this point.

The areas below elevations 162'-6" and 185'-0" between monoliths 3 and 12, all of monoliths 1, 2 and 3 and all of monoliths 12 through 16 are constructed by conventional methods in 7'-6" lifts.

The cells are filled directly by a conveyor at the top of the cells.

CONSTRUCTION SCHEDULE

As shown on concrete demand schedule, sheets AD-S108 through 113, placing of the monoliths takes 166 working days, substantially the same time as required for slip forming the dam as designed. Three months of construction time are saved as compared to placing by conventional methods.

CONSTRUCTION COST

Cost Summary Sheet AD-1S and Cost Sheets AD-11 thru 16 shows the total cost for constructing the dam by this method to be $7,204,000 as compared to $6,937,000 using conventional methods.

J. F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JUL 15, '72 PRICED BY	SHEET NO. AD-1S
	PROJECT: TRUMBULL LAKE DAM	
	ARCHITECT: NEW ENGLAND DIV., CORPS/ENG'R.	

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
SUMMARY - COMPOSITE DESIGN						
GRAVITY DAM						
SHEET AD-11				2,181,020		624,590
-12				256,975		345,395
-13				179,900		126,730
-14				605,810		77,810
-15				377,200		216,500
-16				630,400		430,200
				4,231,305		1,821,225
ESCALATION THRU 1974			2%	84,626	11%	200,335
				4,315,931		2,021,560
PAYROLL, TAXES & INSURANCE					14%	283,018
						2,304,618
				→		4,315,931
TOTAL COST TO CONTRACTOR						6,620,549
O'HD, PROFIT & CONT.					8%	529,644
						7,150,193
BID BOND					3/4%	53,500
TOTAL CONTRACT PRICE						7,203,693

SP 1019bA

J.F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JUL 15, '72 PRICED BY	SHEET NO. AD-11
	PROJECT: TRUMBULL LAKE DAM	
	ARCHITECT: NEW ENGLAND DIV.-CORPS/ENG'R.	

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
ITEM 04 DAM						
CLEARING & GRUBBING	360,000	S.F.	.05	18,000	-	SUB
DISPOSAL	250,000	S.F.	.03	7,500	-	SUB
EXCAV., UNCLASS.	36,000	CY	2.00	72,000	-	SUB
EXCAV., ROCK	11,000	CY	10.00	110,000	-	SUB
EXCAV., TALUS	14,000	CY	3.00	42,000	-	SUB
HAND CLEANING	70,000	S.F.	.75	52,500	-	SUB
CULVERT PIPE	-	LF	4.50	-	1.50	-
CHAIN LINK FENCE	850	LF	3.50	3,000	2.00	1,700
FOUNDATION GROUTING	50,000	S.F.	.90	45,000	-	-
DIVERSION	-	L.S.		714,000	-	SUB
PRECAST SPRAY WALL	17.5	C.Y.	150.	2,700	200.	3,500
CEMENT	11,660	TONS	27.20	320,000	-	-
FLYASH	5,840	TONS	9.00	52,500	-	-
BORROW OPERATION	240,000	TONS	.30	72,000	.29	69,500
AGGREGATE PRODUCTION	231,000	TONS	.53	128,000	.34	78,500
BATCH PLANT OPER.	127,000	C.Y.	3.44	437,360	1.65	209,000
CONC. PLACING (CONV.)	35,280	C.Y.	-	-	.81	28,600
CONC. PLACING (FILL INT. MASS) (FILL CELLS)	71,600	C.Y.	-	-	.46	33,000
VIBRATION (CONV.)	35,280	C.Y.	.44	15,500	.52	18,300
VIBRATION (FILL)	71,600	C.Y.	.21	15,000	.18	12,900
FINISHING	28,000	S.F.	.05	1,400	.28	7,900
CURING	279,000	S.F.	.01	2,800	.01	2,800
HORIZ. JT. TREATMENT	146,000	S.F.	.05	7,300	.15	21,900
FORMS: FOUNDATION	16,000	S.F.	.80	12,800	3.00	48,000
CANTILEVER	13,000	S.F.	.80	10,400	1.17	15,200
TRANSV. BLK'HD	16,000	S.F.	.80	12,800	1.17	18,700
LONG'L BLK'HD	8,000	S.F.	.80	6,400	1.17	9,400
LIFT STARTERS	4,000	S.F.	.80	3,200	1.17	4,700
SLAB (P.H.)	2,470	S.F.	.75	1,850	1.00	2,470
SLAB (ROAD)	2,350	S.F.	.25	590	.75	1,760
WALLS (P.H.)	7,080	S.F.	.75	5,310	2.00	14,160
RET. WALLS	7,450	S.F.	.25	1,860	1.00	7,450
CURBS (TOP)	3,300	S.F.	.50	1,650	1.50	4,950
PUMP HSE. SHORING	35,800	CU.FT.	.06	2,150	.06	2,150
STAIR TOWER	2,300	S.F.	1.50	3,450	3.50	8,050
SP 10196A		-//-		2,181,020		624,590

J.F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV., CORPS/ENG'R.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
SLIP FORM OPERATION						
SLIDING FORMS	1,350	L.F.	14.	18,900	21.	28,300
YOKES (3T)	200	EA.	-	INCL.	50.	10,000
JACK ROD (3T)	20,900	L.F.	1.65	34,400	.05	1,000
DECKS (INT.)	5,600	S.F.	.50	2,800	1.00	5,600
DECKS (EXT.)	1,920	S.F.	.50	960	1.00	1,920
INSIDE SCAFFOLDS	2,800	S.F.	1.50	4,200	2.00	5,600
HYDRAULIC PIPING	3,350	L.F.	-	INCL.	.80	2,700
FIELD ASSIST. ENG'R.	14	DAYS	200.	2,800	-	-
FIELD TECH.	24	DAYS	150.	3,600	-	SUB
OUTSIDE SCAFFOLDS	1,920	S.F.	1.50	2,900	2.00	3,840
TOPPING OUT RODS	200	EA.	2.00	400		INCL.
CONCRETE (SLIP FORMED)	13,430	C.Y.	-	INCL.	-	INCL.
STEEL REINF. (IN SLIP)	520	TONS	230.	119,600	150.	78,000
FINISH	51,000	S.F.	.05	2,600	-	IN SLIDE CREW
CURING	102,000	S.F.	.01	1,000	-	IN SLIDE CREW
SLIDE CREW	-	-	-	-	-	98,200
RAILINGS & LADDERS	1,000	L.F.	4.50	4,500	2.50	2,500
FORM DESIGN	-	-	-	10,000	-	-
STRIP FORMS				-	-	42,500
GALLERY BULKHEADS	2,240	S.F.	.50	1,100	2.00	4,500
HORIZ. KEYS	480	L.F.	.15	75	1.00	480
REBAR PLACING & LISTING	520	TONS	20.00	10,400	-	-
WELD PL (CRANE)	34	EA.	65.00	2,200	36.	1,200
WELD PL (CRANE)	192	EA.	13.50	2,600	21.	4,100
JAY POST	1,275	LF.	1.50	1,920	1.00	1,275
SPILLWAY BULKHEADS	3,280	S.F.	.50	1,640	1.00	3,280
BEAM BLOCKOUTS	320	S.F.	.35	100	.85	300
WELD PL (CONV.)	18	TONS	500.	9,000	-	INCL.
SPILLWAY TOP						
SHORING				1,000		-
FORMS ABOVE SLIP	3,600	SF CA	.30	1,100	1.20	4,300
FORMS BELOW SLIP	5,300	"	.30	1,600	1.20	6,400
PRECAST GALLERY				15,580		39,400
SP 10196A		-12-		256,975		345,395

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JUL 15, '72 PRICED BY SHEET NO. AD-13

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV.-CORPS/ENG'R.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
PRECAST CONC. BLOCKS						
CASTING PLANT, STORAGE YARD, ROAD						
EXCAV. & GRADING CHARGED TO "SITE EQUIPMENT"						
GRAVEL BASE	42,500	S.F.	1.00	42,500	-	SUB
ACCESS ROAD, GRAVEL	4,000	S.F.	1.00	4,000	-	SUB
FORMS						
STEEL FORMS	2,940	S.F.	6.50	19,100	-	SUB
LABOR FOR 1548 UNITS - 80 PRODUCTION DAYS						
FOREMAN	1 x 80	DAYS	-	-	81.60	6,530
LABORERS	15 x 80	"	-	-	44.80	53,800
MASONS	2 x 80	"	-	-	71.20	11,400
CONV. OPER.	2 x 80	"	-	-	62.00	9,900
YARD CRANE OPER.	2 x 80	"	-	-	68.80	11,000
MATERIALS						
CONC. BY SITE PLANT	-	-	-	-		-
INSERTS (LIFTING)	6,200	EA.	1.50	9,300	-	-
MISC.	-	-	-	1,000	-	-
EQUIPMENT (80 DAYS)						
YARD CRANES (2 EA.)	2 x 4	MOS.	1000	8,000	-	-
CONVEYORS	700	L.F.	1.50	84,000	-	-
A-FRAMES	-	-	-	4,000	-	SUB
CONC. HOPPER	-	-	-	3,500	-	SUB
MISC.	-	-	-	1,500	-	-
ERECTION (75 DAYS)						
FOREMAN	1 x 75	DAYS	-	-	76.00	5,700
LABORERS	3 x 75	"	-	-	44.80	10,100
CRANE OPER.	1 x 75	"	-	-	68.80	5,160
2 MASONS (20,000 LF OF JTS.)	2 x 70	"	-	1,000	71.20	10,000
1 LABORER	1 x 70	"	-	-	44.80	3,140
EQUIPMENT	-	-	-	2,000	-	-
SP 10196A		-13-		179,900		126,730

J.F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JUL 15, '72 PRICED BY	SHEET NO. AD-14
	PROJECT: TRUMBULL LAKE DAM	
	ARCHITECT: NEW ENGLAND DIV., CORPS/ENG'R	

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
GENERAL ITEMS:						
HYDRAULIC PACKAGE	1	L.S.	-	303,680	-	-
EXTENSION 36" BLOW-OFF	1	L.S.	-	5,000	-	2,000
3½" Ø STEEL PIPE	1,160	LF	3.50	4,060	5.50	6,380
2½" Ø STEEL PIPE	2,150	LF	1.75	3,760	3.50	7,530
3" DRAINAGE HOLES	2,880	LF	8.10	23,300	-	SUB
1½" GROUT HOLES	9,240	LF	8.00	73,920	-	SUB
6" DRAINS	2,770	LF	1.70	4,720	-	SUB
8" WELLS	1,070	LF	2.25	2,410	-	SUB
PLUMBLINE SHAFT	120	LF	3.00	360	2.50	300
REINF. ST'L (EXCEPT IN SLIP FORM)	50,000	LB	.15	7,500	.09	4,500
BACKFILL	12,000	CY	-	-	2.00	24,000
ROCK SLOPE PROT.	800	CY	3.00	2,400	10.00	8,000
ROCK GRAVEL	1,200	CY	4.50	5,400	2.50	3,000
BIT.CONC. PAVING	1,200	SY	5.00	6,000	-	SUB
ALUM. HAND RAIL	1,000	LF	10.00	10,000	3.00	3,000
COPPER WATER STOPS	3,800	LF	3.50	13,300	4.50	17,100
ENVIRONMENTAL WORK						
TURBIDITY CONTROL			-	80,000	-	SUB
DUST CONTROL			-	1,000	-	-
NOISE CONTROL (EQUIP)			-	80,000	-	-
LANDSCAPE RENEWAL			-	5,000	-	2,000
R.R. BED	270,000	S.F.	.20	54,000	-	SUB
SP 10196A			-12-	605,810		77,810

J.F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JUL 15, '72 PRICED BY SHEET NO. AD-15

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV.-CORPS/ENG'R.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
EQUIPMENT						
CONCRETE HOIST	2	EA.	7000	14,000	1200	2,400
MATERIAL TOWER	1 x 6	MOS.	1200	7,200		12,000
YARD CRANE	1 x 12	MOS.	4500	54,300	1500 1200	32,500
PERSONNEL TOWER	2 x 6	MOS.	80	1,000	-	1,400
TIMBER TRESTLE	480	L.F.	73	35,000	37	17,800
DOZER	1 x 15	MOS.	1200	18,000	1330	20,000
COMPRESSOR	2 x 6	MOS.	1100	13,200	1300	15,600
UTILITY TRUCKS	2 x 15	MOS.	800	24,000	940	28,200
VIBRATORY COMPACTOR	1 x 1-1/3	EA.		16,000	1500	2,000
TOWER CRANE	4	MOS.		25,000	-	30,000
ST'L BM. FOR CRANE	65	TONS	300	19,500	100	6,500
RAILS FOR CRANE	960	L.F.	12	11,500	15	14,300
RAILROAD BUMPERS	2	EA.	350	700	150	300
HYDRAULIC BOOM CRANE	2 x 5	MOS.	1500	15,000	1400	14,000
CONVEYOR SYSTEM	1	L.S.	-	107,000	-	12,800
CONVEYOR SUPPORT TRUSSES	30	TONS	400	12,000	150	4,500
RAIL BEAMS FOR TRUSSES	11	TONS	300	3,300	200	2,200
ELEPHANT TRUNKS				500	-	-
SP10196A		-15-		377,200		216,500

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV., CORPS/ENG'R.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
FIELD OVERHEAD						
BRIDGE	1	EA.		1,000		5,000
IMPROVE R.R. BED	268,000	S.F.	1.50	402,000	-	SUB
ACCESS RD, VALLEY	72,000	S.F.	1.00	72,000	-	SUB
FIELD OFFICE,SHOPS,STORAGE			-	27,000	-	3,000
HARDWARE, TOOLS, BUGGIES			-	45,000	-	-
FUEL & OIL			-	12,000	-	-
START-UP & LAYOUT			-	-	-	5,000
MIX DESIGNS			-	1,000	-	-
CONC. TESTING			-	25,000	-	SUB
TEMPORARY LIGHTING			-	3,000	-	10,000
SANITARY FACILITIES			-	5,400	-	SUB
CLEAN-UP			-	-	-	20,000
HEATING			-	20,000	-	-
PROJECT MANAGER	1 x 117	WKS	-	-	500.	58,500
SUPERINTENDANT	1 x 90	"	-	-	400.	36,000
PROJECT ENG'R	1 x 80	"	-	-	400.	32,000
CLERKS	2 x 80	"	-	-	200.	32,000
SURVEYORS	4 x 80	"	-	-	250.	80,000
UTILITY MECH.	6 x 52	"	-	-	300.	93,600
WATCHMEN	3 x 117	"	-	-	100.	35,100
WINTER PROTECTION			-	2,000	-	5,000
COMMUNICATIONS			-	5,000	-	5,000
POWER DISTRIBUTION			-	10,000	-	10,000
				630,400		430,200

SF 10196A

COST ANALYSIS

In spite of earlier completion by 3 months this design shows a cost $267,000 higher than is obtained using conventional methods. The inherent problem is the division of construction into 4 different operations, cantilever forming, slip forming, precasting and dry placing. Each operation must be completely implemented and reuse of plant, formwork and equipment is considerably reduced.

A rectangular valley cross-section would of course improve economy greatly by eliminating or greatly reducing the conventional costing required.

As always, an increase in dam size would result in better utilization of plant and equipment and a more favorable economic position for this design alternate.

COST AND FEASIBILITY STUDY

MASSIVE HEAD BUTTRESS DAM

GENERAL DESCRIPTION

This type of dam has been slip formed in Europe with good success. It is so designed that each buttress section is monolithic and self-sufficient. The foundations are cut into the rock sufficiently to provide safety against sliding and are stepped as required. The low sections at the abutments are shown and costed as also slip formed but these can be fixed formed more economically using structural concrete methods. The design and construction methods for the Massive Head Buttress Dam are shown on Drawings 209-AD-2 and 3A.

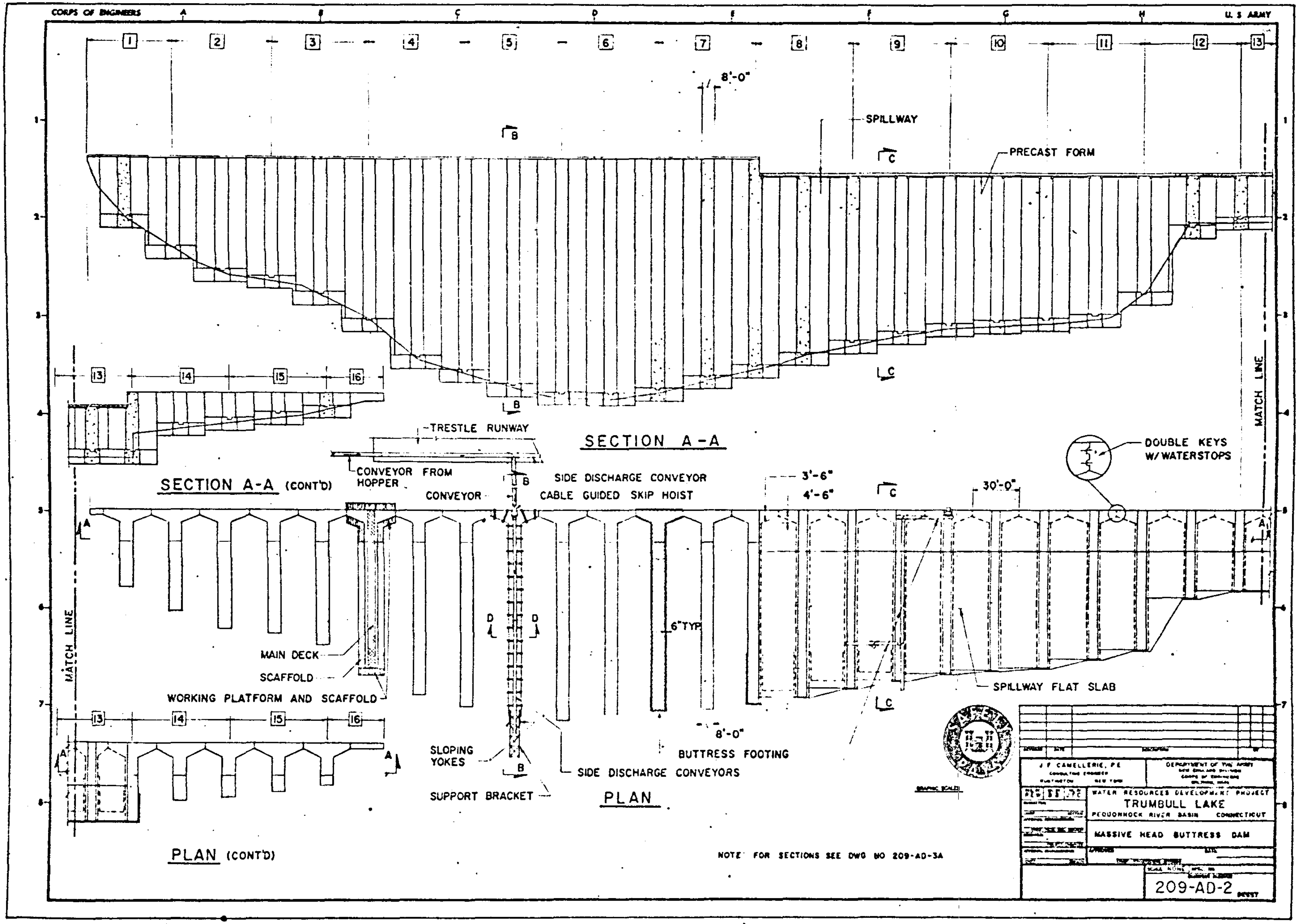
As shown on Section B-B, the driveway sits directly on the head and stem avoiding any intermediate sections which would increase construction operations. The spillway section is shown on Section C-C, and consists of a concrete slab placed on precast concrete sections spanning buttress to buttress and acting as leave-in-place forms. The pumping station may be placed in the enclosed area under the spillway, nestled between the buttresses or placed in a specially designed double buttress section.

This type of dam allows use of prestressed rock anchors to reduce the overall size and weight (concrete content) of the dam. As an alternate to the cast-in-place concrete spillway slab, a fully precast spillway slab may be used. Both of these possibilities were studied and are discussed in this report. A flat spillway slab at the top with a lip and sheer drop to the base is also a possibility.

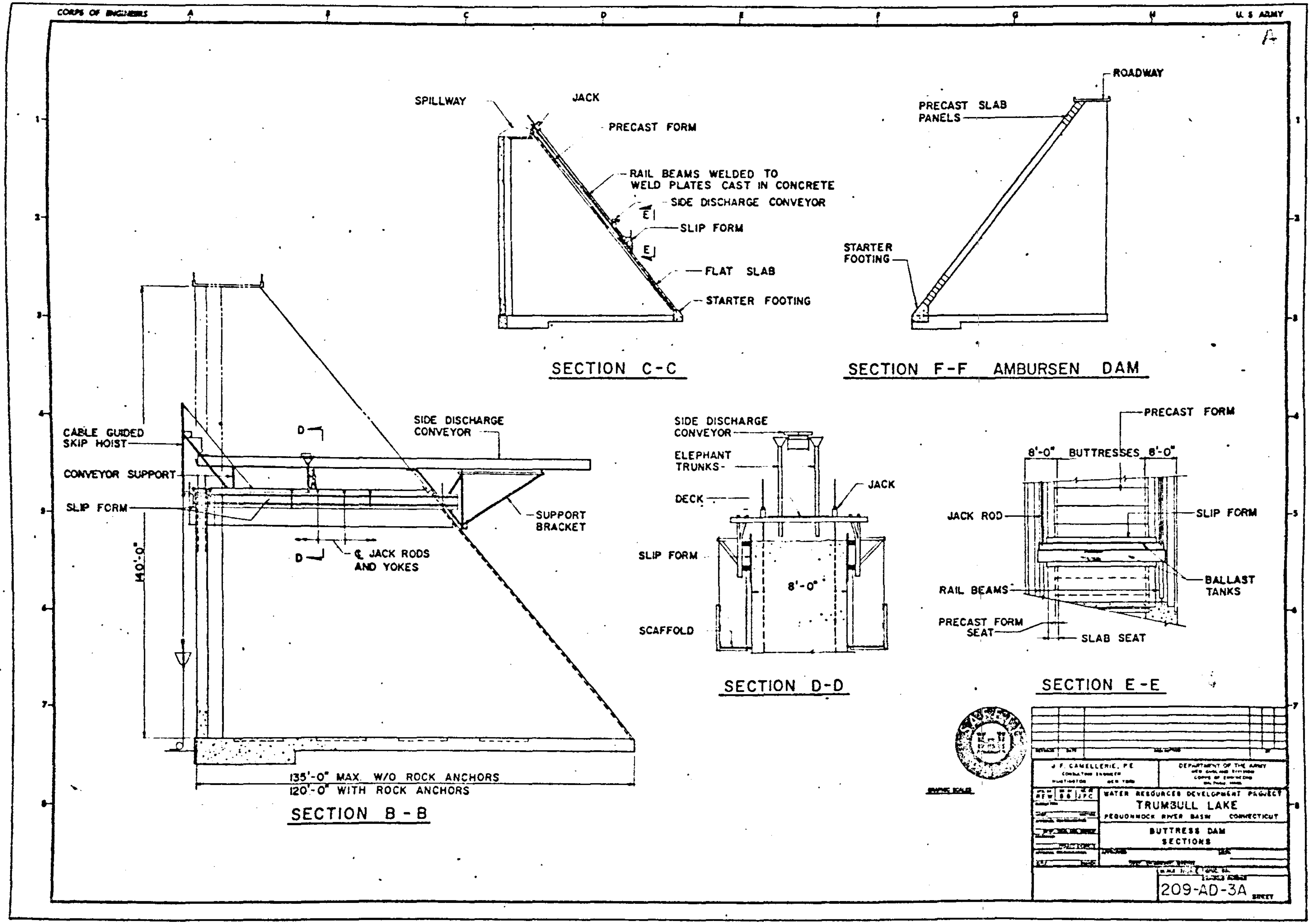
DESIGN

Cursory stability and heel pressure calculations were made for the Massive Head Dam on calculation sheets AR-200 through AR-217. A base length of 135 feet (Scheme #2) was selected with the dimensions shown for a height of 140' above footings. This results in heel pressures of 730 pounds per square foot.

An alternate design was made with a 120 foot base resulting in an uplift pressure of 3270 pounds per square foot at the heel or a total uplift of 448 kips per monolith. Prestressed anchor bolts were provided to reduce this stress to positive pressures. These prestress anchors were allowed to run to the top of the dam thereby resulting in a compressed condition of the upstream face with superior impermeability.



CORPS OF ENGINEERS
U. S. ARMY
1
2
3
4
5
6
7
8
9
10
11
12
13
8'-0"
SPILLWAY
PRECAST FORM
B
C
SECTION A-A
13
14
15
16
SECTION A-A (CONT'D)
MATCH LINE
TRESTLE RUNWAY
CONVEYOR FROM HOPPER
CONVEYOR
SIDE DISCHARGE CONVEYOR
CABLE GUIDED SKIP HOIST
3'-6"
4'-6"
30'-0"
DOUBLE KEYS W/ WATERSTOPS
6" TYP
D
MAIN DECK
SCAFFOLD
WORKING PLATFORM AND SCAFFOLD
SPILLWAY FLAT SLAB
8'-0"
BUTTRESS FOOTING
SLOPING YOKES
SIDE DISCHARGE CONVEYORS
SUPPORT BRACKET
PLAN
PLAN (CONT'D)
NOTE: FOR SECTIONS SEE DWG NO 209-AD-3A
J F CAMELLERIE, P.E.
DEPARTMENT OF THE ARMY
WATER RESOURCES DEVELOPMENT PROJECT
TRUMBULL LAKE
PEQUONNOCK RIVER BASIN CONNECTICUT
MASSIVE HEAD BUTTRESS DAM
209-AD-2


CORPS OF ENGINEERS
U.S. ARMY
SPILLWAY
JACK
PRECAST FORM
RAIL BEAMS WELDED TO WELD PLATES CAST IN CONCRETE
SIDE DISCHARGE CONVEYOR
SLIP FORM
FLAT SLAB
STARTER FOOTING
SECTION C-C
ROADWAY
PRECAST SLAB PANELS
STARTER FOOTING
SECTION F-F AMBURSEN DAM
CABLE GUIDED SKIP HOIST
CONVEYOR SUPPORT
SLIP FORM
SIDE DISCHARGE CONVEYOR
SUPPORT BRACKET
℄ JACK RODS AND YOKES
140'-0"
135'-0" MAX. W/O ROCK ANCHORS
120'-0" WITH ROCK ANCHORS
SECTION B-B
SIDE DISCHARGE CONVEYOR
ELEPHANT TRUNKS
DECK
JACK
SLIP FORM
8'-0"
SCAFFOLD
SECTION D-D
PRECAST FORM
8'-0" BUTTRESSES 8'-0"
JACK ROD
SLIP FORM
RAIL BEAMS
BALLAST TANKS
PRECAST FORM SEAT
SLAB SEAT
SECTION E-E
J. F. CAMELLERIE, P.E.
DEPARTMENT OF THE ARMY
WATER RESOURCES DEVELOPMENT PROJECT
TRUMBULL LAKE
PEQUONNOCK RIVER BASIN CONNECTICUT
BUTTRESS DAM SECTIONS
209-AD-3A

Refined calculations will probably result in a more economical design.

CONSTRUCTION METHODS

In this study, conventional cantilever forming has been entirely eliminated thereby obtaining a one system forming, that being a slip form system. The head and stem sections of each buttress monolith are slip formed as a unit in a continuous 24 hour operation in groups of one to three monoliths joined or separated as site conditions and economy dictate. The head and stem areas under the driveway slide the full height of the dam and may be constructed of steel for reuse on all monoliths. The sloped section of the stem is constructed of wood as it must be continually cut as the slip proceeds. Concrete is handled by a cable guided skip bucket and a side discharge conveyor riding on and with the form as shown on Sections B-B and D-D. The slip form system for forming the sloped surfaces is identical with the system described for sliping the gravity dam.

The casting of the spillway slab presents some problems because of the weight of concrete, span and the fact that the form will end up on the underside of the slab where cranes cannot reach for stripping. For this reason precast leave-in-place forms were selected to supportthe concrete slab as shown on Section C-C and E-E. The concrete is placed by a slip form riding on the buttress walls and a conveyor resting on this form. The form is weighted by use of water ballast tanks to overcome the uplift due to concrete hydrostatic forces. The concrete is brought up by the skip buckets and brought down the face of the spillway by conveyors running diagonally along the face. Pumping of the concrete seems to have definite advantages in this operation.

This system for casting the spillway slabs results in two distinct operations in addition to the basic buttress slide and is therefore subject to reduction of economy. As an alternate, the face of the spillway may be entirely precast with no concrete facing. Watertight joints are required but the elimination of the spillway slab slide will result in overall economy.

If the spillway slab is eliminated altogether, and the water is allowed to fall free from flat slab at the top of the buttresses on to rock protection at base, another construction operation is eliminated and additional economy is gained.

Prestressing of the upstream face may be accomplished using four 1¼" diam. high strength rods per buttress. Average embedment into the rock is assumed at twenty feet. These rods are readily placed in the same manner as reinforcing steel and are partially or finally prestressed through boxes left in the concrete or at the top of the slide. Wrapping prevents bond to the concrete.

CONSTRUCTION SCHEDULE

The construction schedule for the massive head buttress dam is shown on Sheet AD-S-218. This compares favorably with conventional construction for the base gravity dam design reducing the construction time by at least 2 months, and matches the construction time for constructing the base gravity dam utilizing slip form techniques. An additional two months may be saved if the spillway slab is eliminated.

CONSTRUCTION COST

The cost for constructing the massive head buttress dam is $7,256,000 as shown on cost sheets AD-2S and AD-21 through AD-25. (See also Cost Study Sheets AD-S201 through AD-S220.) This cost is $283,000 higher than conventional construction of the base gravity dam.

If the spillway face is constructed using precast sections, the cost is reduced by $200,000 as shown on cost sheet AD-2A (Study sheet AD-S-221).

The use of prestressed rock anchors and reduction of dam width to suit will result in a savings of $64,000 as shown on Cost Sheets AD-2B1 and AD-2B2 (Study Sheets AD-S222 thru S225).

Assuming the precast and rock bolt alternates are used the total cost is reduced to approximately $6,992,000.

Elimination of the spillway slab entirely (free fall to rock protected base) will result in a significant saving in the area of $500,000.

J.F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATIDUD 15, 72 PRICED BY SHEET NO. MASSIVE HEAD BUTTRESS DAM PROJECT: TRUMBULL LAKE DAM ARCHITECT: NEW ENGLAND DIV. C/E

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
SUMMARY - MASSIVE HEAD BUTTRESS DAM						
SHEET AD-21				1,953,600		66,800
22				1,539,355		885,995
23				249,095		403,350
24				282,720		273,750
25				96,000		319,000
TOTAL				4,120,770		1,948,895
ESCALATION THRU 1974			2%	82,416	11%	215,000
				4,203,186		2,163,895
PAYROLL, TAXES & INS.					14%	303,000
						2,466,895
				→		4,203,186
TOTAL COST TO CONTRACTOR						6,670,081
OVERHEAD, PROFIT & CONT.					8%	532,000
						7,202,081
BID BOND					3/4%	54,000
TOTAL CONTRACT PRICE						7,256,081

SP 10196A

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JUL 15, '72 PRICED BY SHEET NO. AD-21

MASSIVE HEAD BUTTRESS DAM

PROJECT: TRUMBULL LAKE

ARCHITECT: NEW ENGLAND DIV., CORPS/ENGRS

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
SITE WORK						
CLEARING & GRUBBING	360,000	S.F.	.05	18,000	-	SUB
DISPOSAL	250,000	S.F.	.03	7,500	-	SUB
EXCAVATION (UNCLASS.)	36,000	CY	2.00	72,000	-	SUB
" (ROCK)	2,860	CY	10.00	28,600	-	SUB
" (TALUS)	14,000	CY	3.00	42,000	-	SUB
HAND CLEANING	27,500	S.F.	.75	20,600	-	SUB
CULVERT PIPE	-			-		-
CHAIN LINK FENCE	850	LF	3.50	3,000	2.00	1,700
FOUNDATION GROUTING	27,500	S.F.	.90	25,000	-	-
DIVERSION		L.S.		714,000	-	SUB
BACK FILL	12,000	CY	-	-	2.00	24,000
ROCK SLOPE PROT.	800	CY	3.00	2,400	10.00	8,000
ROAD GRAVEL	1,200	CY	4.50	5,400	2.50	3,000
BIT. CONC PAVING	1,200	CY	5.00	6,000	-	SUB
ALUM. HAND RAIL	1,000	LF	10.00	10,000	3.00	3,000
TIMBER TRESTLE	480	LF	73.00	35,000	37.00	17,800
BRIDGE	1	EA		1,000		5,000
IMPROVE R.R. BED	268,000	S.F.	1.50	402,000		SUB
VALLEY ACCESS ROAD	72,000	S.F.	1.00	72,000		SUB
MECHANICAL ITEMS						
HYDRAULIC PACKAGE	1	L.S.		303,700		-
EXTENSION 36" BLOW-OFF	1	L.S.		5,000		2,000
PLUMBLINE SHAFT	120	LF	3.00	400	2.50	300
ENVIRONMENTAL WORK						
TURBIDITY CONTROL				80,000		SUB
DUST CONTROL				1,000		-
NOISE ABATEMENT				40,000		-
LANDSCAPE RENEWAL				5,000		2,000
R.R. BED "	270,000	S.F.	.20	54,000	-	SUB
SP 10196A		-2	-	1,953,600		66,800

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

MASSIVE HEAD BUTTRESS DAM

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV., CORPS/ENGRS

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
BUTTRESS SLIDE						
SLIDING FORMS	7,000	LF	6.65	46,500	10.50	73,500
YOKES	425	EA		INCL.	75.00	31,875
JACK RODS (3T)	52,600	LF	1.65	86,000	.05	2,600
DECKS	18,600	S.F.	.25	4,650	1.00	18,600
SCAFFOLDS	14,000	S.F.	.50	7,000	1.50	21,000
RAILINGS & LADDERS	7,000	LF	1.50	10,500	1.50	10,500
HYDRAULIC PIPING	11,900	LF	-	INCL.	.80	9,520
TOPPING OUT RODS	360	EA	2.00	720	-	INCL.
FORM DESIGN				7,500		-
FIELD ENGR.	20	DAYS	200-	4,000		-
FIELD TECH.	40	DAYS	150-	6,000		SUB
CONCRETE	56,000	CY		INCL.	-	-
REINFORCING STL	500	TONS	230-	115,000	-	SLIDE CREW
SLIDE CREW				-		451,000
FINISH	425,000	S.F.	.05	21,250	-	SLIDE CREW
CURING	425,000	S.F.	.01	4,250	-	" "
STRIP FORMS				-		37,000
VERTICAL KEYS	4,800	L.F.	1.00	4,800	.50	2,400
WATER STOPS	4,800	L.F.	3.50	16,800	4.00	19,200
REBAR PLACING & LISTING	709	TONS	15-	10,635	-	-
END, BULKHEAD FORMS	240	LF	3.60	900	10.50	2,500
YOKES	60	EA	180-	10,800	135-	8,100
JACK RODS 6T	6,200	LF	2.50	15,500	.13	800
PRECAST INSERTS	1,550	EA	9.00	13,950	-	SLIDE CREW
GUIDE WHEEL BRKTS	18	EA	65-	1,200	-	" "
SPILLWAY SLAB SEAT	2,600	LF	6.00	15,600	9.00	23,400
PRECAST SEAT	2,600	LF		INCL. ↑		INCL. ↑
HOR PRECAST SEAT	576	LF	3.00	1,800	6.00	3,600
CEMENT	18,300	TONS	27.20	497,000	-	-
BORROW OPERATION	110,000	TONS	.65	72,000	.29	32,000
AGGREGATE PRODUCTION	104,000	TONS	1.23	128,000	.34	35,400
BATCH PLANT OPERATION	64,820	YDS.	6.75	437,000	1.75	103,000
SP 10196A		- 24 -		1,539,355		885,995

J.F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JUL 15, '72 PRICED BY SHEET NO. AD-23

MASSIVE HEAD BUTTRESS DAM

PROJECT: TRUMBULL LAKE

ARCHITECT: NEW ENGLAND DIV. CORPS/ENGR

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
FOUNDATIONS						
FORMWORK	22,400	S.F.	.20	4,500	.80	18,000
CONCRETE	6,000	CY	-	-	7.00	42,000
REINF. STL.	96	TONS	230	22,000	400	38,500
CURING	30,000	S.F.	.01	300	.02	600
KEYWAYS	3,000	LF	1.00	3,000	1.00	3,000
WATERSTOPS	2,000	LF	3.50	7,000	4.00	8,000
SPILLWAY						
SLIDING FORMS	288	LF	13-	3,800	20.50	6,000
FORM RAILS	1,260	LF	3-	3,800	3.00	3,800
JACK ROD ANCHORS	24	EA	25-	600	50.00	1,200
JACK ROD 22T	4,776	LF	2.50	12,000	.20	1,000
PLATFORM DECKS	288	LF	1.00	300	1.00	300
FORM DESIGN				5,000		-
SLIDE CREW				-		108,000
FIELD ENGR.	14	DAYS	200-	2,800		-
FIELD TECHNICIAN	30	DAYS	150-	4,500		-
HYDRAULIC PIPING	300	LF		INCL	1.00	300
CONCRETE	1,620	YDS	-	-	-	-
REINF. STEEL	122	TONS	230	28,000	135-	16,500
FINISHING	54,500	S.F.	.05	2,725		SLIDE CREW
CURING	54,500	S.F.	.01	550		SLIDE CREW
STRIP FORMS				-		6,000
PRECAST FORMS	54,500	S.F.	2.25	122,620	2.50	136,250
FILL AT TOP	570	CY	-	-	8.00	4,600
FINISHING TOP	10,800	S.F.	.05	500	.15	1,600
CURING TOP	10,800	S.F.	.01	100	.02	200
STARTER FOOTINGS	500	CY	50-	25,000	15.00	7,500
SP 10196A		-27-		249,095		403,350

J.F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE [illegible] PRICED BY [illegible] SHEET NO. [illegible] MASSIVE HEAD BUTTRESS DAM
	PROJECT: TRUMBULL LAKE
	ARCHITECT: NEW ENGLAND DIV. CORPS/ENGR.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
DRIVEWAY TOP OF DAM						
PRECAST DECK	7,800	S.F.	2.50	19,500	2.50	19,500
CONCRETE FILL	8,000	S.F.	.25	2,000	.50	4,000
CURBING	800	L.F.	2.50	2,000	2.50	2,000
ADD'L CONC AT FDN.	30	CY	30-	900	50-	1,500
PUMPING STATION	750	CY	30-	22,500	95-	71,250
RETAINING WALLS	350	CY	30-	10,500	45-	15,800
STAIR TOWER	60	CY	55-	3,300	125-	7,500
EQUIPMENT						
CRANE	1 x 8	MOS	4500	36,000	1500 1200	21,600
DOZER	1 x 12	"	1200	14,400	1330	16,000
UTILITY TRUCKS	2 x 12	"	800	19,200	940	22,600
PERSONNEL TOWERS	3 x 8	"	80	1,920	-	2,000
HEEDE HOIST	6 x 5	"	2000	60,000	1500	9,000
LOWER CONV. SYSTEM	20	WKS	3000	60,000	-	5,000
SPILLWAY CONV. SYS.	8	WKS	875	7,000		19,000
SLIP FORM CONV.	20	WKS	875	17,500		48,000
CONV. SUPPORT BRKT	30	EA	200	6,000	300	9,000
SP 10196A		-2[illegible]-		282,720		273,750

	J. F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JUL 15, '72 PRICED BY SHEET NO. AD-25 MASSIVE HEAD BUTTRESS DAM PROJECT: TRUMBULL LAKE ARCHITECT: NEW ENGLAND DIV., CORPS/ENGR.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
FIELD OVERHEAD						
FIELD OFFICES, SHOPS, STORAGE				15,000		2,000
HARDWARE & TOOLS				20,000		-
FUEL & OIL				10,000		-
START-UP & LAYOUT				-		5,000
MIX DESIGNS				1,000		-
CONCRETE TESTING				15,000		SUB
TEMPORARY LIGHTING				6,000		20,000
SANITARY FACILITIES				4,000		SUB
CLEAN-UP				-		10,000
HEATING				10,000		-
PROJECT MANAGER	1 x 117	WKS		-	500	58,500
SUPERINTENDENT	1 x 60	"		-	400	24,000
PROJECT ENGR.	1 x 52	"		-	400	20,800
CLERKS	2 x 52	"		-	200	20,800
SURVEYORS	4 x 52	"		-	250	52,000
UTILITY MECH.	6 x 36	"		-	300	64,800
WATCHMEN	3 x 87	"		-	100	26,100
WINTER PROTECTION	NONE			-		-
COMMUNICATIONS				5,000		5,000
POWER DISTRIB.				10,000		10,000
SP 10196A		-2? -		96,000		319,000

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JUL 15, '74 PRICED BY SHEET NO. AD-2?

MASSIVE HEAD BUTTRESS DAM

PROJECT: TRUMBULL LAKE

ARCHITECT: NEW ENGLAND DIV.-CORPS/ENGR.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
PRECAST SPILLWAY ALTERNATE						
SPILLWAY FROM SH. AD-23				212,295		293,250
PRECAST SPILLWAY						
PRECAST SLABS	33,200	S.F.	8.00	265,600	-	-
PLACING CREW	33,200	S.F.	-	-	.50	16,600
PLACING CRANE	1	MO		INCL. IN EQUIPMENT		INCL. IN EQUIPMENT
JOINT TREATMENT	13,500	LF	5.00	67,500		INCL. IN PLACING CREW
FILL AT TOP	570	CY	-	-	8.00	4,600
FINISHING TOP	11,000	S.F.	.05	550	.15	1,650
CURING TOP	11,000	S.F.		110		220
STARTER FOOTINGS	500	CY	50-	25,000	15-	7,500
				358,760		30,570
DIFFERENCE			(-)	146,465		262,680
ESCALATION THRU 1974			2%	2,930	11%	28,895
			(-)	149,395		291,575
PAYROLL, TAXES & INS.					14%	40,820
						332,395
				→		149,395
						183,000
OVERHEAD, PROFIT & CONT.					8%	14,640
						197,640
BID BOND					3/4%	1,483
CREDIT IF SPILLWAY ALT. IS USED						199,123

SP 10196A

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JUL 15, '72 PRICED BY MASSIVE HEAD BUTTRESS DAM SHEET NO. AD-2B1

PROJECT: TRUMBULL LAKE

ARCHITECT: NEW ENGLAND DIV. C/E

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
PRESTRESSING ALTERNATE						
FOUNDATIONS (REDUCTION)						
FORMWORK	2,700	S.F.	.20	540	.80	2,160
CONCRETE	600	CY	-		7.00	4,200
REINF. STEEL	-					
CURING	4,050	S.F.	.01	40	.02	81
KEYWAYS	-					
WATERSTOPS	-					
BUTTRESS SLIDE (REDUCTION)						
SLIDING FORMS	900	LF	6.65	5,985	10.50	9,450
YOKES	60	EA	-	INCL.	75.-	4,500
JACK RODS (3T)	3,450	LF	1.65	5,693	.05	173
DECKS	2,250	SF	.25	563	1.00	2,250
SCAFFOLDS	1,800	SF	.50	900	1.50	2,700
RAILINGS & LADDERS	900	LF	1.50	1,350	1.50	1,350
HYDRAULIC PIPING	2,100	LF	-	INCL.	.80	1,680
CONCRETE	5,400	CY	-	INCL.	-	-
FINISH	3,600	SF	.05	180	-	SLIDE CREW
CURING	3,600	SF	.01	36	-	SLIDE CREW
CEMENT	1,700	TONS	27.20	46,240	-	-
BORROW OPERATION	6,300	TONS	-	3,600	.29	1,827
AGGREGATE PROD.	9,600	TONS	-	-	.34	3,264
BATCH PLANT OPERATION	6,000	CY	-	-	1.75	10,500
SITE WORK (REDUCTION)						
EXCAVATION (ROCK)	150	CY	10.00	1,500	-	SUB
HAND CLEANING	4,050	SF	.75	3,038	-	SUB
FDN. GROUTING	4,050	SF	.90	3,645	-	SUB
SP 10196A		- 31 -		73,310		44,135

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JUL 15, '72 PRICED BY SHEET NO. AD-2B2

MASSIVE HEAD BUTTRESS DAM

PROJECT: TRUMBULL LAKE

ARCHITECT: NEW ENGLAND DIV. C/E

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
PRESTRESSING ALT. (CONT.)						
SITE WORK (ADDITIONAL)						
ROCK DRILLING	2,400	LF	-	-	2.00	4,800
1¼" Ø H.S. RODS	15,360	LF	-	45,000	1.00	15,360
				45,000		20,160
TOTAL REDUCTIONS				73,310		44,135
TOTAL ADDITIONS				45,000		20,160
				28,310		23,975
ESCALATION THRU 1974			2%	567	11%	2,638
				28,877		26,613
PAYROLL, TAXES & INS.					14%	3,726
						30,339
						28,877
TOTAL COST TO CONTRACTOR						59,216
OVERHEAD, PROFIT & CONT.					8%	4,738
						63,954
BID BOND						480
TOTAL CONTRACT PRICE						64,434

SP 10196A

COST ANALYSIS

The cost figures for this and the other two design alternates are based on site work, excavation, diversion, access and mechanical items remaining unchanged. Rock excavation, hand cleaning and foundation grouting were varied however to suit the different conditions. The driveway at the top of the dam was not changed in length or profile but the configuration of the dam immediately below was altered slightly. The cost of the pumping station, retaining walls and stair tower was arrived at using the original quantity estimates prepared by the Corps of Engineers for these items and applying a reasonable cost figure for concrete of this type in place less the cost of concrete which is included elsewhere. On first consideration the slip formed massive head dam seems not to offer any economy in construction cost and the construction time differential is not impressive. Construction of the spillway surfaces is more expensive than for the gravity design even when precast concrete is used for this purpose. Actually the spillway for this type of dam must be handled in another manner.

The savings in cost that accrues from the use of prestressed rock anchors is modest but so is the amount of prestressing used. It can be reasonably deduced from this study that the use of such anchor bolts holds promise for better economy and that their use should be considered in future designs.

The use of pumping in lieu of conveyor equipment was studied on cost study sheets AD-S226 and S227. Pumping saves over $120,000 in this particular situation, most of the savings ($70,000) resulting from the elimination of the material hoists required for raising the concrete vertically to the conveyors. The pumps do have the advantage of vertical rise capabilities.

As a matter of interest some cost figures were run for a dam twice as high and twice as wide with the savings not as great as for the smaller dam. If the hoists are deducted, the savings drop to less than $10,000 (less than the cost of the special slip form cantilevered brackets required because of the sloped buttresses).

In general it may be said that pumping has an edge in equipment and installation cost while conveyors have an edge in labor cost involved in using the equipment.

If vertical lifting equipment is not required for raising concrete to the conveyors, the two methods are quite competitive with the pumping possibly more economical on smaller dams and the conveyors more economical on larger dams.

The possibility is obvious that a cost comparison based on a dam the size of the one at Trumbull Lake may not give sufficient construction volume to truly arrive at cost differentials between various designs. This is especially true when one considers that most of the cost and construction time is expended on site work, diversion, mechanical, etc., which are not in this instance related to the design of the structure itself. In order to explore this possibility, a study was made of a dam twice the height and twice the width of the one at Trumbull. Many simplifying assumptions had to be made; proportions of the dam would remain the same, volume of concrete would be quadrupled, diversion clearing and site work would remain substantially the same. The results of this cost study for both the conventional gravity dam and the slip formed massive head dam are shown on Cost Sheets AD-EC-S and AD-2CS, respectively. Backup cost sheets are included here; calculation sheets (see Sheets AD-EC-S1 thru S-3 and AD-2C-S1 thru S7) and cost study sheets and construction schedules are in the appendix.

J. F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JUL 15, '72 PRICED BY CONVENTIONAL DAM (INCR. SIZE) SHEET NO AD-EC-S PROJECT: TRUMBULL LAKE DAM ARCHITECT: NEW ENGLAND DIV. C/E

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
SUMMARY CONVENTIONAL DAM (INCR. SIZE)						
SHEET AD-EC1				5,852,106		3,148,506
AD-EC2				520,040		174,710
AD-EC3				1,234,400		934,300
				6,606,546		4,257,516
ESCALATION THRU 1974			12%	792,785	14%	596,022
				7,399,331		4,853,538
PAYROLL TAXES & INS.					14%	679,462
						5,533,000
				→		7,399,000
TOTAL COST TO CONTRACTOR						12,932,000
OVERHEAD, PROFIT & CONT.					8%	1,035,000
						13,967,000
BID BOND					3/4%	105,000
TOTAL CONTRACT PRICE						14,072,000

SP 10196A

J.F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

CONVENTIONAL DAM (INCR. SIZE)

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. C/E

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
CLEARING & GRUBBING	430,000	SF	.05	21,500	-	SUB
DISPOSAL	320,000	SF	.03	9,600	-	SUB
EXCAV., UNCLASS.	72,000	CY	2.00	144,000	-	SUB
EXCAV., ROCK	20,000	CY	10-	200,000	-	SUB
EXCAV., TALUS	28,000	CY	3.00	84,000	-	SUB
HAND CLEANING	140,000	SF	.75	105,000	-	SUB
CHAIN LINK FENCE	850	L.F.	3.50	3,000	2.00	1,700
FOUNDATION GROUTING	100,000	SF	.90	90,000	-	-
DIVERSION STAGE I	-	-	L.S.	547,000	-	SUB
DIVERSION STAGE II	-	-	L.S.	167,000	-	SUB
CEMENT	43,100	TON	27.20	1,175,000	-	-
FLY ASH	24,500	TON	9.00	220,500	-	-
BORROW OPERATION	933,000	TON	.20	178,000	.29	271,000
AGGREGATE PRODUCTION	924,000	TON	.46	426,000	.34	314,000
BATCH PLANT OPER.	508,000	C.Y.	2.04	1,036,720	1.75	888,000
CABLEWAY OPER.	508,000	C.Y.	1.28	646,000	.61	310,000
CONCRETE PLACING	508,000	C.Y.	.03	15,200	.52	264,000
VIBRATION	508,000	C.Y.	.35	178,000	.41	208,000
HOR. JOINT TREATMENT	851,300	SF	.05	42,600	.15	128,000
FINISHING	292,000	SF	.05	14,600	.28	81,500
CURING	861,600	SF	.01	8,616	.01	8,616
FORMS: FDN	18,300	CA	.80	14,640	3.00	55,000
LIFT STARTERS	12,830	CA	.43	5,520	1.17	15,000
CANTILEVER	227,400	CA	.43	98,000	1.17	266,000
BULKHEAD	206,400	CA	.43	88,500	1.17	241,000
LONG'L BLKH'D	11,520	CA	.30	3,460	1.25	14,400
SPRAY WALL	1,600	CA	.30	500	1.50	2,400
SLAB (P.H.)	2,470	CA	.75	1,850	1.00	2,470
SLAB (TOP)	2,350	CA	.25	590	.75	1,760
WALLS (P.H.)	7,080	CA	.75	5,310	2.00	14,160
DAM (TOP)	12,400	CA	.25	3,100	1.50	18,600
RET. WALLS	7,450	CA	.25	1,860	1.00	7,450
CURBS	3,300	CA	.50	1,650	1.50	4,950
GALLERY	16,500	CA	.65	10,720	1.75	28,875
STAIRS	1,300	CA	.30	390	1.25	1,625
HYDRAULIC PACKAGE	1	L.S.	-	303,680	-	-
SP 10196A		-334-		5,852,103		3,148,506

	J.F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JUL 15, '72 PRICED BY SHEET NO. AD-EC2 CONVENTIONAL DAM (INCR. SIZE) PROJECT: TRUMBULL LAKE DAM ARCHITECT: NEW ENGLAND DIV. C/E

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
EXTENSION 36" BLOW-OFF	1	L.S.	-	5,000	-	2,000
SHORING	35,800	LF	.06	2,150	.06	2,150
3½" Ø STEEL PIPE	1,160	LF	3.50	4,060	5.50	6,380
2½" Ø " "	2,150	LF	1.75	3,760	3.50	7,530
3" Ø DRAINAGE HOLES	2,880	LF	7.20	20,750	-	SUB
1½" Ø GROUT HOLES	9,240	LF	8.00	73,920	-	SUB
6" Ø DRAINS	2,770	LF	1.50	4,150	-	SUB
8" Ø WELLS	2,140	LF	2.00	4,280	-	SUB
PLUMBLINE SHAFT	240	LF	3.00	720	2.50	600
REINF. STELL	100,000	LBS	.15	15,000	.08	8,000
BACKFILL	12,000	CY	-	-	2.00	24,000
ROCK SLOPE PROT.	800	CY	3.00	2,400	10-	8,000
ROAD GRAVEL	1,200	CY	4.50	5,400	2.50	3,000
BIT. CONC. PAVING	1,200	SY	5.00	6,000	-	SUB
ALUM. HANDRAIL	1,000	LF	10.00	10,000	3.00	3,000
COPPER WATERSTOP	8,000	LF	3.50	28,000	4.00	32,000
FORMWORK, STAIR TOWER	2,300	CA	1.50	3,450	3.50	8,050
WEEKEND OVERTIME				-		60,000
ENVIRONMENTAL WORK						
TURBIDITY CONTROL			-	100,000	-	SUB
DUST CONTROL ON ROADS			-	2,000	-	-
NOISE CONTROL EQUIP.			-	150,000	-	-
LANDSCAPE RENEWAL			-	25,000		10,000
R.R. BED RENEWAL	270,000	SF	.20	54,000	-	SUB
SP 10196A				520,040		174,710

J.F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

CONVENTIONAL DAM (INCR. SIZE)

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. C/E

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
EQUIPMENT						
YARD CRANE	1 x 24	MOS	4500	108,000	2700	64,800
HYDRAULIC BOOM CRANE	2 x 20	"	1500	60,000	1400	56,000
COMPRESSORS	2 x 20	"	1100	44,000	1300	52,000
UTILITY TRUCKS	2 x 27	"	800	43,200	940	51,000
PERSONNEL STAIR TOWER	3 x 24	"	80	5,800	-	-
DOZER	1 x 27	"	1200	32,400	1330	36,000
FIELD OVERHEAD						
ACCESS ROAD TOP	7,350	SF	1.50	11,000	-	SUB
BRIDGE	1	EA	-	1,000	-	5,000
IMPROVE R.R. BED	268,000	SF	1.50	402,000	-	SUB
ACCESS ROAD VALLEY	72,000	SF	1.00	72,000	-	SUB
FIELD OFF., SHOPS & STOR.	-	-	-	90,000	-	4,000
HARDWARE & TOOLS	-	-	-	135,000	-	-
FUEL & OIL	-	-	-	48,000	-	-
STARTUP & LAYOUT				-	-	5,000
MIX DESIGNS				1,000	-	SUB
CONC. TESTING				75,000	-	SUB
TEMPORARY LIGHTING				3,000	-	6,000
SANITARY FACILITIES				24,000	-	SUB
CLEAN-UP				-	-	30,000
HEATING				48,000	-	-
PROJECT MANAGER	1 x 175	WKS		-	500	87,500
SUPERINTENDENT	1 x 140	"		-	400	56,000
PROJECT ENGR.	1 x 140	"		-	400	56,000
CLERKS	2 x 140	"		-	200	56,000
SURVEYORS	4 x 120	"		-	250	120,000
UTILITY MECHANICS	6 x 90	"		-	300	162,000
WATCHMEN	3 x 170	"		-	100	51,000
WINTER PROTECTION				6,000		15,000
COMMUNICATIONS				10,000		6,000
POWER DISTRIBUTION				15,000		15,000
SP 10196A		-38-		1,234,400		934,300

J.F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JUL 15, '72 PRICED BY MASSIVE HEAD BUTTRESS DAM SHEET NO. AD-2CS

PROJECT: TRUMBULL LAKE

ARCHITECT: NEW ENGLAND DIV. C/E

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
SUMMARY - MASSIVE HEAD BUTTRESS DAM						
(DOUBLE HEIGHT & WIDTH, SAME LENGTH AS TRUMBULL)						
SHEET AD-2C-1				2,184,900		66,800
2				4,004,020		2,286,200
3				480,250		782,600
4				353,900		290,850
5				170,000		366,800
TOTAL				7,193,070		3,793,250
ESCALATION THRU 1974			4%	287,723	11½%	436,224
				7,480,793		4,229,474
PAYROLL, TAXES & INS.					14%	592,126
						4,821,600
					→	7,480,793
TOTAL COST TO CONTR.						12,302,393
O'HD, PROFIT & CONT.					8%	984,191
						13,286,584
BID BOND					3/4%	99,650
TOTAL CONTRACT PRICE						13,386,234

SP 10196A

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JUL 15, '72 PRICED BY SHEET NO. AD-2C-1
MASSIVE HEAD BUTTRESS DAM

PROJECT: TRUMBULL LAKE

ARCHITECT: NEW ENGLAND DIV. C/E

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
SITE WORK						
CLEARING & GRUBBING	387,500	S.F.	.05	19,300	-	SUB
DISPOSAL	277,500	S.F.	.03	8,300	-	SUB
EXCAVATION (UNCLASS)	72,000	CY	2.00	144,000	-	SUB
" (ROCK)	5,720	CY	10-	57,200	-	SUB
(TALUS)	28,000	CY	3.00	84,000	-	SUB
HAND CLEANING	55,000	S.F.	.75	41,200	-	SUB
CHAIN LINK FENCE	850	LF	3.50	3,000	2.00	1,700
FOUNDATION GROUTING	55,000	S.F.	.90	50,000	-	-
DIVERSION		LS		714,000	-	SUB
BACKFILL	12,000	CY	-	-	2.00	24,000
ROCK SLOPE PROT.	800	CY	3.00	2,400	10-	8,000
ROAD GRAVEL	1,200	CY	4.50	5,400	2.50	3,000
BIT. CONC. PAVING	1,200	CY	5.00	6,000	-	SUB
ALUM. HAND RAIL	1,000	LF	10-	10,000	3.00	3,000
TIMBER TRESTLE	480	LF	73-	35,000	37-	17,800
BRIDGE	1	EA.		1,000		5,000
IMPROVE R.R. BED	268,000	S.F.	1.50	402,000	-	SUB
VALLEY ACCESS RD.	72,000	S.F.	1.00	72,000	-	SUB
MECHANICAL ITEMS						
HYDRAULIC PACKAGE	1	L.S.		303,700		-
EXTENSION 36" BLOW-OFF	1	L.S.		5,000		2,000
PLUMBLINE SHAFT	120	L.F.	3.00	400	2.50	300
ENVIRONMENTAL WORK						
TURBIDITY CONTROL				80,000	-	SUB
DUST CONTROL				2,000		-
NOISE ABATEMENT				80,000		-
LANDSCAPE RENEWAL				5,000		2,000
R.R. BED "	270,000	S.F.	.20	54,000	-	SUB
SP 10196A		-40-		2,184,900		66,800

	J.F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JUL 15, '72 PRICED BY	SHEET NO. AD-2C-2
		MASSIVE HEAD BUTTRESS DAM	
		PROJECT: TRUMBULL LAKE	
		ARCHITECT: NEW ENGLAND DIV., C/E	

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
BUTTRESS SLIDE						
SLIDING FORMS	12,650	L.F.	6.65	84,200	10.50	133,000
YOKES	750	EA.	-	INCL.	75.00	56,200
JACK RODS (3T)	276,410	L.F.	1.65	456,000	.05	13,800
DECKS	33,000	S.F.	.25	8,250	1.00	33,000
SCAFFOLDS	28,000	S.F.	.50	14,000	1.50	42,000
RAILINGS & LADDERS	14,000	L.F.	1.50	21,000	1.50	21,000
HYDRAULIC PIPING	20,750	L.F.	-	INCL.	.80	16,600
TOPPING OUT RODS	360	EA.	2.00	720	-	INCL.
FORM DESIGN				10,000		-
FIELD ENG'R	20	DAYS	200-	4,000	-	-
FIELD TECH.	40	DAYS	150-	6,000		SUB
CONCRETE	224,000	CY	-	INCL.	-	-
REINF. STEEL	1,000	TONS	230-	230,000	-	SLIDE CREW
SLIDE CREW				-		1,100,000
FINISH	1,485,000	S.F.	.05	74,200	-	SLIDE CREW
CURING	1,485,000	S.F.	.01	14,850	-	" "
STRIP FORMS				-		37,000
VERTICAL KEYS	9,600	L.F.	1.00	9,600	.50	4,800
WATERSTOPS	9,600	L.F.	3.50	33,600	4.00	38,400
REBAR PLACING & LISTING	1,400	TONS	15-	21,000	-	-
END BULKHEAD FORMS	240	L.F.	3.60	900	10.50	2,500
YOKES	60	EA.	180-	10,800	135-	8,100
JACK RODS (6T)	13,000	L.F.	2.50	32,600	.13	1,700
PRECAST INSERTS	3,260	EA.	9.00	29,300	-	SLIDE CREW
GUIDE WHEEL BRACKETS	18	EA.	65-	1,200	-	" "
SPILLWAY SLAB SEAT	5,500	L.F.	6-	33,000	9.00	49,500
PRECAST SEAT	5,500	L.F.		INCL.↑		INCL.↑
HORIZ. PRECAST SEAT	576	L.F.	3-	1,800	6.00	3,600
CEMENT	73,000	TONS	27.20	1,990,000	-	-
BORROW OPERATION	440,000	TONS	.23	102,000	.29	128,000
AGGREGATE PROD.	416,000	TONS	.63	263,000	.34	142,000
BATCH PLANT OPER.	260,000	YDS.	2.12	552,000	1.75	455,000
SP 10196A		-41-		4,004,020		2,286,200

	DATE JUL 15, '72 PRICED BY SHEET NO. AD-2C-3
J. F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	MASSIVE HEAD BUTTRESS DAM
	PROJECT: TRUMBULL LAKE
	ARCHITECT: NEW ENGLAND DIV. C/E

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
FOUNDATIONS						
FORMWORK	43,400	S.F.	.20	8,700	.80	34,700
CONCRETE	11,500	CY	-	-	7.00	81,000
REINF. STEEL	192	TONS	230-	44,200	400-	77,000
CURING	60,000	S.F.	.01	600	.02	1,200
KEYWAYS	6,000	L.F.	1.00	6,000	1.00	6,000
WATERSTOPS	4,000	L.F.	3.50	14,000	4.00	16,000
SPILLWAY						
SLIDING FORMS	288	L.F.	13-	3,800	20.50	6,000
FORM RAILS	2,520	L.F.	3-	7,600	3.00	7,600
JACK ROD ANCHORS	24	EA.	25-	600	50.00	1,200
JACK RODS (22T)	9,550	L.F.	2.50	24,000	.20	2,000
PLATFORM DECKS	288	L.F.	1.00	300	1.00	300
FORM DESIGN				5,000		-
SLIDE CREW				-		216,400
FIELD ENG'R	14	DAYS	200-	2,800		-
FIELD TECH	30	DAYS	150-	4,500		-
HYDRAULIC PIPING	300	L.F.		INCL.	1.00	300
CONCRETE	3,240	CY		-		-
REINF. STEEL	244	TONS	230-	56,000	135-	33,000
FINISHING	109,000	S.F.	.05	5,450		SLIDE CREW
CURING	109,000	S.F.	.01	1,100		SLIDE CREW
STRIP FORMS				-		6,000
PRECAST FORMS	109,000	S.F.	2.25	245,000	2.50	272,500
FILL @ TOP	570	CY	-	-	8.00	4,600
FINISHING TOP	10,800	S.F.	.05	500	.15	1,600
CURING TOP	10,800	S.F.	.01	100	.02	200
STARTER FOOTINGS	1,000	CY	50-	50,000	15-	15,000
SP 10196A		-42	-	480,250		782,600

	J.F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JUL 15, '72 PRICED BY SHEET NO. AD-2C-8 MASSIVE HEAD BUTTRESS DAM
		PROJECT: TRUMBULL LAKE
		ARCHITECT: NEW ENGLAND DIV. C/E

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
DRIVEWAY TOP OF DAM						
PRECAST DECK	7,800	S.F.	2.50	19,500	2.50	19,500
CONCRETE FILL	8,000	S.F.	.25	2,000	.50	4,000
CURBING	800	L.F.	2.50	2,000	2.50	2,000
ADD'L CONC. @ FDN.	30	CY	30-	900	50-	1,500
PUMPING STATION	750	CY	30-	22,500	95-	71,250
RETAINING WALLS	350	CY	30-	10,500	45-	15,800
STAIR TOWER	60	CY	55-	3,300	125-	7,500
EQUIPMENT						
CRANE	1 x 12	MOS.	4500	54,000	1500 1200	32,400
DOZER	1 x 14	MOS.	1200	16,800	1330	18,600
UTILITY TRUCKS	2 x 14	MOS.	800	22,400	940	26,300
PERSONNEL TOWER	3 x 16	"	80	3,800	-	2,000
HEEDE HOIST	6 x 5	"	2000	60,000	1500	9,000
LOWER CONV. SYS.	30	WKS.	3000	90,000	-	5,000
SPILLWAY CONV. SYS.	16	WKS.	875	14,000	-	19,000
SLIPFORM CONV.	30	WKS.	875	26,200	-	48,000
CONV. SUPP. BKT.	30	EA.	200	6,000	300	9,000
SP 10196A		-45	-	353,900		290,850

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE [illegible] 15, 72 PRICED BY SHEET NO: [illegible]

MASSIVE HEAD BUTTRESS DAM

PROJECT: TRUMBULL LAKE

ARCHITECT: NEW ENGLAND DIV. C/E

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
FIELD OVERHEAD						
FIELD OFFICE, SHOPS, STORAGE				30,000		2,000
HARDWARE & TOOLS				40,000		–
FUEL & OIL				20,000		–
START UP & LAYOUT				–		5,000
MIX DESIGN				1,000		–
CONCRETE TESTING				30,000		SUB
TEMPORARY LIGHTING				6,000		20,000
SANITARY FACILITIES				8,000		SUB
CLEAN-UP				–		15,000
HEATING				10,000		–
PROJECT MANAGER	1 x 117	WKS.		–	500	58,500
SUPERINTENDENT	1 x 70	"		–	400	28,000
PROJECT ENGINEER	1 x 60	"		–	400	24,000
CLERKS	2 x 60	"		–	200	24,000
SURVEYORS	4 x 60	"		–	250	60,000
UTILITY MECH.	6 x 44	"		–	300	79,200
WATCHMEN	3 x 87	"		–	100	26,100
COMMUNICATIONS				10,000		10,000
POWER DISTR.				15,000		15,000
SP 10196A		—[illegible]—		170,000		366,800

Use of the massive head design for a larger dam results in a cost saving of 3/4 million dollars and nearly two years of construction time (see Construction Schedules Sheets AD-EC-S2 and AD-2C-S7). The savings accrue almost entirely from reduction in cost escalation. Savings in finance cost, field inspection and accounting will be in addition to the 3/4 million dollars.

COST AND FEASIBILITY STUDY

AMBURSEN DAM

GENERAL DESCRIPTION

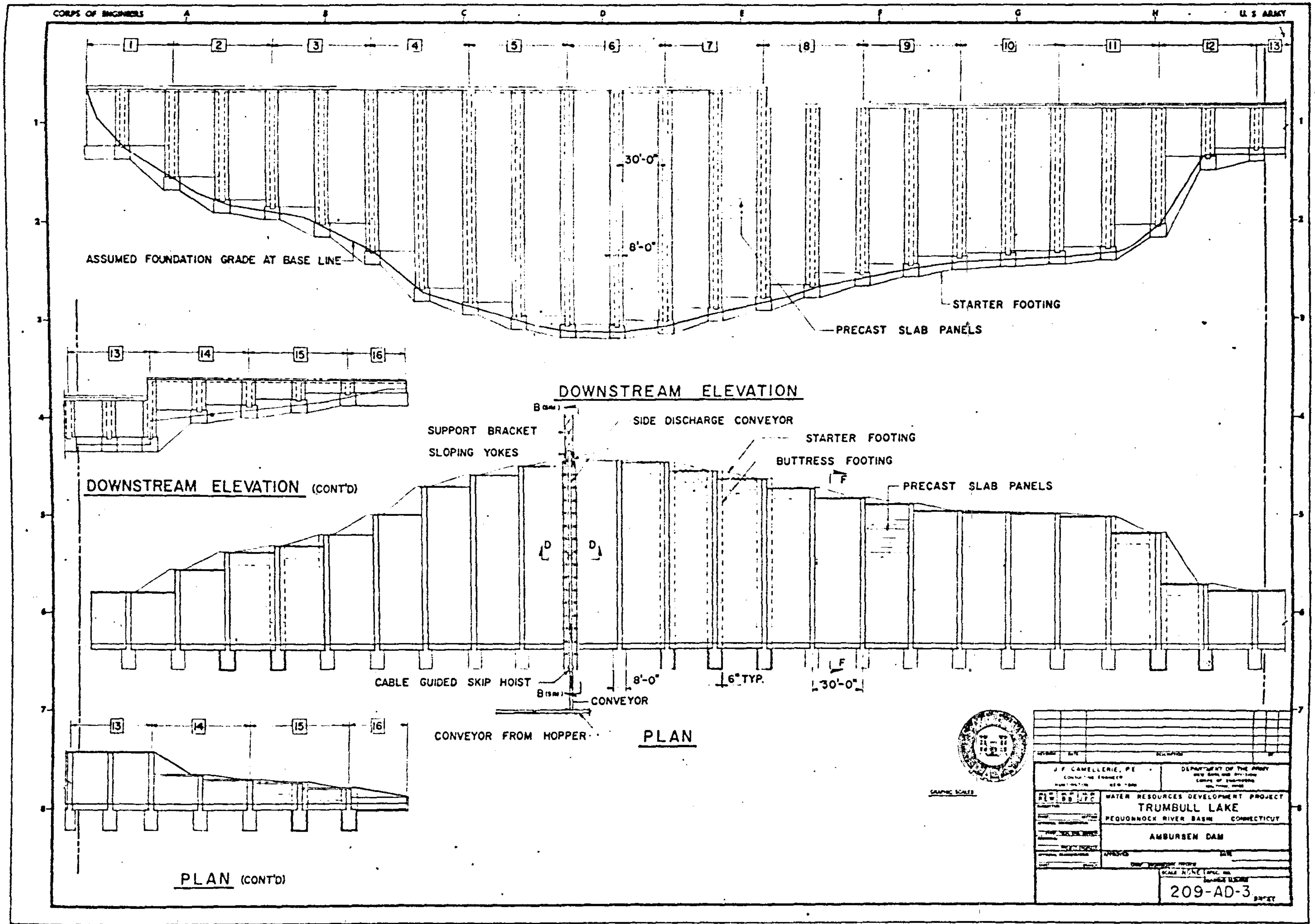
This type of dam takes advantage of the water pressure for stability. Such a dam was very successfully slip formed at West Chazy, N.Y. in 1967. This was a very small dam with 34 foot wide bays sloped at 43 degrees and a height of approximately 35 feet. The dam for Trumbull Lake is shown on drawings 209-AD-3 and Section F-F of drawing 209-AD-3A having 30 foot bays but much higher. Prestressed precast face sections 4'-0" deep by 3'-0" wide by 22'-0" long are shown on Section F-F. A concrete deck similar to section C-C may also be used.

DESIGN

Calculations for this dam using a 20 foot span are given on computation sheets AR-301 through AR-312. Although it was decided to increase the span to 30 feet between buttresses, it is felt that this change will not invalidate the stability calculations beyond the accuracy of the study. The precast sections were designed by C.W. Blakeslee and Sons who also submitted a preliminary quotation for furnishing the sections on a turnkey basis. The sections for the face are designed for a maximum of 8000 pounds per square foot at the base to 650 pounds per square foot at the top. The most heavily loaded sections are 48 inches deep with twelve ½" diameter strands per foot of width bottom steel, No. 11 @ 9" top bars and No. 4 @ 12 inch stirrups. Strands and rebars are decreased to suit pressure change. Lightening holes and depth changes are used to decrease concrete.

CONSTRUCTION METHODS

The buttresses may be constructed by either the slip form method as shown on sections B-B and D-D or by conventional forming. The face of the dam may be slip formed against fixed forms or precast leave-in-place forms as shown on Section C-C and E-E or constructed of precast sections as shown on Section F-F. The precast sections may be cast on the site or trucked in from a commercial precasting yard. A trestle provided upstream will furnish access and working areas for the trucks and cranes. The slip form systems are similar to those described for the massive head dams.



CORPS OF ENGINEERS
U S ARMY
30'-0"
8'-0"
ASSUMED FOUNDATION GRADE AT BASE LINE
STARTER FOOTING
PRECAST SLAB PANELS
DOWNSTREAM ELEVATION
DOWNSTREAM ELEVATION (CONT'D)
SUPPORT BRACKET
SLOPING YOKES
SIDE DISCHARGE CONVEYOR
STARTER FOOTING
BUTTRESS FOOTING
PRECAST SLAB PANELS
CABLE GUIDED SKIP HOIST
8'-0"
6" TYP.
30'-0"
CONVEYOR
CONVEYOR FROM HOPPER
PLAN
PLAN (CONT'D)
J. F. CAMELLERIE, P.E.
DEPARTMENT OF THE ARMY
WATER RESOURCES DEVELOPMENT PROJECT
TRUMBULL LAKE
PEQUONNOCK RIVER BASIN CONNECTICUT
AMBURSEN DAM
209-AD-3

CONSTRUCTION SCHEDULE

Construction time for this dam will approximate the schedule required for the massive head dam.

CONSTRUCTION COST

The cost for constructing the dam using this design alternate is approximately $7,480,000 as shown on Cost Sheets AD-3S and AD-31 through AD-35. Cost Study Sheets AD-S301 through S311 are to be found in the appendix.

J.F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JUL 15, '72 PRICED BY AMBURSEN DAM

SHEET NO. AD-3S

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. C/E

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
SUMMARY - AMBURSEN DAM						
SHEET AD-31				1,973,900		66,800
AD-32				1,167,945		537,700
AD-33				1,602,181		271,296
AD-34				96,000		331,600
AD-35				205,000		159,160
				5,045,026		1,366,556
ESCALATION THRU 1974			2%	100,901	11%	150,321
				5,145,927		1,516,877
PAYROLL, TAXES & INS.					14%	212,363
						1,728,240
						5,145,927
TOTAL COST TO CONTRACTOR						6,874,167
OVERHEAD, PROFIT & CONT.					8%	549,933
						7,424,100
BID BOND					3/4%	55,681
TOTAL CONTRACT PRICE						7,479,781

SP 1019LA

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE OCT 15, 79 PRICED BY AMBURSEN DAM

SHEET NO. AD-31

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. C/E

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
SITE WORK						
CLEARING & GRUBBING	360,000	S.F.	.05	18,000	-	SUB
DISPOSAL	250,000	S.F.	.03	7,500	-	SUB
EXCAVATION (UNCLASS.)	360,000	C.Y.	2.00	72,000	-	SUB
" (ROCK)	3,000	C.Y.	10-	30,000	-	SUB
" (TALUS)	14,000	C.Y.	3-	42,000	-	SUB
HAND CLEANING	29,100	S.F.	.75	22,000	-	SUB
CHAIN LINK FENCE	850	L.F.	3.50	3,000	2-	1,700
FOUNDATION GROUTING	37,100	S.F.	.90	33,500	-	-
DIVERSION		L.S.		714,000	-	SUB
BACKFILL	12,000	CY	-	-	2-	24,000
ROCK SLOPE PROTECT.	800	CY	3.00	2,400	10-	8,000
ROAD GRAVEL	1,200	CY	4.50	5,400	2.50	3,000
BIT. CONC. PAVING	1,200	CY	5-	6,000	-	SUB
ALUMINUM HANDRAIL	1,000	L.F.	10-	10,000	3.00	3,000
TIMBER TRESTLE	480	L.F.	73-	35,000	37-	17,800
BRIDGE	1	EA.	-	1,000	-	5,000
IMPROVE R.R. BED	268,000	S.F.	1.50	402,000	-	SUB
VALLEY ACCESS ROAD	72,000	S.F.	1.00	72,000	-	SUB
MECHANICAL ITEMS						
HYDRAULIC PACKAGE	1	L.S.		303,700		-
EXTENSION 36" BLOW-OFF	1	L.S.		5,000		2,000
PLUMBLINE SHAFT	120	L.F.		400		300
ENVIRONMENTAL WORK						
TURBIDITY CONTROL				80,000	-	SUB
DUST CONTROL				1,000		-
NOISE ABATEMENT				40,000		-
LANDSCAPE RENEWAL				5,000		2,000
R.R. BED RENEWAL	270,000	S.F.	.20	54,000	-	SUB
SP 10196A		-37-		1,973,900		66,800

	J. F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743

DATE JUL 15, '72 PRICED BY AMBURSEN DAM — SHEET NO. AD-32

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. C/E

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
BUTTRESS SLIDE						
SLIDING FORMS	7,100	L.F.	6.65	47,300	10.50	74,600
YOKES	323	EA.	-	INCL.	75.00	24,200
JACK RODS (3T)	50,000	L.F.	1.65	82,500	[illegible]	2,500
DECKS	25,500	SF	.25	6,375	1.00	25,500
SCAFFOLDS	11,100	SF	.50	5,600	1.50	16,800
RAILINGS & LADDERS	6,600	L.F.	1.50	9,900	1.50	9,900
HYDRAULIC PIPING	11,600	L.F.	-	INCL.	.80	9,300
TOPPING OUT RODS	360	EA.	2.00	720	-	INCL.
FORM DESIGN	-	-	-	7,500	-	-
FIELD ENGINEER	20	DAYS	200-	4,000	-	-
FIELD TECH.	40	DAYS	150-	6,000	-	SUB
CONCRETE	40,370	CY	22.50	910,000	-	-
REINF STL	-	-	-	-	-	-
SLIDE CREW	-	-	-	-	-	296,000
FINISH	355,000	SF	.05	17,750	-	SLIDE CREW
CURING	355,000	SF	.01	3,550	-	SLIDE CREW
STRIP FORMS	-			-		37,000
REBAR PLACING & LIST'G	-	-	-	-	-	-
PRECAST SEAT	6,100	LF	4.00	24,400	5.00	30,500
END BULKHEAD FORMS	240	LF	3.60	900	10.50	2,500
YOKES	60	EA	180-	10,800	135-	8,100
JACK RODS 6T	6,200	LF	2.50	15,500	.13	800
PRECAST INSERTS	1,550	EA	9.00	13,950	-	SLIDE CREW
GUIDE WHEEL BRKTS.	18	EA	65-	1,200	-	" "
SP 10196A		-52	-	1,137,945		537,700

J.F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	AMBURSEN DAM PROJECT: TRUMBULL LAKE DAM ARCHITECT: NEW ENGLAND DIV. C/E

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
FOUNDATIONS						
FORMWORK	29,000	SF	.20	5,800	.80	23,200
CONCRETE	7,000	CY	22.50	157,500	7.00	49,000
REINF STEEL	46	TONS	230-	10,600	400-	18,400
CURING	31,000	SF	.01	310	.02	620
KEYWAYS	3,000	LF	1.00	3,000	1.00	3,000
WATERSTOPS	600	LF	3.50	2,100	4.00	2,400
FACE DECK						
PRECAST SLABS	73,800	SF	16-	1,180,000		
PLACING CREW	73,800	SF	-		.60	44,300
PLACING CRANE	1	MO.		10,000		-
JOINT TREATMENT	30,400	LF	5-	152,000	-	INCL. IN PLACING CREW
STARTER FTGS	INCL. IN	FDN CONC.				
SPILLWAY SLAB						
CANTILEVER FORMS	1,100	SF	.35	385	1.00	1,100
CONCRETE	725	CY	22.50	16,300	7.00	5,075
REINF. ST'L	13	TONS	230-	3,000	135-	1,760
FINISHING	8,100	SF	.05	405	.10	810
CURING	8,100	SF	.01	81	.01	81
DRIVEWAY TOP OF DAM						
PRECAST DECK	7,800	SF	2.50	19,500	2.50	19,500
CONCRETE FILL	8,000	SF	.25	2,000	.50	4,000
CURBING	800	LF	2.50	2,000	2.50	2,000
ADD'L CONC. AT FDN	30	CY	30-	900	50-	1,500
PUMPING STA.	750	CY	30-	22,500	95-	71,250
RETAINING WALLS	350	CY	30-	10,500	45-	15,800
STAIR TOWER	60	CY	55-	3,300	125-	7,500
SP 10196A		-53-		1,602,181		271,296

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JUL 15, '72 PRICED BY AMBURSEN DAM SHEET NO. AD-34

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. C/E

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
FIELD OVERHEAD						
FIELD OFFICES, SHOPS, & STORAGE				15,000		2,000
HARDWARE & TOOLS				20,000		-
FUEL & OIL				10,000		-
START-UP & LAYOUT				-		5,000
MIX DESIGNS				1,000		-
CONCRETE TESTING				15,000		SUB
TEMPORARY LIGHTING				6,000		20,000
SANITARY FACILITIES				4,000		SUB
CLEAN-UP				-		10,000
HEATING				10,000		-
PROJECT MANAGER	1 x 117	WKS		-	500	58,500
SUPERINTENDENT	1 x 60	"		-	400	24,000
PROJECT ENGR.	1 x 58	"		-	400	23,200
CLERKS	2 x 58	"		-	200	23,200
SURVEYORS	4 x 58	"		-	250	58,000
UTILITY MECH.	6 x 36	"		-	300	64,800
WATCHMEN	3 x 93	"		-	100	27,900
WINTER PROTECTION	NONE			-	-	-
COMMUNICATIONS				5,000		5,000
POWER DISTRIBUTION				10,000		10,000
SP 10195A		-34-		96,000		331,600

J.T. CAMILLERI P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

AMBURSEN DAM

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV. C/E

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
EQUIPMENT						
CRANE	1 x 8	MOS	4500	36,000	2700	21,600
DOZER	1 x 12	MOS	1200	14,400	1330	16,000
UTILITY TRUCKS	2 x 12	MOS	800	19,200	940	22,560
PERSONNEL TOWERS	3 x 10	MOS	80	2,400	-	-
HEEDE HOISTS	6 x 5	MOS	2000	60,000	3000	90,000
LOWER CONV. SYSTEM	20	WKS	3000	60,000	-	-
SLIP FORM CONV.	8	WKS	875	7,000	-	-
CONV. SUPPORT BRKT.	30	EA	200	6,000	300	9,000
SP 10196A		- 55		205,000		159,160

COST ANALYSIS

This design alternate comes out to be the least economical of all the systems studied, including the basic conventionally built gravity dam. In addition, its relative economy will not be improved materially as larger dams are considered. On the contrary, it has maximum possibilities in the construction of low dams in wide flat valley configurations. Under these conditions the use of ready-mix concrete, gang forms for the buttresses and cranes seems to be the most promising construction combination. The decks may be constructed either by slip forming or precast sections made watertight at the joints.

This type of dam also lends itself to complete precasting including the buttresses. Tilt-up construction is also promising in this area. If time is a major consideration, the Ambursen type dam may be the answer within height limitations.

COST AND FEASIBILITY STUDY

CELLULAR DAM

GENERAL DESCRIPTION

This design alternate is shown on Drawing No. 209-AD-4 and is probably the least orthodox of the group studied. It combines features from both the composite design and the massive head design, substituting a beehive structure for the massive head and the buttresses for the no-slump fill. Because the buttresses (stems) go up the full height and are not sloped, this design is quite prismatic and therefore lends itself completely to the most economical use of slip forming and concrete handling equipment.

The area under the slip formed cells is mass concrete of minimum dimensions while the abutments are constructed as monoliths in the conventional manner.

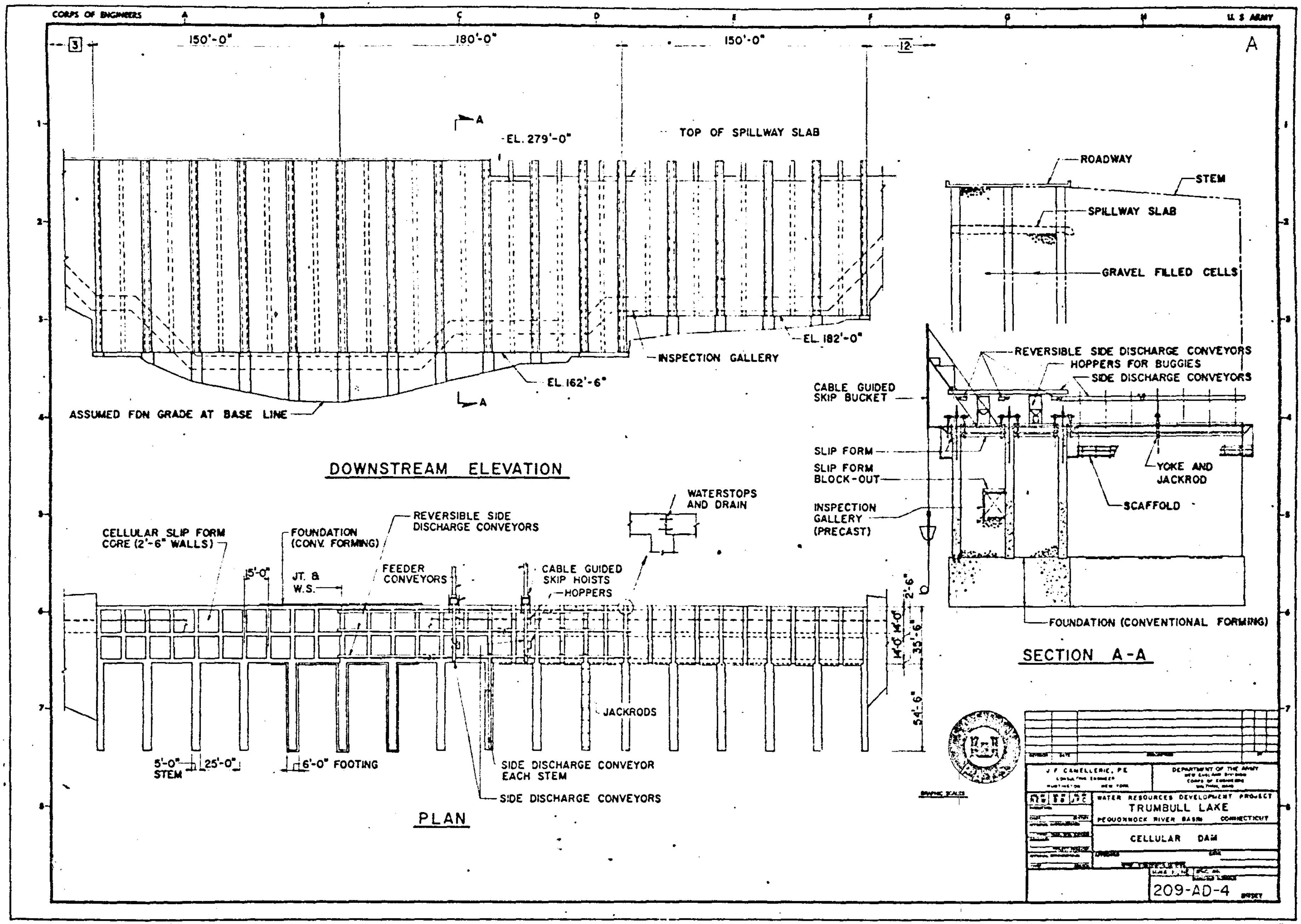
The stems have been allowed to run the full height in the spillway area, but this is not in any way necessary. Piers are however provided for running a roadway completely across the spillway area. Section A-A shows the two lane driveway which encloses the cellular area. The spillway slab is also shown here indicating a vertical drop for the spill water. If necessary, the areas between the buttresses may be filled with low cement mass concrete to produce a sloped fall but this will not be as economical. Spilling through or around the cellular area is of course also possible.

The power station, stair towers and such other structures as may be required may easily be integrated into the cellular enclosure. The precast galleries are carried on the cross walks as shown and the cells are filled with gravel for drained ballast.

The downstream end of the buttresses can be easily enclosed by means of a continuous wall and the entire dam roofed to yield a park and/or overlook area.

DESIGN

Preliminary design of this dam is accomplished on calculation sheets AR-401 through 411. An infinite combination of cell and wall configurations is possible. The configuration selected is reasonable but probably not optimum. This type of construction offers infinite choice as to variation in plan; walls may be of variable thickness, haunched, curved or irregular. Weight masses may be placed where statics indicate the best economy


CORPS OF ENGINEERS
U. S. ARMY
A
150'-0"
180'-0"
150'-0"
EL. 279'-0"
TOP OF SPILLWAY SLAB
INSPECTION GALLERY
EL. 182'-0"
EL. 162'-6"
ASSUMED FDN GRADE AT BASE LINE
DOWNSTREAM ELEVATION
ROADWAY
STEM
SPILLWAY SLAB
GRAVEL FILLED CELLS
REVERSIBLE SIDE DISCHARGE CONVEYORS
HOPPERS FOR BUGGIES
SIDE DISCHARGE CONVEYORS
CABLE GUIDED SKIP BUCKET
SLIP FORM
SLIP FORM BLOCK-OUT
INSPECTION GALLERY (PRECAST)
YOKE AND JACKROD
SCAFFOLD
FOUNDATION (CONVENTIONAL FORMING)
SECTION A-A
WATERSTOPS AND DRAIN
CELLULAR SLIP FORM CORE (2'-6" WALLS)
FOUNDATION (CONV. FORMING)
REVERSIBLE SIDE DISCHARGE CONVEYORS
15'-0"
JT. & W.S.
FEEDER CONVEYORS
CABLE GUIDED SKIP HOISTS
HOPPERS
JACKRODS
2'-6"
14'-0"
14'-0"
35'-6"
54'-6"
5'-0" STEM
25'-0"
6'-0" FOOTING
SIDE DISCHARGE CONVEYOR EACH STEM
SIDE DISCHARGE CONVEYORS
PLAN
J. F. CANELLERIC, P.E.
DEPARTMENT OF THE ARMY
WATER RESOURCES DEVELOPMENT PROJECT
TRUMBULL LAKE
PEQUONNOCK RIVER BASIN CONNECTICUT
CELLULAR DAM
209-AD-4

to be. The requirement is, however, to maintain the plan dimensions the full height of the structure so as to maintain the extruded prism concept; departure from this will chip away from the economy.

CONSTRUCTION METHODS

The walls and cells are constructed monolithically in three sections as shown utilizing slip forms, cable guided hoists and conveyors as shown on Section A-A. The concrete is placed in buttress walls and in the longitudinal walls directly from side discharge conveyors; cross walls are served by means of concrete buggies. All the concrete in this part of the construction is structural concrete, allowing the slip operation to proceed of speeds of 24 feet per 24 hour day and more. The concrete demand remains constant improving the overall plant utilization.

The abutment monoliths are handled in the conventional manner as in the slip form construction for the basic gravity dam.

CONSTRUCTION SCHEDULE

The construction schedule for this dam is shown on Sheet AD-S413. On Sheet AD-S414 is shown an accelerated schedule which pushes somewhat deeply into winter weather to obtain substantial completion within one year.

CONSTRUCTION COST

Construction Summary Sheet AD-4S and Cost Sheets AD-41 through 46 indicate the cost for constructing this dam. See also Cost Study Sheets AD-S401 through AD-S412. The total cost of $6,753,000 is the lowest cost obtained from any alternate studied in this report.

	J. F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JULY 15/72 PRICED BY CELLULAR DAM	SHEET NO. AD-4S
		PROJECT: TRUMBULL LAKE DAM	
		ARCHITECT: NEW ENGLAND DIV.-CORPS/ENG'R.	

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
SUMMARY - CELLULAR DAM						
SHEET AD-41				1,924,280		87,910
42				1,240,660		214,800
43				75,800		184,100
44				441,100		425,300
45				66,880		159,150
46				461,200		439,600
				4,209,920		1,510,860
ESCALATION THRU 1974			2%	84,198	11%	166,195
				4,294,118		1,677,055
PAYROLL, TAXES & INS.					14%	234,788
						1,911,843
						4,294,118
TOTAL COST TO CONTR.						6,205,961
OH'D, PROFIT & CONT.					8%	496,477
						6,702,438
BID BOND					3/4%	50,268
TOTAL CONTRACT PRICE						6,752,706

SP 10196A

	J.F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JUL 15/72 PRICED BY CELLULAR DAM — SHEET NO AD-41 PROJECT: TRUMBULL LAKE DAM ARCHITECT: NEW ENGLAND DIV./CORPS/ENG'RS.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
SITE WORK						
CLEARING & GRUBBING	360,000	S.F.	.05	18,000	-	SUB
DISPOSAL	250,000	S.F.	.03	7,500	-	SUB
EXCAV. (UNCLASS.)	32,000	C.Y.	2.00	64,000	-	SUB
EXCAV. (ROCK)	4,800	C.Y.	10.00	48,000	-	SUB
EXCAV. (TALUS)	14,000	C.Y.	3.00	42,000	-	SUB
HANDCLEANING	34,000	S.F.	.75	25,500	-	SUB
CHAIN LINK FENCE	850	L.F.	3.50	3,000	2-	1,700
FOUNDATION GROUTING	50,000	S.F.	.90	45,000	-	-
DIVERSION	-	L.S.	-	714,000	-	SUB
BACKFILL	12,000	C.Y.	-	-	2-	24,000
ROCK SLOPE PROT.	800	C.Y.	3.00	2,400	10-	8,000
ROAD GRAVEL	1,200	C.Y.	4.50	5,400	2.50	3,000
BIT. CONC. PAVING	1,200	S.Y.	5.00	6,000	-	SUB
ALUM. HANDRAIL	1,000	L.F.	10.00	10,000	3.00	3,000
TIMBER TRESTLE	480	L.F.	73-	35,000	37-	17,800
BRIDGE	1	EA.	-	1,000	-	5,000
IMPROVE R.R. BED	268,000	S.F.	1.50	402,000	-	SUB
VALLEY ACCESS RD.	72,000	S.F.	1.00	72,000	-	SUB
MECHANICAL ITEMS						
HYDRAULIC PACKAGE	1	L.S.	-	303,680	-	-
EXTENSION 36" BLOW OFF	1	L.S.	-	5,000	-	2,000
PLUMBLINE SHAFT	120	L.F.	3.00	360	2.50	300
3½" STEEL PIPE	1,160	L.F.	3.50	4,060	5.50	6,380
2½" STEEL PIPE	2,150	L.F.	1.75	3,760	3.50	7,530
3" DRAINAGE HOLES	2,880	L.F.	8.10	23,300	-	SUB
1½" GROUT HOLES	9,240	L.F.	8.00	73,920	-	SUB
8" WELLS	600	L.F.	2.25	1,350	-	SUB
WATERSTOPS	2,300	L.F.	3.50	8,050	4.00	9,200
SP 10196A	A	-32-		1,924,280		87,910

	J.F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JULY 15/72 PRICED BY CELLULAR DAM	SHEET NO. AD-42
		PROJECT: TRUMBULL LAKE DAM	
		ARCHITECT: NEW ENGLAND DIV. CORPS/ENG'RS	

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
ENVIRONMENTAL WORK						
TURBIDITY CONTROL	-	-	-	80,000	-	SUB
DUST CONTROL	-	-	-	1,000	-	-
NOISE ABATEMENT	-	-	-	40,000	-	-
LANDSCAPE RENEWAL	-	-	-	5,000	-	2,000
R.R. BED "	270,000	S.F.	.20	54,000	-	SUB
CONCRETE PRODUCTION						
CEMENT (TOTAL)	15,200	TONS	27.20	413,400	-	-
FLYASH (TOTAL)	1,100	TONS	9.00	9,900	-	-
BORROW OPER. (SLIP)	78,000	TONS	-	72,000	.32	25,000
BORROW OPER. (OTHER)	148,000	TONS	-	-	.29	43,000
AGGREGATE PROD. (SLIP)	78,000	TONS	-	128,000	.39	30,400
AGGREGATE PROD. (OTHER)	56,000	TONS	-	-	.34	19,100
BATCH PLANT OPER. (SLIP)	42,100	CY	-	437,360	1.00	42,100
" " " (OTHER)	30,400	CY	-	-	1.75	53,200
SP 10196A		-63-		1,240,660		214,800

	J.F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JULY 15/72 PRICED BY CELLULAR DAM	SHEET NO. AD-43
		PROJECT: TRUMBULL LAKE DAM	
		ARCHITECT: NEW ENGLAND DIV.-CORPS/ENGR'S	

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
FOUNDATION						
FORMWORK	46,000	S.F.	.30	13,800	1.00	46,000
CONCRETE	11,000	CY		-	2.00	22,000
REINF. ST'L	35,000	#	.15	5,300	.10	3,500
CURING	23,200	S.F.	.01	300	.01	300
KEYWAYS	2,000	L.F.	1.00	2,000	1.00	2,000
WATERSTOPS	1,200	L.F.	3.50	4,200	4.00	4,800
ABUTMENT MONOLITHS						
CANTILEVER FORMS	22,000	S.F.	.80	17,600	1.17	25,700
TRANSVERSE BLK'HD	2,000	S.F.	.80	1,600	1.17	2,400
FOUNDATION FORMS	8,000	S.F.	.80	6,400	3.00	2,400
LIFT STARTER FORMS	8,000	S.F.	.80	6,400	1.17	9,300
CONCRETE	16,800	CY		-	2.00	33,600
REINF. ST'L	35,000	lb	.15	5,300	.10	3,500
FINISHING	38,500	S.F.	.05	1,900	.28	10,800
CURING	93,000	S.F.	.01	900	.01	900
HORIZ. JT. TREATMENT	54,000	S.F.	.05	2,700	.15	8,100
VIBRATION	16,800	CY	.44	7,400	.52	8,800
SP 10196A			-64-	75,800		184,100

	J. F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JULY 15/72 PRICED BY CELLULAR DAM — SHEET NO. AD-44 PROJECT: TRUMBULL LAKE DAM ARCHITECT: NEW ENGLAND DIV.-CORPS/ENG'R.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
SLIPFORM OPERATION						
SLIDING FORMS	3,100	L.F.	14-	43,400	21-	65,100
YOKES	560	EA.	-	INCL	50-	2,800
JACK RODS (3T)	60,000	LF	1.65	99,000	.05	3,000
DECKS	16,900	S.F.	.50	8,500	1.00	16,900
SCAFFOLDS	5,600	S.F.	1.50	8,400	2.00	11,200
RAILINGS & LADDERS	3,000	L.F.	4.50	13,500	2.50	7,500
HYDRAULIC PIPING	8,700	L.F.	-	INCL	.80	7,000
TOPPING OUT RODS	880	EA.	2.00	1,800	-	INCL
FORM DESIGN	-	-	-	10,000	-	-
FIELD ENG'R	14	DAYS	200	2,800	-	-
FIELD TECH.	24	DAYS	150	3,600	-	SUB
CONCRETE	42,100	CY		-		-
REINF. ST'L.	900	TONS	230	207,000	150-	135,000
SLIDE CREW	-	-	-	-	-	114,700
FINISH	306,600	S.F.	.05	15,300	-	SLIDE CREW
CURING	306,600	S.F.	.01	3,100	-	SLIDE CREW
STRIP FORMS				-		24,000
VERTICAL KEYS	1,500	L.F.	1.00	1,500	.50	800
WATERSTOPS	1,000	L.F.	3.50	3,500	4.00	4,000
REBAR PLACING & LIST.	900	TONS	15-	13,500	-	-
GALLERY BULKHEADS	2,240	S.F.	.50	1,100	2.00	4,500
HORIZ. KEYS @ TOP	1,440	L.F.	.15	200	1.00	1,500
JAY POSTING	1,600	L.F.	1.50	2,400	1.00	1,600
BULKHEADS @ SPILLWAY	5,000	S.F.	.50	2,500	1.00	5,000
CORE FILL (GRAVEL)	45,000	CY	-	-	.46	20,700
SP 10196A		- 65 -		441,100		425,300

J.F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JULY 15/72 PRICED BY CELLULAR DAM	SHEET NO. AD-45
	PROJECT: TRUMBULL LAKE DAM	
	ARCHITECT: NEW ENGLAND DIV.-CORPS/ENG'R.	

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
SPILLWAY SLAB						
CANTILEVER FORM	1,100	S.F.	.35	400	1-	1,100
CONCRETE	860	CY		-	8-	7,000
REINF. STEEL	15	TONS	230-	3,500	135-	2,000
FINISHING	9,600	S.F.	.05	500	.10	1,000
CURING	9,600	S.F.	.01	100	.01	100
ACCESSORY STRUCTURES						
PUMPING STATION	750	CY	30-	22,500	95-	71,250
RETAINING WALLS	350	CY	30-	10,500	45-	15,800
STAIR TOWER	60	CY	55-	3,300	125-	7,500
PRECAST GALLERY	-	-	-	15,580		39,400
TWO LANE DRIVE						
FORMWORK	1,600	S.F.	.40	700	1.00	1,600
CONCRETE FILL	600	CY		-	8.00	4,800
REINF. ST'L.	30	TONS	230-	7,000	135-	4,000
PRECAST CURB	820	L.F.	2.50	1,800	2.50	1,800
FINISH	16,000	S.F.	.05	800	.10	1,600
CURING	16,000	S.F.	.01	200	.01	200
SP 10196A		-66-		66,880		159,150

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N.Y. 11743

DATE JULY 15/72 PRICED BY CELLULAR DAM   SHEET NO. AD-46

PROJECT: TRUMBULL LAKE DAM

ARCHITECT: NEW ENGLAND DIV.-CORPS/ENG'R.

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
EQUIPMENT						
TRUCK CRANE	1 x 15	MOS.	4500	67,500	2700	40,500
DOZER	1 x 12	"	1200	14,400	1330	16,000
UTILITY TRUCKS	2 x 10	"	800	16,000	940	18,800
PERSONNEL TOWERS	3 x 8	"	80	1,900		2,000
HEEDE HOISTS	3 x 6	"	2000	36,000	1500	4,500
LOWER CONVEYOR SYS.	860	L.F.		50,000		5,000
UPPER CONVEYOR SYS.	3 x 920	L.F.		120,000		19,000
FIELD OVERHEAD						
FIELD OFF, SHOP, STORAGE	-	-	-	27,000	-	3,000
HARDWARE & TOOLS	-	-	-	45,000	-	-
FUEL & OIL	-	-	-	12,000	-	-
STARTUP & LAYOUT	-	-	-	-	-	5,000
MIX DESIGN	-	-	-	1,000	-	-
CONCRETE TEST.	-	-	-	25,000	-	SUB
TEMP. LIGHTING	-	-	-	3,000	-	10,000
SANITARY FAC.	-	-	-	5,400	-	SUB
CLEAN UP	-	-	-	-	-	20,000
HEATING	-	-	-	20,000	-	-
PROJECT MANAGER	1 x 104	WKS.	-	-	500	52,000
SUPERINTENDANT	1 x 65	"	-	-	400	26,000
PROJ. ENG'R.	1 x 65	"	-	-	400	26,000
CLERKS	2 x 65	"	-	-	200	26,000
SURVEYORS	4 x 65	"	-	-	250	65,000
UTILITY MECH.	6 x 42	"	-	-	300	75,600
WATCHMEN	3 x 104	"	-	-	100	31,200
WINTER PROTECTION	-	-	-	2,000	-	5,000
COMMUNICATIONS	-	-	-	5,000	-	5,000
POWER DISTRIBUTION	-	-	-	10,000	-	10,000
SP 10196A		-67-		461,200		439,600

J. F. CAMELLERIE P.E. 23 GREEN STREET HUNTINGTON, N.Y. 11743	DATE JULY 15/72 PRICED BY CELLULAR DAM	SHEET NO. AD-4A
	PROJECT: TRUMBULL LAKE DAM	
	ARCHITECT: NEW ENGLAND DIV.-CORPS/ENG'R.	

	QUANTITY	UNIT	UNIT	MATERIAL	UNIT	LABOR
PERSONNEL OVERHEAD						
NORMAL SCHEDULE						
PROJECT MANAGER	1 x 104	WKS.			500	52,000
SUPERINTENDENT	1 x 65	"			400	26,000
PROJECT ENGINEER	1 x 65	"			400	26,000
CLERKS	2 x 65	"			200	26,000
SURVEYORS	4 x 65	"			250	65,000
UTILITY MECHANICS	6 x 42	"			300	75,600
WATCHMEN	3 x 104	"			100	31,200
						301,800
ACCELERATED SCHEDULE						
PROJECT MANAGER	1 x 80	WKS.			500	40,000
SUPERINTENDENT	1 x 40	"			400	16,000
PROJECT ENGINEER	1 x 40	"			400	16,000
CLERKS	2 x 40	"			200	16,000
SURVEYORS	4 x 35	"			250	35,000
UTILITY MECHANICS	6 x 26	"			300	46,800
WATCHMEN	3 x 65	"			100	19,500
						189,300
DIFFERENCE - NORM. & ACC. SCHED.						112,500
ESCALATION THRU 1974					11%	12,375
						124,875
PAYROLL, TAXES & INS.					14%	17,483
						142,358
OVERHEAD, PROFIT & CONT.					8%	11,389
						153,747
BID BOND					3/4%	1,154
TOTAL DIFF.-NORM.& ACC. SCHED.						154,901

SP 10196A

COST ANALYSIS

The cost for constructing the cellular type dam seems to be the most economical of all method/design alternatives studied. In addition, its economy will increase as the size of the dam increases in much the same manner as the massive head dam. Because of the vertical stems, the equipment and form utilization for this construction will show more economy than the massive head dam with increase in size.

COMMENTS AND CONCLUSIONS

The preceding studies give strong indication that alternate dam designs using slip forming and other advanced construction techniques will result in more rapid and therefore more economical construction. Maximum promise lies in the area of dams designed to use smaller volumes of structural strength concrete assisted in some instances by rock anchors and prestressing techniques. The economic advantage of such dams lies in the smaller plants required, more uniform plant utilization, decreased rock preparation, less formwork, less joints and most important of all, rapid construction.

Spillways, pumping stations and other accessory structures must be designed in the same vein.

The massive head buttress dam and the cellular dam are both designed in accordance with the above precepts and both result in halving the construction time and reducing the cost by 5 to 10 percent for large dams (twice the height of the dam at Trumbull Lake). The cellular dam is the more economical of the two designs as it permits more uniform plant utilization, more formwork reuse and less joints.

The design concepts illustrated and costed in the study of the massive head and cellular dam designs apply directly to arch dam design, particularly in valley cross-sections that are deep and rectangular in configuration. Slip forming gives great latitude to the designer whether single or multiple arch designs are considered. In lieu of the vertical curves and beautiful (but expensive) profiles now being designed, cellular vertical sections are suggested having some width and vertical outside faces. These cells may be filled with concrete, gravel or nothing at all as desired to meet design requirements for weight distribution. Aesthetic values and utility of the top deck can be incorporated into the design.

Smaller construction plants and shorter construction schedules will reduce the environmental impact of dams so constructed.

Considering the preceding investigations and discussions, cost and feasibility studies to determine the applicability of advanced construction techniques to dams yet to be designed seems entirely justified and may very well yield savings in time and money far in excess of the cost of such studies.

COST AND FEASIBILITY STUDY

ALTERNATE DESIGNS TO PERMIT USE OF SLIP FORM AND OTHER TECHNIQUES TO MAXIMIZE ECONOMIES

BOOK AC1

APPENDIX: COMPOSITE DAM

COST STUDY SHEETS

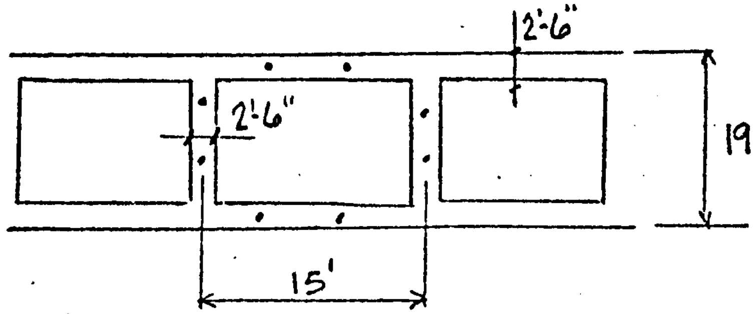
BOOK AC-1 - APPENDIX: COMPOSITE DAM

Sketches AD-S101 through S129

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN. CONN.
COMPOSITE DESIGN - GRAVITY DAM

SLIDING FORMS



DOWNSTREAM FACE	3(160) =	480'
UPSTREAM "	3(160) =	480'
CELLULAR CORES	2x12.5' = 25'	
	2x 14 = 28	
	53' x32 =	1700'
END BULKHEADS (1ST POUR)	19 + 5 = 24'	24'
END BULKHEADS (2ND POUR)		5'
" " (3RD POUR)		19'
		2708 L.F. /2 = 1354 LF

YOKES (3T) 6/CELL x 32 CELLS = 192
+ 2 STARTING END
194
+6 HOIST + EQUIP.
200

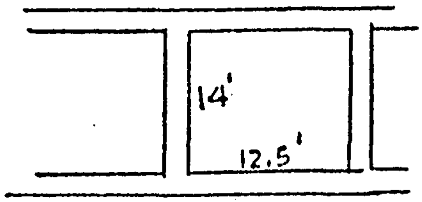
JACK ROD (3T)	2 RODS x 116.5 =	234'
	6 RODS x 116.5' = 700' x 21 CELLS	14,600'
UP	21 x 94 =	1980
DN	21 x 94 =	1980
CROSS	22 x 94 =	2070
		20,864

SAY 20,900

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
COMPOSITE DESIGN - GRAVITY DAM

DECKS (INT.)



14 x 12.5 = 175 ⊄'/CELL
x 32 CELLS
5600 ⊄'

DECKS (EXT.)

480'
x 2 SIDES
960' x 2 = 1920 ⊄'

CONCRETE: SLIP #1

160 x 2.5 = 400
160 x 2.5 = 400
11 x 14' x 2.5 = 386
1186 ⊄' x 116.5' = 138,000 CU FT

138,000 / 27 = 5150 C.Y. / 116.5 = 44 C.Y./HR.

SLIP #2

UP 80 x 2.5 x 116.5 = 23,400
80 x 2.5 x 102 = 20,400
DN 80 x 2.5 x 116.5 = 23,400
80 x 2.5 x 80 = 16,000
CROSS 11 x 14 x 2.5 x 116.5 = 45,200
128,400 / 27 = 4750 C.Y.

SLIP #3

UP 160 x 2.5 x 80 = 32,000
DN 160 x 2.5 x 68 = 27,200
CROSS 11 x 14 x 2.5 x 94 = 36,000
95,200 / 27 = 3530 C.Y.

TOTAL
5150
4750
3530
13,430 C.Y.

MAX. 44 YD/HR. / [illegible] = 9 BUGGIES ≈ SAY 10

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15, '72 REV. SKETCH# AD-5-10-3

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

COMPOSITE DESIGN - SLIDE CREW

SPEED = 12"/HR AVE.

SLIP #1 116'-6"/1 = 116.5 HRS

SLIP #2 116.6/1 = 116.5

SLIP #3 94/1 = 94

~~WORK 3 SHIFTS/DAY = 24 x 5 = 120 HR/WK.~~

SLIP #1 — WEEK 1, 5 DAYS

SLIP #2 — WEEK 2, 5 DAYS

SLIP #3 24 x 4 = 96 HRS OR 4 DAYS

14 DAYS x 3 SHIFTS/DAY = 42 SHIF

CLASSIFICATION	#	HR. RATE INCL. FRINGE BENEFITS	COST/SHIFT. WEEKDAY SHIFT RATE 8 HR. WORK/9 HR. PAY	
HOIST ENG'R	1	8.60	$ 77	
JACK OPER.	2	8.00	144	
CARPENTERS	2	9.00	162	
ELECTRICIAN	2/3	8.28	50	
FINISH FOR.	1	9.37	84	
FINISHERS	1	8.87	80	
FINISH HELPER	1	7.15	64	
LABORERS:				
FOREMAN	1	6.10	55	* PLACING HAS 1 TOP MAN, 10 BUGGIES, 10 SHOVEL, 1 UTILITY MAN
PLACING *	22 } 29	5.60	1460	
VIBRATING	5	5.60		
CURING	2	5.60		
CRANE OPER.	2/3	8.60	52	
OILER	2/3	6.85	41	
CONV. OPER	1	7.75	70	
			$ 2339	

42 SHIFTS x $2339 = $ 98,200

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15, '72 REV. SKETCH # AD-310...

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
COMPOSITE DESIGN - GRAVITY DAM

FINISH

SLIP #1	116.5 x 160 x 2 =	37,500	
SLIP #2	116.5 x 80 x 2 =	18,800	
	102 x 80 x 1 =	8,200	
	90 x 80 x 1 =	7,200	
SLIP #3	102 x 160 x 1 =	16,300	
	90 x 160 x 1 =	14,400	
		102,400 ф'/2 = 51,000	

CURING

CROSS	2 x 14 = 28 x 116.5 x 43 WALLS =	141,000	
	28 x 94 x 21 WALLS =	55,000	
EXT.		102,000	← REQ'D
INT.	2 x 12.5 = 25 x 2 = 50 x 116.5 x 16 CELLS =	93,000	} NOT REQ'D
	50 x 94 x 16 =	75,000	
		466,000 ф'	

RAILINGS + LADDERS

480'
480'
960 ≈ SAY 1000

STRIP FORMS 50% ERECTION x

FORMS	65,000
YOKES	10,000
DECKS	5600 / 1920
RAILS	2500
	85,000 x 1/2 = 42,500

REINF. ST'L $77 \#/YD. \times 13,430$ c.y. $= \frac{1,040,000\#}{2000} = 520$ TONS

GALLERY BULKHEADS 33 CROSS WALLS

7 + 10 + 10 = 27 LF x 2.5' = 67.5 ф'/WALL x 33 WALLS = $\frac{2240 ф'}{2.5}$ = 900...

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK, RIVER BASIN, CONN.
COMPOSITE DESIGN GRAVITY DAM

CRANE SUPPORT

WHEEL LOADING = 123K'

$M = \frac{1}{8}(123^k)(12.5)^2 = 2{,}400^{'k}$

$S_{req} = \frac{2{,}400 \times 12}{24 \times 1.33} = 900$

USE WF 36 x 260#

TOTAL WEIGHT =

$\frac{2 \times 260 \times 240' \times 1.05}{2000} = 65$ TONS

BEAM BLOCKOUTS

17 EA 3.0 x 1.5 7.5 LF/BOX

LUMBER PER BOX = 7.5 x 2.5 x 17 x 2 bd ft
= 640 bd ft

320 ф' @ (2 x .17)
SAY 35¢

MAKE UP 35¢
PLACE \$9.00/18.75 ф' = .50
TOTAL PLACING COST 85¢

WELD PLATES FOR CRANE
ANCHOR BOLTS,
2 x 5.3# x 4' = 42#
PL, 1.33 x 1.33 x 61# x 2 = 216#

SAY 250# EA @ 15'

@ .25 #= 65 EA. MTL.
@ 4 x #9 = \$36 EA. MTL.

AT 30" SPACING (OVER WALL)

ANCHOR BOLTS	\$3.00	\$21.00
PLATE @ 1.33 (40)	\$13.30	—
	13.30	\$21.00

NO REQ'D = $\frac{240 \times 2}{2.5}$ = 192

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 13, 78 REV.

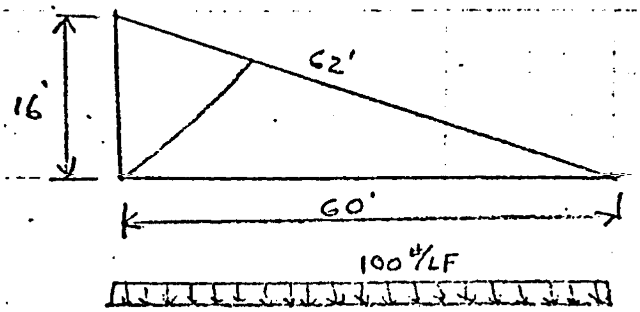
TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

COMPOSITE DESIGN - GRAVITY DAM

CONVEYOR SUPPORT TRUSS

LOADING. EACH OF DOUBLE TRUSSES



$\downarrow \frac{75' \times 50^{\#}}{2} = 1900^{\#}$

M = 100 × 60 × 30 + 1,900 × 60
= 180 + 114 = 294 'K SAY 300 'K

BOT CHORD:
B = 300'K / 16' = 18.75 K

T = 18.75 × $\frac{62}{60}$ = 19.6 K

MIN R = $\frac{720}{200}$ = 3.6

BOT CHORD
2 Ls 8 × 4 × 7/16 (35#/ft)

Top Chord = $\frac{744}{240}$ = 3.1

TOP CHORD
2 Ls 7 × 4 × 3/8 (27#/ft)

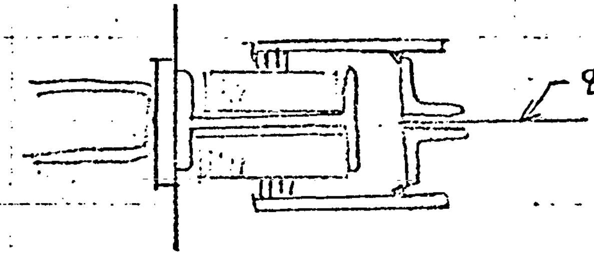
DIAGONALS:
V = 6 + 19 = 7.9 K SAY 8 K
LOAD = 8 × 1.5 = 12 K
MIN r = $\frac{300}{300}$ = 1.0

USE 8 × 6 × 7/16 L (20#/ft) × 1.5

TOTAL WEIGHT OF TRUSS:
92# × 1.10 × 60' = 6000 = 3 TONS
3 TONS × 10 = 30 TONS

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

CONV. SUPPORT TRUSS CONT



TRY W6 x 25

$M = \frac{Pl}{8} = \frac{20 \times l}{8} = 2.5l$

$M = S_S = \frac{13.4 \times 24}{12} = 26.8$

$2.5l = 26.8$

$l = 10.75'$ SAY 10'-0"

CONVEYOR RAIL

$20^{\#} \times 7 \times 116 = 16,200^{\#}$

$20^{\#} \times 3 \times 94 = 5,700^{\#}$

$22,000^{\#} = 11$ TONS

WELD PLS

$10 \times 12 \times \frac{1}{2}" = 15^{\#}$

Anchors $1.5^{\#}$ 12' = $18^{\#}$

$33^{\#}$

No OF PLS = 1100

TOTAL WEIGHT = $33^{\#} \times 1100 = 36,000^{\#}$

18 TONS

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1 1972 REV. SKETCH# AD-

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CO

SLIP FORM CONSTRUCTION

CONCRETE DEMAND SCHEDULE

MONTH-

WORKING DAY	PLACEMENT DESIGNATION	CONCRETE DEMAND (Yds)	PLACING RATE Yds/HR	REMARKS
1	1	115	15	
2	2	530	67	
3	3	830	104	
4	3	830	104	
5	4	570	72	
6	4	565	72	
7	5	960	120	
8	6	545	69	
9	6	545	69	
10	7	935	117	
11	7	935	117	
12	8	930	117	
13	8	930	117	
14	9	840	105	
15	9	840	105	
16	10	590	74	
17	10	585	74	
18	11	855	107	
19	11	855	107	
20	12	830	104	
21	12	830	104	
22	13	900	113	

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1 1972 REV. SKETCH # A

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, C

SLIP FORM CONSTRUCTION

CONCRETE DEMAND SCHEDULE

MONTH-

WORKING DAY	PLACEMENT DESIGNATION	CONCRETE DEMAND (Yds)	PLACING RATE Yds/HR	REMARKS
23	14	715	90	
24	14	715	90	
25	15	875	110	
26	15	875	110	
27	16	825	104	
28	16	825	104	
IN SLIDE	17	560	70	
	17	560	70	
	18	745	94	
	18	740	93	
	19	750	94	
	19	750	94	
	20	775	97	
	20	775	97	
	21	680	85	
	21	680	85	
	22	665	84	
	22	665	84	
	23	640	80	
	23	640	80	
IN SLIDE	24	620	78	
IN SLIDE	24	620	78	

5 DAYS SLIDE, DAY 29 TO 33

J. F. CAMELLERIE, P.E. 23 GREEN STREET HUNTINGTON, N. Y.	DATE JUNE 1 1972 REV. SKETCH #AD-5110 TRUMBULL LAKE DAM PEQUONNOCK RIVER BASIN, CONN. SLIP FORM CONSTRUCTION

CONCRETE DEMAND SCHEDULE

MONTH -

WORKING DAY	PLACEMENT DESIGNATION	CONCRETE DEMAND (Yds)	PLACING RATE Yds/Hr	REMARKS
IN SLIDE	25	607	76	
IN SLIDE	26	935	117	
34	27	544	68	START ~~FILLING~~
35	28	316	40	CAVITIES
36	29	194	25	WHERE CONCRETE
37	30	510	64	CAPACITY AND
38	30	510	64	TIME IS
IN SLIDE	31	609	77	AVAILABLE
IN SLIDE	31	608	76	↓
IN SLIDE	32	519	65	↓
IN SLIDE	32	513	65	↓
IN SLIDE	33	765	96	
IN SLIDE	33	760	95	
39	34	225	29	
39 1/3 SEE REMARK	35	560	70	1/3 DAY ALLOW.
IN SLIDE	35	560	70	FOR PART NOT IN SLIDE
IN SLIDE	36	690	87	
IN SLIDE	36	690	87	
40 1/3	37	312	39	
41 1/3	38	424	53	
42 1/3	39	350	44	

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1, 19[illegible] REV. SKETCH# AD-5111

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
SLIP FORM CONSTRUCTION

CONCRETE DEMAND SCHEDULE

MONTH-

WORKING DAY	PLACEMENT DESIGNATION	CONCRETE DEMAND (Yds)	PLACING RATE Yds/HR	REMARKS
42 2/3	40	557	70	1/3 DAY ALLOW
IN SLIDE	40	557	70	FOR PART NOT IN SLIDE
43 2/3	41	491	62	
44 2/3	42	612	77	
45 2/3	43	670	84	ONLY PARTIALLY
IN SLIDE	43	670	84	IN SLIDE
55	44	516	65	1/3 DAY ALLOW
IN SLIDE	44	516	65	FOR PART NOT IN SLIDE
56	45	900	113	
57	46	63	8	
58	47	225	29	
59	48	535	74	
60	49	385	49	
61	50	900	113	
IN SLIDE	51	718	90	
62	52	610	77	
63	53	794	100	
64	54	617	78	
IN SLIDE	55	615	77	
65	56	610	77	
66	57	189	24	SPILLWAY
67	58	691	87	

9 DAYS SLIDE DAY 46 THRU 54 →

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1 1972 REV. SKETCH #AD-S11

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

SLIP FORM CONSTRUCTION

CONCRETE DEMAND SCHEDULE

MONTH-

WORKING DAY	PLACEMENT DESIGNATION	CONCRETE DEMAND (Yds)	PLACING RATE Yds/HR	REMARKS
68	59	764	96	
IN SLIDE	60	512	64	
69	61	189	24	
70	62	189	24	SPILLWAY
71	63	615	77	
72	64	768	96	
IN SLIDE	65	406	51	
IN SLIDE	66	186	24	
IN SLIDE	67	186	24	
73	68	512	64	
74	69	784	98	
IN SLIDE	70	302	38	
IN SLIDE	71	186	24	
IN SLIDE	72	186	24	
75	73	406	51	
76	74	667	84	
IN SLIDE	75	189	24	
77	76	189	24	SPILLWAY
78	77	302	38	
79	78	481	61	
IN SLIDE	79	296	37	
IN SLIDE	80	296	37	

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1 1972 REV. SKETCH#A

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, C

SLIP FORM CONSTRUCTION

CONCRETE DEMAND SCHEDULE

MONTH-

WORKING DAY	PLACEMENT DESIGNATION	CONCRETE DEMAND (Yds)	PLACING RATE Yds/HR	REMAR
IN SLIDE	81	296	37	
80	82	186	24	
81	83	186	24	
IN SLIDE	84	296	37	
ROAD 82	85	38	5	
ROAD 83	86	38	5	
84	87	296	37	
85	88	296	37	
86	89	247	31	
ROAD 87	90	38	5	
ROAD 88	91	31	4	
ROAD 89	92	38	5	
ROAD 90	93	38	5	
ROAD 91	94	38	5	
91 DAYS FOR	CONV. + SLIPFORM			
75 DAYS FOR	PRECAST + FILL			
166 TOTAL				

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

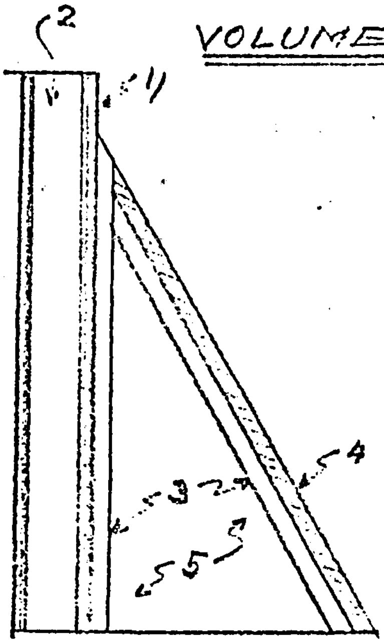
DATE JULY 15/72 REV. SKETCH# AD-5114-

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

COMPOSITE DESIGN - GRAVITY DAM

VOLUME SUMMARY



	SEC. I	SEC. II	SEC. III	TOTAL CY
1) SLIP WALLS	5,100	4,870	3,640	13,610
2) CORE FILL	8,000	7,530	5,480	21,010
3) LOW SLUMP	2,770	2,770	2,020	7,560
4) PRECAST	2,400	2,400	1,700	6,500
5) NO SLUMP	18,330	18,330	6,380	43,040
				91,720 CY

TOTAL CONC. IN DAM = 127,000 C.Y.
−91,720
35,280 C.Y. CONVENTIONAL

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15'72 REV. SKETCH# AD-5115
TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
COMPOSITE DESIGN - GRAVITY DAM

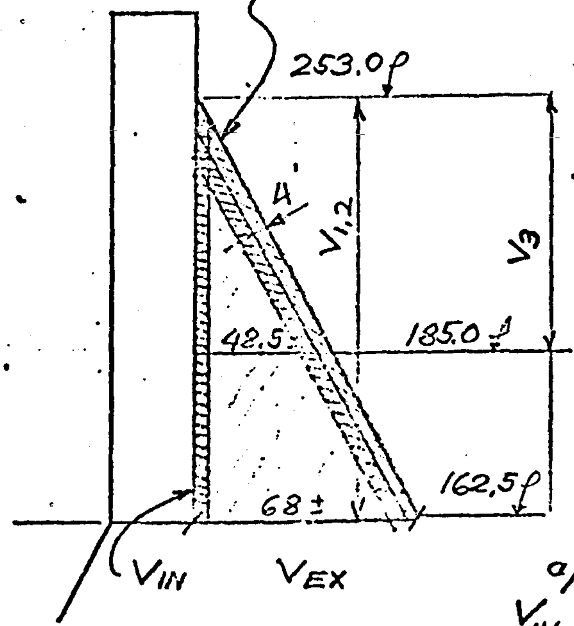
TYPE OF CONCRETE	C.Y.	CEMENT	FLYASH	REMARKS
SLIP FORMED	13,610	x470 = 6,400,000 = 6.4×10^6	—	
CELL FILL (NO SLUMP)	21,010	x94 = 1,980,000 = 1.98×10^6	x130 = 2,740,000 = 2.74×10^6	
LOW SLUMP (EXT. MASS)	7,560	x183 = 1,380,000 = 1.38×10^6	x 78 = 590,000 = $.59 \times 10^6$	
PRECAST BLOCKS	6,500	x470 = 3,060,000 = 3.06×10^6	—	
NO SLUMP CONCRETE	43,040	x94 = 4,050,000 = 4.05×10^6	x130 = 5,600,000 = 5.6×10^6	
EXT. MASS CONC. (CONV. FORM)	35,280	x183 = 6,450,000 = 6.45×10^6	x 78 = 2,750,000 = 2.75×10^6	
TOTALS		23.32×10^6 #	11.68×10^6 #	

23,320,000/2000 = 11,660 TONS OF CEMENT

11,680,000/2000 = 5,840 TONS OF FLYASH

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

B/ TRIANGULAR GRAVITY SECTION



1/ $V_{1,2} = \frac{68 \times 90.5}{2} \times 160 = 492{,}000$ CF

$V_3 = \frac{48.5 \times 68}{2} \times 160 = 264{,}000$ CF

2/ PRECAST CONC. FACE

$V_{P_{1,2}} = 101 \times 160 \times 4 = 64{,}700$ CF

$V_{P_3} = 72 \times 160 \times 4 = 46{,}100$ CF

3/ LOW SLUMP CONCRETE

a/ INT. FACE.

$V_{IN_{1,2}} = 85 \times 2.5 \times 160 = 34{,}000$ CF

$V_{IN_3} = 62 \times 2.5 \times 160 = 24{,}800$ CF

b/ EXT. FACE

$V_{EX_{1,2}} = 102 \times 2.5 \times 160 = 40{,}800$ CF

$V_{EX_3} = 74 \times 2.5 \times 160 = 29{,}600$ CF

34,000
40,800
74,800 CF = 2,770 CY

24,800
29,600
54,400 CF = 2,020 CY

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15/72 REV. SKETCH# AD-S117

TRUMBULL LAKE DAM
BEQUONNOCK RIVER BASIN
COMPOSITE DESIGN - GRAVITY DAM

A/ CONCRETE VOLUMES

1/ SLIP FORM SECTION

SECTION # 1 (NO SPILLWAY)

NO	L	W	H	VOL-CF	FILL CF	
1	160	19	116,5	354,000		TOT. VOL.
10	12,5	14	116,5		204,000	} FILL
1	7,5	14	116,5		12,230	

WALL VOL. = 354.000 - 216,230 = 137.770 CF
say 137.800 CF

SECTION # 2 (77,5 FT SPILLWAY)

WALL VOL. = 137,800 CF
(77,5 - 5×2.5)×(15+26)×2,5 = - 6.660 "
131,140 CF

FILL
216,200 - 65×(12×14 + 9×7/2) = 203.200 CF

SECTION # 3 (160 FT SPILLWAY)

WALL VOL.
160×(79+68)×2,5 = 59,000 CF
11×14×94×2,5 = 36,100 "
95,100 CF

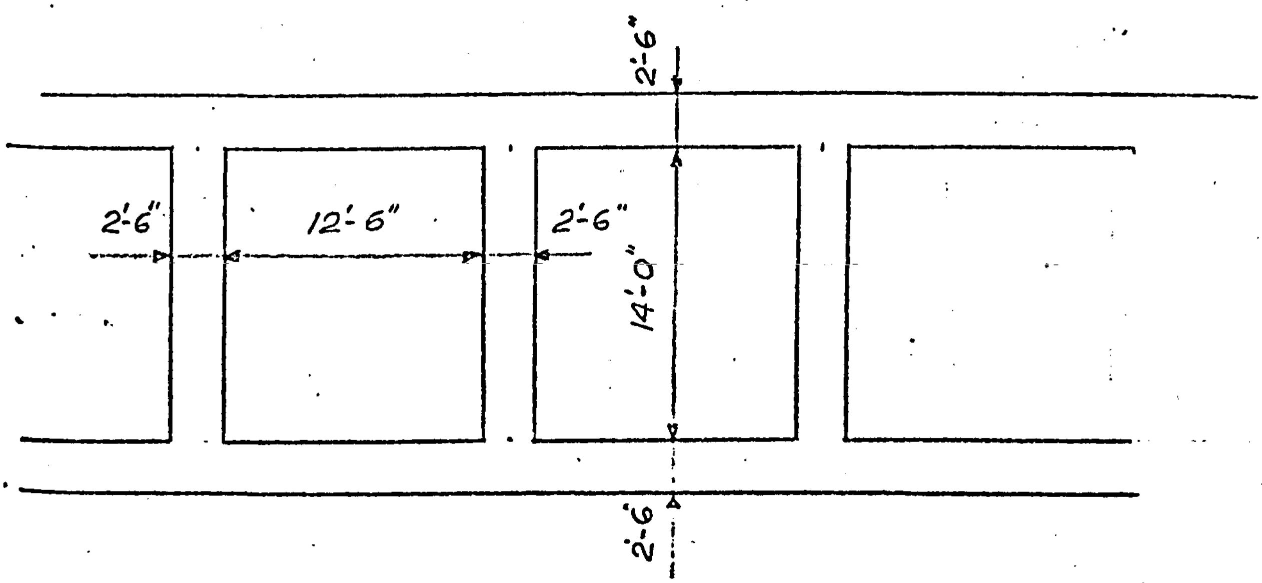
FILL
132,5×(94×14 - 200) = 148,000 CF

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUNE 1/72 REV. SKETCH# AD-5118

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN



14 x 12,5 = 175 SF

A 1 FT LAYER REQ. 6,5 CY OF CONC.

RATE OF PLACEMENT: 160 CY/HR / 6.5 = 25 FT/HR

MAX. LATERAL PRESSURE OF 3000 PSF GOVERNS.

$\text{MAX. NEG. M} = \frac{p \times l^2}{12} = \frac{3 \times 13.25^2}{12} = 43.8'^{K}$

$-A_s = \frac{43.8}{1,76 \times 26,5} = 0,94 \square''$ say #7 @ 8" (3")

$+A_s = 0,47 \square''$ say #7 @ 16 (1,6")

TEMP. STEEL

0,0015 × 30" × 12" = 0,54 □"
say #5 @ 15" E.F.
(2×0,9")

RE: TOTAL WEIGHT PER LIN. FT

EXT. WALLS

3" + 1,6" + 1,8" = 6,4"

$\frac{27}{2,5}$ = 10,8 × 6,4 = 69#/CY

CROSS WALLS 10,8 × 7,8 = 84#/CY

AVERAGE = 76#/CY

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE July 15 '72 REV. SKETCH# AD-S-117
Trumbull Lake Dam
Pequonnock River Basin, Conn.
Composite Design - Gravity Dam

CONC. PLACING (CONV.)

CONV. OPERATORS 3 @ 7.75 = 23.25
CREW 3 MEN @ 5.60
1 FORMAN @ 6.10 } = 22.90
#46.15

COST/DAY = #46.15 x 8 = #370/DAY
#370/DAY x 77 DAYS = #28,600
COST/C.Y. = #28,600/35,280 C.Y. = .81 ¢/YD.

CONC. PLACING (FILL INT. MASS & CELLS)

3 CONV. OPER @ 7.75 = 23.25
1 HOIST OPER @ 8.60 = 8.60
CREW 3 MEN
1 FORMAN } = 22.90
#54.75

COST/DAY #54.75 x 8 = #440/DAY
#440/DAY x 75 DAYS = #33,000
COST/C.Y. = #33,000/71,600 CY = .46¢/CY.

VIBRATION

PLACING INT. MASS CONC. FILL. & FILL CELLS.
1 HAND VIB. = 5.60
1 COMPACTOR OPER = 7.80
1 COMPRESSOR " = 7.40
20.80
x8
$167/DAY
EQUIP (NOT INCL. COMPACTOR) = 200/DAY
167 x 75 = 12,500/71,600 = .18¢/YD
200 x 75 = 15,000/71,600 = .21¢/YD

PLACING CONV. CONC. ON SIDES AND FOR PHASE I @ BOTTOM.
4 MEN @ #5.60 = 22.40
COMPRESSOR OPER. 7.40
#29.80 x 8 = #238/DAY
EQUIP. — — — — — #200/DAY
#238/DAY x 77 DAYS = #15,400/35,280 YD = .52
#200/DAY x 77 = 15,400/35,280 = .44/YD.

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
COMPOSITE DESIGN - GRAVITY DAM

FINISHING

TOTAL AREA = 146,000 ϕ'
SLIP AREA
116.5 x 160 x 2 x 2.25 = 84,000
94 x 160 x 1 x 2.25 = 34,000
118,000

146,000
-118,000
28,000 ϕ'

CURING:

308,000 ϕ'
-29,000
279,000 ϕ'

12 x 40 x 60' = 29,000 ϕ'
(↑ LAYERS, ↑ AVE. WIDTH)

HORIZONTAL JT. TREATMENT TOTAL = 425,650 ϕ'
ELIMINATED BY SLIPFORM = 190,000 ϕ' (ER-57)
ADD'L ELIMINATION
83.75 x 12 = 1000 → 1000.00
77.50
71.25
65.00
58.75
52.50
46.25
40.00
33.75
27.50
21.25
1493.55 x 60 = 89,600
190,000
279,600

425,650
- 279,600
146,050 ϕ' REMAINING

JAY POST

31 JACKRODS x 15' = 465 LF
31 " x 26' = 810
1275 LF

SPILLWAY FIXED BULKHEADS 16 CROSS WALLS

16 WALLS x 2 x 2.5' x 15' = 1200 ϕ'
16 " x 2 x 2.5 x 26' = 2080 TOT'L = 3280 ϕ'

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15, '72 REV. SKETCH# AD-5121
TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
COMPOSITE DESIGN - GRAVITY DAM

CONVEYOR SYSTEM

	L.F.
BATCH PLANT TO TRESTLE =	50
MAIN DISTRIBUTION CONV. ON TRESTLE =	430
3 DISTRIBUTION CONV. ⊥ TO TRESTLE (3×50) =	150
1 CONV. (MAT'L TOWER TO CELL FILLER CONV.) =	15
CELL FILLER DISTRIBUTION CONV. =	465
~~3 CONV. (CELL FILLER CONV. TO ELEPHANT TRUNKS (3×10) =~~	30
2 CONV. (DIST. CONV. ON DBL. TRUSS) (2×60) = (1 RE-USE)	120
2 CONV. (SPREADERS) (2×80) = (2 RE-USE)	160
1. CONV. (SPREADERS) (1×90) = (1 RE-USE)	190
	1510

ADD'L CONVEYORS:

ABUTMENT CONV.	200
PLACING CONV. (FOR CONVENTIONA)	150
RADIAL CONV.	30
	380

TOTAL 1510
380
1890 LF × \$150/LF = \$284,000
RAIL + ACCESS @ 10% 29,000
SIDE DISCHARGE 7,000
\$320,000
SAY − 160,000 SALVAGE
\$160,000

\$160,000 BASED ON 24" CONV.

WE'LL USE 16" CONV. ∴ 67% × 160,000
= \$107,000 FOR 166 DAYS

\$107,000 / 166 DAYS = \$650/DAY

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15, '72 REV. SKETCH # AD-3122

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

COMPOSITE DESIGN - GRAVITY DAM

CONV. SYSTEM CONT:

INITIAL ERECTION

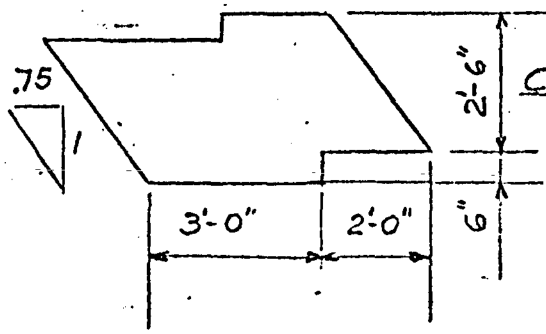
5 MEN @ 8.00 = $40/HR = $1600/WK
X 5 WKS = 8000 ERECT
X 3 WKS = 4800 DISMANTLE
$12,800 TOTAL

COST/YD = 12,800 / 127,000 = .10¢/YD.

1/

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

PRECAST BLOCKS



SEC. THRU PRECAST UNIT
L = 10 FT

MISC.

1/ CONC. VOL. FOR ONE UNIT.
5 × 2,5 × 10 = 125 CF = 4,7 CY
WEIGHT = 18750# ≈ 9,5 TONS
1548 UNITS

ASSUME DAILY PRODUCTION OF 21 EA.
STORAGE ≈ 7 DAY SUPPLY

2/ FORMS 21 EA. REQ
CONTACT AREA
5×10 + 7×10 + 2×10 = 140 SF

3/ INSERTS
4 EA. PER UNIT (USE PRESTRESSING STRANDS)
1,548 × 4 = 6,192 SAY 6200 EA. @ 1.50 EA.
6200 × 1,5 = $9,300.00

4/ REINF. - NONE

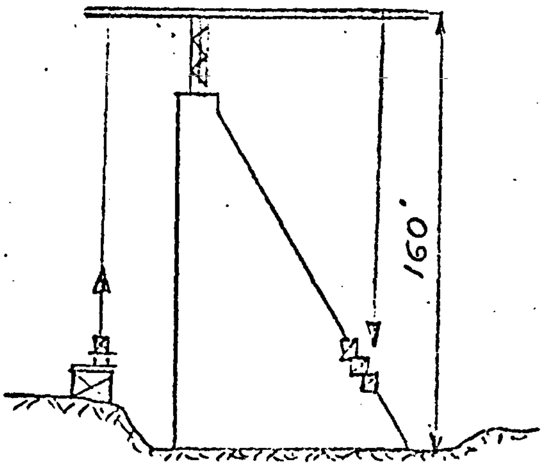
2

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15/72 REV. SKETCH# AD-S124
TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN CONN.
COMPOSITE DESIGN - PRECAST ...

CRANE CYCLE & SETTING TIME

1/ PICKUP POINT UPSTREAM EL. 170' ±
2/ LANDING POINT DOWNSTREAM - LOW POINT 162' ±
HIGH PT. 250' ±



CENTER OF UNLOADING AREA ~ 110 FT FROM PICKUP HORIZONTALLY.
VERT. TRAVEL TO CTR. OF UNLOADING AREA ~ 230 FT

1/	HOOK PRECAST SEC.	120 SEC.	
2/	ACCELERATE & RAISE	60 "	
3/	SWING	60 "	
4/	LOWER & DECELERATE	60 "	
5/	SPOT & PLACE SEC.	360 "	
	UNHOOK	60 "	720 SEC
6/	RAISE, SWING & LOWER HOOK	90 "	90 "
			810 SEC/CYCLE
			= 13,5 MIN/CYCLE

ASSUME 7½ PRODUCTION HR'S PER 8 HR DAY

SAY 14 MIN/CYCLE.

$\frac{7,5 \times 60}{14}$ = 32 SECTIONS/DAY

3

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15/72 REV. SKETCH# AD-S125

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
COMPOSITE DESIGN-PRECAST FACE

PRODUCTION SCHEDULE & STORAGE

DAY	Nº PRODUCED	Nº SET		
1	21	0	POUR 21/DAY	1ST PHASE
7	147 = STOCK	0		
8	168	16	SET 16/DAY	
25	525	288		
32	672 - 516 156 = STOCK	516	SET 32/DAY	
33	693	532	21/DAY; SET 16/DAY	2ND PHASE 3RD SIM.
50	1050	804		
57	1197 - 1028 169 = STOCK	1028	SET 32/DAY	
74	1548 EA			

4

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15 /77 REV. SKETCH# AD - 512(

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
COMPOSITE DESIGN - PRECAST FACE

PRECAST OPERATION FOR 1548 BLOCKS

A/ FORMS, 21 REQ.

21 × 140 SF = 2940 SF × 6,50 = $ 19,100

PRICE/SF DEL. 6^{50}

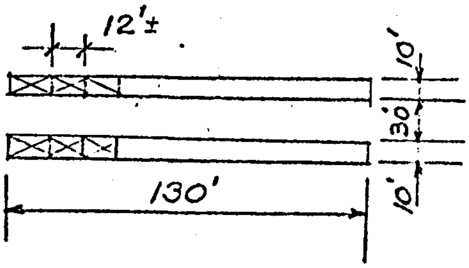
CASTING BEDS

GRAVEL BASE

130 × 50 × 1' = 6500 SF/CF

COMPACTED 6500 $

@ 1 $/SF



EXCAVATION & GRADING CHARGED TO "GEN. EQUIPMENT"

B/ LABOR

No OF POURS/DAY = 21

CONCRETE /DAY = 21 × 4,7 CY = 100 CY/DAY

LABOR FOR FACE BLOCKS (GANG MOLDS)

OPERATION	MEN	HRS	TOTAL
SET	3	1/4	3/4
POUR	3	3/4	2 1/4
FINISH	1	3/4	3/4
STRIP & CLEAN	3	1	3
PRODUCTION TIME		2 HRS	6 3/4 HRS

ONE CREW PRODUCES 4 UNITS / 8 HR DAY

5 CREWS WILL BE REQ. FOR 21 UNITS/DAY

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15/72 REV. SKETCH# AD-S 12

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

COMPOSITE DESIGN - PRECAST FACE

CREW FOR PRECAST OPERATION

1 FOREMAN	10.20	10.20
15 LABORERS	5.60	84.00
2 MASONS	8.90	17.80
2 CONV. OPER.	7.75	15.50
		127.50/HR × 8 = 1020.00/SHIFT

ASSUME 80 PRODUCTION DAYS

80 × 896 = 71,680.00

2 YARD CRANE OPERATORS 8.60 17.20 × 8 = 137.60/SHIFT

C/ CONCRETE PRODUCTION & PLACING.

1/ CONC. PRODUCTION CHARGED TO MIXING PLANT

2/ TRANSPORTATION & PLACING.

a/ 1 - 400 FT CONVEYOR @ 1.50/LF/DAY × 80 = 48,000.00

A-FRAMES TO SUPPORT ABOVE CONV. INCL. INSTALLATION. = 2000.00

b/ 2 - 150 FT. CONVEYORS @ 1.50/LF/DAY × 80 = 36,000.00

A-FRAMES FOR ABOVE = 2000.00

c/ 1 - CONC. HOPPER = 3500.00

D/ STORAGE YARD - EXCAV., GRADING & ACCESS - ROAD

1 FT GRAVEL BED COMPACTED - 300' × 120' = 36,000 SF @ 1.00/SF = 36,000.00

EXCAV. & GRADING CHARGED TO "GEN. EQUIPMENT".

4000 SF OF ACCESS ROAD @ 1.00/SF = 4000.00

E/ EQUIPMENT

2 YARD CRANES 1000.00/MONTH

6

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15/72 REV. SKETCH# AD - 512

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

COMPOSITE DESIGN-PRECAST FACE

F/ ERECTION

20,000 LF OF JT.

ASSUME 3 SQ. INCH AREA ≈ 15 CY OF MORTAR

REQ. CREW = 2 MASONS
1 LABORER

PROJECTED WORKING TIME

60 DAYS AT 335 LF/DAY
SAY 70 DAYS

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

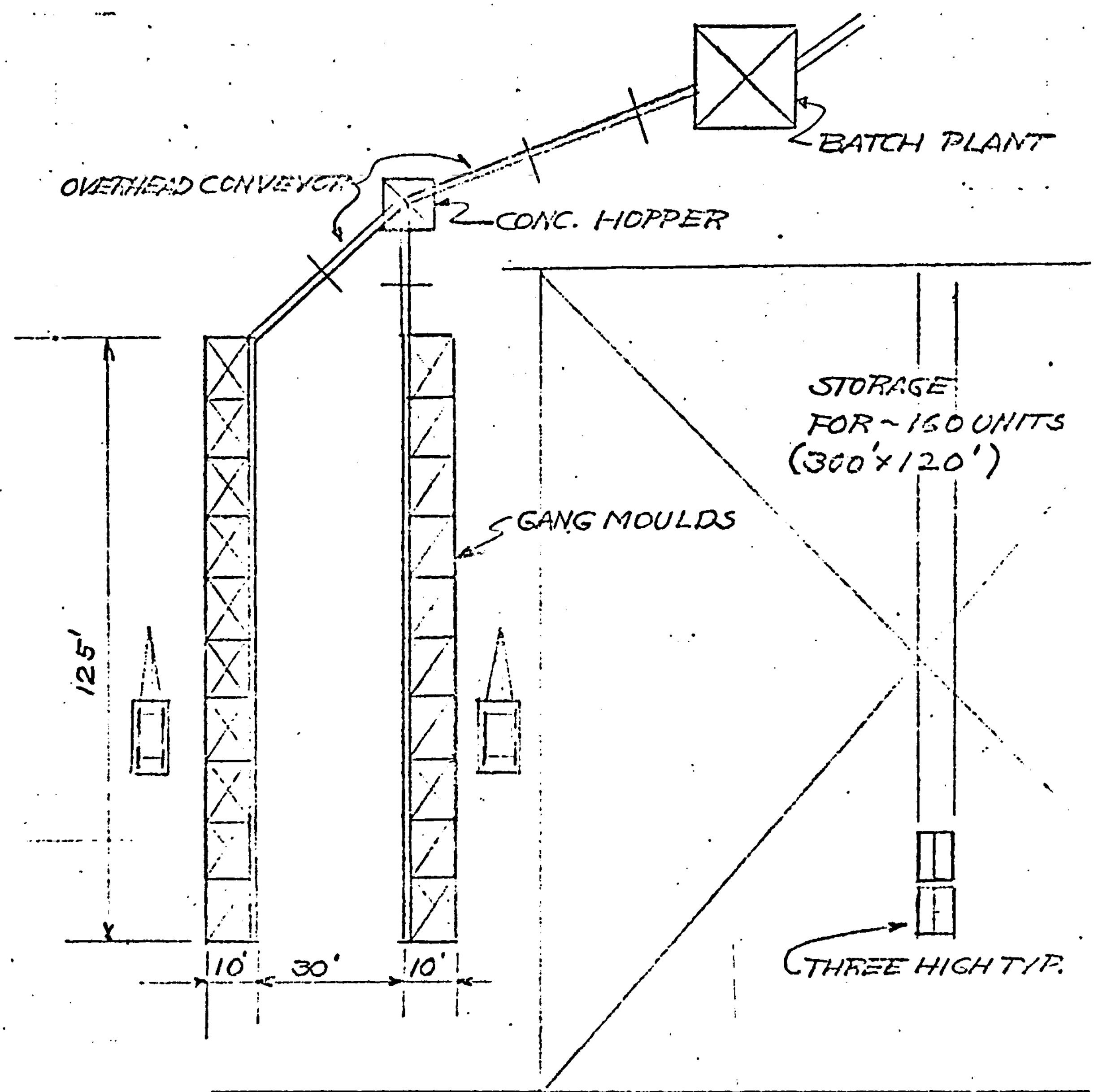
DATE JULY 15/[illegible] REV. SKETCH # AD-S14

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

COMPOSITE CONSTRUCTION - PRECAST

PROPOSED PRECAST PLANT LAYOUT



COST AND FEASIBILITY STUDY
ALTERNATE DESIGNS TO PERMIT USE
OF SLIP FORM AND OTHER TECHNIQUES
TO MAXIMIZE ECONOMIES

BOOK AC2

APPENDIX: MASSIVE HEAD BUTTRESS DAM

CALCULATIONS AND COST STUDY SHEETS

BOOK AC-2 - APPENDIX: MASSIVE HEAD BUTTRESS DAM, CALCULATIONS AND COST STUDY SHEETS

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15/72 REV. SKETCH# AR-200

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
BUTTRESS DAM STUDY

THIS PRELIMINARY INVESTIGATION ENCOMPASSES HEAD BUTTRESS DAMS OF 4 DIFFERENT SIZES AND ONE FLAT SLAB BUTTRESS DAM.

1/ THE HEAD BUTTRESS DAMS WERE INVESTIGATED FOR VARYING STEM SIZES WITH CONSTANT HEAD DIMENSIONS.

SCHEME #	STEM LENGTH	STEM WIDTH
1	135'	10'
2	135'	8'
3	100'	8'
4	120'	8'

2/ SCHEME #2 SATISFIES THE CONDITION OF 0-STRESSES AT THE HEEL IN THE MOST SATISFACTORY WAY.

3/ SCHEME #1 INCLUDES A SPILLWAY LAYOUT WHICH IS APPLICABLE TO THE OTHER SIZES.

4/ SCHEME #4 WAS DESIGNED FOR MODERATE UPLIFT (~450 K) AND USE OF ROCK BOLTS (112K ROCK ANCHORS)

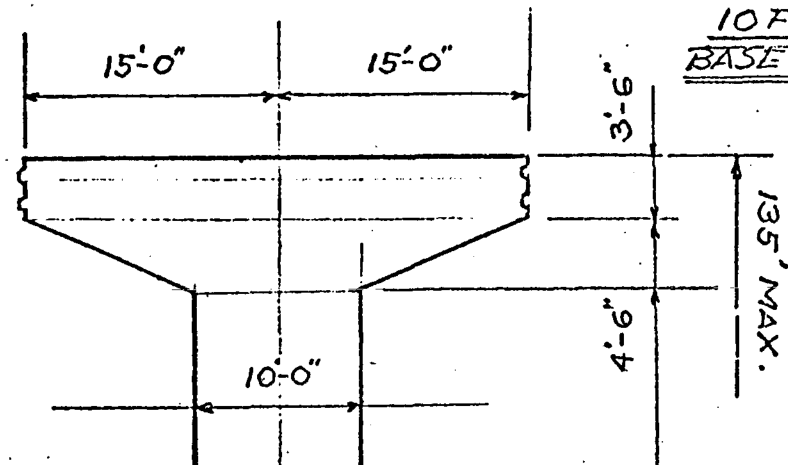
5/ THE FIRST TRY FOR THE AMBURSEN DAM RESULTED IN NEGATIVE STRESSES AT THE HEEL (-5,2 K/SF)
IT IS SUGGESTED TO USE A 125 FT BASE-LENGTH INSTEAD OF 118 FT.

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15/73 REV. SKETCH# AR-201

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
BUTTRESS DAM STUDY, SCHEME "1
10

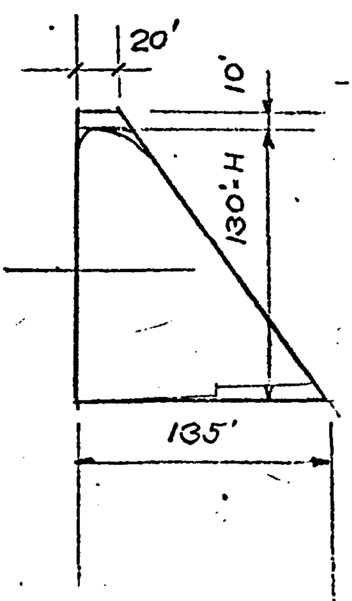
10 FT STEM
BASE LENGTH = 135'



MAX. WATER PRESSURE = $130' \times 60 = 7.8^k$

$M_{MAX} = \frac{7.8 \times 10^2}{2} = 390^{'k}$

$A_s = \frac{390}{1.76 \times 92.5} = 2.4 \square''$



FOR $H = 65' - M = 195^{'k}$

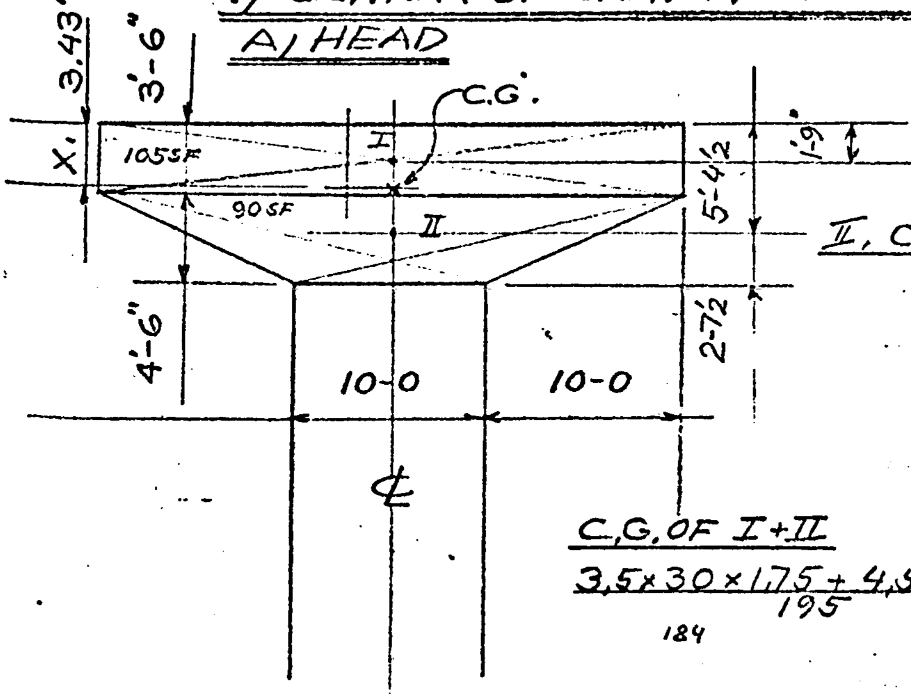
$A_s = 1.2 \square''$

FOR $H = 32.5' - M = 97.5^{'k}$

$A_s = 0.6 \square''$

1/ CENTER OF GRAVITY OF CONC. SECTION

A/ HEAD



II, C.G. = $\frac{4.5}{3} \times \frac{10 \times 60}{40} = 2.62'$

$4.5 - 2.62 = 1.88'$

C.G. OF I + II

$\frac{3.5 \times 30 \times 1.75 + 4.5 \times 20 \times 5.38}{195} = X_1 = 3.43'$

184 484

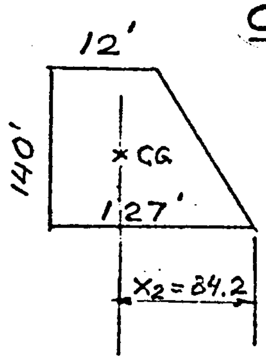
TOT. VOL. OF BUTTRESS HEAD

$V_I = (105 + 90) \times 140 = 27{,}300\,CF = 1010\,CY$

TOT. WEIGHT OF BUTTRESS HEAD

$1{,}010 \times 4{,}000^{\#} = 4{,}040^{K}$

B/ STEM



C.G. OF STEM $= X_2 = \frac{2 \times 127}{3} - \frac{12^2}{3(12+127)} = 84.2'$

84.5 0.35

TOT. VOL. OF STEM

$V_{II} = 69.5 \times 140 \times 10' = 97{,}300\,CF = 3{,}600\,CY$

TOT. WEIGHT OF STEM

$3600 \times 4000^{\#} = 14{,}400^{K}$

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

C/ C.G. OF HEAD + STEM

$$\frac{4{,}040 \times 131.57 + 14{,}400 \times 84.2}{18.440} = Z = 94.5'$$

14400
4040
18,440^K

2/ WATER PRESSURE (HORIZ.)

RESULTANT WATER PRESSURE $= P_W = \frac{W \times H^2}{2} \times b$

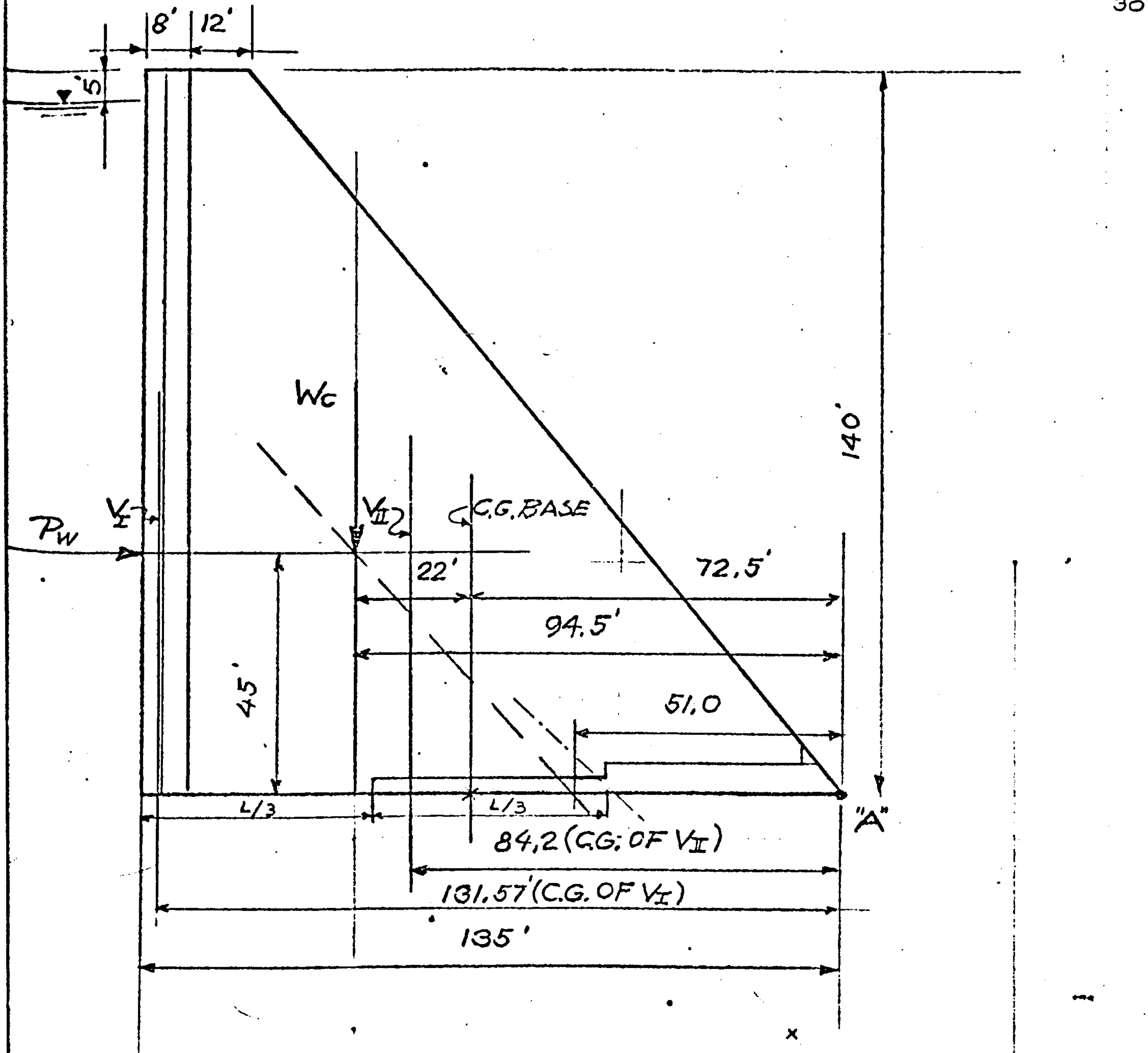
$H = 135'$ $b = 30'$

$P_W = \frac{62.5 \times 135^2 \times 30'}{2} = 17{,}100^K$/BUTTRESS

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15/72 REV. SKETCH # AR 204

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
BUTTRESS DAM STUDY, SCHEME #1



FORCE	MOMENT ARM-FT	MOMENT "A"
W_c = 18,440^K	94.5	+1,741,000 'K
P_W = 17,100^K	45.0	- 769,000 'K
	RIGHTING M =	+972,000 'K

$\frac{M_c}{M_w}$ = 2.26

1) UPLIFT MAY BE DISREGARDED WITH PROPER DRAINAGE.

2) 2.26 > 1.5 O.K. BECAUSE EARTHQUAKE & ICE NOT CONSIDERED IN CALCULATION.

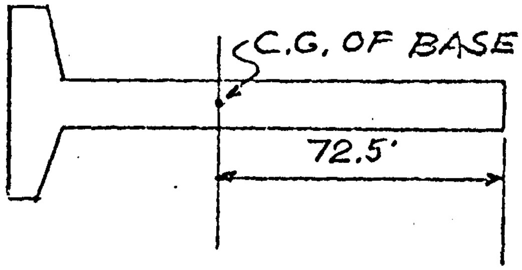
J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

CENTER OF GRAVITY OF BASE

135.0
3.43
131.57

195
1270
1465

TAKING M AROUND "A" : $\frac{195 \times 131.57 + 1270 \times 63.5}{1465} = Y = 72.5'$ FROM TO



J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

STRESS ANALYSIS

$\sigma = \frac{W}{A} \pm \frac{M \times Y}{I}$

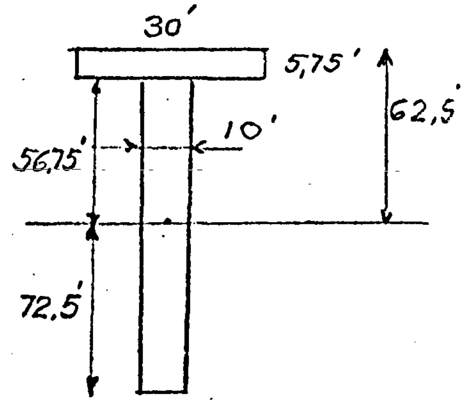
(PW) +769,000
(WC) −406,000 = 22 × 18440
363,000 'K

$W = 18,440^{K}$

$A = 195 + 1270 = 1465$ SF

$M_{CG} = +363,000$ 'K

$Y_{1,2} = 72.5', 62.5'$



$I = \frac{30 \times 62.5^3 + 10 \times 72.5^3 - 2 \times 10 \times 56.75^3}{3}$

$= \frac{30 \times 244{,}140 + 10 \times 381{,}100 - 20 \times 182{,}300}{3}$

7,330,000 3,811,000 3,646,000

$I = 2,498,300 \text{ FT}^4$

$\sigma_{TOE} = 12.6 + \frac{363{,}000 \times 72.5}{2498{,}300} = 23.1$ KSF

$= 160$ PSI

0.074
5.4

$\sigma_{HEEL} = 12.6 - 9 = 3.6$ KSF

$= 25$ PSI

$\frac{363{,}000 \times 62.5}{2{,}498{,}300} = 9$

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

SPILLWAY SLAB

CLEAR SPAN = 20'-0"

ASSUME SLAB THICKNESS OF 12" - d = 9"

DL = 150 #/SF
LL = 620 #/SF (10 FT SURCHARGE)
770 #/SF

$M = \frac{pl^2}{10} = 0,77 \times 40 = 30,8^{1K} > 23,9^{1K}$

TRY 18" SLAB - d = 15"

DL = 216 #/SF
LL = 620 #/SF
836 #/SF

$M = 0.836 \times 40 = 33,4^{1K} < 66^{1K} \left(\frac{Kd^2}{1000}\right)$

$As = \frac{33,4}{1,76 \times 15} = 1,26 \square''$

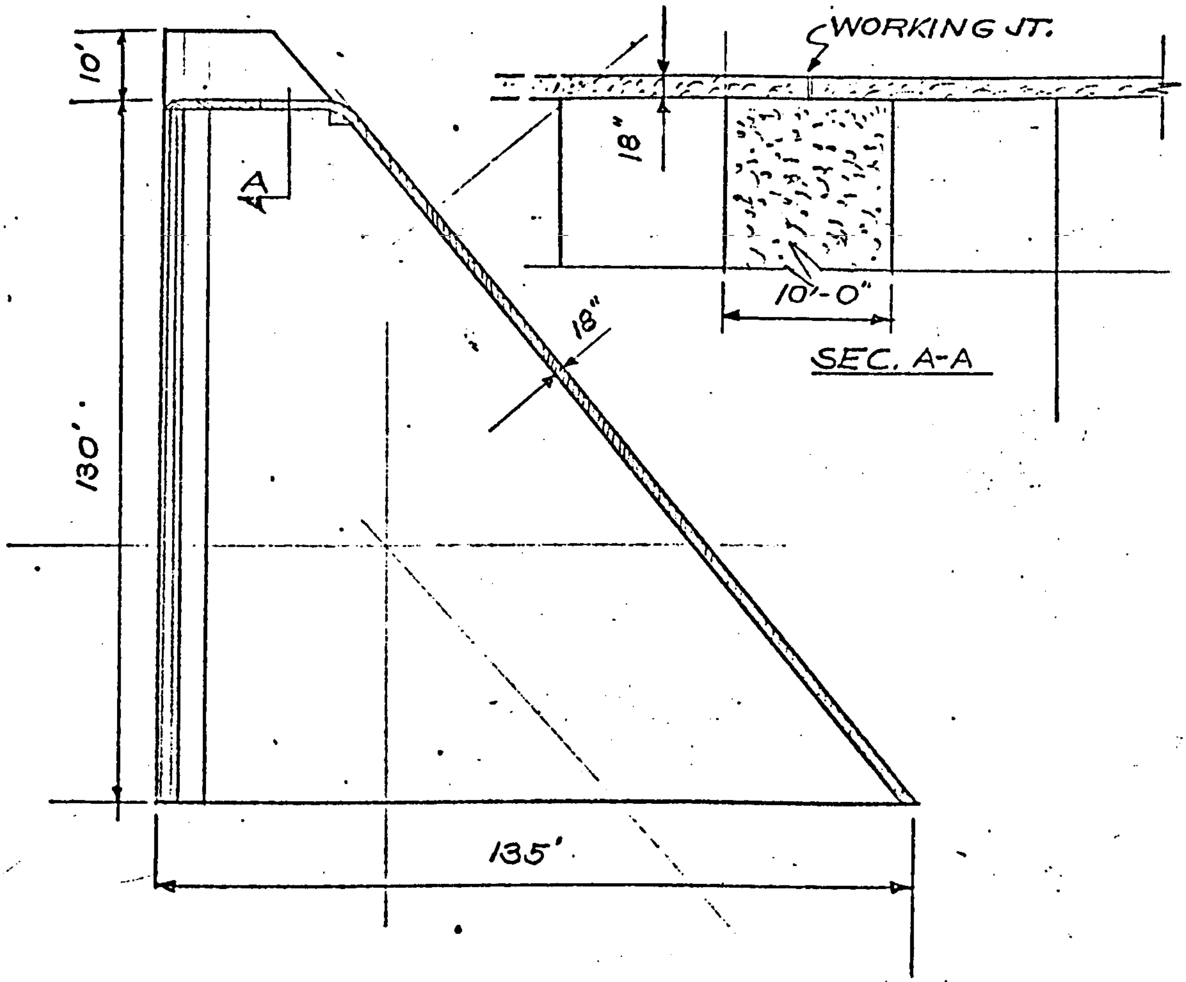
SAY #8@8"

(#8@7" FOR 22 FT SPAN)

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15/72 REV. SKETCH # AR-203

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
BUTTRESS DAM STUDY, SCHEME #1



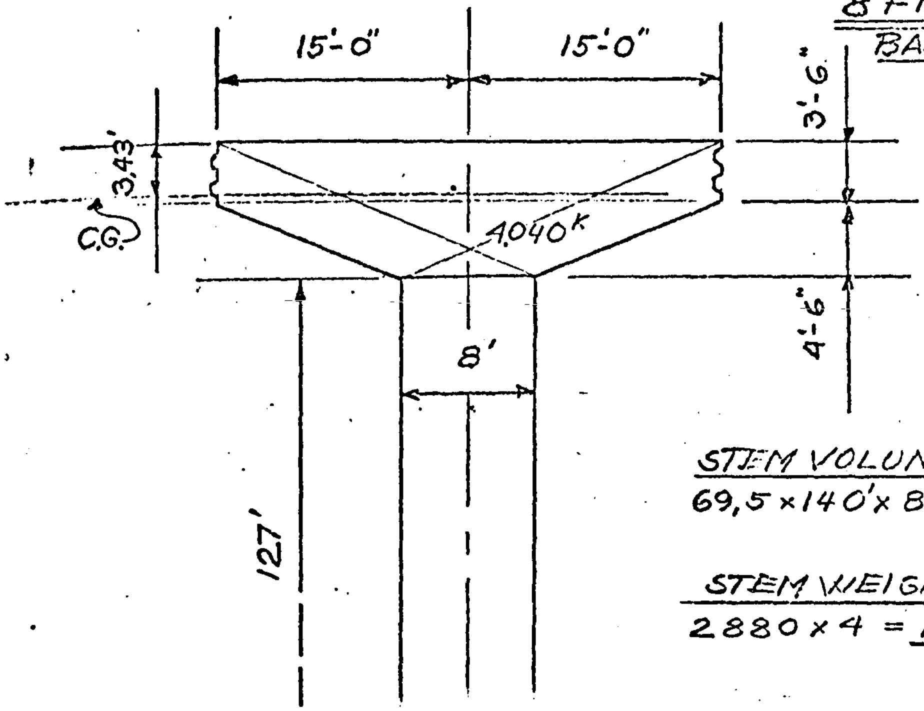
SECTION TROUGH SPILLWAY

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 11/72 REV. SKETCH

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
BUTTRESS DAM STUDY, SCHEME #2

8 FT. STEM
BASE LENGTH = 135'



3600
2888
- 712 CY

STEM VOLUME
69,5 × 140' × 8' = 77,800 CF
2,880 CY

STEM WEIGHT
2880 × 4 = 11,520^K

	CY	FORCE^K	MOMENT ARM	MOMENT	TOTAL
HEAD	1,010	4,040	131,57	+ 532.000	
STEM	2,880	11,520	84,20	+ 971.000	+ 1,503,000
WATER	—	17,100	45.00	- 769.000	- 769,000

RIGHTING M = + 734.000

$$\frac{M_c}{M_w} = \frac{1,503,000}{769,000} = 1,96$$

C.G. OF BASE
TAKING M AROUND TOE.

$$\frac{195 \times 131,57 + 1016 \times 63,5}{1211} = Y = 74,4'$$

195
1016
1211

25,600
64,500
90,100

W_c = 4,040 K
11,520 "
15,560 K

C.G. OF HEAD + STEM FORCES

$$\frac{4,040 \times 131,57 + 11,520 \times 84,2}{15,560} = 97' \text{ FROM TOE}$$

- 11 -

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15/72 REV. SKETCH# AR-210

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
BUTTRESS DAM STUDY, SCHEME #2

STRESS ANALYSIS

$\sigma = \frac{W}{A} \pm \frac{M \times Y}{I}$

$W = 15{,}560^{k}$

$A = 1211$ SF

$M_{CG} = +419.000^{\prime k}$

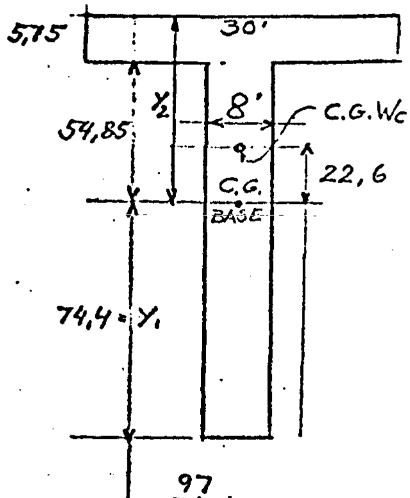
$Y_{1,2} = 74{,}4'$, $60{,}6'$

$I = \frac{30 \times 60{,}6^3 + 8 \times 74{,}4^3 - 2 \times 11 \times 54{,}85^3}{3}$

$\frac{30 \times 222{,}545 + 8 \times 411{,}830 - 22 \times 165000}{3}$

6,676,400 3284,640 3,630,000

$I = 2{,}110{,}350$ FT^4



97
−74,4
22,6

(Pw) +769000
(Wc) −350000
+419,000 $^{\prime K}$ 15,560×22,5

$\sigma_{TOE} = \frac{15{,}560}{1{,}211} + \frac{419{,}000 \times 74{,}4}{2{,}110{,}350}$

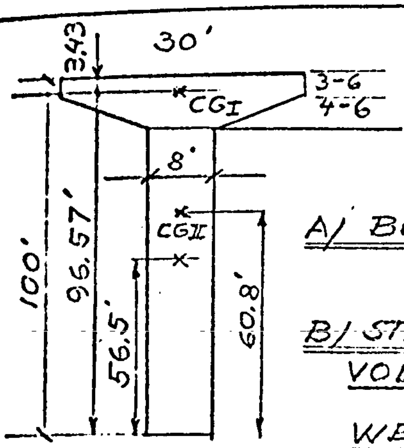
12,83 + 14,8 = +27,63 KSF
= +192 PSI

$\sigma_{HEEL} =$ 12,83 − 12,1 = + 0,73 KSF
= + 5 PSI

$Y_2 = 54{,}85 + 5{,}75 = 60{,}60'$

$\frac{M \times Y_2}{I} = \frac{419{,}000 \times 60{,}6}{2{,}110{,}350} = 12{,}1$

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.



8 FOOT STEM
BASE LENGTH = 100 FT

1/ C.G. OF CONC. SECTION

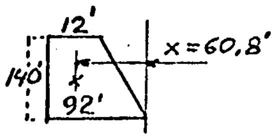
A/ BUTTRESS HEAD: 1010 CY - 4040^K

B/ STEM

VOL.: 52' × 140' × 8' = 58,200 CF = 2160 CY

WEIGHT = 2160 × 4^K = 8640^K

C.G. OF STEM



$$\frac{2}{3} \times 92 - \frac{12^2}{3 \times (12 + 92)} = 60.8'$$

61.3 0.46

100.00'
3.43
96.57'

C/ C.G. OF HEAD + STEM

4040
8640
12,680

$$\frac{4040 \times 96.6 + 8640 \times 61}{12,680} = Z = 66'$$

2/ WATER PRESSURE

P_W = 17,100 K/BUTTRESS

3/ C.G. OF BASE (M AROUND TOE)

195
736
931

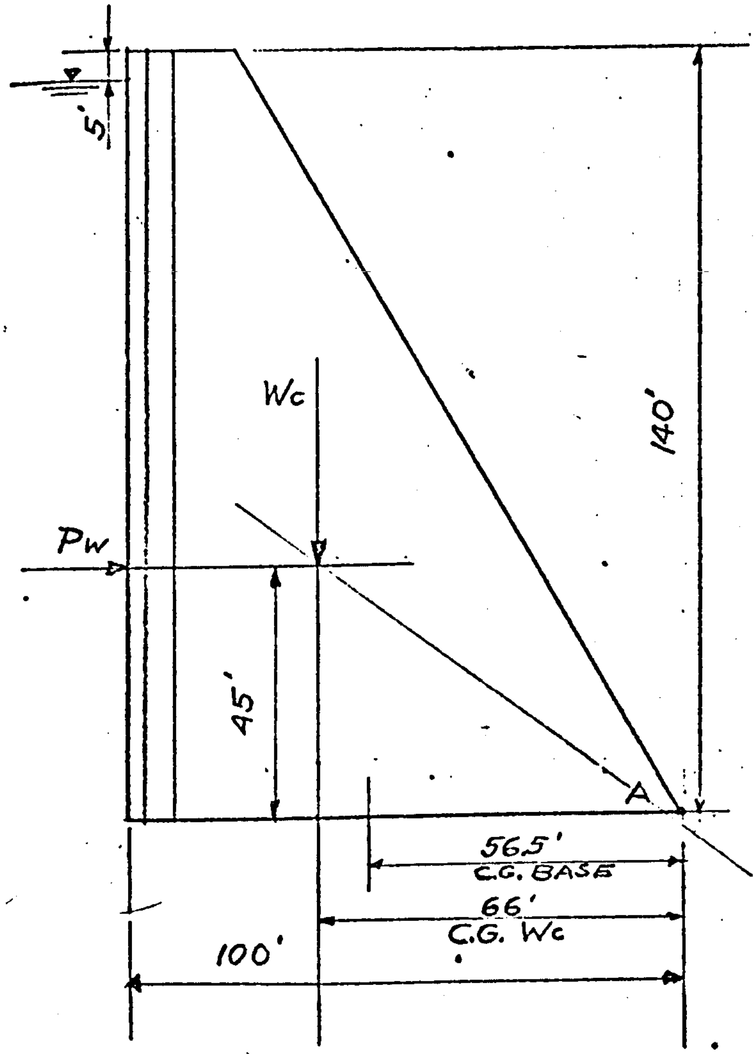
$$\frac{195^{SF} \times 96.6' + 736^{SF} \times 46'}{931} = Y = 56.5'$$

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15/72 REV. SKETCH #AR-212

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN CONN.
BUTTRESS DAM STUDY, SCHEME #5

30



FORCE	MOMENT ARM, FT	MOMENT "A"
Wc = 12,680 K	66	+ 836,000 IK
Pw = 17,100 K	45	−769,000 IK
	RIGHTING MOMENT =	+ 67,000 IK

$\frac{M_c}{M_w} = 1.1$

769 000 IK × 2 = 1,538,000 IK (ASSUMING SAFETY FACTOR 2)
− 836,000 IK
702,000 IK = ADDITIONAL "+M" REQ.

ASSUME LEVER ARM OF 97 FT

$\frac{702,000^{IK}}{97}$ = 7,250 K − TOO HIGH, TRY 120 FT BASE

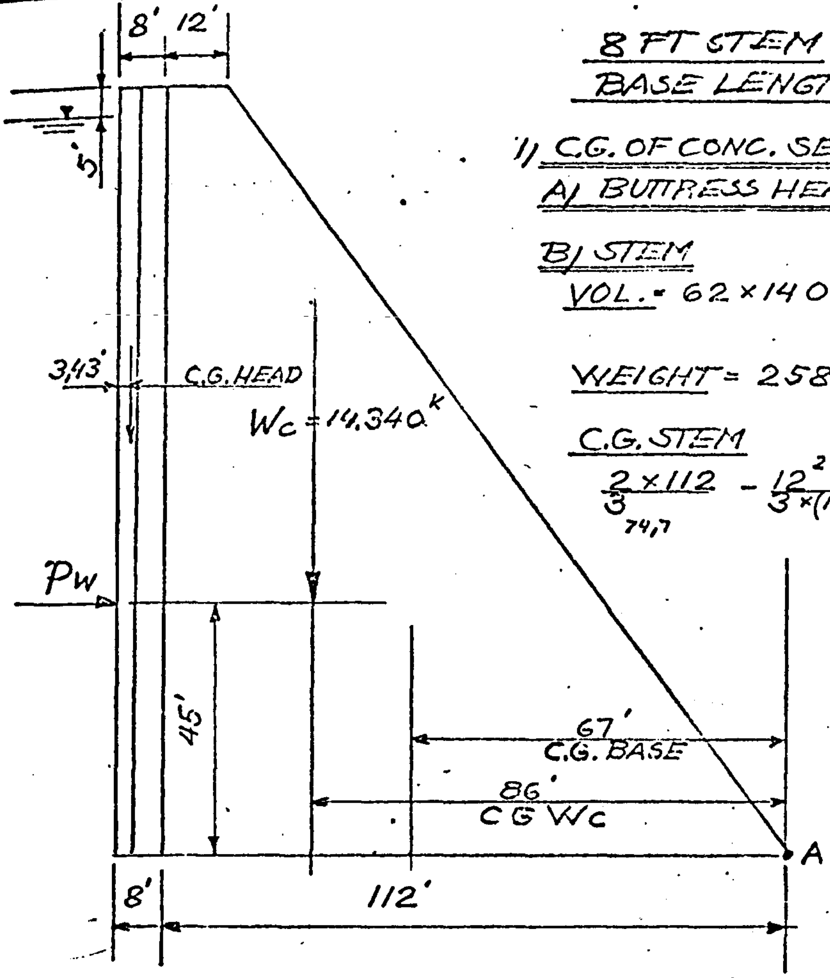
J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 10/72 REV. SKETCH # AR-213

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

BUTTRESS DAM STUDY, SCHEME #4



8 FT STEM

BASE LENGTH = 120 FT

1) C.G. OF CONC. SECTION

A) BUTTRESS HEAD: 1010 CY – 4,040^K

B) STEM

VOL. = 62 × 140 × 8 = 69,500 CF

= 2,580 CY

WEIGHT = 2580 × 4^K = 10,300^K

C.G. STEM

$$\frac{2 \times 112}{3}_{\,74,7} - \frac{12^2}{3 \times (12 + 112)}_{\,0,39} = 74,3'$$

4,040
10,300
14,340 = Wc

112 × 8 = 896

195
896
1091 SF

C) C.G. OF HEAD + STEM

$$\frac{4,040 \times 116,6 + 10,300 \times 74,3}{14,340} = z = 86'$$

2) WATER PRESSURE

$P_W = 17,100^K$

3) C.G. OF BASE (M AROUND TOE)

$$\frac{195^{SF} \times 116,6 + 896^{SF} \times 56}{1091} = Y = 67'$$

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15/72 REV. SKETCH # AH-214

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
BUTTRESS DAM STUDY, SCHEME 4

FORCE	MOMENT ARM, FT	MOMENT "A"
W_C = 14,340	86	+1,235,000
P_W = 17,100	45	-769,000
	RIGHTING MOMENT =	+466 000

$\frac{M_C}{M_W} = 1.61$

STRESS ANALYSIS

$\sigma = \frac{W}{A} \pm \frac{M \times Y}{I}$

$W = 14{,}340^{k}$

$A = 1{,}091$ SF

$M_{CG} = 769{,}000 - 19' \times 14{,}340 = 469{,}500^{\,'K}$

$Y_{1,2} = 67', 53'$

$I = \frac{30 \times 53^3 + 8 \times 67^3 - 2 \times 11 \times 47.25^3}{3}$

$\frac{30 \times 148{,}877 + 8 \times 300{,}763 - 22 \times 105{,}642}{3}$

4,460,000 2,406,000 2,321,000

$I = 1{,}513{,}000$ FT^4

86 − 67 = 19'

53 − 5.75 = 47.25

$\sigma_{TOE} = \frac{14{,}340}{1{,}091} + \frac{469{,}500 \times 67}{1{,}513{,}000}$

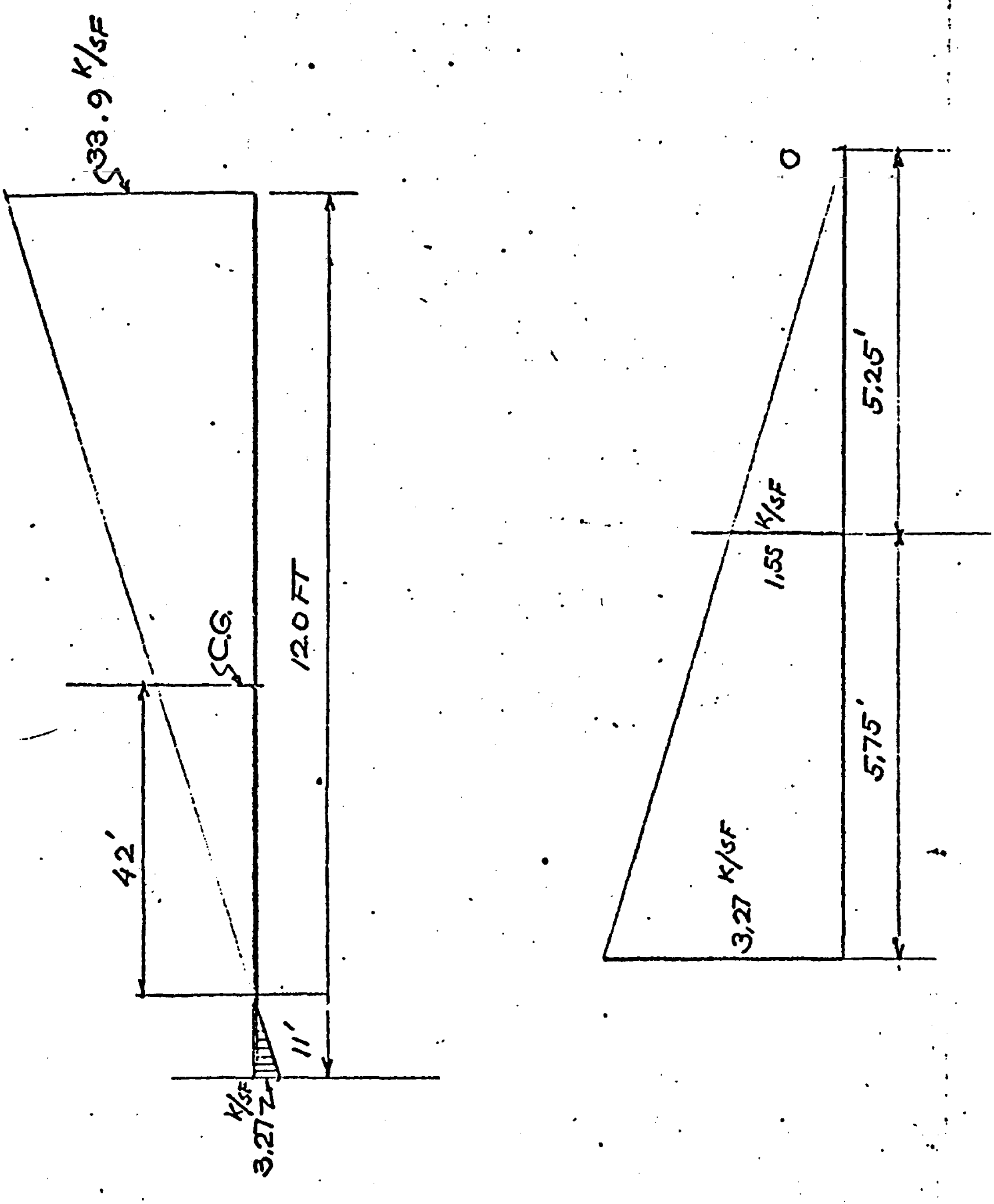
$13.13 + 20.75 = +33.88$ KSF
$= +235$ PSI

$\sigma_{HEEL} = 13.13 - 16.4 = -3.27$ KSF
$= -23$ PSI

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15/72 REV. SKETCH# AR-215

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN
BUTTRESS DAM STUDY, SCHEME



J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

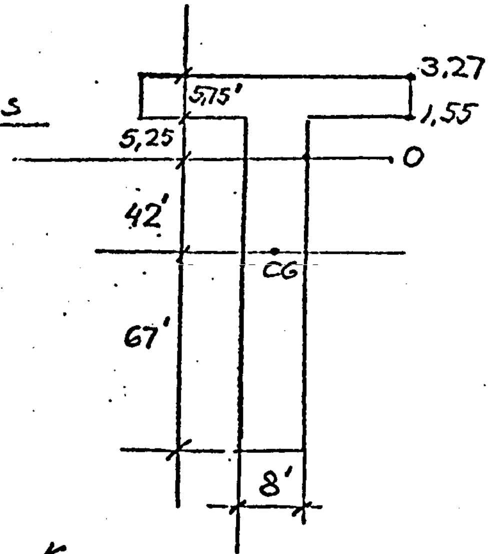
DATE JULY 15/72 REV. SKETCH# AR-216

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
BUTTRESS DAM STUDY, SCHEME "4"

A/ POINT OF ZERO STRESS

$13,13 = \frac{469,500}{1,373,000} \times Y$

$Y = 42,1'$



B/ TOTAL UPLIFT

1/ $\frac{1,55 \times 5,25 \times 8}{2} = 33^{k}$

2/ $\frac{3,27 + 1,55}{2} \times 5,75' \times 30' = 415^{k}$

TOTAL = $415 + 33 = 448^{k}$

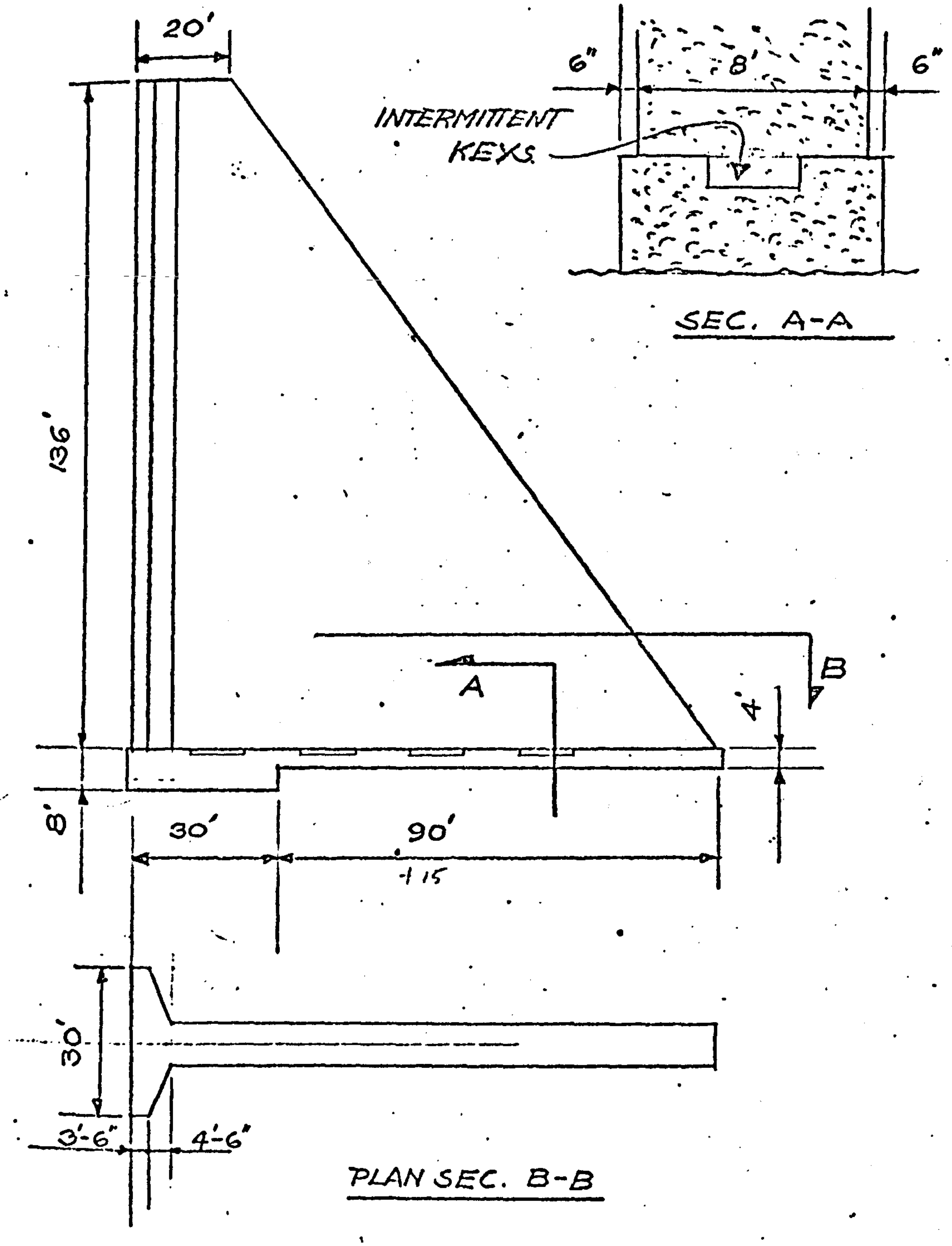
USING HIGH STRENGTH ROCK ANCHORS — 4 EA REQ. @ 112^{k} EA
TO BE SPACED EQUALLY ALONG C.G. LINE OF HEAD

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 19/72 REV. SKETCH # AH-411

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
BUTTRESS DAM STUDY, SCHEME 4

30



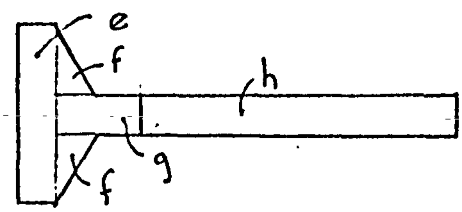
COST STUDY SHEETS

MASSIVE HEAD BUTTRESS DAM

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15, 72 REV. SKETCH# AD-S201
TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
BUTTRESS DAM ESTIMATE

BUTTRESS STEM VOLUME



e = 3.5(30) = 105
f = 4.5(11) = 49.5
g = 17.5(8) = 140

TOTAL H OF ALL HEADS

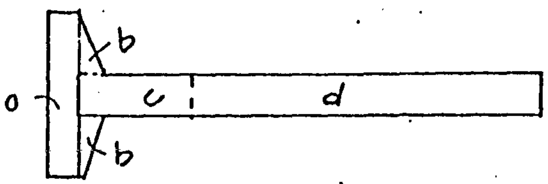
294.5 S.F (2385)/27 = 26,000 CY

½B	H	= AREA	½B	H	= AREA	½B	H	= AREA
14	36	504	51	126	6420	14	35	490
22	54	1190	48	108	5190	8	19	162
27	68	1840	45	101	4550	7	15	105
29	72	2080	43	95	4080	5	12	60
32	81	2590	41	91	3730	3	8	24
39	98	3830	40	89	3560			
48	120	5760	39	88	3440			100,308 S.F.
51	129	6580	36	85	3060			
54	137	7400	34	72	2450			
56	143	8020	15	31	465			
54	143	7730	14	26	374			
53	140	7420	14	26	374			
52	132	6880						

h = [100,308(8)]/27 = 30,000

TOTAL STEM QUANT. = 56,000 CY

AREA OF ROCK EXCAVATION



a = 4.5 (30) (30) = 4050 S.F

b = 1/2 (10.5)(4.5)(2)(30) = 1420 S.F.

c = 9(765) = 6885 SF

d = 9(1688) = 15192 SF

27,547 SF.

VOLUME OF ROCK EXCAVATION

[(27,547 - 15,192) 5 (AVER.) + 15,192 (1)]/27 = 2,860 CY.

VOLUME OF FOUNDATION CONC.

[(27,547 - 15192) (8) + 15,192 (4)]/27 = 6000 CY

AREA PRECAST PLANK AT SPILLWAY

24(20)(12)	= 5,750
$(\sqrt{(83)^2+(97)^2})$ 6(24)	= 18,300
$(\sqrt{(67)^2+(85)^2}$ 2(24)	= 5,380
$(\sqrt{(30)^2+(30)^2}$ 2(24)	= 2,030
$(\sqrt{(25)^2+(25)^2}$ 2(24)	= 1,750

A_T = 33,210 S.F.

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15, 72 REV. SKETCH# AD-S203
TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
BUTTRESS DAM ESTIMATE

SPILLWAY SLAB VOLUME

$$1.5\left[26(360) + 121(240) + 68(30) + 39(30) + 34(60)\right] / 27$$

$$= 1620 \text{ C.Y.}$$

CONCRETE SUMMARY

FOUNDATION	= 6000	CY
BUTTRESS STEM	= 56000	CY
SPILLWAY SLAB	= 1620	CY
	63,620	CY

KEYWAYS - 7,850 LF

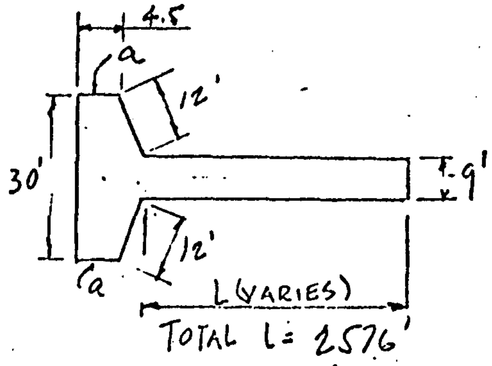
WATERSTOPS - 6820 LF

FOUNDATION FORMS

$$3\left[30(30) + 24(30) + 2576(2) \; 30(9)\right] = 21,125$$

SIDE a = 4.5(285) = 1,285

TOTAL AREA = 22,410 SF.



H. OF FORM EXC. FOR SIDE a = 3' AVER.

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

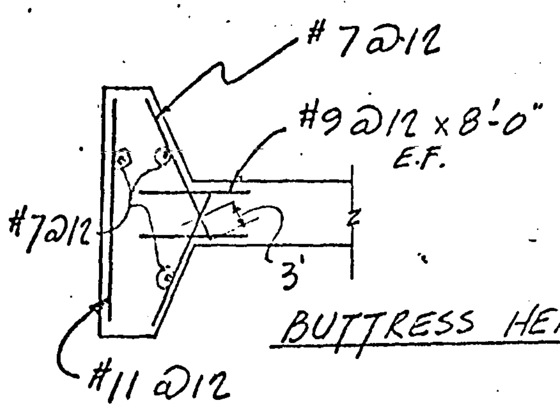
DATE JULY 15, 72 REV. SKETCH # AD-520 4

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

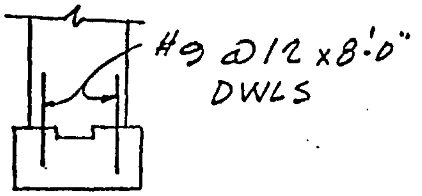
BUTTRESS DAM ESTIMATE

REINFORCEMENT



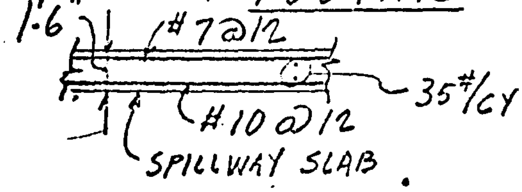
BUTTRESS HEAD

2 x 2386 #7 x 18' = 175,000#
2 x 2386 #9 x 8' = 140,000#
2386 #11 x 29.5' = 375,000#
60 #7' x 2385' = 292,000#
982,000



63(30) + 2576(2) =
7042 LF
7100 #9 x 8' = 192,000 #

FOOTING



#7@12 = 2.04
#10@12 = 4.3
6.34 / 1.5 = 4.2#/C.F.
4.2 (27) = 113#/CY.
+ 35#/CY
147#/CY
SAY 150#CY

SPILLWAY = 1620 CY ∴ 1620 (150) = 243,000#

SPILLWAY

TOTAL WT = 1,417,000#

1,417,000/2000 = 709 T

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 19, '72 REV. SKETCH AD-5 205

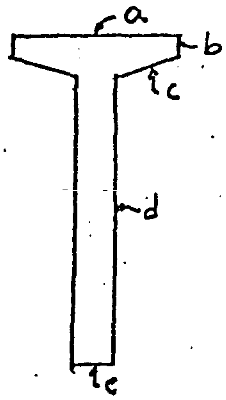
TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

MASSIVE HEAD BUTTRESS DAM

BUTTRESS SLIDE

SLIDING FORMS



a	30' x 30 =	900'
b	2 x 3.5 x 30 =	210
c	2 x 12 x 30 =	720
d	2576 x 2 =	5152
e	(SEE END BLKH. FORMS) 8 x 30 = 240	6,982'
		SAY, 7000'

YOKES

HEAD: 4 YOKES/POUR x 30 POURS = 120 YOKES

STEM:

①	30	⑥	24	⑪	16
②	30	⑦	20	⑫	14
③	30	⑧	20	⑬	11
④	27	⑨	19	⑭	9
⑤	26	⑩	18	⑮	5
				⑯	1

TOTAL IN STEM: 300

END FORM IN STEM 2 x 30 = 60

TOTAL = 120
300
420

JACK RODS

HEAD:	8 RODS x 2380'	=	19,040 LF
①	2 x 2380	=	4760
②	2 x 2380	=	4760
③	2 x 2200	=	4400
④	2 x 1913	=	3826
⑤	2 x 1650	=	3300
⑥	2 x 1401	=	2802
⑦	2 x 1180	=	2360
⑧	2 x 998	=	1996

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 197? ... SKETCH NO ...

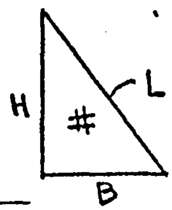
TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

MASSIVE HEAD BUTTRESS DAM

(10)	2 x	610	=	1220
(11)	2 x	521	=	1042
(12)	2 x	297	=	594
(13)	2 x	208	=	416
(14)	2 x	134.	=	268
(15)	2 x	54	=	108
(16)	2 x	11	=	22
				52,506 LF

END BULKHEAD JACKRODS



#	B	H	B^2	H^2	L^2	L	2L
1	28	36	784	1296	2080	46	92
2	44	54	1936	2916	4852	70	140
3	54	68	2916	4624	7540	87	174
4	58	72	3364	5184	8548	93	186
5	64	81	4096	6561	10,657	103	206
6	78	98	6084	9604	15688	126	252
7	96	120	9216	14400	23616	154	308
8	102	129	10404	16641	27045	165	330
9	108	137	11664	18769	30433	175	350
10	112	143	12544	20449	32993	181	362
11	112	143	12544	20449	32993	181	362
12	106	140	11236	19600	30836	176	352
13	104	132	10816	17424	28240	168	336
14	102	126	10404	15876	26280	162	326
15	96	108	9216	11664	20830	144	288
16	90	101	8100	10201	18301	135	270
17	86	95	7396	9025	16421	124	248
18	82	91	6724	8281	15005	122	244
19	80	89	6400	7921	14321	119	238
20	78	88	6084	7744	13828	117	234
21	72	85	5184	7225	12409	111	222
22	68	72	4624	5184	9808	99	198

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

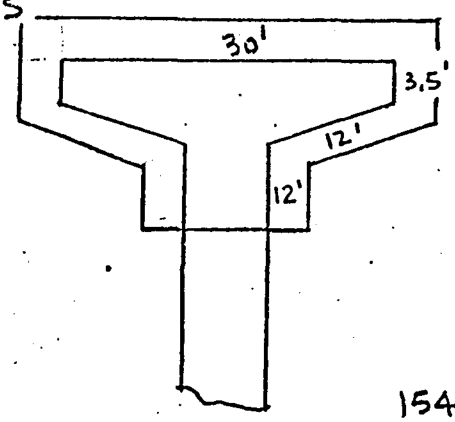
DATE JULY 15, '72 REV. SKETCH # AD- 5207

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
MASSIVE HEAD BUTTRESS DAM

#	B	H	B^2	H^2	L^2	L	2L
23	30	31	900	961	1861	43	86
24	28	26	784	676	1460	38	76
25	28	26	784	676	1460	38	76
26	28	35	784	1225	2009	45	90
27	16	19	256	361	617	25	50
28	14	15	196	225	421	21	42
29	10	12	100	144	244	16	32
30	6	8	36	64	100	10	20

TOTAL = 6190 LF

DECKS HEADS



30
3.5
3.5
12
12
12
12
4
77 LF x 2' = 154 ☐'

154 ☐' x 30 = 4620 ☐'

STEMS: 2576 LF
30 x 7 = 210

2786 LF x 5' WIDE = 13,930 ☐'

TOTAL = 18,550 ☐'

SCAFFOLDS 6982 LF x 2' WIDE = 13,964 ☐'

RAILING + LADDERS

MAIN DECK: 6982 LF SAY 7000 LF

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15 '72 REV. SKETCH# AD-S208

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

MASSIVE HEAD BUTTRESS DAM

HYDRAULIC PIPING

LGT. FORM = 7000 LF
10' x (425+60) = 4850
11,850 LF

TOPPING-OUT RODS 12/HEAD x 30 = 360 EA

SLIDE CREW 9 SETS OF HD FORMS
(2 WKS TO DISMANTLE + RE-ASSEMBLE)
30 SETS OF STEM FORMS (NO REUSE)

SLIDE @ 12"/HR.

SLIDE	9/8	16/8
1,2,3	15	3
4,5,6	15	1.5
7,8,9	15	1
10,11,12	15	—
13,14,15	15	—
16,17,18	15	—
19,20	12	—
	102	6

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

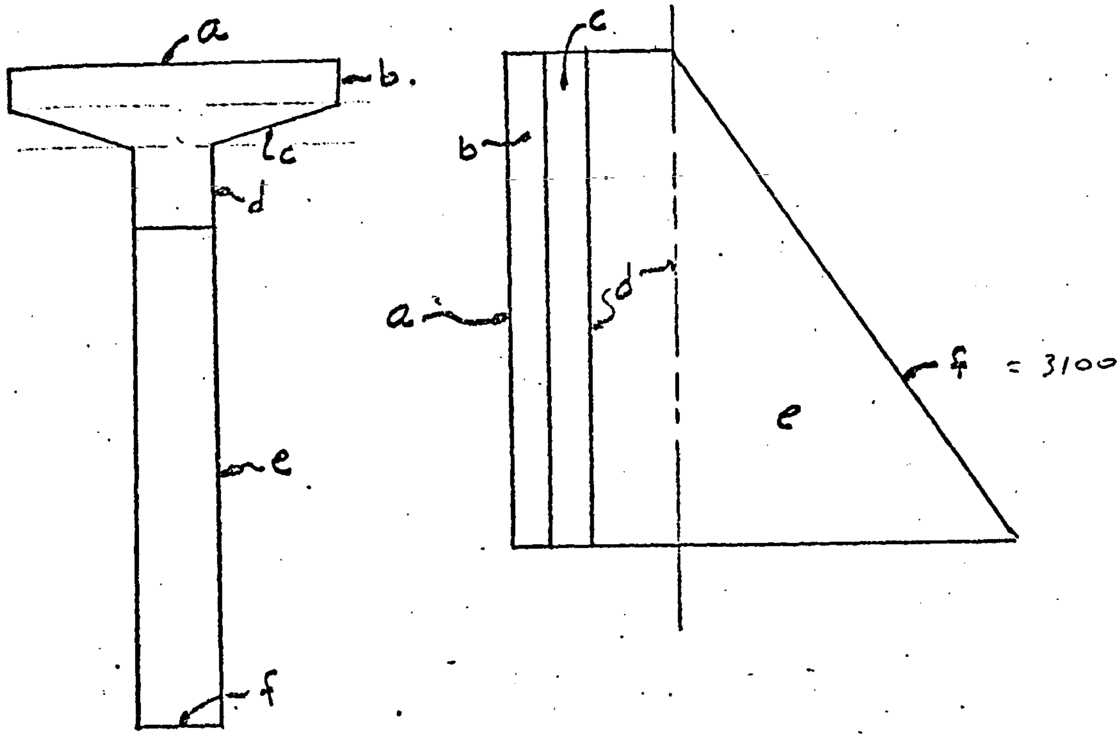
TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
MASSIVE HEAD BUTTRESS DAM

CLASSIFICATION	#	HR. RATE INCL. FR. BENIFITS	COST/SHIFT 9/8	COST/SHIFT 16/8
CONV. OPER.	1	7.75	70	124
HOIST OPER.	3	8.60	234	415
JACK OPER.	3	8.00	217	385
CARPENTER	6	9.00	488	868
ELECTRICIAN	1	8.28	75	132
FIN. FORMAN	1	9.37	85	150
FINISHERS	6	8.87	480	854
FIN. HELPERS	3	7.15	192	343
LABORERS:				
FORMAN	1	6.10	55	98
PLACING	15	5.60	755	1340
VIBRATION	6	5.60	303	538
CURING	6	5.60	303	538
IRONWORKERS	6	10.20	553	980
CRANE OPER.	2/3	8.60	51	92
OILER	2/3	6.85	41	74
IRONWORKER FORM.	1	10.70	97	171
			3999	7102

102 SHIFTS x 3999 = 408,000
6 " x 7102 = 42,700
$450,700

J. F. CAMELLERIE, P.E. 23 GREEN STREET HUNTINGTON, N. Y.	DATE JULY 15 '72 REV. SKETCH# AD-S 210 TRUMBULL LAKE DAM PEQUONNOCK RIVER BASIN, CONN. MASSIVE HEAD BUTTRESS DAM

FINISH + CURING



AREA "a"	=	30' W X HT.	30 X 2380 =	71,400 ф'
b	=	3.5 W X 2 X HT	7 X 2380 =	16,660
c	=	12' W X 2 X HT	24 X 2380 =	57,120
d	=	12' W X 2 X HT		57,120
e	=	100 300 (2) =		200,600
f	=	3100 (6)		18,600
				421,500

SAY 425,000 SF

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

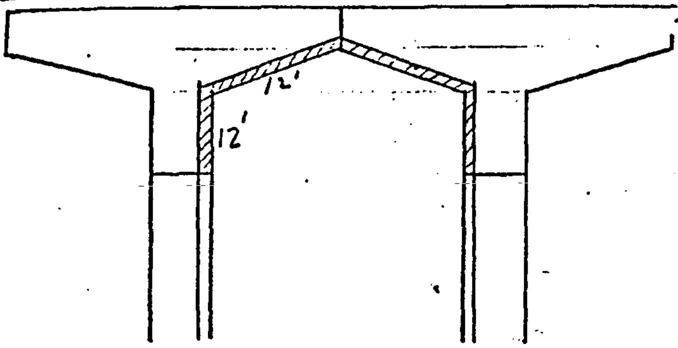
TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
MASSIVE HEAD BUTTRESS DAM

VERTICAL KEYS + WATERSTOPS

2380 x 2 = 4760 LF

SPILLWAY HORIZ. PRECAST SEAT

48' x 12 = 576 LF



SPILLWAY SLAB SEAT
+ PRECAST SEAT

#	LF	#	LF
14	163	23	86
15	288	24	76
16	270	25	76
17	248	26	90
18	244	27	50
19	238	28	42
20	234	29	32
21	222	30	20
22	198		

2577 LF

SPILLWAY

SLIDING FORMS 12 BAYS x 24' W = 288 LF

FORM RAILS

BAY	LF	BAY	LF
14	162'	21	111
15	144	22	99
16	135	23	86
17	124	24	76
18	122	25	76
19	119	26	90
20	117		

TOTAL = 1261 LF

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15, 72 REV. SKETCH# AD-5212

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

MASSIVE HEAD BUTTRESS DAM

JACKROD ANCHORS

2 ANCHORS / POUR × 12 POURS = 24

JACK ROD (22T)

	#	LF
1 –	14	326
	15	288
2 –	15	288
	16	270
3 –	16	270
	17	248
4 –	17	248
	18	244
5 –	18	244
	19	238
6 –	19	238
	20	234
7 –	20	234
	21	222
8 –	21	222
	22	198
9 –	22	198
	23	86
10 –	23	86
	24	76
11	24	76
	25	76
12	25	76
	26	90
		4776 LF

SPILLWAY SLIDE CREW

2 SETS OF FORMS
18"/HR. SLIDE SPEED

POUR	HT	HRS	÷8	
1	144'	96	12 SHIFTS	SAY
12	38	26	3.3	1 WK
2	135'	90	11.2	1 WK
11	38	25	3.1	
3	124	83	10.4	1 WK
10	43	29	3.6	
4	122	81	10.1	2 WK
9	99	65	8	
8	111	74	9.3	
5	119	79	10	1 WK
6	117	79	10	1 WK
7	111	74	10	1 WK

8 WKS

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15 '76 REV. SKETCH # AD-5 [illegible]

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
MASSIVE HEAD BUTTRESS DAM

SPILLWAY SLIDE CREW CONT'

8 WKS × 5 DAYS/WK = 40 DAYS × 3 SHIFTS(9/8)/DAY = 120 SHIFTS

CLASSIFICATION	#	HR. RATE INCL. FRINGE BENIFIT	COST/SHIFT 9/8
LOWER CONV. OPER	1	7.75	70
TOP CONV. OPER	1	7.75	70
HOIST OPER	1	8.60	78
JACK OPER	1	8.00	72
CARPENTER	1	9.00	81
ELECTRICIAN	1	8.28	75
FIN. FORMAN	1	9.37	85
FIN. HELPER	1	7.15	64
LABORERS.			
FORMAN	1	6.10	55
PLACING	3	5.60	252
VIBRATION	1	5.60	
CURING	1	5.60	
			$902

120 SHIFTS @ $902/SHIFT = $108,204

HYDRAULIC PIPING

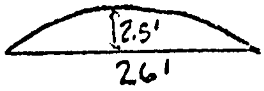
288 LF FORM
SAY 300 LF

FINISHING + CURING

2270 LF × 24 FT. WIDE = 54,500 □'

FILL @ TOP

$\frac{2}{3}bh = \frac{2}{3}(26)(2.5) = 43$ □'



43 □' × 360' = 15,200 CF

FIN: 30 LF × 360' = 10,800 □'

15,200 CF/27 = 570 CY

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

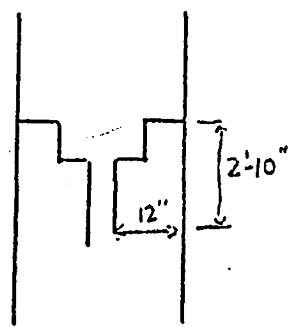
DATE JUL 15 '72 REV. SKETCH # AD-5-214
MASSIVE HEAD BUTTRESS DAM
TRUMBULL LAKE
NEW ENGLAND DIV., CORPS / ENG'R.

SLIDING FORMS 2550 LF ST'L FORMS (30 HEADS)
USE 9 SETS (3.33 USES / SET) -1 = 2.33 REUSES
x 5%
.116

ST'L FORMS = #5.00/sf w/ REUSE $\frac{5.00 \times 1.116}{3.33}$ = #1.67/sf
COST / LF = #1.67 x 4 = #6.70
4450 LF WOOD FORM (NO REUSE) COST / LF = #6.60
AVERAGE COST =.
2550 LF @ 6.70 = 17,100
4450 LF @ 6.60 = 29,400
7000 46,500 / 7000 = #6.65 AV. COST.

SPILLWAY YOKES
#600 EA / 3.33 = #180

SPILLWAY SLAB SEAT



FORM HT = 8'
DEPTH = 4'
LUMBER = 32 x 3 bd ft x .20 = #20.00
HANGERS = 2/3 x 2 x 6 x .25 = 2.00
HARDWARE 2.00
#24

LABOR = 4 x #9 = 36
#60

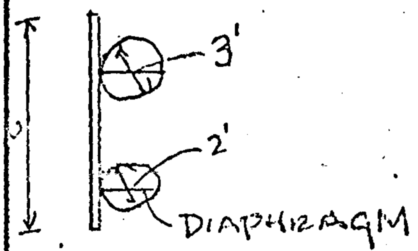
OR #15 / LF
#6 MAT'L
#9 LAB.

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUL 15, '72 REV. SKETCH # AD-S-215

MASSIVE HEAD BUTTRESS DAM
TRUMBULL LAKE
NEW ENGLAND DIV. CORPS/ENGRS.

SPILLWAY FORM



FORM	6 LF
3' TANK	9 LF
2' TANK	6 LF
DIAPHRAGMS	5 LF
	26 LF @ 5# = 130#/ft
	+ 20% 26#
	156#/ft

156#/ft @ .40 = $62.4
SAY $60.00/LF.

12 SLIDES TO BE MADE
2 SETS OF FORMS REQ'D
6 REUSES

COST PER LF = $60.00 × 1.3 / 6 = $13.00

PLACING
5 IRONWORKERS @ 10.20 = 51.00/hr.
FOREMAN 10.70
Crane & OILER IN EQUIP 61.70/hr.
$493.60/DAY

COST / L.F. = 493 / 24' = $20.50/LF INCL DISMANTLING

FORM RAILS
30 lb × .144 × 4 = 18000 lb FAB (600 LF)
@ 20¢ = $3600
SAY 3.00/LF

PLACING = 30# × 10¢ = $3.00/LF

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

MASSIVE HEAD BUTTRESS DAM
TRUMBULL LAKE
NEW ENGLAND DIV. CORPS/ENGRS.

CONVEYOR REQUIREMENTS

TRESTLE CONVEYOR 450 LF
ABUTMENT " 200 LF
650 LF

650 L.F. @ $110 = 72,000
RAIL & ACC @ 10% = 7,000
SIDE DISCHARGE 1,500
80,500
SAY 40,000 SALVAGE
40,500

TOTAL USE = 100 DAYS
COST / DAY = $400
CHECK RENTAL BASIS = 650 LF @ 1.25 = $800/day
USE $600/day
= 3000/wk

ERECTION = $5,000

DISTRIBUTING CONVEYORS FOR SLIP FORM
2 @ 90' = 180 L.F.
180 LF @ $110 = $20,000
RAIL & ACC 2,000
SIDE DISCH 1,500
$ 23,500
11,500 SALVAGE
$ 12,000

$12,000/100 days = $120/day
CHECK RENTAL BASIS = 180 × 1.25 = $220/day
USE 175.00/day
875/wk

ERECTION = $1600 × 30 = 48,000

SPILLWAY CONVEYOR
4 × 30 = 120 LF @ $110 = 13,200
1,300
1,500
16,000
- 8,000
$8,000

Rental = 120 LF × $1.25 = $150/day
$8000/40 days = $200/day
USE $175/day

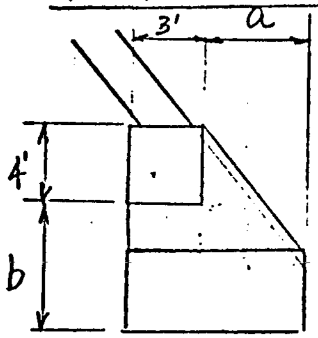
ERECTION = $1600 × 12 = $19,200

36

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUL 15 '72 REV. SKETCH# AD-5-21
MASSIVE HEAD BUTTRESS DAM
TRUMBULL LAKE
NEW ENGLAND DIV, CORPS/ENGRS

FLAT SLAB STARTER FOOTINGS



WIDTH = 22'

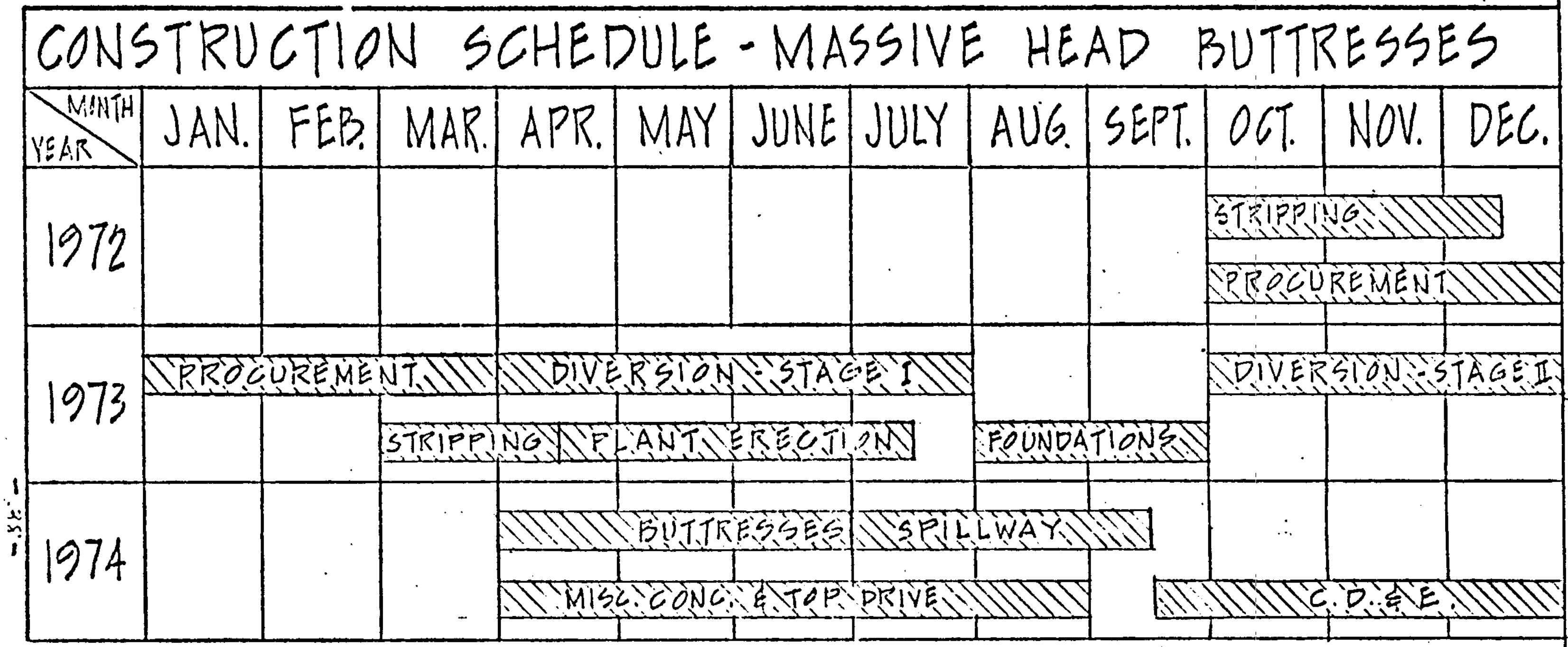
AVER. AREA = $(4+\frac{b}{2})(3+\frac{a}{2})$

VOL = $A_A(22)/27$ = CY

a	b	AREA	VOL
6	7.5	7.8(6) = 46.8	38.5
5.5	7	7.5(5.8) = 43.5	35.5
5	6	7 (5.5) = 38.5	31.5
4	5	6.5 (5) = 32.5	26.5
1.5	2	5 (3.8) = 19	15.5
1.5	2	5 (3.8) = 19	15.5
1.5	2	5 (3.8) = 19	15.5
5	6	7 (5.5) = 38.5	31.5
27	33	20.5(16.5) = 338	275.0
5	5.5	6.8 (5.5) = 37.5	30.5
0	0	4(3) = 12	10.
0	0	4(3) = 12	10.
			536. CY

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE
PEQUONNOCK RIVER BASIN CONN.
MASSIVE HEAD BUTTRESS DAM



* CLEAN-UP, DEMOBILIZATION & ENVIRONMENT

CONTRACTURAL COMPLETION DATE DEC. 1974

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15/72 REV. SKETCH# AD-S-219
TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
BUTTRESS DAM; COST STUDY

ON SITE PLANT

MASSIVE HEAD BUTTRESS DAM

SUBSTITUTE SITE PLANT FOR READY MIXED CONC.

CONVENTIONAL CONSTRUCTION

	MAT	LAB	TOTAL
BORROW OPERATION	.30/TON	.29/TON	.59/TON
AGGREGATE PROD.	.53/TON	.34/TON	.87/TON
BATCH PLANT	3.44/CY	1.75/CY	5.19/CY

HEAD BUTTRESS

TOTAL CONC. REQ.

BUTTRESS	56,000 CY
FOUND.	6,000 CY
SPILLWAY	1,620 CY
MISC.	1,200 CY
TOTAL	64,820 CY × 22.50

PLANT EQUIPMENT

BORROW OPER.	72,000
AGGR. PROD.	128,000
BATCH PLANT	437,000
	$ 637,000

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15/72 REV. SKETCH# AD-S 220

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
BUTTRESS DAM, COST STUDY

ON SITE PLANT

ASSUME 6 BAGS OF CEMENT / CY
AGGREGATE ~ 3200# / CY

1) CEMENT REQ.
64,820 CY × 6 × 94# = 36,600K = 13,300 TONS
× $27.20 = $497,000

2) AGGREGATE REQ.
64,820 × 1,6 TONS = 104,000 TONS

3)

		MAT.	LAB.	TOTAL
BORROW OP.	110,000 TONS	.65	.29	$ .94
AGGR. PROD.	104,000 TONS	1,23	,34	$1.57
CONC. BATCH	64 820 CY	6,75	1,75	$8.50

110,000 × .94 = 103,300
104.000 × 1.57 = 163.000
64,820 × 8,50 = 550.000
$ 816.300
CEMENT $ 497,000 (27,20/TON)
1,313.300

READY MIX = 1,460,000
SITE PLANT = 1,313.000
SAVINGS = $ 147,000

FOR 7 BAG MIX
DEDUCT $ − 78.000
SAVINGS = $ 69.000

3200
− 3060
140#/cy
64,820 × 0,14 = 9100K
4550 T
× 0,94 = $4,300

− 83000
+ 4300
78,700

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUL 15, 72 REV. SKETCH# AD-5-221
TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
MASSIVE HEAD BUTTRESS DAM

ALTERNATE PRECAST SPILLWAY DESIGN

COST OF PRECAST (QUOTATION)
$8.00/SQ. FT

WEIGHT = 1.33' x 3.0' x 24' x 150# = 14,400#
SAY 7 TONS

PLACING RATE:
3 x 24 x 3/hr x 8 hr. = 1730 ф'

LENGTH OF OPERATION:
33200 ф'/1,730 ф' = 19.2 days
SAY 20 DAYS

PLACING CREW:

1 FOREMAN	10.70
6 ERECTORS	61.20
2 FINISHERS	17.80
1 HELPER	5.60

$95.30/hr (8)(20) = $15,250

COST PER SQ. FT = 15,250 / 33,200 = .46

SAY 50¢/ф'

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15 '72 REV. SKETCH# AD-S 222

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN CONN.
MASSIVE HEAD BUTTRESS DAM - SCHEME ALTERNATE

CONCRETE VOLUME REDUCTION.

STEM: $15/2 (2385)(8)/27$

$= 5{,}400$ CY

FTG: $15(30)(9)(4)/27$

$= 600$ CY

TOTAL $= 6{,}000$ CY

SURFACE AREA REDUCTION (BUTTRESS)

$15/2 (2385)(2) = 36{,}000$ SF

ROCK EXCAVATION REDUCTION

$9(15)(30)(1)/27 = 150$ CY.

HAND CLEANING REDUCTION

$15(9)(30) = 4050$ SF

FOUNDATION GROUTING REDUCTION

$15(9)(30) = 4050$ SF

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15, 72 REV. SKETCH# AD-S223
TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN CONN.
MASSIVE HEAD BUTTRESS DAM - SCHEME 4
ALTERNATE

CEMENT REDUCTION

6000 CY × 6 × 94# = 3400 K = 1700 TONS

AGGREGATE REDUCTION

6000 CY × 1.6 TONS = 9,600 T

BORROW OPERATION REDUCTION

6000 + 5% ± = 6300 TONS

RENTAL OF EQUIPM'T 10 MO. FOR 110,000 TONS

(6300/110,000)(10) = .57 SAY 1/2 MO.

5(7200) = $ 3,600 REDUCTION

JACKROD REDUCTION

3	1	× 29	× 2	=	58
4	2.5	26	2	=	130
5	4	26	2	=	208
6	5.5	22	2	=	242
7	7	21	2	=	294
8	8.5	20	2	=	340
9	10.	19	2	=	380
10	11.5	18	2	=	414
11	13.0	15	2	=	390
12	14.5	12	2	=	348
13	16	10	2	=	320
14	17.5	6	2	=	210
15	23	2	2	=	92
16	11	1	2	=	22
					3448 LF

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15, 72 REV. SKETCH# AD-52
TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN CONN.
MASSIVE HEAD BUTTRESS DAM - SCHEME
ALTERNA

YOKE REDUCTION

2 YOKES PER BUTTRESS = 60 YOKES

SLIDING FORM REDUCTION

15 (2)(30) = 900 LF

DECK REDUCTION

15 (5)(30) = 2250 SF

SCAFFOLD REDUCTION

15 (2)(2)(30) = 1800 SF

RAILING & LADDER REDUCTION

15 (2) (30) = 900 LF

HYDRAULIC PIPING REDUCTION

15 (2) (30) + 10 (4)(30) = 2100 LF

FINISH / CURING REDUCTION (STEM)

3600 SF

REINF. REDUCTION (FTG)

2x16 #9 x 8'-0 = 256 (2.044) = 520#

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15, 1972 REV. SKETCH# AD-5225
TRUMBULL LAKE
PEQUONNOCK RIVER BASIN CONN.
MASSIVE HEAD BUTTRESS DAM - SCHEME ALTERNATE

FOUNDATION:

FORM WORK REDUCTION:
15(2)(3)(30) = 2700 SF

CURING REDUCT. (FTG)
9(15)(30) = 4050 SF

KEYWAY REDUCTION
NONE

WATERSTOP REDUCTION
NONE

PRESTRESS ITEMS (ADDED)

4-1¼ H.S. RODS PER BUTTRESS:
4(30) = 120 RODS @ 128 (AVER.)
= 15,360 LF.

LABOR: 15,360 @ $1.00/LF = $15,360

ROCK DRILLING: 120(20) = 2400 LF.
@ $2.00/LF = $4,800

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUL 15 '72 REV. SKETCH# AD-S22
MASSIVE HEAD BUTTRESS DAM
TRUMBULL LAKE
NEW ENGLAND DIV. CORPS/ENG

PUMPING ALTERNATE

LOWER CONVEYORS	650 L.F.
VERTICAL RUN	110 L.F.
DISTRIB. RUNS	180 L.F.
	940 L.F.

COST OF EQUIPMENT:

PUMP	$4000	
LINE @ $6.00	$6000	INCL GATES
LINE SUPPORT	$2000	
	$12,000	
	4,000	33% SAVING
	$8,000	EQUIP COST

SAVINGS IN EQUIP COST:

CONVEYORS	52,500
PUMPING	8,000
	$44,500

ERECTION SAME COST

HEEDE HOISTS ARE NOT REQUIRED
SAVINGS: 60,000 RENTAL
9,000 ERECTION
CONVEYOR SUPPORT BRACKETS
6,000 EQUIP
9,000 ERECTION

PLACING CREWS

			$
CONVEYOR:	3 CONVY. OPER @ 7.75	=	23.25
	1 HOIST OPER @ 8.60	=	8.60
			$31.85
PUMPING	1 PUMP OPER @ 7.75	=	7.75
	3 GUNMAN @ 6.85	=	20.55
	4 LABORERS @ 5.60	=	22.40
			$50.70

DIFF/HR PLACING: PUMPING $3.35 MORE
TOTAL COST DIFF. FOR SLIP: $18.85×8 / 255.00 (450,700) = $19,00

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

MASSIVE HEAD BUTTRESS DAM
TRUMBULL LAKE
NEW ENGLAND, DIV. CORPS/ENGRS

AD-5227

SPILLWAY OPERATION

240 L.F @ #6.00 — #1440
support — #1000
#2500
500 SALVAGE
#2000 EQUIP COST
ERECTION SAME COST

SAVINGS IN EQUIPMENT #8,000
LESS 2,000
#6,000

PLACING CREW: CONVEYOR #31.85/hr.

PUMPING:

1 PUMP OPERATOR	@7.75 =	#7.75
1 GUNMAN	6.85	6.85
2 LABORERS	5.60	11.20
		#25.80

DIFF/HR PUMPING #6.05 LESS
TOTAL COST DIFF = $6(8)(40) = #2000

SUMMARY

	BUTTRESSES		SPILLWAY	
	CONV.	PUMP.	CONV.	PUMP
EQUIPMENT	52,500	#6,000	8,000	2,000
PLACING LABOR		#19,000	2,000	
HOISTS	69,000			
SUPPORT	15,000			
TOTAL	136,500	#25,000	#10,000	#2,000

TOTAL SAVING PUMP #119,150

SUMMARY DAM TWICE AS HIGH & WIDE (SAME LGT)

	BUTTRESSES		SPILLWAY	
	CONV	PUMP	CONV.	PUMP
EQUIPMENT	52,500	6,000	8,000	2,000
PLACING LABOR		76,000	8,000	
HOISTS	99,000			
SUPPORT	24,000			
TOTAL	175,500	#82,000	16,000	2,000

TOTAL SAVING PUMP #107,500

BATCH PLANT OPER.: 127,000 (4) = 508,000 CY.

BORROW OPERATION : 231,000 (4) + 9000 = 933,000 T

AGGREGATE PROD : 924000 T

PLANT EQUIP.

a) BORROW OPERATION

	EQUIP.	SALVAGE	NET
1- 2½ CY DRAGLINE	100,000	50,000	50,000
4-6CY REAR DUMP TRUCKS	52,000	13,000	39,000
			$ 89,000

b) AGGREGATE PROD.

INSTALLATION			10,000
CRUSHER UNIT	490,000	295,000	195,000
WATER DISTRIB			8000
			$213,000

c) MIXING PLANT :

MIX. EQUIP	432,000	75,000	358,000
INSTALLATION			110,000
CEMENTVEYOR	60,360	10,000	50,360
			$ 518,360

D) CABLEWAY

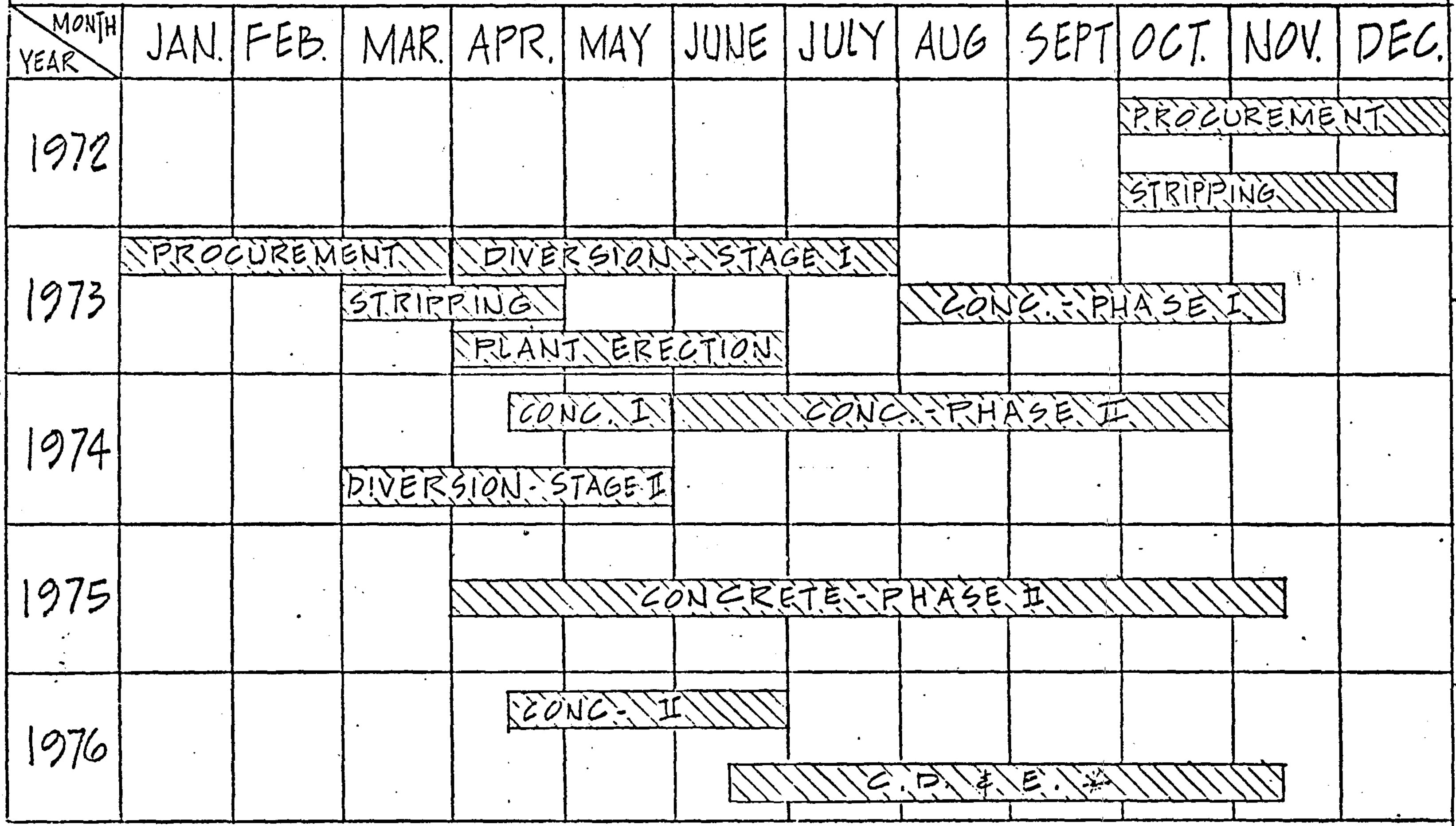
6 CY CABLEWAY	395,000	130,000	265,000
INSTALLATION & MISC.			58,000
			$ 323,000

CEMENT REQ
10,755 (4) = 43,020 T

		MAT'L	LABOR
BORROW OPER	933,000 T	.10	.29
AGG. PROD.	924,000 T	.23	.34
CONC. BATCH.	508,000 CY	1.02	1.75
CABLEWAY	508,000 CY	.64	.61

NOTE : MATERIAL PRICES BASED ON 160 YD CAPACITY PLANT. USE 320 YD PLANT (DOUBLE MAT'L COST)

CONSTRUCTION SCHEDULE



* CLEAN-UP, DEMOBILIZATION & ENVIRONMENT.

CONV. DAM (INCR. SIZE) CONSTR. SCHED.

ESCALATION IMPACT

ASSUMED ESCALATION:	LABOR	MATERIAL
1973	8%	8%
1974	6%	4%
1975	4%	4%
1976	4%	4%

LABOR ESCALATION

1973	30% OF WORK @ 8% ----	2.4%
1974	30% OF WORK @ 8+6% ---	4.2%
1975	30% OF WORK @ 14+4% ---	5.4%
1976	10% OF WORK @ 18+4% ---	2.2%
		14.2%

MATERIAL ESCALATION

1973	50% OF WORK @ 8% ------	4.0%
1974	20% OF WORK @ 8+4% ----	2.4%
1975	20% OF WORK @ 12+4% ---	3.2%
1976	10% OF WORK @ 16+4% ---	2.0%
		11.6%

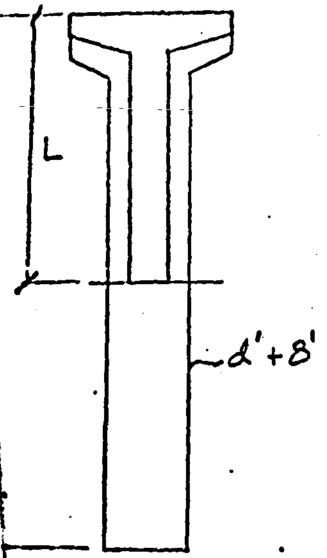
USE 14% LABOR ESCALATION
12% MATERIAL "

(...E HEIGHT + WIDTH, LENGTH SAME AS TRUMBULL)

...RESS SLIDE

SLIDING FORMS

LENGTH = 6982' (AD-5205)
$d' = 2576 \times 2 =$ 5152'
$8' \times 2 = 16 \times 30 =$ 480'
12,614' LF

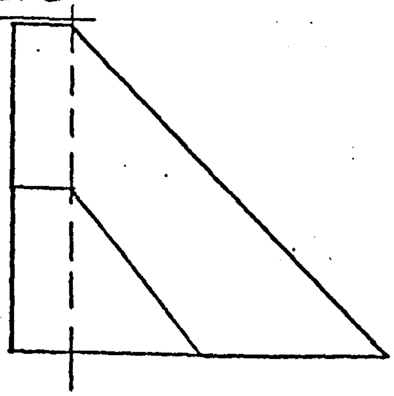


END BULKHEAD FORMS = 240 LF

YOKES

HEAD ------ 120 yokes (AD-5205)
STEM ------ 600
30
750
END FORM ---- 60

JACK RODS



J. T. CAMILLERI, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
MASSIVE HEAD BUTTRESS DAM

(AD-5205)

HEAD 19,040 x 2 = ———— 38,080 LF

ROD	X' STEM	L/STEM	L	x 2
1	30	295	8870	17,740
2	30	295	8870	17,740
3	30	295	8870	17,740
4	30	290	8700	17,400
5	30	280	8400	16,800
6	27	270	7300	14,600
7	27	260	7000	14,000
8	26	250	6500	13,000
9	26	240	6250	12,500
10	24	230	5500	11,000
11	24	220	5300	10,600
12	20	210	4200	8400
13	20	200	4000	8000
14	20	190	3800	7600
15	20	180	3600	7200
16	19	170	3250	6500
17	19	160	3050	6100
18	18	150	2700	5400
19	18	140	2520	5040
20	16	130	2075	4150
21	16	120	1920	3840
22	14	110	1540	3080
23	14	100	1400	2800
24	11	90	990	1980
25	11	80	880	1760
26	9	70	630	1260
27	9	60	540	1080
28	5	50	250	500
29	5	40	200	400
30	1	30	30	60
31	1	20	20	40
32	1	10	10	20
				238,330

238,330 ——→ 238,330

276,410 LF

23 GREEN STREET
HUNTINGTON, N. Y.

END BULKHEAD JACKRODS 6200 x 2 = 12400 LF (AD-S207)

DECKS (AD-S207)
4620 □' HEAD
13,930 □' STEM
14,500 STEM
33,050 □'

SCAFFOLDS 6982 LF x 2 = 13,964
x 2' WIDE
27,928
SAY 28,000 □'

HYDRAULIC PIPING
L.F. FORM 12,650'
10'(750+60) = 8,100'
20,750 LF

CONCRETE 56,000 CY x 4 = 224000 CY

REINF. ST'L
982,000 # HEAD x 2 = 1,960,000 = 982 T
192,000 DWLS x 2 = 384,000 = 192 T
243,000 SPILLWAY x 2 = 486,000 = 244 T

SLIDE CREW
SLIDE 6-12"/HR.
SLIP 3 BUTTRESSES AT A TIME.

9 SETS OF HD. FORMS.
2 WKS TO DISMANTLE + RE-ASSEMBLE)
30 SETS OF STEM FORMS (NO RE-USE)

AVERAGE FOR FIRST 1/2 OF SLIDE = 9"/HR. = 6'/SHIFT
AVERAGE FOR 2ND HALF = 12"/HR = 8'/SHIFT

AVERAGE HT. OF SLIP = 165' = 24-9/8 SHIFTS.

10 SLIPS x 21 SHIFTS/SLIP = 210 SHIFTS (9/8)

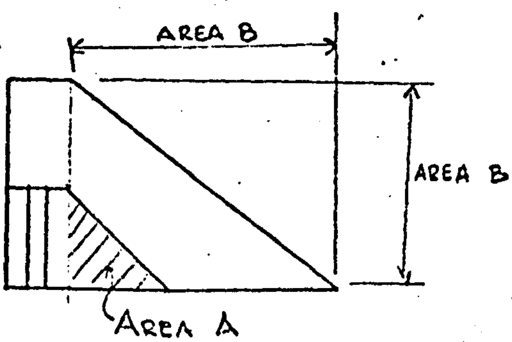
MASSIVE HEAD BUTTRESS DAM

CLASSIFICATION	#	HR. RATE INCL. FR. BENIFITS	COST/SHIFT 9/8
CONV. OPER.	1	7.75	70
HOIST OPER.	3	8.60	234
JACK OPER.	3	8.00	217
CARPENTERS	6	9.00	488
ELECTRICIAN	1	8.28	75
FIN. FOR.	1	9.37	85
FINISHERS	9	8.87	720
FIN. HELP.	4	7.15	258
LABORERS:			
FORMAN	1	6.10	55
PLACING	25	5.60	
VIB.	12	5.60	→ 2320
CURING	9	5.60	
IRONWORKERS	6	10.20	553
CRANE OPER.	2/3	8.60	51
OILER	2/3	6.85	41
IRONWORKER FOR.	1	10.70	97
			5,264

210 SHIFTS × $5,264 = $1,100,000

FINISH + CURING (AD-S210)

a	71,400 × 2 =	142,800
b	16,600 × 2 =	33,200
c	57,120 × 2 =	114,240
d	57,120 × 2 =	114,240
		404,480 ϕ'



RATIO $\frac{\text{AREA B}}{\text{AREA A}} = \frac{276,410}{52,506} = 5.4$

e 200,600 × 5.4 = 1,080,000
404,480
1,484,480
SAY 1,485,000 ϕ'

J. . . . . .
23 GREEN STREET
HUNTINGTON, N. Y.

PEQUONNOCK RIVER BASIN, CONN.
MASSIVE HEAD BUTTRESS DAM

PLANT EQUIP.	EQU.	SALV.	NET
a) BORROW OPERATION			
1-2½ CY DRAGLINE	100,000	40,000	60,000
4-6CY REAR DUMP TRUCKS	52,000	10,000	42,000
			102,000
b) AGGREGATE PRODUCTION			
INSTALLATION			10,000
CRUSHER UNIT	490,000	245,000	245,000
WATER DISTRIBUTION			8,000
			263,000
c) MIXING PLANT			
MIX. EQUIP.	432,000	50,000	382,000
INSTALLATION			110,000
CEMENTVEYOR	60,360	10,000	50,360
INSTATION			10,000
			552,360

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
MASSIVE HEAD BUTTRESS DAM

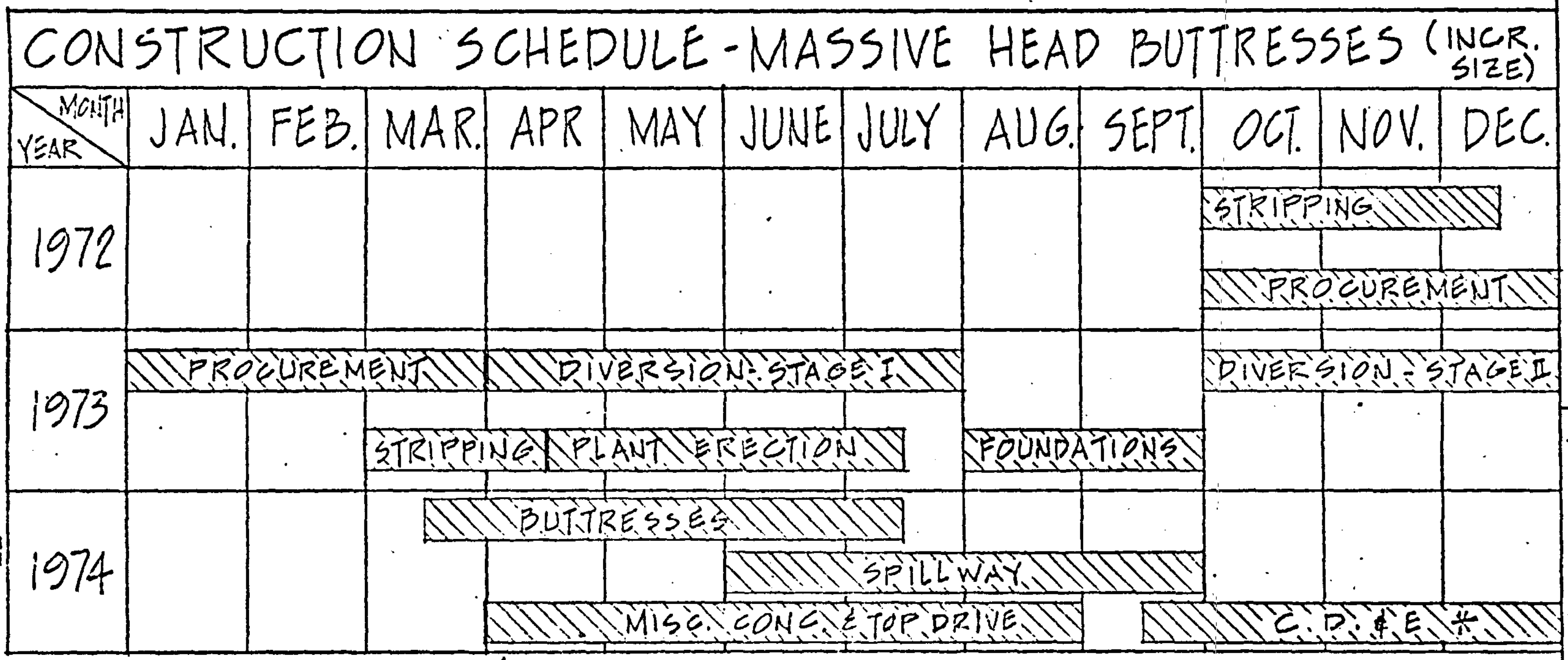
LABOR ESCALATION

1973	40% OF WORK @ 8%	3.2%
1974	60% OF WORK @ 8+6%	8.4%
		11.6%

MATERIAL ESCALATION

1972	60% OF WORK @ 0%	0.0%
1973	20% OF WORK @ 8%	1.6%
1974	20% OF WORK @ 8+4%	2.4%
		4.0%

USE 11½% Labor Escalation
4% Material "



* CLEAN-UP, DEMOBILIZATION & ENVIRONMENT

CONTRACTORAL COMPLETION DATE DEC. 1974

23 GREEN STREET
HUNTINGTON, N. Y.

PEQUONNOCK RIVER BASIN CONN.
MASSIVE HEAD BUTTRESS DAM (INCR. SIZE)

COST AND FEASIBILITY STUDY

ALTERNATE DESIGNS TO PERMIT USE

OF SLIP FORM AND OTHER TECHNIQUES

TO MAXIMIZE ECONOMIES

BOOK AC3

APPENDIX: AMBURSEN DAM

CALCULATIONS AND COST STUDIES

BOOK AC-3 - APPENDIX: AMBURSEN DAM,

CALCULATIONS AND COST STUDIES

1. Sketches AR-301 through -312
2. Sketches AD-S-301 through -311

J. F. CAVALLEE..., INC.
23 GREEN STREET
HUNTINGTON, N. Y.

CONSIDER 1FT STRIP AT h=130 FT

$F = 130 \times 62,5 = 8,12^K$

$M = \frac{8,12 \times 20^2}{10} = 325^{1K}$

$K_{24000/12,0/1200} = 295$

$\frac{325}{295} = 1,1 = F = 12 \times 33$ USE $33 + 3 = 36''$

$A_s = \frac{325}{1,76 \times 33} = 5,6 \square''$ $2,37 - d = 78$, $+3$, $= 81$ 6-9

$2,37^{\square''} \times 1,76 \times 33'' = 137,5^{1K}$

$\sqrt{\frac{137,5 \times 10}{8,12}} = L = 13'$ (CLEAR SPAN)

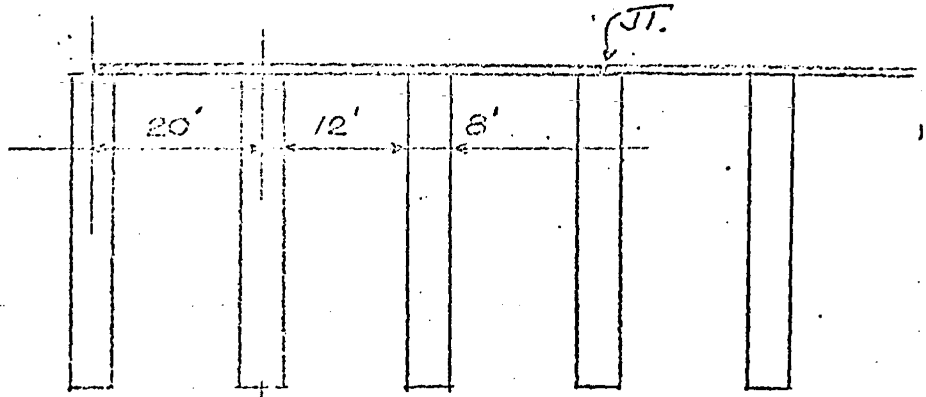
FOR 8 FT WIDE STEMS, SPACING CAN BE 21' O.C.

USE STEMS 20' O.C.
3'-0" SLAB, PARTIALLY RESTRAINED.
MAX. $+A_s = 2,37 \square'' = \#11 @ 8''$

TRY ALTERNATE: SLAB CONTINUOUS OVER 6 SPANS = 120 FT

J. F. CAMELLERIE, P.E.
93 GREEN STREET
HUNTINGTON, N. Y.

ASSUME SLAB CONTINUOUS OVER 3 – 20 FT SPANS.



PARTIAL PLAN

MOMENTS

$pL^2 \times$	−0.033	−0.10	−0.10	−0.033
	+0.07	+0.03	+0.07	

USE CLEAR SPAN OF 12' FOR "M"

1) FORCE ON ONE FT. STRIP AT H = 130 FT

$p = 130 \times 62.5 = 8.12\ ^k/SF$

2) $-M_{MAX} = -0.1 \times 8.12 \times 12^2 = \underline{117}^{\,1K}$

ASSUME SLAB THICKNESS TO BE 36"

$-As = \frac{117}{1.16 \times 32} = \underline{2.08\ \square''}$

say #9 @ 6" (MAX. RE)

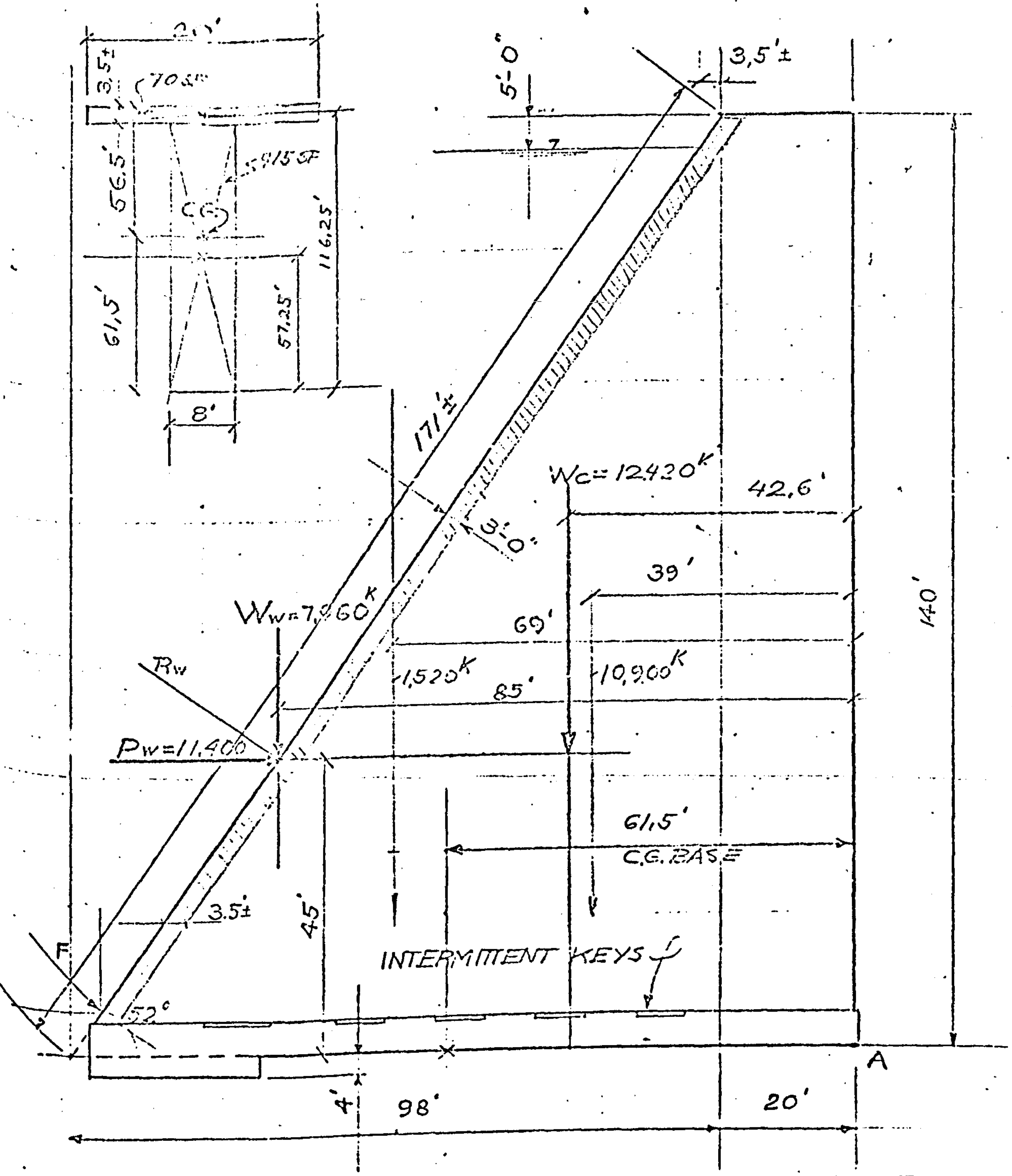
3) $+M_{MAX} = +0.07 \times 8.12 \times 12^2 = \underline{82}^{\,1K}$

$+A_s = \frac{82}{1.16 \times 32} = \underline{1.45\ \square''}$

say "#9 @ 8"

23 GREEN STREET
HUNTINGTON, N. Y.

AMBURSEN DAM



USE 125 FT BASE, VARY ANGLE ACCORDINGLY.

61.5 85
42.6 61.5
18.9 23.5

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

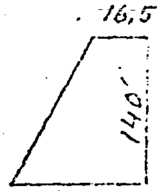
[illegible] LAKE DAM
[illegible] RIVER BASIN [illegible]
AMBURSEN DAM

1/ C.G. OF CONC. SECTION

A/ FLAT SLAB

VOL. = 171' × 20' × 3' = 10,260 CF = 380 CY

WEIGHT = 380 × 4^K = 1520^K



B/ STEM

VOL. = 65,5' × 140' × 8' = 73.300 CF = 2720 CY

WEIGHT = 2720 × 4^K = $10,900^K$

C.G. STEM

$$\frac{16,5^2 + 16,5 \times 114,5 + 114,5^2}{3 \times (16,5 + 114,5)} = 39'$$

1310

272
1890
13100
15262
393

C/ C.G. OF SLAB + STEM

$$\frac{1520 \times 69' + 10900 \times 39'}{12,420} = Z = 42,6'$$

1520^K
10900
12420^K

105,000
425,000
530,000

2/ WATER PRESSURE   b = 20'

A/ HORIZ.

$P_W = 11,400^K$

B/ VERT.

$$W_W = \frac{62,5 \times 94,5 \times 135}{2} \times 20' = 7,960^K$$

FORCE	MOMENT ARM	MOMENT "A"	
W_C = 12.420	42,6'	+ 530,000'K	
W_W = 7.960	85,0'	+ 676,000'K	+ 1,206.000'K
P_W = 11,400	45,0'	− 513.000'K	− 513.000'K
		RIGHTING M =	+ 693.000'K

$$\frac{M_W}{M_P} = 2,35$$

3/ C.G. BASE (M AROUND TOE)

60540
985.

$$\frac{70 \times 116,25 + 915 \times 51,25}{[illegible]} = Y = 61,5'$$

STRESS ANALYSIS

$\sigma = \frac{W}{A} + \frac{M \times Y}{I}$

$W = 12{,}420 + 7{,}960 = \underline{20{,}380}^{K}$

$A_{BASE} = 3{,}5' \times 20' + 114{,}5 \times 8' = \underline{990}$ SF

$M_{CG} = 11{,}400^{K} \times 45' + 12{,}420^{K} \times 18{,}9' - 7{,}960^{K} \times 23{,}5' = \underline{561{,}00}$

513,000 235,000 187,000

$Y_{1,2} = 61{,}5',\ 56{,}5'$

$I = \frac{20 \times 56{,}5^3 + 8 \times 61{,}5^3 - 2 \times 6 \times 53^3}{3}$

$\frac{20 \times 180{,}362 + 8 \times 232{,}608 - 12 \times 148{,}830}{3}$

3,610,000 1,861,000 1,785,000

$I = 1{,}228{,}500\ FT^4$

$\sigma_{TOE} = \frac{20{,}380}{990} + \frac{561{,}000 \times 61{,}5}{1{,}228{,}500}$

$20{,}6 + 28{,}1 = +48{,}7$ KSF

$= \underline{+338\ PSI}$ < 1000 PSI AL

$\sigma_{HEEL} = 20{,}6 - \frac{561{,}000 \times 56{,}5}{1{,}228{,}500} = -5{,}2$ KSF

25,8 $= \underline{-36\ PSI}$ < 102 PS ALL

$\frac{H}{V} = \frac{11400}{20380} = 0{,}56$

USE 125 FT BASE INSTEAD OF 118 FT

J. F. CAMELLERIE P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
RECOMMENDED REPAIRS
AMBURSEN DAM

d = 44"   48" SLAB

1) V_d = 89 − 8,12 × 3,83 = 58 K

$v_d = \frac{58000}{12 \times 44}$ = 110 PSI > 70 PSI

2) V_d = 89 − 8,12 × 1,92 = 73,4 K

$v_d = \frac{73400}{12 \times 44}$ = 139 PSI > 126 PSI

3) $A_s = \frac{490}{1,16 \times 44}$ = 6,3□" — 4 #11 / LIN FT

100 CF / 27 = 3,7 CY / LF HEIGHT

4 × 5,3" = 21,2 × 25 = 530 # / 3,7 = 143 #/CY

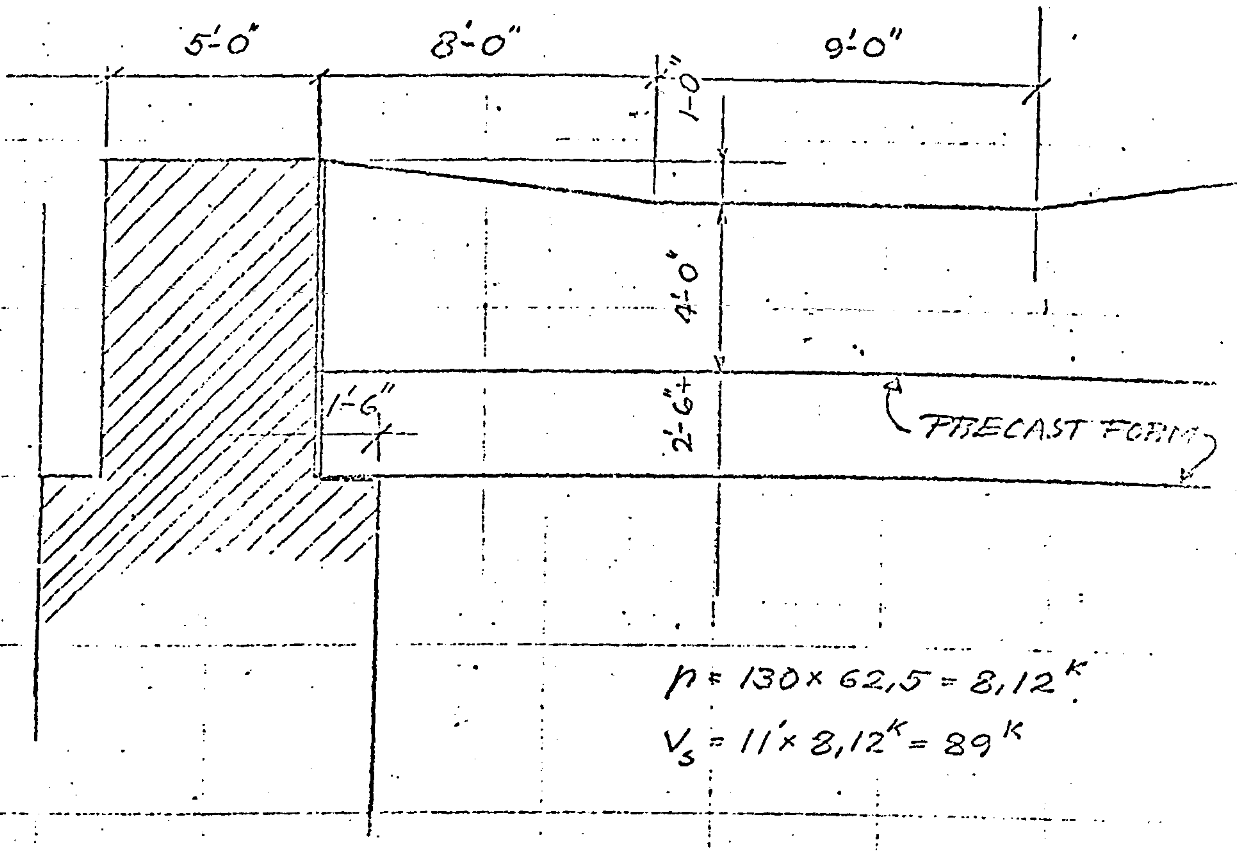
TEMP. STEEL "8@9"

4#/SF × 25 = 100# / 3,7 = 27 #/CY

170 #/CY

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
AMBURSEN DAM



$p = 130 \times 62.5 = 8.12^{K}$

$V_s = 11' \times 8.12^{K} = 89^{K}$

$\underline{M_{MAX}} = \dfrac{8.12 \times 22^2}{8} = \underline{490'^{K}}$

$F = \dfrac{M}{K} = \dfrac{490}{295} = 1.66 \qquad d \approx 41''$

SAY 48" SLAB $- \; d = 44''$

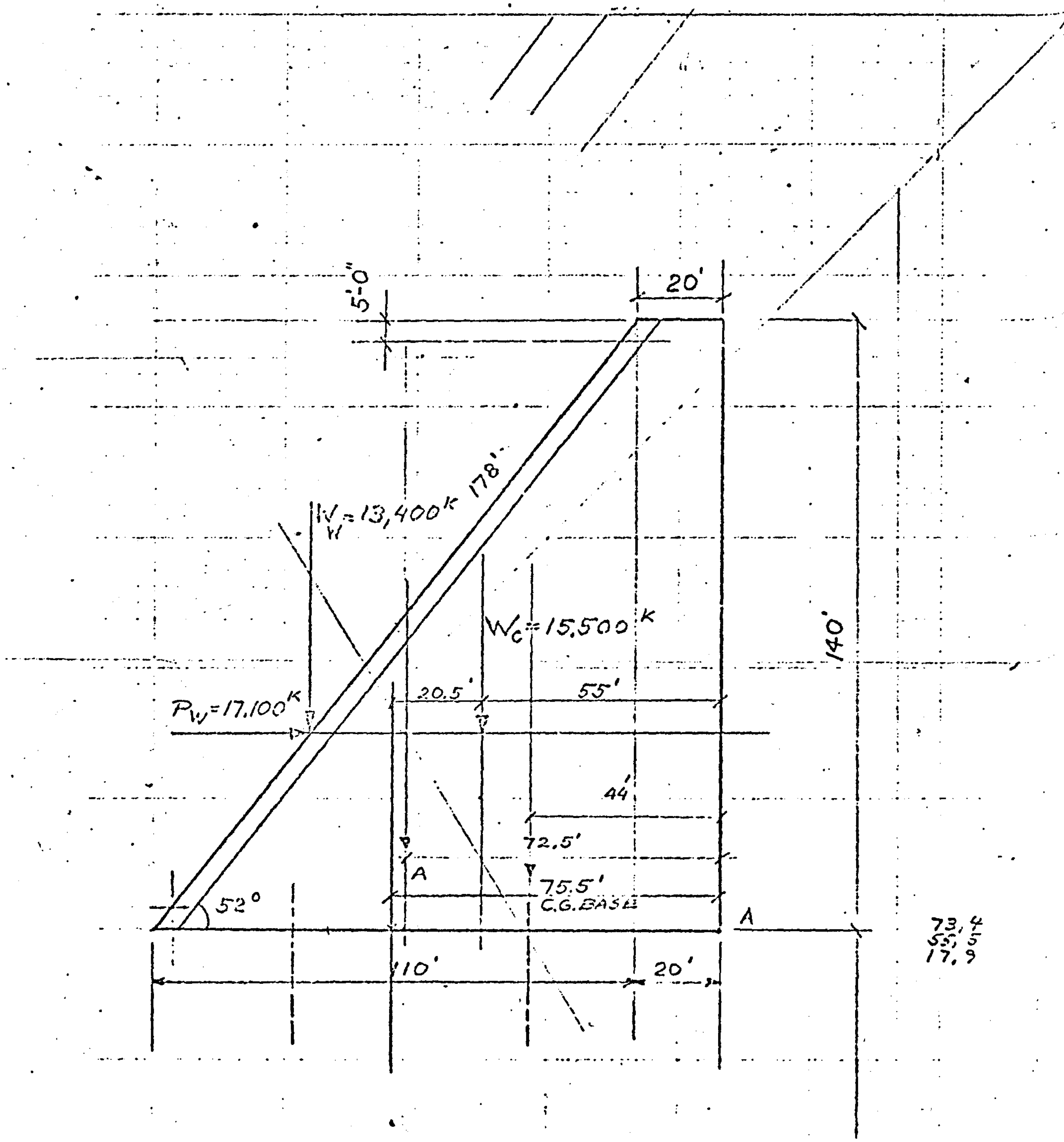
$V_d = 89 - 4.5 \times 8.12 = 52.5^{K}$

$\underline{v} = \dfrac{52.5}{12 \times 50} = \underline{87 \text{ PSI}}$ (36.5 written above)

42

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

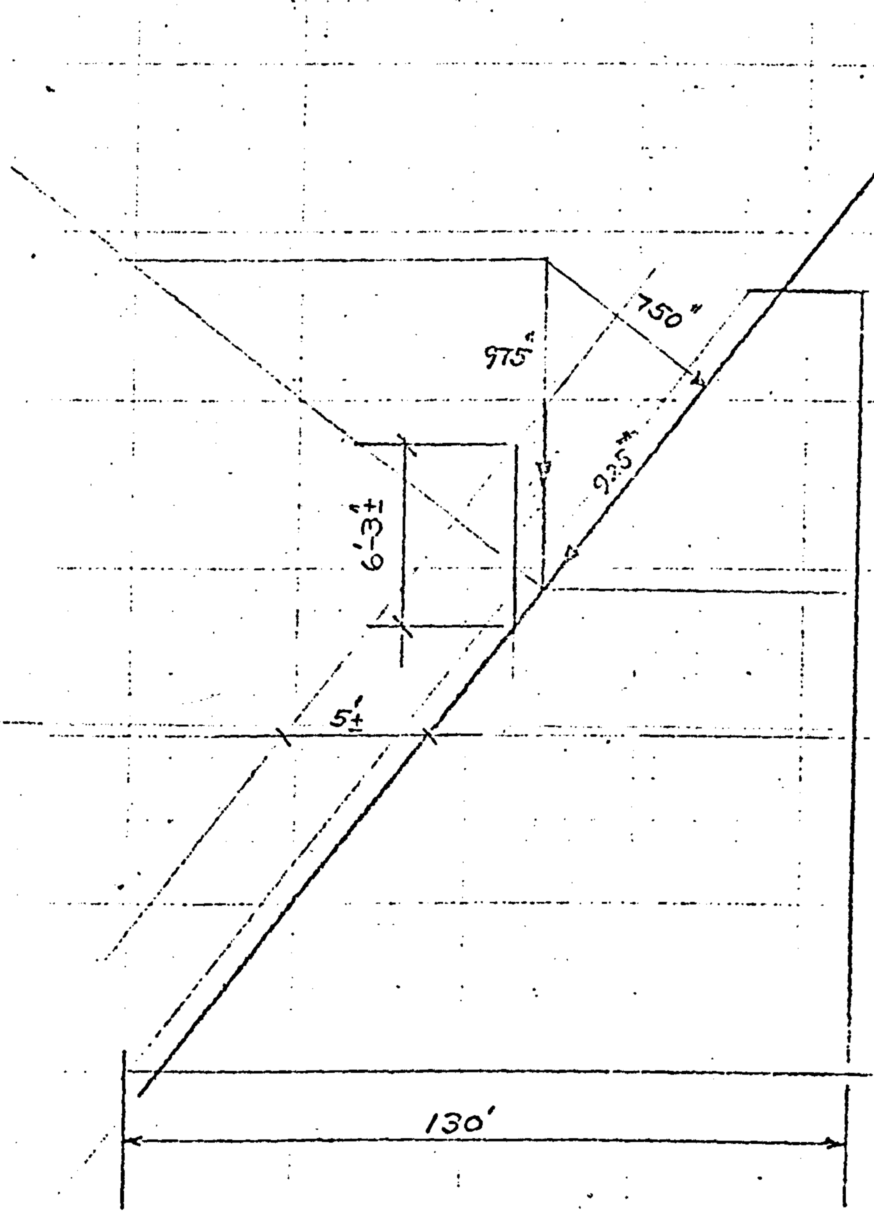
TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
AMBURSEN DAM



73.4
55.5
17.9

STRESS ANALYSIS

CONSTRUCTION LOAD ON PRECAST SECTION.



J. F. CAMELLERIE, P. [illegible]
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN STUDY
AMBURSEN DAM

1/ C.G. OF CONCRETE SECTION

A/ SLAB + PRECAST $\quad L = 25'-0''$

AVERAGE SLAB THICKNESS = 4,30 FT
" PRECAST " = 1.00 "
5.30 FT × 25' = 133 SF

a/ CONC. VOLUME
178' × 133" = 23,674 CF = 876 CY / UNIT

b/ C.G. = 72,5' FROM TOE (x_1)

c/ WEIGHT = $876 \times 4^K = 3500^K$

B/ STEM

a/ CONC. VOLUME

$$\frac{130' + 20'}{2} \times 140' \times 8' - 172 \times 3 \times 7{,}5 = 80{,}000\ CF$$

84000 $\qquad$ 4000 $\qquad$ = 3,000 CY

b/ WEIGHT = $12{,}000^K$

c/ C.G OF STEM

$$x_2 = \frac{20^2 + 20 \times 130 + 130^2}{3 \times 150} = 44'$$

C/ C.G. OF SLAB + STEM

254000
528000
782000

$$\frac{3500 \times 72.5' + 12.000 \times 44'}{15.500} = z = 55'$$

2/ WATER PRESSURE

A/ $T_H = \frac{62.5 \times 135^2 \times 30}{2} = 17100^K / STEM$

B/ VERT. WATER PRESSURE

$$W_W = \frac{62.5 \times 106' \times 135' \times 30'}{2} = 13{,}400^K$$

3/ MOMENTS AROUND TOE.

FORCE	MOMENT ARM	MOMENT "A"	
W_C = 15,500	55'	+852,000'k	
W_W = 13,400	93,4'	+1,250,000'k	+ 2,102,000'k
P_W = 17,100	45'	− 769,000'k	− 769,000'k
			1,833,000'k

$$\frac{M_W}{M_P} = 2,73$$

4/ C.G. BASE (M-"A")

$$\frac{130 \times 8 \times 65 + 22 \times 10 \times 125}{1260} = Y = 75,5'$$

1040
+ 220
1260

67500
+ 27500
95.000

STRESS ANALYSIS

$$\sigma = \frac{W}{A} + \frac{M \times Y}{I}$$

W = 15,500 + 13,400 = 28,900 k

A_{BASE} = 1260 SF

M_{CG} = 17.100 × 45' + 15,500 × 20.5' − 13.400 × 17,9' = 848,000 1K

770.000 318,000 240,000

$Y_{1,2}$ = 75,5' , 54,5'

$$I = \frac{30 \times 54,5^3 + 8 \times 75,5^3 - 22 \times 44,5^3}{3}$$

$$= \frac{30 \times 161879 + 8 \times 430369 - 22 \times 88121}{3}$$

$$= 2,120,000 \ FT^3$$

4,855,000
+ 3,44[illegible]
8,2[illegible]
− 1,[illegible]
6,35[illegible]

$$\sigma_{TOE} = \frac{28,900}{1260} + \frac{842,000 \times 75,5}{2,120,000}$$

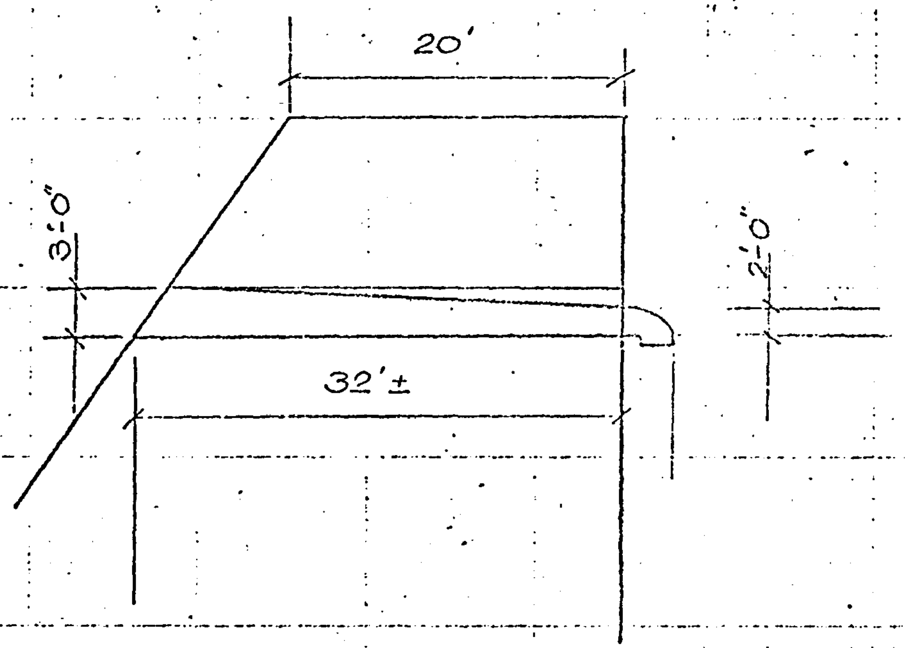
$$= 23 + 30,2 = 53,2 \ KSF = \pm 370 \ PSI$$

0,4 × 75,5 = 30,2

$$\sigma_{HEEL} = 23 - 0,4 \times 54,5 = 1,2 \ KSF = \pm 8,3 \ PSI$$

(21,8 written above 0,4 × 54,5)

J. F. CA[illegible]LLERIE, P.E.
23 [illegible] STREET
HUNTINGTON, N. Y.



CONC. VOL. OF SLAB

32' × 350' × 2,5' = 28,000 CF = 1040 CY

REINF. 30#/CY × 710 = 15,6 TONS

USING PRECAST FORMS, THE AVERAGE SLAB THICKNESS WILL BE 1½ FT.

CONC. VOL. = 32 × 350 × 1,5 = 16,800 CF = 625 CY

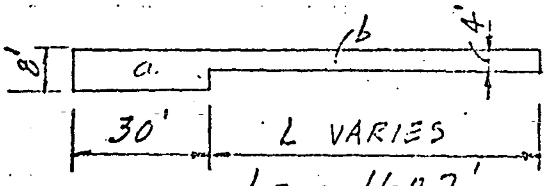
COST STUDY SHEETS

AMBURSEN DAM

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15, 72 REV. SKETCH AD-3-
TRUMBULL LAKE
PEQUONNOCK RIVER BASIN CONN.
AMBURSEN DAM ESTIMATE

CONCRETE !
BUTTRESS FOOTINGS.

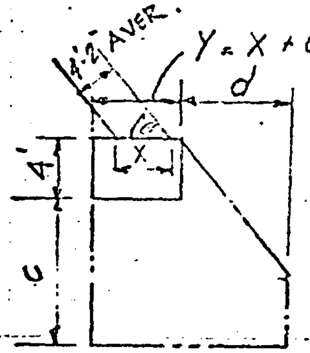


9' WIDE

$a = 30(30)(8)(9)/27$. 2400 CY

$b = 1627(4)(9)/27$ = 2170 CY

FLAT SLAB STARTER FTGS -



$\sin 52° = \frac{4.2}{X}$

.61979
9.89653
.72326

X = 5.3

VOLUME (SEE TABULATION ON NEXT SHEET) = 2350 CY

BUTTRESS STEM

= 40,370 CY

(SEE TABULATION ON NEXT SHEET)

HUNTINGTON, N. Y.

AMBL[illegible] DAM ESTIMATE

STARTER FTGS TABULATION

① 6'3" + d/2	② 4' + d/2	VOLUME ① x ② x 4/27	
13.3	13.5	[illegible]	148
11.8	11	130	106
8.3	6	50	41
9.8	9	88	72
12.8	12.5	160	130
15.3	15.5	23?	194
9.8	8.5	83	68
9.3	8.5	79	65
8.3	7	57	48
6.8	5	34	28
6.8	5.5	37	30
9.3	8	74	61
6.8	7.5	66	54
9.3	8	74	60
9.3	7.5	70	57
8.3	7	58	48
8.8	6.5	57	47
6.8	5	34	28
6.8	4.5	31	26
7.3	5.5	40	33
11.3	11.0	125	102
22.3	24.5	[illegible]	456
8.3	6.5	54	44
6.3	4	25	21
6.3	4	25	21
13.3	13	173	141
7.8	6	47	39
7.3	6	44	36
8.3	6	50	41
4	4		14

8 (4)(31)/27 = 37

290 LF 247 LF

2296 CY
+54 CY*
+675 CY**
3025 CY

* STARTER FTG SITTING ON BUTTRESS FTG
** ADD. 2' EXCAV.

BUTTRESS STEM TAB.

½ B	H	A	Vol = A (4/27)
23.5	59	1385	
30.5	77	2350	
36	92	3310	
38	95	3610	
41.5	105	4360	
48	122	5880	
56.5	144	8150	
60	152	9100	
63	161	10150	
65	166	10800	
65	167	10850	
64	164	10500	
61.5	157	10250	
59	150	8850	
56	142	7940	
53	135	7150	
51	130	6630	
49	125	6120	
48.5	123	5970	
48	122	5870	
47	120	5630	
42	106	4450	
26.5	65	1740	
24	60	1440	
24	60	1440	
24	60	1440	
16.5	43	710	
15.5	40	620	
14.5	36	522	
12.5	[illegible]	270	

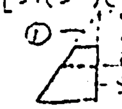
157,493 (4/27) = 46,700 CY

V = 46,700

① [24(20)(4/27)] 19 = 2710

② [37(30)(4/27)] 11 = 3620

−6330



V_T = 40,370

J. F. CAVALLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE
PEQUANNOCK RIVER BASIN CO[illegible]
AMBURSEN DAM ESTIMATE

PRECAST SLAB PANELS

B	H	$\sqrt{B^2+H^2} = L$
28	35	44.5
28	35	44.5
42	53	67.5
52	68	88
57	71	91.
64	81	102
76	98	120
94	120	153
101	128	163
106	137	173
110	142	180
108	140	177
103	133	168
98	126	160
92	113	149
86	111	140
82	106	133
78	101	127
77	99	126
77	98	125
75	96	122
64	82	102
32	41	52
28	36	46
28	36	46
28	36	46
14	19	23.5
11	16	18
9	12	15
5	8	9.5
	2352	3013 l.f.

$A = 3013(23.5) =$
73,800 SF

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

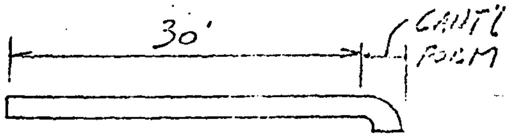
TRUMBULL LAKE
POQUONNOCK RIVER BASIN, CONN.
AMBURSEN DAM ESTIMATE

JOINT TREATMENT (AT PRECAST UNITS)

$3013/3 = 1005(23.5) + 3013(2) + 30(23.5) =$

$= 30,400$ LF

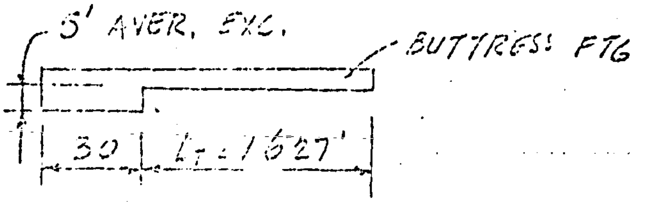
SPILLWAY (CELLULAR DAM BY PROPORTIONS)



$30/36 = .84$

1. CANTILEVER FORMS = 1100 SF
2. CONCRETE = 860 (.84) = 725 CY
3. REINF STL = 15 (.84) = 12.6^T SAY 13^T
4. FINISHING = 9600 (.84) = 8100 SF
5. CURING = 8100 SF.

ROCK EXCAVATION



30 × 30(9)(5)/27 = 1500 CY

1627 (9)(1)/27 = 550 CY

STARTER FTGS

9.4 (22)(29)(4)/27 = 900 CY

2950 CY

FOUNDATION FORMS

[900(2) + 1627(2) + 30(9)(2)] 3 = 17,400 SF

247(22)(2) - 22(2)(1)(27) = 8,660 SF

SLOPING FORM ADD 30% OF 8660 = 2,600 SF

28,660 S.F.

HAND CLEANING:

(1627 + 900)(9) + 9.4 (22)(30) = 29,00 SF

REINF STL (DWLS)

#9 @12 × 8'-0 (2527) = 90,700# = 46T

3.4

23 GREEN STREET
HUNTINGTON, N. Y.

PEQUONNOCK RIVER - BASIN, CONN
AMBURSEN DAM ESTIMATE

CONCRETE SUMMARY

BUTTRESS STEMS	40370 CY
" FTGS	4570 CY
STARTER FTGS	2350 CY
	47,290 CY

PLANT EQUIPMENT

BORROW OPERATION	72,000
AGGREGATE PROD.	128,000
BATCH PLANT	437,000

ASSUME: 6 BAGS OF CEMENT/CY
AGGREGATE - 3200 #/CY

CEMENT REQUIREMENT

47,290 (6)(94) = 25,800,000 # = 12,900 T.

AGGREGATE REQUIREMENT

47,290 (1.6 T) = 75,700 T.

			MAT.	LABOR	TOTAL
1. BORROW OPER.	80,000 T		.90	.29	1.19
2. AGG. PROD.	76,000 T		1.69	.34	2.03
3. CONC. BATCH	47,300 CY		9.30	1.75	11.05

1. 80,000 (1.19) = 95,200
2. 76,000 (2.03) = 154,000
3. 46,000 (11.05) = 510,000
4. CEMENT 12,900 (27.20) = 351,000

$ 1,110,200

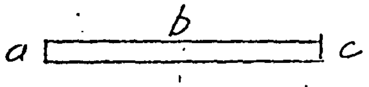
READY MIX 46,000 (22.50) = $ 1,035,000

$ 75,200 ← SAVING IF READY MIX IS USED

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

TRU[illegible]
PE[illegible]
AM[illegible] ESTIMATE

SLIDING FORMS



a = 8(30) = 240 SF

b = [2527 + 30(30)]2 = 6854 SF

C = SEE END BULKH'D FORM - MASSIVE HEAD BUTTRESS. EST.

7094 SF

SAY 7100 SF

YOKES - STEM (SIDES a & b)

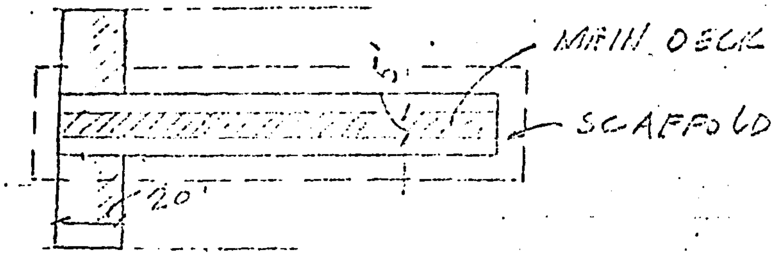
1	30	7	22	12	16
2	30	8	21	13	11
3	30	9	20	14	9
4	30	10	19	15	7
5	30	11	18	16	4
6	26				

TOTAL = 323

(SIDE C) 2 x 30 = 60.

JACK RODS = 50,000 LF.

DECKS & SCAFFOLDS:



MAIN DECK - 5[(2527)] + [22(29)]20 = 25,395 S.F

SCAFFOLDS - [2(2527) + 8(2)(30)] 2' WIDE = 11,100 S.F

RAILINGS & LADDERS:

RAILINGS - (2527)2 + 22(29)(2) = 6340 LF

LADDERS - 260 LF

TOTAL = 6600 LF

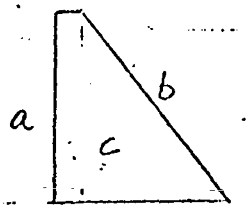
HYDRAULIC PIPING

2527 (2) + 323(2)(10) = 11,600

TOPPING OUT RODS

3(2)(60) = 360

FINISH & CURING



a = 8 (2360)	=	18,880
b = 8 (3020)	=	24,160
c = 156,000 (2)	=	312,000
		354,040

SAY = 355,000 SF

PRECAST SLAB SEAT

30/3 (2) = 6026 LF

SAY 6100 LF

PRECAST DAM FACE

COST OF PRECAST (VARIES)

$24.00/□' @ BOTTOM
TO 8.00/□' @ TOP
$32.00/□'/2 = $16.00/□' AVERAGE

MAXIMUM WEIGHT

$\frac{4 \times 3 \times 26' \times 4^k}{27} = 46^k = 23$ TONS MAX

(WEIGHT DECREASES AS REACH INCREASES)

PLACING RATE

3' × 26' × 3/hr × 8 hr = 1,880 □'/DAY

LGT. OF OPERATION:

$\frac{73,800 \square'}{1,880} = 39$ DAYS

SAY 8 WEEKS

PLACING CREW

	$
1 FOREMAN	10.70
6 ERECTORS	61.20
4 FINISHERS	35.60
2 HELPERS	11.20
1 CRANE OPER	8.60
1 OILER	6.85
	$134.15/hr

TOTAL COST = $134.15 × 8 × 40 = $43,000

COST PER SQ. FT:

$\frac{\$43,000}{73,800} = .58¢/\square'$

SAY 60¢/□'

J. F. C[illegible]ERIE, P.E.
[illegible] STREET
[illegible], N. Y.

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN CONN.
AMBULLEN DAM

CLASSIFICATION	#	HR RATE INC. FR. BENEFITS	COST/SHIFT 9/8	COST/SHIFT 16/8
CONV. OPER.	1	7.75	70	124
HOIST OPER.	3	8.60	234	415
JACK OPER.	2	8.00	144	256
CARPENTER	6	9.00	488	868
ELECTRICIAN	1	8.28	75	132
FIN. FOREMAN	1	9.37	85	150
FINISHERS	4	8.87	319	568
FIN. HELPERS	2	7.15	129	228
LABORERS:				
FOREMAN	1	6.10	55	98
PLACING	11	5.60	554	985
VIBRATION	3	5.60	151	269
CURING	4	5.60	202	358
IRONWORKERS	6	10.20	—	—
CRANE OPER.	2/3	8.60	52	92
OILER	2/3	6.65	73	41
IRONWORKER FOR.	1	10.70	—	—
			2631	4584

102 SHIFTS × 2631 = 268,400
6 SHIFTS × 4584 = 27,500
$ 295,900

COST AND FEASIBILITY STUDY

ALTERNATE DESIGNS TO PERMIT USE

OF SLIP FORM AND OTHER TECHNIQUES

TO MAXIMIZE ECONOMIES

BOOK AC4

APPENDIX: CELLULAR DAM

CALCULATIONS AND COST STUDIES

BOOK AC-4 - APPENDIX: CELLULAR DAM, CALCULATIONS AND COST STUDIES

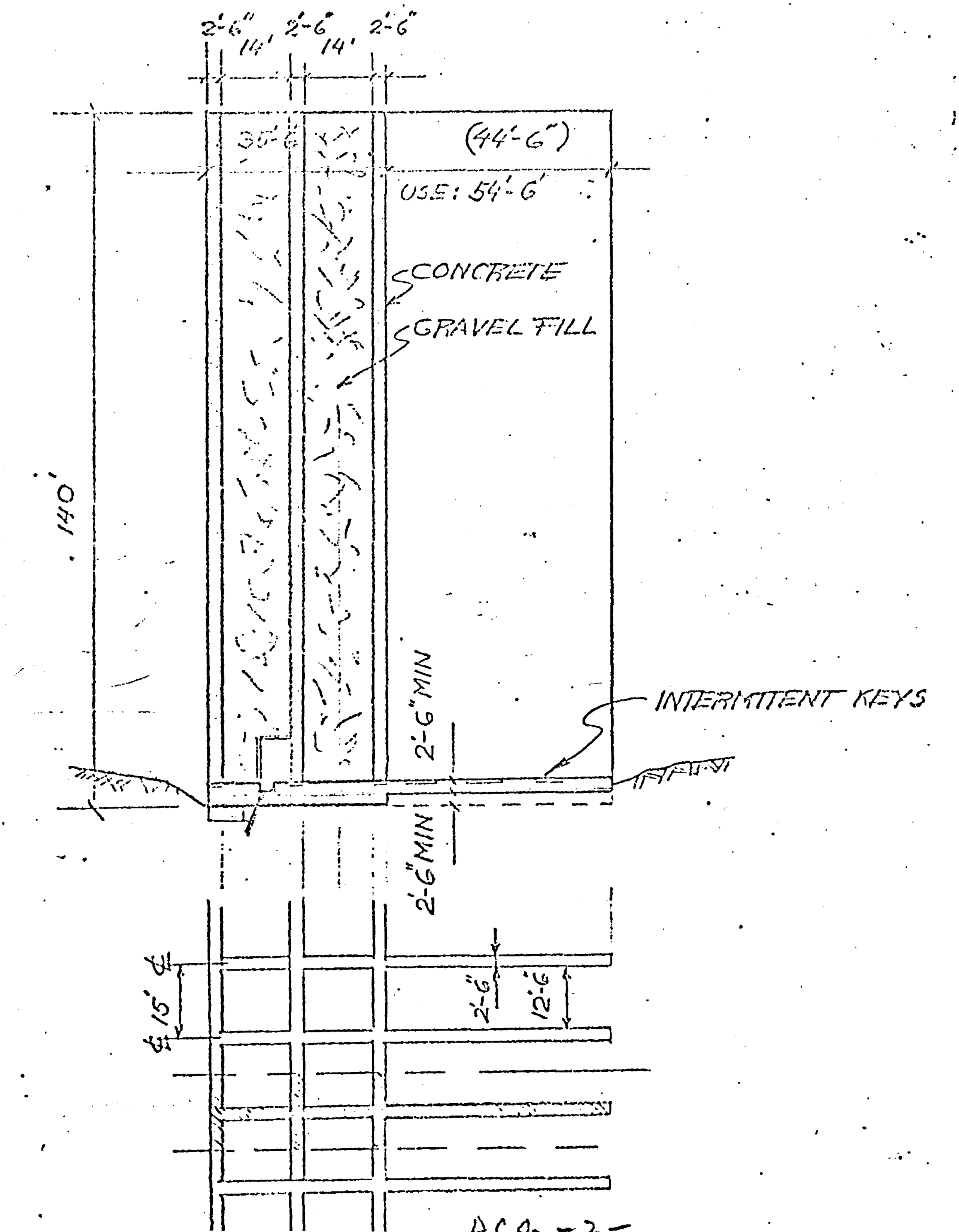
J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15/72 REV. SKETCH # AR-

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN

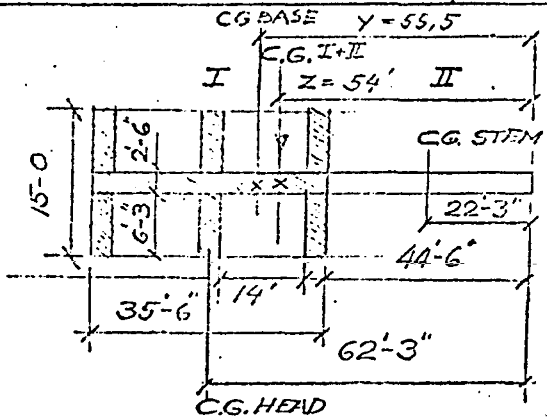
CELL DAM STUDY



J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15/72 REV. SKETCH# AR-4…

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN
CELL DAM STUDY



BASE LENGTH = 80'-0"
STEM = 2'-6"

1/ C.G. OF CONC + CELL FILL

A/ HEAD SECTION

$(35,5 \times 15 \times 150^{\#} - 12,5 \times 28 \times 50^{\#}) \times 135' = 8450^{K}$

80 17,5

B/ STEM (INCL. BASE)

$2,5 \times 44,5 \times 150'' \times 137,5 = 2290^{K}$

C/ HEAD FOUNDATION

$35,5' \times 15' \times 5' \times .15^{k} = 400^{K}$

D/ C.G. OF A,B,C

8850
2290
11140

$$\frac{(8,450 + 400) \times 62,25' + 2,290 \times 22,25'}{11140} = Z = 54'$$

2/ WATER PRESSURE

$H = 135'$ $b = 15'$

$$P_W = \frac{62.5 \times 135^2 \times 15}{2} = 8550^{K}$$

3/ C.G. OF BASE

33200
2500
35,700

$$\frac{533 \times 62,25 + 111 \times 22,5}{644} = Y = 55,5$$

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

E) RESISTANCE AGAINST OVERTURNING

FORCE	MOMENT ARM	MOMENT "TOE"
$W_{CB} = 11,140^K$	54'	+ 602.000
$P_W = 8,550^K$	45'	- 385.000
	RIGHTING MOMENT =	217.000 ^{1K}

$\frac{M_{CB}}{M_W} = 1,56$

PROVIDE PROPER DRAINAGE TO ELIMINATE UPLIFT

STRESS ANALYSIS

$$\sigma = \frac{W}{A} \pm \frac{M \times Y}{I}$$

$W = 11.140^K$

$A = 644$

$533 + 111 = 644$

$M_{CG} = 11140 \times 1,5' + 385000 = 401,700^{1K}$

16,700

$Y_{1,2} = 55,5 \; , \; 24,5$

$$I = \frac{15 \times 24,5^3 + 15 \times 55,5^3 - 12,5 \times 44,5^3}{3}$$

$$= \frac{15 \times (14706 + 170.953) - 12,5 \times 88121}{3} = 560,000 \, FT^4$$

2,780,000 1,100,000

$$\sigma_{TOE} = \frac{11,140}{644} + \frac{401,700 \times 55,5}{560,000} = 17,3 + 39,8 = 57,1 \, ^K/_{SF}$$

17,3 0,72

$= 396 \, PSI$

$$\sigma_{HEEL} = 17,3 - 17,6 = -0,3 \, ^K/_{SF}$$

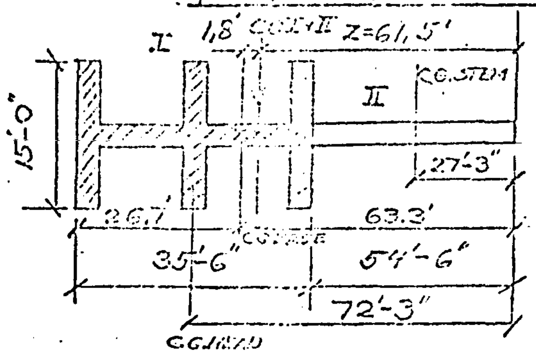
$= -2 \, PSI$

J. F. CAMELLINE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15/72 REV. SKETCH# AR-404

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
CELL DAM STUDY

ALTERNATE : BASE LENGTH = 90'-0"



1) C.G. CONC. + CELL FILL

A) HEAD SEC.
8,450 K

B) STEM INCL. BASE
2,5 × 54,5 × 150" × 137,5 = 2810 K

C) HEAD FOUNDATION = 400 K

D) C.G. OF A,B,C.

$$\frac{8{,}850 \times 72{,}25' + 2{,}810 \times 27{,}25'}{11{,}660} = z = 61{,}5'$$

8850
2810
11660
716,500

2) WATER PRESSURE = 8550 K

3) C.G. BASE

$$\frac{533 \times 72{,}25 + 136 \times 27{,}25}{669} = y = 63{,}3'$$

533
+136
=669

38600
3700
42,300

E) RESISTANCE AGAINST OVERTURNING

	FORCE	MOMENT ARM	MOMENT "TOE"
$W_{C.B.}$ =	11.660	61,5'	+ 717,000
P_W =	8.550	45'	− 385,000
		RIGHTING MOMENT	332.000 1K

$$\frac{M_{CB}}{M_W} = 1{,}87$$

2/

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

STRESS ANALYSIS (90 FT BASE)

$\sigma = \frac{W}{A} \pm \frac{M \times Y}{I}$

$W = 11{,}660^{K}$

$A = 669$

$M_{CG} = 11{,}660 \times 1{,}8' + 385{,}000 = 406{,}000^{'K}$

$Y_{1,2} = 63{,}3', 26{,}7'$

$I = \frac{15 \times 26{,}7^3 + 15 \times 63{,}3^3 - 12{,}5 \times 54{,}5^3}{3}$

$= \frac{15 \times (19034 + 253.636) - 12{,}5 \times 161.878}{3} = 690...$

4,090,000 2,020,000

0,5...

$\sigma_{TOE} = \frac{11.660}{669} + \frac{406.000 \times 63.3}{690.000} =$

$17{,}4 + 37{,}2 = 54{,}6\ ^{K}/_{SF} = 379\ PSI$ +

σ_{HEEL} $17{,}4 - 15{,}7 = 1{,}7\ ^{K}/_{SF} = 12\ PSI$ +

PROVIDE ADEQUATE DRAINAGE NEAR UPSTREAM FACE TO COUNTER UPLIFT

UPLIFT (NO DRAINAGE)

$\frac{135 + 20}{2} = \frac{155}{2} = 77'$

$U = 62{,}5^{\#} \times 35{,}5' \times 77' \times 15' = 2560^{K}$

$e_o = \frac{20 + 270 \times 35{,}5}{3 \times 155} = 22{,}1$

$22{,}1 + 54{,}5 = 76{,}6'$

$M = 2560 \times 76.6 = 196{,}000^{'K}$
385,000
581,000

$\frac{M_{CB}}{M_W} = \frac{71...}{581...}$
$= 1{,}2...$

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

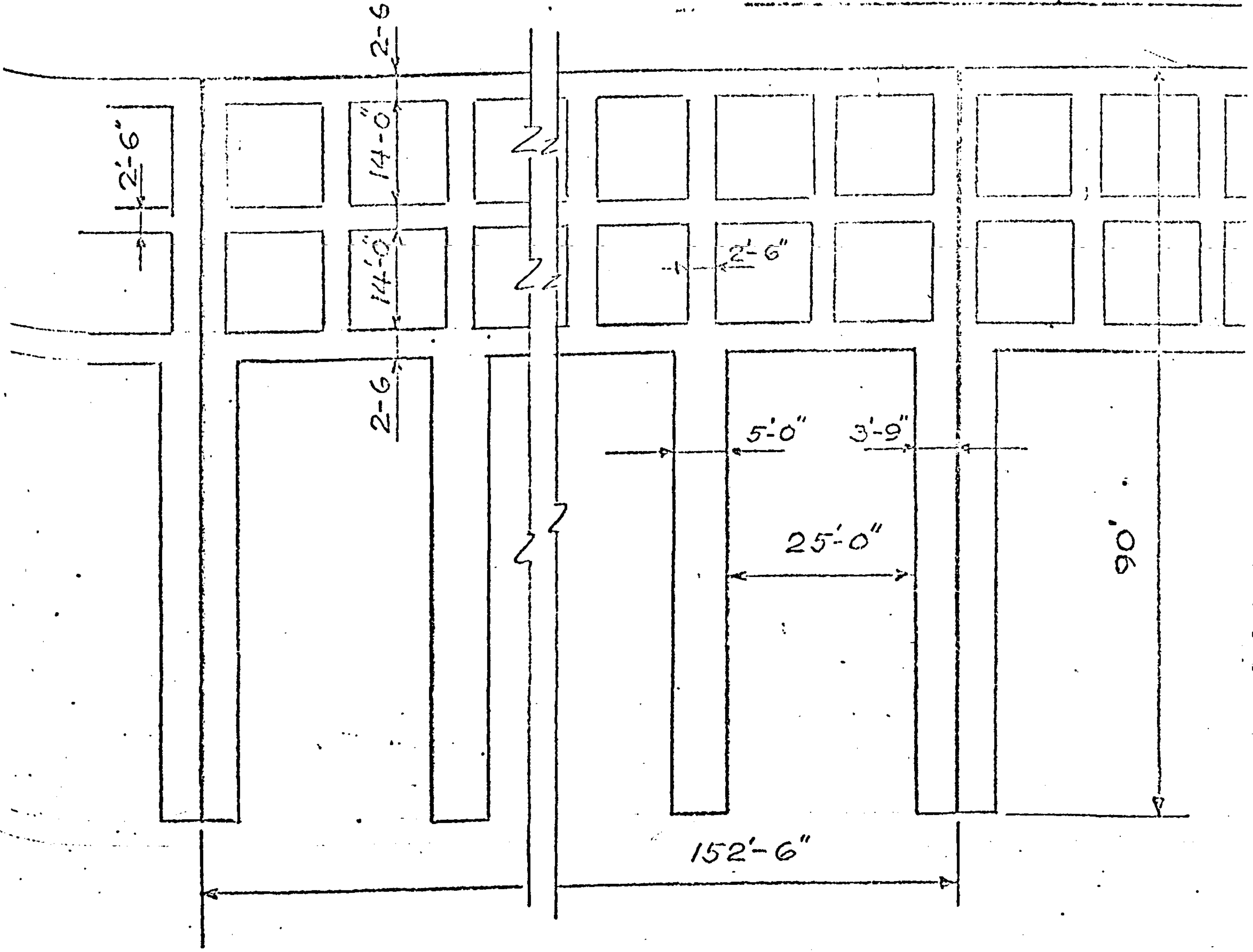
DATE JULY 15/7? REV. SKETCH # [illegible]

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN

CELL DAM STUDY

ALTERNATE LAYOUT # 1

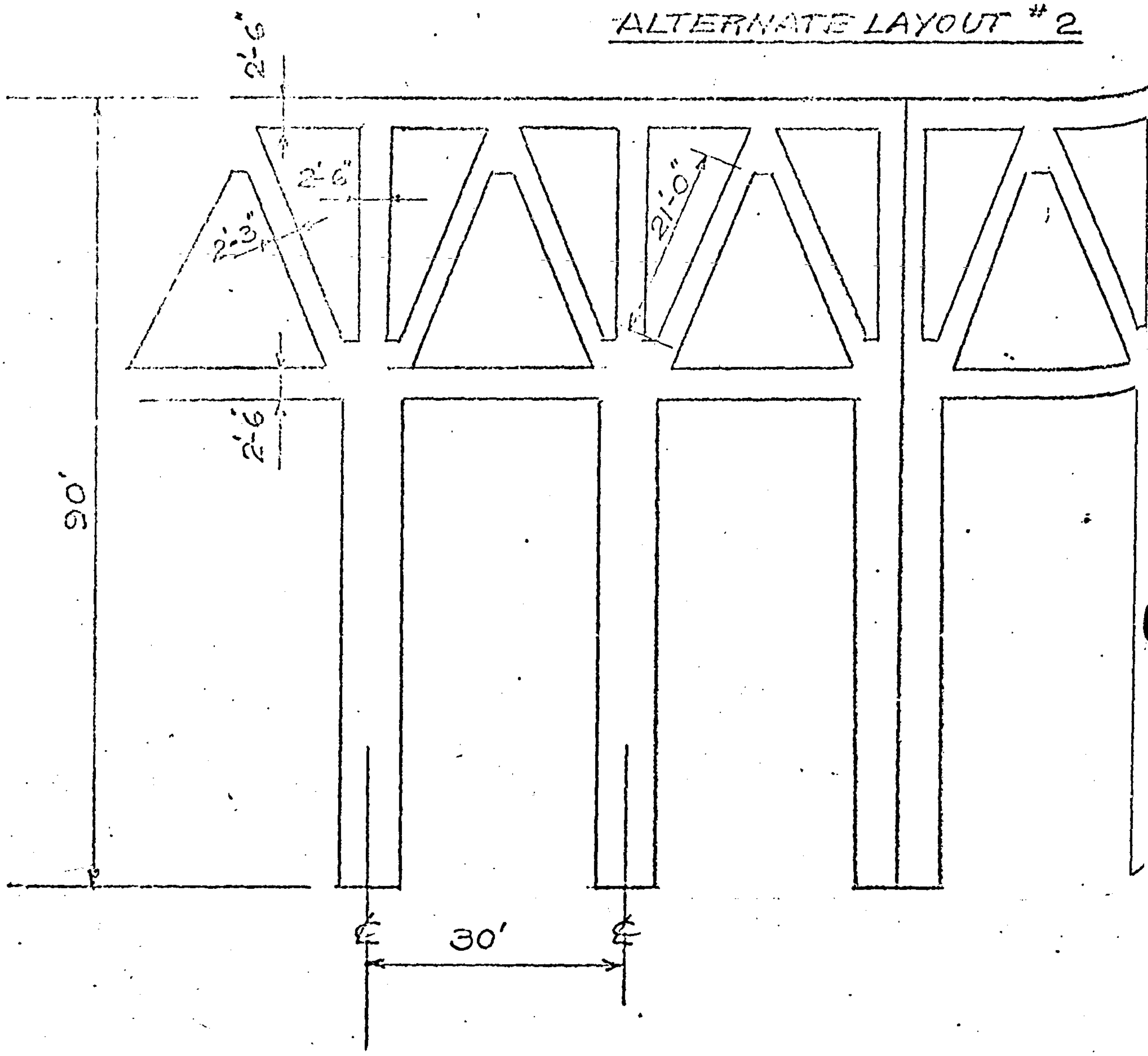


I. A. CAMELLERIE, P.E.
23 [illegible] STREET
HUNTINGTON, N. Y.

DATE JULY 15/72 REV. SKETCH# AR-

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN
CELL DAM STUDY

ALTERNATE LAYOUT #2



NOT USED

J. F. CAVALLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

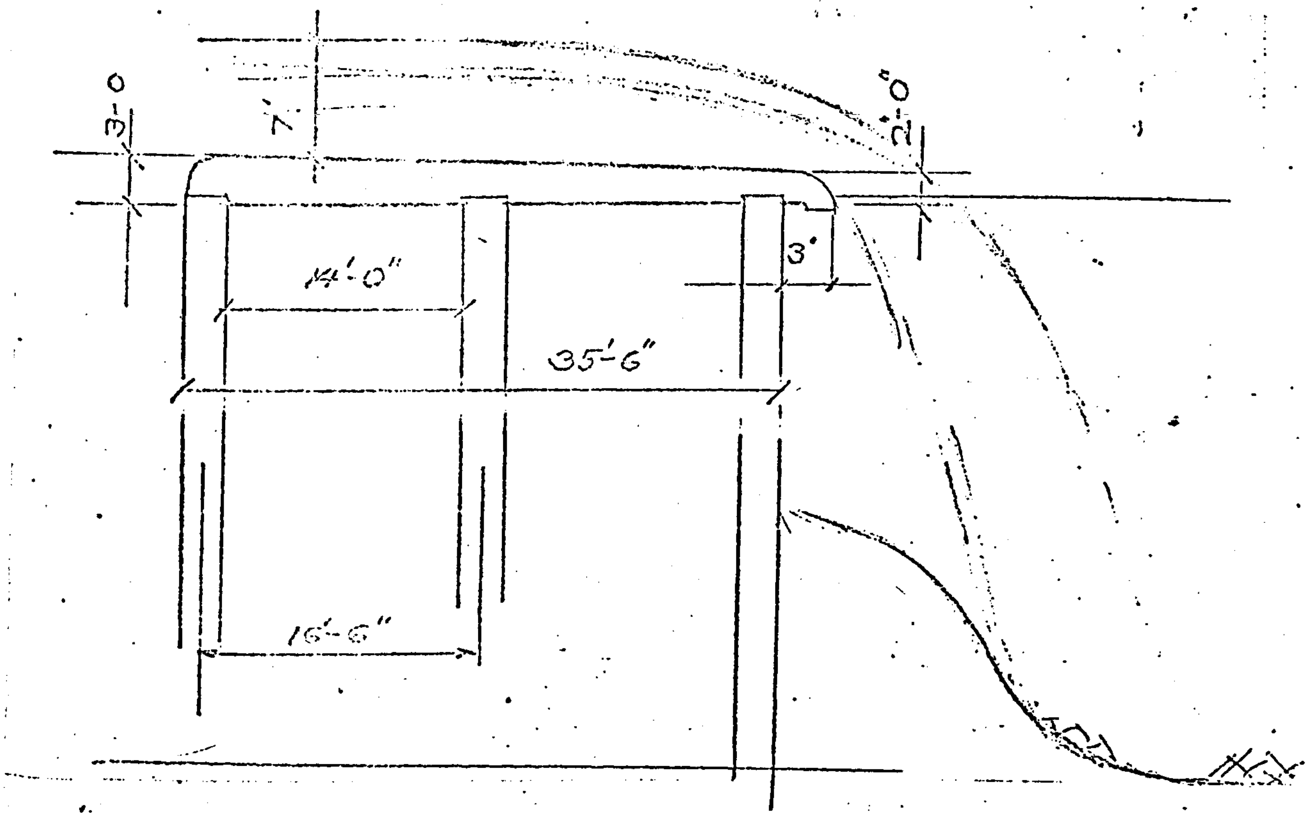
DATE JULY 15, '72 REV. SKETCH# AK-410

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

CELL DAM STUDY

SPILLWAY SLAB



LL = 7' × 62.5 = 440 #/SF (7' SURCHARGE)

DL = 2.5 × 150# = 375 #/SF 815 #/SF

CLEAR SPAN = 14'-0" , 12'-6"

C.O.C. = 16'-6" , 15'-0"

AVER. SLAB THICKNESS = 2'-6'

d = 26"

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE 7/01/15/77 REV. SKETCH# AR-411

TRUMBULL LAKE DAM

REDUANNOCK RIVER BASIN COMM.

CELL DAM STUDY

1/ − M TRANSV. = $\frac{WL^2}{20}$ = $\frac{0.815 \times 16.5^2}{20}$ = 11,1 ^1K } 16'-6"

2/ + M TRANSV. = $\frac{WL^2}{24}$ = 9,25 ^1K

3/ ± M LONG. = $\frac{WL^2}{24}$ = 7,65 ^1K } 15'-0"

$A_{s_1} = \frac{11,1}{1,16 \times 26} = 0,242$ □" = #4 @ 10"

0,88 #/SF

$A_{s_2} = \frac{9,25}{45,8} = 0,2$ □" #4@12"

0,73 #/SF

$A_{s_3} = \frac{7,65}{45,8} = 0,17$ □" #4@14" say #4@15"

0,59 #/SF × 2

TOTAL RE./SF = 2,79 #/SF

TOTAL SLAB AREA = 38,5' × 240' = 9,300 SF

TOTAL REINF. = 9,300 × 2,79 = 26,000# = 13 TONS

~30#/CY

CONC. VOL. OF SPILLWAY SLAB

9,300 × 2,5 = 23,200 CF = 860 CY

COST STUDY SHEETS

CELLULAR DAM

AC4 -11-

FOUNDATION CONC.

UNDER SLIDE I 150' x 37' x 16' DP. AVE. = 89,00
II 180 x 37 x 14' = 93,00
III 150 x 37 x 8' = 45,00
227,0

227,000 CF/27 = 8,400 C.Y.

UNDER STEM (I) 54' L x 6' x 16' DP. AVE. x 6 = 31,00
(II) 54 x 6 x 14' x 6 = 27,00
(III) 54 x 6 x 8' x 5 = 13,00
71,00

71,000 CF/27 = 2600 CY

TOTAL FDN. CONC.
UNDER SLIDES = 8,400 + 2,600 = 11,000 C.Y.

FOUNDATION FORMWORK

FACE FORMS 480' x 2 = 960 LF
TRANSV. " 37' x 17' = 630 LF
STEM " 114' x 17 = 1940 LF
3,530 LF x 13' DP = 45

ABUTMENT FORMWORK

TOTAL FACE FORMING ... 38 x 7.5 x 60 x 2.25
= 38,50

FDN. FORMS < 480 x 7.5 x 2.25 = 8,000 □'
LIFT STARTERS 8,000 □'
CANTILEVER FORMS 22,500 □'

TRANSV. BULKHEADS 8 x 7.5 x 30 = 1,80

HORIZONTAL JOINT TREATMENT

30 x 60' x 30' = 54,000 □'
LIFTS AV. DP

CONC. ABUTEMENTS

ABUTEMENT #	CONC. REQ'D
91	31
94	38
90	38
89	247
88	296
87	296
83	186
82	186
78	481
77	302
74	667
73	406
69	784
68	512
64	768
63	615
59	764
58	691
54	617
53	794
50	900
49	385
45	900
42	612
39	350
61	189
56	610
52	610
48 + MISC.	585 + 300
46	63
37	312
27	544
47	225
41	491
34	229
28 + 35	316 + 424

16,760 C.Y TOTAL

J. F. CAMPELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

ROCK EXCAVATION:

AREA OF ROCK EXCAV. (ORIG. DAM.) 45,510 SF = A_1

AREA OF REDUCED ROCK EXCAV. = A_R

[25 (43 + 57 + 66 + 67 + 68 + 68 + 62 + 56 + 51 + 46 + 43 + 42 + 41 + 40 + 39 + 33)]

− [6 (11 + 12 + 13 + 13 + 11 + 6)]

+ [6 (4 + 5 + 10 + 11 + 13 + 14 + 14 + 16]

+ [4.5 (26 + 16)] + [7 (480) = − 24,180 SF = A_R

21,330 SF = A_2

Rock Exc. = (21,330 / 45,510) (10,000) = 4700 C.Y. (VOL. EXCAV. ORIG. DAM EST.)

ADD'L EXCAV.

{[23 (30)/2 + 37 (6) + 15 (13)/2] 36 + [3 (54) (4.5)] 2 + 3 (54) (6)} / 27 = 120 CY

TOTAL ROCK EXCAV = 4820 CY

FOUNDATION GROUTING: 50,000 S.F.

HAND CLEANING:

A_1 = 45,510 SF
A_R = 24,180 SF

A_2 = 21,330 SF

(21,330 / 45,510) (71,060) = 33,600 S.F.

1/ CONC. VOLUME NO SPILLWAY, CELL SEC.

a/ SEC. I & II

LENGTH = 160 FT EA.
HEIGHT = 117 FT

CELL WALLS = 3 × 160' × 117' × 2,5' + 11 × 82,5 × 117' × 2,
140,500 + 265,000 = 405,500 CF = 15,00

FILL = 2 × 216,200 = 432,400 CF = 16,00

b/ SEC. III

LENGTH = 160 FT
HEIGHT = 94 FT

CELL WALLS = $\frac{15,000 \times 94}{117}$ = 12,070 CY
FILL = 132' × 14' × 94' × 2 = 348,000 CF = 12,900 CY

c/ TOTAL CONCRETE
2 × 15,000 + 12,100 = 42,100 CY

d/ TOTAL FILL
16,000 × 2 + 12,900 = 44,900 CY

TOTAL CONCRETE

MASS CONC.

FOUNDATION	11,000 C.Y.
ABUTMENTS	16,800 C.Y.
	27,800 C.Y.
STRUCT. CONC	44,720 C.Y.

STRUCT. CON

CELLS	42,100
SPILLWAY	860
ROADWAY	600
STAIR TOWER	60
PUMP HOUSE	700
RET. WALL	35

J. F. [illegible], P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JUL. 15 '72 REV. SKETCH # AD-54[illegible]

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN

CELL DAM STUDY

CEMENT & FLYASH REQUIREMENTS

EXTERIOR CONCRETE

$27,800 \text{ CY} \times \frac{1.83 \text{ CWT}}{20} =$ 2550 TONS

STRUCTURAL CONCRETE

$44,720 \text{ CY} \times \frac{5.64 \text{ CWT}}{20} =$ 12 650 TONS

15,200 TONS

FLYASH

$27,800 \text{ CY} \times \frac{.78 \text{ CWT}}{20} =$ 1,100 TONS

AGGREGATE REQUIREMENTS (BORROW

72 500 CY × 1.85 TONS =	134,000 T
CELL FILL 45,000 (1.85) =	83,500 T
SITE WORK	9,000 T
	226,500 T
SLIP FORM CONC (42,100)(1.85) =	78,000 T
	148,500 T

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15/72 REV. SKETCH# AD-5406

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
CELL DAM — COST STUDY

QUARRY OPERATION 1600 TONS / SHIFT

STRAIGHT SHIFT $.29 / TON

SHIFT COST BASED ON 24 HR PRODUCTION / DAY

FOREMAN	85.50	
DRAGLINE OPER.	77.75	
1 OILER	62.10	
1 SPOTTER	50.40	
		275.75
SUPPLIES	40.00	
AGGREGATE HAUL		
4 TRUCK DRIVERS	191.00	231.00
		$ 506.75
		$ 0.32 / TON

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15, '72 REV. SKETCH# AD-6407

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
CELL DAM - COST STUDY

AGGREGATE PRODUCTION (1580 TONS/SHIFT)

STRAIGHT SHIFT $.34 /TON

SHIFT BASED ON 24 HR PRODUCTION $.39/TON

MIX PLANT 1000 CY/SLIP SHIFT

STRAIGHT SHIFT $1.75 /CY

SHIFT BASED ON 24 HR PRODUCTION

LABOR	721.00	(641 x 9/8)
MISC. MAT.	300.00	
	$ 1021.00	

$\frac{1021.00}{1000}$ = $1.00 / CY

L

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE July 15/72 REV. SKETCH# AD-5

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

CELLULAR DAM

SLIDING FORMS

UPSTREAM FACE		480 LF
DOWNSTREAM FACE	480 − (15×5 + 2×3.75) =	400
STEM ENDS		80
CELL INSIDE (HORIZ)	12.5 × 32 × 4 = 1600	1600
CELL INSIDE (VERT.)	14 × 2 × 64 =	1800
STEM SIDES	2 × 54 × 17 =	1840
		6200 LF

6200 LF CONTACT SURFACE / 2 = 3100 LF FORM

YOKES (3T)

10/BAY × 32 BAYS = 320 YOKES

14/STEM × 15 STEM = 210

7/STEM × 2 STEM = 14

END BAYS = 8

552

SAY 560 YOKES

JACK ROD (3T)

10/BAY × 20 BAYS = 200

14/STEM × 10 = 140

7/STEM × 1 = 7

END = 4

351 × 117' HIGH = 41,200 LF.

552 TOTAL

−351

201 LEFT × 94' HIGH = 18,800 LF

60,600 LF

J. F. CAMBLERIE, P.E.
23 CRES? STREET
HUNTINGTON, N. Y.

TRUMBULL LAKE DAM
HOUSATONIC RIVER BASIN, CONN.
CELLULAR DAM

DECKS	CELLS	12.5 x 14 x 2 x 32 =	11,300 □'
	UPSTREAM	2'W x 480' LG =	960
	DOWN STREAM		960
	STEM SIDES	2 x 54 x 2 x 17 =	3680
			16,900 □'

SCAFFOLDS	UPSTREAM	2 x 480	960 □'
	DWN. ST.		960
	STEM SIDES		3680
			5,600 □'

RAILINGS + LADDERS		480	
		480	
	54 x 2 x 17 =	1840	
		2,800 LF	SAY 3000 LF

HYDRAULIC PIPE	L.F. FORM =	3100 LF
	560 JACKS x 10'/JACK =	5600
		8,700 LF

TOPPING-OUT RODS	320 YOKES x 2/YOKE =	640
	8 x 2 =	16
	224 x 1/YOKE =	224
		880

L

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE July 13 '72 REV. SKETCH # AD-5

TRUMBULL LAKE DAM
PEQUONNOCK RIVER BASIN, CONN.
CELLULAR DAM.

SLIDE CREW

TOTAL CONC. IN SLIP. = 42,100 C.Y.
MAX. CONC. IN 1 SLIP = 15,000 C.Y.

14 DAYS x 3 SHIFTS/DAY = 42 SHIFTS $\frac{42,100}{42 \times 8}$ = 125 CY/HR.

CLASSIFICATION	#	HR. RATE INCL. FRINGE BENEFITS	COST / SHIFT 9/8	
HOIST OPER.	1	8.60	77	
JACK OPER.	3	8.00	216	
CARPENTER	1	9.00	81	
ELECTRICIAN	2/3	8.25	50	
FIN. FORMAN	1	9.37	84	
FINISHERS	6	8.87	477	
FIN. HELPER	2	7.15	129	
LABORERS:				
FORMAN	1	6.10	55	* 1 TOP MAN, 4 CONV. MEN, 8 SHOVEL, 1 UTILITY
PLACING *	13 (25)	5.60	1260	
VIBRATING	8	5.60		
CURING	3	5.60		
CRANE OPER.	2/3	8.60	52	
OILER	2/3	6.85	41	
CONV. OPER	3	7.75	209	
			$ 2731	

42 SHIFTS x $2731 = $114,700

J. F. CAMELLERIE, P.E.
23 GREEN STREET
HUNTINGTON, N. Y.

DATE JULY 15/77 REV. SKETCH# AD-541

TRUMBULL LAKE DAM

PEQUONNOCK RIVER BASIN, CONN.

CELLULAR DAM

FINISH UPSTREAM 150(117)+(180×117)+(150×94) =
17,600 + 21,100 + 14,100 = —— 52,800 □'

DOWNSTREAM —— 52,800
STEM SIDES 54×2 ×11 STEMS × 117' = —— 140,000
54×2 × 6 × 94 = —— 61,000
306,600 □'

VERTICAL KEYS 3 KEYS ×117 = 352
3 × 94 = 283
735 LF × 2 = 1470 LF

JAY FOOTING 32 × 3 = 96
16 × 4 = 64
160 × 10' = 1600 LF

SPILLWAY SLAB FINISH + CURING
40' W × 240' = 9600 □'

REINFORCING STEEL
CELL = 24,000 cu ft × 70# = 1,680,000 #
= 840 TONS
SAY 900 TONS

CONVEYOR SYSTEM (LOWER SYSTEM)

FEEDER CONVEYOR, PLANT TO TRESTLE 1
SIDE DISCHARGE CONVEYOR ON TRESTLE 1
CONVEYORS TO MONOLITHS 1
3

3 OPERATORS INCLUDED ELSEWHERE

CONVEYOR REQUIREMENTS: 16"
860 LF @ $145,000 (.67) = $100,000
LESS SALVAGE = 50,000
$50,000

ERECTION = 5,000

(UPPER CONVEYOR SYSTEM)

MATERIAL TOWER TO DIST CONV. 2 x 40' = 80LF
LONGL. CONVEYORS 3 x 180 = 540LF
STEM CONVEYORS 7 x 60 = 420LF
1040LF
(920 AV.
(830 MIN

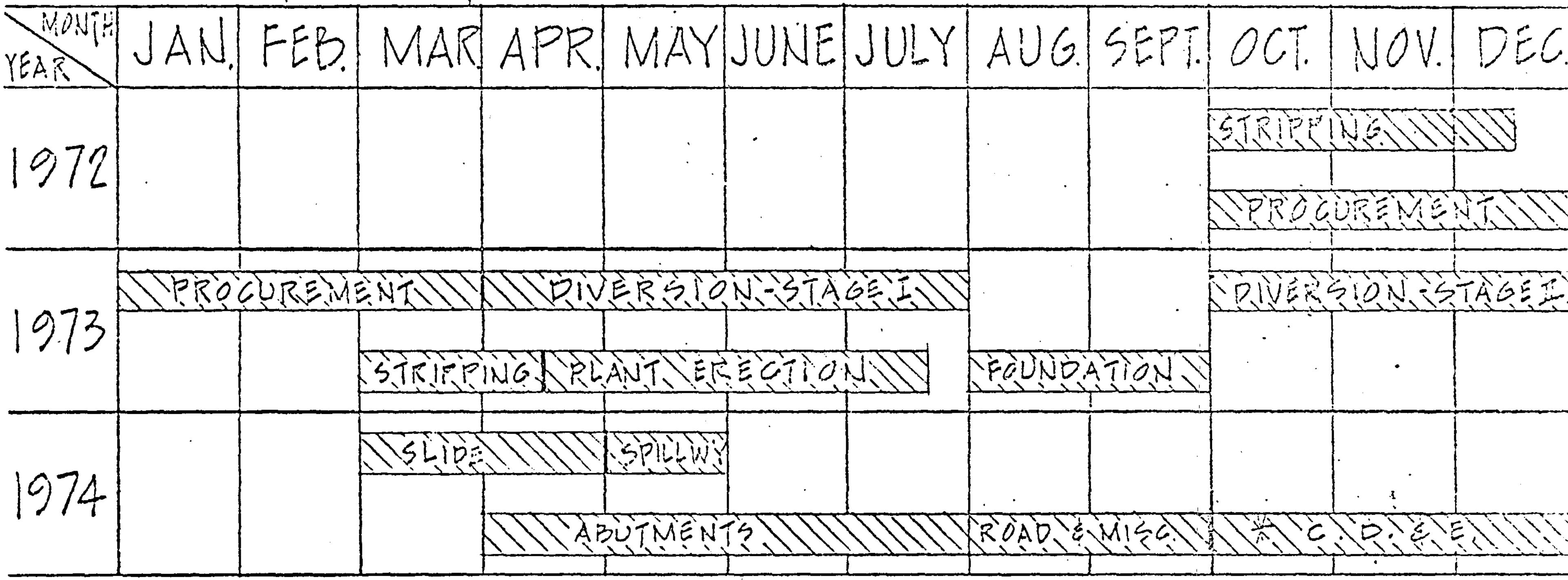
1040 LF @ 105 = 109,000
RAILS & ACC. 11,000
SIDE DISC 700 (12) = 9,000
129 000
LESS SALVAGE = 64,000
$65,000

ERECTION
$6400 x 3 = $19,200 (3 SETS)

ADD'L SET CONVEYORS

830 @ 105 = 87,500
RAILS & ACC = 8,500
SIDE DISC. 9,000
$105,000
LESS SALV. 50,000
$55,000 $120,000

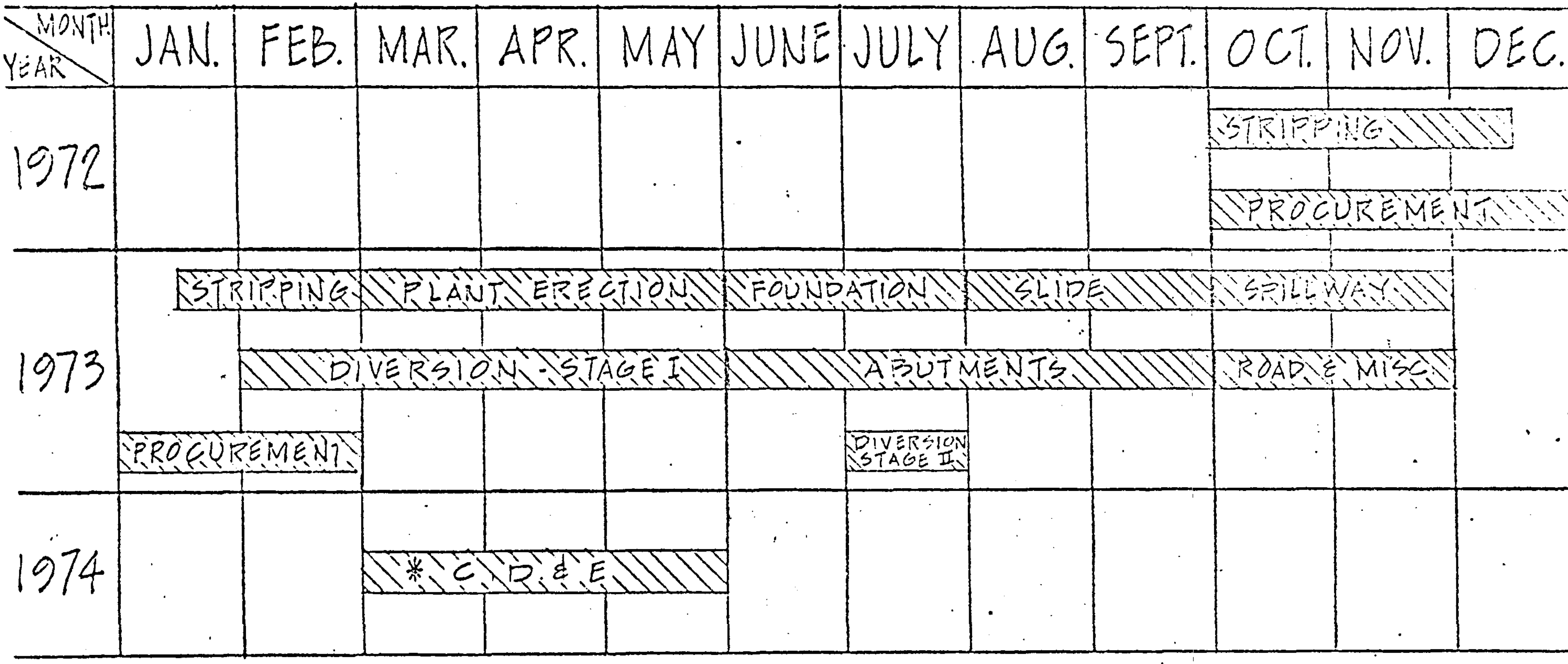
CONSTRUCTION SCHEDULE · CELLULAR DAM



* CLEAN-UP, DEMOBILIZATION & ENVIRONMENT

CONTRACTURAL COMPLETION DATE DEC. 1974

ACCELERATED CONSTRUCTION SCHEDULE - CELLULAR DAM



* CLEAN-UP, DEMOBILIZATION & ENVIRONMENT

CONTRACTURAL COMPLETION DATE MAY 1974

PEQUANNOCK RIVER BASIN COMM.

ACCELERATED CONST. SCHED. CELLULAR DAM

AD 414

In accordance with ER 70-2-3, paragraph 6c(1)(b), dated 15 February 1973, a facsimile catalog card in Library of Congress format is reproduced below.

Camellerie (J. F.), Consulting Engineer.
Cost and feasibility study; alternate designs to permit use of slip form and other techniques to maximize economies, Trumbull Lake Dam, Pequonnock River Basin, Connecticut; final report, by J. F. Camellerie, Consulting Engineer. Vicksburg, U. S. Army Engineer Waterways Experiment Station, 1974.
1 v. (various pagings) illus. 27 cm. (U. S. Waterways Experiment Station. Miscellaneous paper C-74-15)
Prepared for U. S. Army Engineer Division, New England, Waltham, Massachusetts.

1. Concrete. 2. Concrete costs. 3. Dam construction. 4. Slip form techniques. 5. Trumbull Lake Dam. I. U. S. Army Engineer Division, New England. (Series: U. S. Waterways Experiment Station, Vicksburg, Miss. Miscellaneous paper C-74-15)
TA7.W34m no.C-74-15