PHASE III.2 - PRELIMINARY DESIGN REPORT

BULLDOG FLOODWAY AND APACHE JUNCTION OUTLET

BUCKHORN - MESA WATERSHED PROTECTION AND FLOOD PREVENTION PROJECT

Prepared for

THE SOIL CONSERVATION SERVICE

U.S. DEPARTMENT OF AGRICULTURE

Phoenix, Arizona

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USDA Soil Conservation Service
Phoenix, Arizona

I. SUMMARY

A. Design of this project is being carried out by Ebasco Services Incorporated for the Phoenix, Arizona office of SCS. The contract number is 53-9457-5-00475 and is dated April 8, 1985. Completion is scheduled for April 7, 1986. The Contracting Officer for SCS is David O. Lambson, and the Government Representative is Donald E. Paulus.

Work completed in this phase includes:

1. Completion of hydraulic design and dimensioning of the Apache Junction Outlet Channel from its beginning at station 101+50.0 to its end at station 129+76.16.

2. Completion of hydraulic design and dimensioning of the Bulldog Floodway concrete channel from the end of the Apache Junction Outlet to the end of the floodway at station 203+50.0.

3. Completion of hydraulic design and dimensioning of the drop structure/energy dissipator at the end of the Bulldog Floodway concrete channel.

4. Completion of hydraulic design and dimensioning of the Bulldog Floodway earth channel from station 205+56.0 to the end at station 219+76.97.

5. Location and hydraulic design of six curved side channel inlets, one into the Apache Junction Outlet section and five into the Bulldog Floodway concrete channel.

6. Location and hydraulic design of eight overflow weir inlets, seven into the Bulldog Floodway concrete channel and one into the Bulldog Floodway earth channel.

7. Structural design of the concrete channel floor and walls.

8. Preliminary drawings for the layout and geometry of all features.

9. Preliminary preparation of a portion of the construction specification.

10. Bid schedule with preliminary quantities. units prices and total engineer's cost estimate.

B. Work to be completed in final design includes:

1. Completion of all structural design.
2. Completion of all construction drawings.
3. Completion of construction specifications.
4. Completion of bid schedule.
5. Completion of engineer's cost estimate.
6. Completion of construction schedule.
7. Preparation of Final Design Report and Final Design Folder.

II DESCRIPTION OF JOB

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A. Major features of the project are:

1. A concrete open rectangular outlet channel, 3.5 feet wide, starts from the outlet of the Apache Junction principal spillway 30 inch diameter pipe. The length of this section is 2826 feet.

2. A concrete floodway channel extending 7374 feet from station 129+76.16 (end of Apache Outlet) to station 203+50.0.

3. Six curved side channel inlets and eight overflow weir inlets.

4. A grouted riprap chute and stilling basin at the end of the concrete floodway.

5. An earth floodway channel extending 1421 feet from station 205+56.0 to station 219+76.97.

A more detailed description of the elements of the project appears in the "Phase I - Feasibility Study" and will be provided in the "Final Design Report".

III DESIGN

III. DESIGN

A. DESIGN OBJECTIVES

The design objective is to receive flow discharge from the Apache Junction FRS Principal Spillway, intercept flood flows in natural channels in the project area, direct them into a constructed floodway and safely and economically convey them to the next flood retention structure, the Signal Butte FRS. The purpose of this is to reduce flooding damage to irrigated cropland and urban land downstream from the floodway.

B. BASIS FOR DESIGN

The following documents and references are being used as a basis for design:

1. Hydraulics

   NEH - 5
   TR - 39
   TR - 29
   TR - 70
   TR - 48

   Department of Transportation, Hydraulic Engineering Circular No. 14.

2. Structure

   TR - 18
   TR - 46
   TR - 30
   TR - 5
   TR - 67
   NEH - 6

Eng. Monograph No. 25 (USBR)
TR - 63
NEH - 14
TR - 50
TR - 99
NEH - 11
Design Note 21

3. Soils/Layout
TR - 25
ICES Lease - 11
SMN - 3
ENG - PO - 18
SMN - 1
TR - 52
TR - 2
Sedimentation, 1974 Supplement, Buckhorn - Mesa
Soil Test Results

4. Hydrology
TR - 66
TR - 16
Hydrometeorological Report NO. 49
Hydrology - PO-6 (Rev. 2)
TR - 20
TR - 61
NEH - 4
NOAA - Atlas 2
Curve Number Reduction Factors

5. Other
TR - 60
NEH - 20
NEH - 2
Catalog of National Engineering Standard Drawings

Design of Small Damm (USBR)
USDA Design Note 22
HRD 108
National Engineering Manual
Buckhorn - Mesa Watershed, Workplan w/Supplement
Geological Investigation Report
SCS Drawings and Reports
Engineering Hydraulics - Ed. by H. Rouse
Phase 1 - Feasibility Study (Ebasco)
Phase II - Soil Mechanics Report (Ebasco)

C. HYDROLOGY

The hydrology associated with the 4.54 square mile basin controlled by the Project was developed by SCS. Inflow quantities at each inlet location were provided to Ebasco.

D. HYDRAULIC DESIGN

The basic hydraulic design and the associated sizing of elements of the Project was completed in Phase I, with results presented in the "Phase I - Feasibility Report." A summary of the complete development of the hydraulic design will be presented in the "Final Design Report."

Discrepancies in survey information were corrected during the preliminary design phase with the result that all of the major inlets were relocated to correspond to the location of the natural drainage channels. The channel dimensions and slope were not changed significantly.

Inlets 4C,5B and 6A were originally designed as overflow weir inlets. The natural topography and channel invert elevation at the location of these inlets result in the channel wall being several feet above the invert of the wash, resulting in extensive inundation behind the weir during overflow conditions. A comparison was made between the cost and

extent of inundation of weir inlets and curved side channel inlets for each of these locations. The decision was made by SCS to choose the side channel inlet configuration for all three inlets.

A review of the floodway alinement showed that the final bend in the Bulldog Floodway occurred near the intersection with Meridian Road. Since this would complicate the road bridge crossing of the floodway, the curve P.I. was moved downstream from station 195+50.9 to station 197+20.9.

The bridge crossings of the floodway at Ironwood and Meridian Roads are being coordinated between the Flood Control District of Maricopa County and Ebasco. It is intended to use the bridge abutment as a continuation of the floodway walls.

Curves in the concrete floodway channel, where the flow is supercritical, are being designed to handle the standing wave phenomenon at minimum cost. The floor will remain level rather than superlevated and extra wall height will be provided consistent with wave height. A properly designed compound curve, with increased radius at the beginning and end, significantly reduces both the wave height and the length over which extra wall height must be provided. The details of this part of the design will be completed in the Final Design.

The floor of the concrete channel throughout will be kept level in the horizontal direction rather than incurring the complication of a slope to the middle of the channel. This is considered acceptable since flow occurs in the channel very infrequently.

A number of alternatives for project features were examined. Many of these were studied in Phase I and described in the "Phase I - Feasibility Study". These included:

Selection of overflow weir or curved side channel inlets.

Location of inlets.

E. FOUNDATION DESIGN

The parameters which apply to the foundation design are discussed thoroughly in the "Phase II - Soil Mechanics Report". This background will be discussed in the "Final Design Report."

Much of the concrete floodway will rest upon caliche. No special bedding will be placed under the bottom slab, either on the caliche or other soils. Non-caliche soils will be compacted before construction of the channel to avoid possible settlment. Where the channel intersects a wash, a cutoff wall will be included to minimize seepage and possible piping during flood events.

The energy dissipator at the end of the concrete channel is designed with a grouted riprap chute and stilling basin, a total of 206 feet to the beginning of the unlined channel.

Grouted riprap will be provided upstream from each of the inlets to the floodway in the region where velocities may be high and scour may occur.

The earth channel has a bottom width of 100 feet and side slopes of 2:1. No special treatment will be required to withstand maximum velocities of about 3.5 fps.

F. STRUCTURAL DESIGN

Structural design of floodway concrete walls and floor was based upon the following parameter:

Moist Unit Soil Weight	130 $lb.ft^3$
At-Rest Lateral Earth Pressure Coeff.	0.60
Drainage	2 1/2 in. diameter weep @ 8 ft holes backed by filters.

The drainage will effectively reduce the uplift to an amount well below the gravity forces. Minimum wall thickness has been established as ten inches.

Keyed and waterstopped construction joints will be provided at intervals along the floodway of 30 feet.

Alternatives examined in the preliminary design, in addition to minor changes in some of those items described above, were as follow:

1. Inlets locations were moved to correspond to corrected locations of natural drainage channels.

2. Inlets 4C, 5B, and 6A were changed from overflow weir to curved side channel inlets to reduce extensive ponding which would occur because of the topography.

3. Inlet 4G was changed from overflow weir to curved side channel inlet to eliminate the hydraulic interference caused by the short floodway reach between inlet 4F and 4G.

4. Weep holes and drainage behind concrete floodway walls were provided to reduce wall loads and possible uplift on bottom slab.

5. Floodway channel walls were established as a constant thickness from bottom to top with a minimum of 10 inches, to facilitate construction.

6. Road bridge abutmont walls at Ironwood and Meridian Roads will be incorporated with the Bulldog Floodway channel walls to minimize construction costs.

There are no utilities which will be affected by the Project known at this time.

IV CONSTRUCTION DRAWINGS

IV. CONSTRUCTION DRAWINGS

Thirty-two drawings will be prepared for the Project tender documents. Twenty of these are submitted as part of the preliminary design. These include the general arrangement, plan and profiles and representative sections and details. The drawing list is attached with identification of those included with this package.

USDA-SOIL CONSERVATION SERVICE
APACHE-BULLDOG FLOOD CONTROL PROJECT

LIST OF DRAWINGS

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2-2	Project Plan and Right-Of-Way
	Apache Junction
2-3	Outlet Channel - Plan & Profile - Sta 101 + 46.34 to Sta 115 + 00
2-4	Outlet Channel - Plan & Profile - Sta 115 + 00 to Sta 129 + 76.16
2-5	Outlet Channel - Transition - Details
2-6	Side Channel Inlet No. 1 - Details
	Bulldog Floodway
2-7	Plan and Profile - Sta 129 + 76.16 to Sta 145 + 00
2-8	Plan and Profile - Sta 145 + 00 to Sta 160 + 00
2-9	Plan and Profile - Sta 160 + 00 to Sta 175 + 00
2-10	Plan and Profile - Sta 175 + 00 to Sta 190 + 00
2-11	Plan and Profile - Sta 190 + 00 to Sta 205 + 00
2-12	Plan and Profile - Sta 205 + 00 to Sta 219 + 32.52
2-13	Sections & Details - Sh. 1
2-14	Sections & Details - Sh. 2
2-15	Side Channel Inlet No. 2 - Details
2-16	Side Channel Inlet No. 3 - Details

(Continued)

LIST OF DRAWINGS

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2-18	Weir Inlet No. 3 - Details
2-19	Weir Inlet No. 4 - Details
2-20	Weir Inlet No. 5 - Details
2-21	Side Channel Inlet No. 5 - Details
2-22	Weir Inlet No. 6 - Details
2-23	Side Channel Inlet No. 6 - Details
2-24	Weir Inlet No. 7 - Details
2-25	Side Channel Inlet No. 7 - Details
2-26	Weir Inlet No. 8 - Details
2-27	Weir Inlet No. 9 - Details
2-28	Bar Bending Schedule - Sh. 1
2-29	Bar Bending Schedule - Sh. 2
2-30	Energy Dissipator No. 2 Details
2-31	Misc Details
2-32	Identification Sign

V SPECIFICATIONS

USDA-SOIL CONSERVATION SERVICE
APACHE-BULLDOG FLOOD CONTROL PROJECT

LIST OF SPECIFICATIONS

BULLDOG FLOODWAY AND APACHE JUNCTION OUTLET

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Water-Reducing And Set-Retarding Admixtures for Portland Cement Concrete	533
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Non-Metallic Waterstops	537
Steel Reinforcement (for concrete)	539
Steel Pipe and Fittings	553
Metal	581
Galvanizing	582
Farm Field Fencing Materials	591

V. SPECIFICATIONS

Specifications are based upon the NEH20 standards. The standards cover all of the Project elements, and no special sections are required. The standard sections are being modified as needed to fit the Project requirements.

SECTION C - DESCRIPTION/SPECIFICATIONS/WORK STATEMENT

BULLDOG FLOODWAY/APACHE JUNCTION OUTLET

2. CLEARING AND GRUBBING

1. SCOPE

The work shall consist of the clearing and grubbing of designated areas by removal and disposal of trees, snags, logs, stumps, shrubs and rubbish.

2. MARKING

The limits of the areas to be cleared and grubbed will be marked by means of stakes, flags, tree markings or other suitable methods. Trees to be left standing and uninjured will be designated by special markings placed on the trunks at a height of about six feet above the ground surface.

3. REMOVAL

All trees not marked for preservation and all snags, logs, brush, stumps, shrubs and rubbish shall be removed from within the limits of the marked areas. Unless otherwise specified, all stumps, roots and root clusters having a diameter of one inch or larger shall be grubbed out to a depth of at least two feet below subgrade elevation for concrete structures and one foot below the ground surface at embankment sites and other designated areas.

4. DISPOSAL

Unless otherwise specified, all materials removed from the cleared and grubbed areas shall be burned or buried at locations approved by the Engineer or otherwise disposed of as approved by the Engineer.

5. MEASUREMENT AND PAYMENT

The cleared and grubbed area will be measured to the nearest 0.1 acre. Payment for clearing and grubbing will be made for the total area within the designated limits at the contract unit price. Such payment will constitute full compensation for all labor, equipment, tools and all other items necessary and incidental to the completion of the work.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 6 of this specification.

6. ITEMS OF WORK AND CONSTRUCTION DETAILS-Bulldog Floodway/Apache Junction Outlet

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 2, Clearing and Grubbing

(1) This item shall consist of clearing and grubbing of all areas shown on the drawings and staked in the field.

(2) If waste materials are disposed of by buring, they shall be buried a minimum of 18 inches below the existing ground surface in the waste disposal areas shown on the drawings. When disposal is complete, the waste disposal areas shall be smoothed and graded to blend into the surrounding terrain.

(3) If materials removed from the cleared and grubbed area are to be burned, burning must be carried out in accordance with Pinal and Maricopa County Health Department regulations.

BULLDOG FLOODWAY/ APACHE JUNCTION OUTLET

5. POLLUTION CONTROL

1. SCOPE

The work shall consist of installing measures or performing work to control erosion and minimize the production of sediment and other pollutants to water and air during construction operations in accordance with these specifications.

2. MATERIALS

All materials furnished shall meet the requirements of the Material Specifications listed in Section 8 of this specification.

3. EROSION AND SEDIMENT CONTROL MEASURES AND WORKS

The work and measures shall include but not be limited to the following, as shown on the drawings or as specified in Section 8 of this specification.

Staging of Earthwork Activities - The excavation and moving of soil materials shall be scheduled so that the smallest possible areas will be unprotected from erosion for the shortest time feasible.

Seeding - Seeding to protect disturbed areas shall be used as specified on the drawings or in Section 8 of this specification.

Mulching - Mulching shall be used to provide temporary protection to soil surfaces from erosion.

Diversions - Diversions shall be used to divert water away from work areas and/or to collect runoff from work areas for treatment and safe disposition.

Stream Crossings - Stream crossings shall be used where fording of streams by equipment is necessary.

Sediment Basins - Sediment basins shall be used to settle and filter out sediment from eroding areas to protect properties and streams below the construction site.

Straw Bale Filters - Straw bale filters shall be used to trap sediment from areas of limited runoff. Bales are temporary and shall be removed when permanent measures are installed.

Waterways - Waterways shall be used for the safe disposal of runoff from fields, diversions and other structures or measures.

4. CHEMICAL POLLUTION

The Contractor shall provide tanks or barrels or construct a sump sealed with plastic sheets to be used to dispose of chemical pollutants produced as a by-product of the project's work such as drained lubricating or transmission oils, greases, soaps, asphalt, etc. At the completion of the construction work, the sump shall be covered or filled as directed by the Engineer. Storage tanks or barrels shall be removed from the site.

Sanitary facilities such as pit toilets, chemical toilets, or septic tanks shall not be placed adjacent to live streams, wells, or springs. They shall be located at a distance sufficient to prevent contamination of any water sources.

5. AIR POLLUTION

Local and state regulations concerning the burning of brush or slash or disposal of other materials shall be adhered to.

Fire prevention measures shall be taken to prevent the start or the spreading of fires which result from project work. Fire breaks or guards shall be constructed at locations as shown on the drawings.

All public access or haul roads used during construction of the project shall be sprinkled as required to fully suppress dust.

6. MAINTENANCE REMOVAL AND RESTORATION

All measures and works shall be adequately maintained in a functional condition as long as needed during the construction operation. All temporary measures shall be removed and the site restored to as nearly to original conditions as practicable as directed by the Engineer.

7. MEASUREMENT AND PAYMENT

Compensation for item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidary. Such items, and the items to which they are made subsidary, are identified in Section 8 of this specification.

(5-3)

8. ITEMS OF WORK AND CONSTRUCTION DETAILS - Bulldog Floodway/Apache Junction Outlet

Items of work to be performed in conformance with this specification and the construction details are:

a. Subsidiary Item, Pollution Control

(1) This item shall consist of all measures required to control dust, erosion, sedimentation or any other form of pollution resulting from the Contractor's activities in constructing the project.

(2) No separate payment will be made for this item. Compensation for this work will be included in the payment for Bid Items 4 through 7.

BULLDOG FLOODWAY/APACHE JUNCTION OUTLET

8. MOBILIZATION

1. SCOPE

The work shall consist of the mobilization of the Contractor's forces and equipment necessary for performing the work required under the contract.

It shall include the purchase of contract bonds; transportation of personnel, equipment, and operating supplies to the site; establishment of offices, buildings, and other necessary facilities at the site, and other preparatory work at the site.

It shall not include mobilization for any specific item of work for which payment for mobilization is provided elsewhere in the contract.

The specification covers mobilization for work required by the contract at the time of award. If additional mobilization costs are incurred during performance of the contract as a result of changed or added items of work for which the Contractor is entitled to an adjustment in contract price, compensation for such costs will be included in the price adjustment for the items of work changed or added.

2. PAYMENT

Payment will be made as the work proceeds, after presentation of invoices by the Contractor showing his own mobilization costs and evidence of the charges of suppliers, subcontractos, and others for mobilization work performed by them. If the total of such payments is less than the contract lump sum for mobilization, the unpaid balance will be included in the price final contract payment. Total payment will be the lump sum contract price for mobilization, regardless of actual cost to the Contractor.

Payment will not be made under this item for the purchase costs of materials having a residual value, the purchase costs of materials to be incorporated in the project, or the purchase costs of operating supplies.

Payment of the lump sum contract price for mobilization will constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to completion of the work.

BULLDOG FLOODWAY/APACHE JUNCTION OUTLET

10. WATER FOR CONSTRUCTION

1. SCOPE

The work shall consist of furnishing, transporting, and using water for construction purposes in accord with the applicable specifications.

2. FACILITIES AND EQUIPMENT

The Contractor shall build and maintain such access and haul roads as are needed, and shall furnish, operate, and maintain all pumps, piping, tanks, and other facilities needed to load, transport, and use the water as specified.

These facilities shall be equipped with meters, tanks, or other devices by which the volume of water supplied can be measured.

3. DUST ABATEMENT AND HAUL ROAD MAINTENANCE

Water for dust abatement and haul road maintenance shall be applied to haul roads and other dust-producing areas as needed to prevent excessive dust and to maintain the roads in good condition for efficient operation while they are in use.

4. EARTHFILL, DRAINFILL, ROCKFILL

Water for earthfill, drainfill, or rockfill shall be used in the fill materials as specified in the applicable construction specifications.

5. CONCRETE, MORTAR, GROUT

Water used in mixing or curing concrete, pneumatically applied mortar, or other portland cement mortar or grout shall meet the requirements of the applicable construction specifications and shall be used in conformance with those specifications.

6. MEASUREMENT AND PAYMENT

For water items for which specific unit prices are established in the contract, the volume of water furnished and used in accordance with the specifications will be measured to the nearest 1000 gallons.

(10-2)

Except as otherwise specified, the measurement for payment will include all water needed at the construction site to perform the work required under the contract in accordance with the specifications but will not include water wasted or used in excess of the amount needed. It will not include water used in concrete which is mixed elsewhere and transported to the site.

Payment for water will be made at the contract unit price which shall be the price per 1000 gallons shown in the Bid Schedule. Such payment will constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to furnishing, transporting, and using the water.

BULLDOG FLOODWAY/APACHE JUNCTION OUTLET

11. REMOVAL OF WATER

1. SCOPE

The work shall consist of the removal of surface water and ground water as needed to perform the required construction in accordance with the specifications. It shall include (1) building and maintaining all necessary temporary impounding works, channels, and diversions, (2) furnishing, installing and operating all necessary pumps, piping and other facilities and equipment, and (3) removing all such temporary works and equipment after they have served their purposes.

2. DIVERTING SURFACE WATER

The Contractor shall build, maintain and operate all cofferdams, channels, flumes, sumps, and other temporary diversion and protective works needed to divert streamflow and other surface water through or around the construction site and away from the construction work while construction is in progress. Unless otherwise specified, a diversion must discharge into the same natural drainage way in which its headworks are located.

Unless otherwise specified, the Contractor shall furnish to the Engineer, in writing, his plan for diverting surface water before beginning the construction work for which the diversion is required. Acceptance of this plan will not relieve the Contractor of responsibility for completing the work as specified.

3. DEWATERING THE CONSTRUCTION SITE

Foundations, cutoff trenches and other parts of the construction site shall be dewatered and kept free of standing water or excessively muddy conditions as needed for proper execution of the construction work. The Contractor shall furnish, install, operate and maintain all drains, sumps, pumps, casings, wellpoints, and other equipment needed to perform the dewatering as specified. Dewatering methods that cause a loss of fines from foundation areas will not be permitted.

Unless otherwise specified, the Contractor shall furnish to the Engineer, in writing, his plan for dewatering before beginning the construction work for which the dewatering is required. Acceptance of this plan will not relieve the Contractor of responsibility for completing the work as specified.

(11-2)

4. DEWATERING BORROW AREAS

Unless otherwise specified in Section 8, the Contractor shall maintain the borrow areas in drainable condition or otherwise provide for timely and effective removal of surface and ground waters that accumulate within the borrow areas from any source. Borrow material shall be processed as necessary to achieve proper and uniform moisture content for placement.

5. EROSION AND POLLUTION CONTROL

Removal of water from the construction site, including the borrow areas shall be accomplished in such a manner that erosion and the transmission of sediment and other pollutants are minimized.

6. REMOVAL OF TEMPORARY WORKS

After the temporary works have served their purposes, the Contractor shall remove them or level and grade them to the extent required to present a sightly appearance and to prevent any obstruction of the flow of water or any other interference with the operation of or access to the permanent works.

Except as otherwise specified, pipes and casings shall be removed from temporary wells and the wells shall be filled to ground level with gravel or other material approved by the Engineer.

7. MEASUREMENT AND PAYMENT

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 8 of this specification.

(11-3)

8. ITEMS OF WORK AND CONSTRUCTION DETAILS - Bulldog Floodway/Apache Junction Outlet

Items of work to be performed in conformance with this specification and the construction details are:

a. Subsidiary Item, Removal of Water

(1) This item shall consist of the removal or diversion of surface, ground and construction water, or direct rainfall from the construction area as needed to construct the work.

(2) The Contractor's plans for control of surface water and any dewatering necessitated by rainfall or runoff into construction areas shall be furnished to the Engineer prior to performance of any excavation or earthfill work.

(3) No separate payment will be made for the Removal of Water. Compensation for this work will be included in the payment for Bid Items 4 through 10.

BULLDOG FLOODWAY/APACHE JUNCTION OUTLET

21. EXCAVATION

1. SCOPE

The work shall consist of the excavation required by the drawings and specifications and disposal of the excavated materials.

2. CLASSIFICATION

Excavation will be classified as common excavation or rock excavation in accordance with the following definitions or will be designated as unclassified.

Common excavation shall be defined as the excavation of all materials that can be excavated, transported, and unloaded by the use of heavy ripping equipment and wheel tractor-scrapers with pusher tractors or that can be excavated and dumped into place or loaded on to hauling equipment by means of excavators having a rated capacity of one cubic yard and equipped with attachments (such as shovel, bucket, backhoe, dragline or clam shell) appropriate to the character of the materials and the site conditions.

Rock excavation shall be defined as the excavation of all hard, compacted or cemented materials the accomplishment of which requires blasting or the use of excavators larger than defined for common excavation. The excavation and removal of isolated boulders or rock fragments larger than one cubic yard in volume encountered in materials otherwise conforming to the definition of common excavation shall be classified as rock excavation.

Excavation will be classified according to the above definitions by the Engineer, based on his judgment of the character of the materials and the site conditions.

The presence of isolated boulders or rock fragments larger than one cubic yard in size will not in itself be sufficient cause to change the classification of the surrounding material.

For the purpose of this classification, the following definitions shall apply:

Heavy ripping equipment shall be defined as a rear-mounted, heavy

duty, single-tooth, ripping attachment mounted on a tractor having a power rating of 200-300 net horsepower (at the flywheel).

Wheel tractor-scraper shall be defined as a self-loading (not elevating) and unloading scraper having a struck bowl capacity of 12-20 yards.

Pusher tractor shall be defined as a track type tractor having a power rating of 200-300 net horsepower (at the flywheel) equipped with appropriate attachments.

3. UNCLASSIFIED EXCAVATION

Items designated as "Unclassified Excavation" shall include all materials encountered regardless of their nature or the manner in which they are removed. When excavation is unclassified, none of the definitions or classifications stated in Section 2 of this specification shall apply.

4. BLASTING

The transportation, handling, storage, and use of dynamite and other explosives shall be directed and supervised by a person of proven experience and ability in blasting operations.

Blasting shall be done in such a way as to prevent damage to the work or unnecessary fracturing of the foundation and shall conform to any special requirements in Section 12 of this specification.

5. USE OF EXCAVATED MATERIALS

To the extent they are needed, all suitable materials from the specified excavations shall be used in the construction of required permanent earthfill or rockfill. The suitablity of materials for specific purposes will be determined by the Engineer. The Contractor shall not waste or otherwise dispose of suitable excavated materials.

6. DISPOSAL OF WASTE MATERIALS

All surplus or unsuitable excavated materials will be designated as waste and shall be disposed of at the location shown on the drawings.

7. BRACING AND SHORING

Excavated surfaces too steep to be safe and stable if unsupported shall be supported as necessary to safeguard the work and workers, to prevent

sliding or settling of the adjacent ground, and to avoid damaging existing improvements. The width of the excavation shall be increased if necessary to provide space for sheeting, bracing, shoring, and other supporting installations. The Contractor shall furnish, place and subsequently remove such supporting installations.

8. STRUCTURE AND TRENCH EXCAVATION

Structure or trench excavation shall be completed to the specified elevations and to sufficient length and width to include allowance for forms, bracing and supports, as necessary, before any concrete or earthfill is placed or any piles are driven within the limits of the excavation.

9. BORROW EXCAVATION

When the quantities of suitable materials obtained from specified excavations are insufficient to construct the specified fills, additional materials shall be obtained from the designated borrow areas. The extent and depth of borrow pits within the limits of the designated borrow areas shall be as directed by the Engineer.

Borrow pits shall be excavated and finally dressed in a manner to eliminate steep or unstable side slopes or other hazardous or unsightly conditions.

10. OVEREXCAVATION

Excavation in rock beyond the specified lines and grades shall be corrected by filling the resulting voids with portland cement concrete made of materials and mix proportions approved by the Engineer. Concrete that will be exposed to the atmosphere when construction is completed shall contain not less than 6 sacks of cement per cubic yard of concrete. Concrete that will be permanently covered shall contain not less than 4.5 sacks of cement per cubic yard. The concrete shall be placed and cured as specified by the Engineer.

Excavation in earth beyond the specified lines and grades shall be corrected by filling the resulting voids with approved compacated earthfill, except that, if the earth is to become the subgrade for riprap, rockfill, sand or gravel bedding or drainfill, the voids may be filled with material conforming to the specifications for the riprap, rockfill, bedding or drainfill.

11. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the volume of each type and class of excavation within the specified pay limits will be measured and computed to the nearest cubic yard by the method of average cross-sectional end areas. Regardless of quantities excavated, the measurement for payment will be made to the specified pay limits, except that excavation outside the specified lines and grades directed by the Engineer to remove unsuitable material will be included. Excavation required because unsuitable conditions result from the Contractor's improper construction operations, as determined by the Engineer, will not be included for measurement and payment.

Method 1 The pay limits shall be defined as follows:

a. The upper limit shall be the original ground surface as it existed prior to the start of construction operations except that where excavation is performed within area designated for previous excavation or fill the upper limit shall be the modified ground surface resulting from the specified previous excavation or fill.

b. The lower and laterial limits shall be the true surface of the completed excavation as authorized by the Engineer.

Method 2 The pay limits shall be defined as follows:

a. The upper limit shall be the original ground surface as it existed prior to the start of construction operations except that where excavation is performed within areas designated for previous excavation or fill the upper limit shall be the modified ground surface resulting from the specified previous excavation or fill.

b. The lower limit shall be at the bottom surface of the proposed structure.

c. The lateral limits shall be 18 inches outside of the outside surfaces of the proposed structure or shall be vertical planes 18 inches outside of and parallel to the footings, whichever gives the larger pay quantity, except as provided in d, below.

d. For trapezoidal channel linings or similar structures that are to be supported upon the sides of the excavation without intervening forms, the lateral limits shall be at the under side of the proposed lining or structure.

e. For the purposes of the definitions in b, c, and d, above, any specified bedding or drainfill directly beneath or beside the structure will be considered to be a part of the structure.

All Methods The following provisions apply to all methods of measurement and payment.

Payment for each type and class of excavation will be made at the contract unit price for that type and class of excavation. Such payment will constitute full compensation for all labor, materials, equipment, and all other items necessary and incidental to the performance of the work, except that extra payment for backfilling required overexcavation will be made in accordance with the following provisions:

Payment for backfilling overexcavation, as specified in Section 10 of this specification, will be made only if the excavation outside specified lines and grades is directed by the Engineer to remove unsuitable material and if the unsuitable condition is not a result of the Contractor's improper construction operations as determined by the Engineer.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 12 of this specification.

12. Items of Work and Construction Details-Bulldog Floodway/Apache Junction Outlet

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 4, Structure Excavation, Common

(1) This item shall consist of all excavation required for the installation of the concrete lined Apache Junction Outlet channel and the Bulldog Floodway between stations 101+46 and 203+00, including side channel inlets numbers 1 through 3 and weir inlets numbers 3 through 11 is shown on drawings and staked in field.

(2) Measurement and payment will be by Method 2; and will include compensation for Subsididary Items: Removal of Water, Pollution Control and Spoil Disposal.

b. Bid Item 5, Channel Excavation, Common

(1) This items shall consist of all excavation required to construct;

a. The Bulldog Floodway Earth Channel between stations 203+00 and 220+00;

b. The approach channels to side channel inlets numbers 1 through 6 and weir inlets numbers 3 through 10, as shown on drawings and staked in the field.

(2) Suitable materials in (1) above in excess of the amount needed to construct the required earthfill shall be stockpiled for construction of the FRS, unless otherwise directed by the Engineer.

(3) Measurement and payment will be by Method 1; and will include compensation for Subsidiary Items; Removal of Water, Pollution Control and Spoil Disposal.

BULLDOG FLOODWAY/APACHE JUNCTION OUTLET

31. CONCRETE

1. SCOPE

The work shall consist of furnishing, forming, placing, finishing and curing portland cement concrete as required to build the structures designated in Section 26 of this specification.

2. MATERIALS

Portland cement shall conform to the requirements of Material Specification 531 for the specified type. One brand only of any type of cement shall be used in any single structure as defined in Section 26.

Aggregates shall conform to the requirements of Material Specification 522 unless otherwise specified. The grading of coarse aggregates shall be as specified in Section 26.

Water used in mixing or curing concrete shall be clean and free from injurious amounts of oil, salt, acid, alkali, organic matter or other deleterious substances.

Air entraining admixtures shall conform to the requirements of Material Specification 532. If air-entraining cement is used, any additional air-entraining admixture shall be of the same type as that in the cement.

Pozzolan shall conform to ASTM C618, Class F except the loss of ignition shall not exceed 5.0 percent.

Water-reducing, set-retarding admixture shall conform to the requirements of Material Specification 533.

Shear plates shall conform to the requirements of Material Specification 581 for structural quality or commercial or merchant quality steel. Structural quality shall be used if specifically designated in the drawings or specifications.

Preformed expansion joint filler shall conform to the requirements of Material Specification 535.

Waterstops shall conform to the requirements of Material Specifications 537 and 538 for the specified kinds.

Curing compound shall conform to the requirements of Material Specification 534.

3. CLASSES OF CONCRETE

Concrete shall be classified according to the required compressive strength. The strength of the concrete at 28 days shall equal or exceed the Minimum Compressive Strength at 28 days tabulated below for the class of concrete specified.

Class of Concrete	Minimum Compressive Strength at 28 days (psi)
5000	5000
4000	4000
3000	3000
2500	2500

4. AIR CONTENT AND CONSISTENCY

The air content (by volume) of the concrete at the time of placement shall be:

Maximum Size Aggregate	Air Content (%)
3/8 inch to 1/2 inch	6 to 9
Over 1/2 inch to 1 inch	5 to 8
Over 1 inch to 2-1/2 inches	4 to 7

The consistency of the concrete shall be such as to allow it to be worked into place without segregation or excessive laitance. Unless otherwise specified, the slump shall be:

Type of Structure	Slump (inches)
Massive sections, pavements, footings	2 ± 1/2
Heavy beams, thick slabs, thick walls (over 12 in.)	3 ± 1/2
Colums, light beams, thin slabs, thin walls (12 in. or less)	4 ± 1

5. DESIGN OF THE CONCRETE MIX

The Contractor will be responsible for the design of the concrete mixtures. At least 5 days prior to any placement of concrete he shall furnish the Contracting Officer a statement of the materials and mix proportions (including admixtures, if any) he intends to use for each specified class of concrete. The statement shall include evidence satisfactory to the Engineer that the materials and proportions selected will produce concrete of the quality, consistency and strength specified.

The materials and proportions so stated shall constitute the "job mix". After a job mix has been designated, neither the source, character or grading of the aggregates nor the type or brand or quantity of cement or admixture shall be changed without prior notice to the Engineer and establishment of a new job mix supported by evidence, as required for the initial job mix, that the proposed new materials and mix proportions will produce concrete of the quality, consistency, and strength specified.

When specified, a water-reducing, set-retarding admixture shall be used. When conditions are such that the temperature of the concrete at the time of placement is consistently above 75° F, a water-reducing , set retarding admixture may be used, at the option of the Contractor. The cement content shall be the same as that required in the mix without the admixture.

The use of calcium chloride or other accelerators or antifreeze compounds will not be allowed.

When it is anticipated that a water-reducing, set-retarding admixture will be used, the Contractor shall furnish to the Engineer a sample ofthe admixture he proposes to use sufficient for the tests required by Material Specification 533, Section 4. Concrete containing the admixture shall not be placed until test results have been obtained showing that its performance in the job mix meets the requirements of Material Specification 533, Section 4.

Before placing concrete containing a water-reducing, set retarding admixture, the Contractor shall furnish test results to the Engineer showing that its performance in the job mix meets the requirements of Material Specification 533, Section 4.

When specified, mixes that include fly ash as a partial substitution for portland cement shall be based on absolute volume with a maximum substitution of 20 percent.

6. INSPECTING AND TESTING

The following tests will be performed by the methods indicated:

Test	Method (ASTM) Designation)
Sampling	C 172 1/
Slump Test	C 143 1/
Air Content	C 231 1/ or C 713 1/
Compression Test Specimens	C 31 1/ or C 42
Compressive Strength	C 39 2/, C 42 or C 684 2/
Unit Weight	C 138

1/ Test of portion of a batch may be made on samples representative of that portion for any of the following purposes:

(1) Determining uniformity of the batch.

(2) Checking compliance with requirements for slump and air content when the batch is discharged over an extended period of time.

(3) Checking compliance of the concrete with the specifications when the whole amount being placed in a small structure, or a distinct portion of a larger structure, is less than a full batch.

2/ For each strength test of specimens made according to ASTM Designation C 39, 3 standard test specimens shall be made. The test result shall be the average of the strength of the 3 specimens, except that if one specimen in the test shows manifest evidence of improper sampling, molding or testing, it shall be discarded and the strengths of the remaining 2 specimens shall be averaged. Should more than one speciment representing a test show such defects, the entire test shall be discarded.

The Engineer shall have free entry to the plant and equipment furnishing concrete under the contract. Proper facilities shall be provided for the Engineer to inspect materials, equipment and processes, to obtain samples of the concrete. All tests and inspections will be conducted so as not to interfere unnecessarily with the manufacture and delivery of the concrete.

7. HANDLING AND MEASUREMENT OF MATERIALS

Aggregates shall be stored or stockpiled in such a manner that separation of coarse and fine particles of each size will be avoided and that various sizes will not become intermixed before proportioning. Methods of handling and transporting

aggregates shall be such as to avoid contamination, excessive breakage, segregation or degradation, or intermingling of various sizes.

Scales for weighing aggregates and cement shall be beam type or springless dial type. They shall be accurate within 1 percent under operating conditions. All exposed fulcrums, clevises and similar working parts of scales shall be kept clean.

The quantities of cement and aggregates in each batch of concrete, as indicated by the scales, shall be within the following percentage of the required batch weights:

Cement	plus or minus 1.0 percent
Aggregates	plus or minus 2.0 percent

Measuring tanks for mixing water shall be of adequate capacity to furnish the maximum amount of mixing water required per batch and shall be equipped with outside taps and valves to provide for checking their calibration unless other means are provided for readily and accurately determining the amount of water in the tank.

Except as otherwise provided in Section 8, cement and aggregates shall be measured as follows:

Cement shall be measured by weight or in bags of 94 lbs. each. When cement is measured by weight, it shall be weighed on a scale separate from that used for other materials, and in a hopper entirely free and independent of the hopper used for weighing the aggregates. When cement is measured in bags, no fraction of a bag shall be used unless weighed.

Aggregates shall be measured by weight. Mix proportions shall be based on saturated, surface-dry weights. The batch weight of each aggregate shall be the required saturated, surface-dry weight corrected by the weight of surface moisture it contains.

Mixing water shall consist of water added to the batch, ice added to the batch, water occurring as surface moisture on the aggregates and water introduced in the form of admixtures. The added water shall be measured by weight or volume to an accuracy of 1 percent of the required total mixing water. Added ice shall be measured by weight. Wash water shall not be used as a portion of the mixing water for succeeding batches.

Dry admixtures shall be measured by weight, and paste or liquid admixtures by weight or volume, within a limit of accuracy of 3 percent.

8. MIXERS AND MIXING

Mixers and mixing shall be in accordance with recommended standards set forth in ACI 304, some specific interpretations of which are stated below.

Concrete may be furnished by batch mixing at the site of the work or by ready-mix methods.

Mixers shall be capable of thoroughly mixing the concrete ingredients into a uniform mass within the specified mixing time and of discharging the mix without segregation. Each mixer or agitator shall bear a manufacturer's rating plate indicating the rated capacity and recommended speeds of rotation, and shall be operated in accordance with these recommendations.

Concrete shall be uniform and thoroughly mixed when delivered to the forms. Variations in slump of more than 1 inch within a batch will be considered evidence of inadequate mixing and shall be corrected by changing batching procedures, increasing mixing time, changing mixers or other means. Mixing time shall be within the limits specified below unless the Contractor demonstrates by mixer performance tests that adequate uniformity is obtained by different times of mixing.

No mixing water in excess of the amount called for by the job mix shall be added to the concrete during mixing or hauling or after arrival at the delivery point. If less water than the design maximum water-cement ratio has been incorporated in the batch, water to compensate for up to 1-inch loss in slump may be added, up to the design maximum water cement ratio. Withholding some of the mixing water until the concrete arrives on
the job, then adding the remaining water and turning the mixer 30 revolutions at mixing speed may overcome transporting conditions. When loss of slump or workability cannot be offset by these measures, complete mixing shall be performed on the job using centrally dry batched materials, or by on site batching and mixing.

Batch mixing at the site. For concrete mixed at the site of the work with paving mixers or stationary construction mixers, the time of mixing after all cement and aggregates are in the mixer drum shall be not less than 1-1/2 minutes. The batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates and all mixing water shall be introduced into the drum before one-fourth of the mixing time has elapsed.

Control shall be provided to insure that the batch cannot be discharged until the required time has elapsed.

If truck mixers are used, the requirements below for truck mixers and truck-mixed concrete shall apply

Volumetric batching and continous mixing at the site. Volumetric batching and continuous mixing at the construction site will be permitted if approved by the Contracting Officer. The batching and mixing equipment shall conform to the requirements of ASTM Specification C 685 and shall be demonstrated prior to placement of concrete, by tests with the job mix, to produce concrete meeting the specififed proportioning and uniformity requirements. Concrete made by this method shall be produced, inspected, and certified in conformance with Sections 6, 7, 8, 13, and 14 of ASTM Specification C 685.

Ready-mixed concrete. Ready-mixed concrete shall be mixed and delivered to the site of the work by one of the following methods:

a. Truck-mixed concrete--Mixed completely in a truck mixer.

b. Shrinked-mixed concrete.--Mixed partially in a stationary mixer, and the mixing completed in a truck mixer.

c. Central-mixed concrete.--Completely in a stationary mixer and the mixed concete transported to the point of delivery in a truck agitator or in a truck mixer operating at agitating speed or in nonagitating equipment.

Truck mixers and agitators shall be equipped with revolution counters by which the number of revolutions of the drum or blades may be readily verified.

When ready-mixed concrete is furnished, the Contractor shall furnish the Engineer a statement-of-delivery ticket showing the time of loading, the revolution counter reading at the time of loading and the quantities of materials used for each load of concrete.

Truck-mixed concrete. When concrete is mixed in a truck mixer loaded to its maximum capacity, the number of revolutions of the drum or blades at mixing speed shall be not less than 70 nor more than 100. If the batch is at least 1/2 cubic yard less than maximum capacity, the number of revolutions at mixing speed may be reduced to not less than 50. Mixing in excess of 100 revolutions shall be at the speed designated by the manufacturer of the equipment as agitating speed. The mixing operation shall begin within 30 minutes after the cement has been added to the aggregates and the water shall be added during mixing. When mixing is begun during or immediately after charging, a portion of the mixing water shall be added ahead of, or with, the other ingredients.

Shrink-mixed concrete. When concrete is partially mixed at a central plant and the mixing is completed in a truck mixer, the mixing time in the central plant mixer shall be the minimum required to intermingle the ingredients and shall be not less than 30 seconds. The mixing shall be completed in a truck mixer and the number of revolutions of the drum or blades at mixing speed shall be not less than 50 nor more than 100. Mixing in excess of 100 revolutions shall be at the speed designated by the manufacturer of the equipment as agitating speed.

Central-mixed concrete. For central-mixed concrete, mixing in the stationary mixer shall meet the same requirements as batch mixing at the site.

When an agitator, or truck mixer used as an agitator, transports concrete that has been completely mixed in a stationary mixer, mixing during transportation shall be at the speed designated by the manufacturer of the equipment as agitating speed.

The use of nonagitating equipment to transport concrete to the site of the work will be permitted only if the consistency and uniformity of the concrete as discharged at the point of delivery meet the requirments of this specification. Bodies of nonagitating hauling equipment shall be so constructed that leakage of the concrete mix, or any part thereof will not occur. Concrete hauled in open-top vehicles shall be protected from rain, and from more than 20 minutes exposure to the sun when the air temperature is above 75°F.

9. FORMS

Forms shall be of wood, plywood, steel or other approved material and shall be mortar tight. The forms and associated falsework shall be substantial and unyielding and shall be constructed so that the finished concrete will conform to the specified dimensions and contours. Form surfaces shall be smooth and free from holes, dents, sags or other irregularities. Forms shall be coated with a nonstaining form oil before being set into place.

Metal ties or anchorages within the forms shall be equipped with cones, she-bolts or other devices that permit their removal to a depth of at least one inch without injury to the concrete. Ties designed to break off below the surface of the concrete shall not be used without cones.

All edges that will be exposed shall be chamfered, unless finished with molding tools as specified in Section 20.

10. PREPARATION OF FORMS AND SUBGRADE

Prior to placement of concrete, the forms and subgrade shall be free of hips, sawdust, debris, water, ice, snow, extraneous oil, mortar, or other harmful substances or coatings. Any oil on the reinforcing steel or other surfaces required to be bonded to the concrete shall be removed.

Rock surfaces shall be cleaned by air-water cutting, wet sand blasting or wire brush scrubbing, as necessary, and shall be wetted immediately prior to placement of concrete. Earth surfaces shall be firm and damp. Placement of concrete on mud, dried earth, uncompacated fill or frozen subgrade will not be permitted. All ice, snow and frost shall be removed and the temperature of all surfaces to be in contact with the new concrete shall be no colder than 40°F.

Items to be embedded in the concrete shall be positioned accurately and anchored firmly.

Weepholes in walls or slabs shall be formed with nonferrous materials.

11. CONVEYING

Concrete shall be delivered to the site and discharged into the forms within 1-1/2 hours after the introduction of the cement to the aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85°F or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes.

The Engineer may allow a longer time, provided the setting time of the concrete is increased a corresponding amount by the addition of an approved set-retarding admixture. In any case, concrete shall be conveyed from the mixer to the forms as rapidly as practicable, by methods that will prevent segregation of the aggregates or loss of mortar.

12. PLACING

Concrete shall not be placed until the subgrade, forms and steel reinforcement have been inspected and approved.

The Contractor shall have all equipment and materials required for curing available at the site ready for use before placement of concrete begins.

No concrete shall be placed except in the presence of the Engineer. The Contractor shall give reasonable notice to the Engineer each time he intends to place concrete. Such notice shall be far enough in advance to give the Engineer adequate time to inspect the subgrade, forms, steel reinforcement and other preparations for compliance with specifications.
Other preparations include but are not limited to the concrete batching plant, mixing and delivery equipment and system, placing and finishing equipment and system, schedule of work, work force and heating or cooling facilities as applicable. All deficiencies are to be corrected before concrete is delivered for placing.

The concrete shall be deposited as closely as possible to its final position in the forms and shall be worked into the corners and angles of the forms and around all reinforcement and embedded items in a manner to prevent segregation of aggregates or excessive laitance. The depositing of concrete shall be regulated so that the concrete can be consolidated with a minimum of lateral movement.

Concrete shall not be dropped more than 5 feet vertically unless suitable equipment is used to prevent segregation.

13. LAYERS

Unless otherwise specified, slab concrete shall be placed to design thickness in one continuous layer. Formed concrete shall be placed in horizontal layers not more than 20 inches thick. Hoppers and chutes, pipes or "elephant trunks" shall be used as necessary to prevent splashing of mortar on the forms and reinforcing steel above the layer being placed.

Successive layers shall be placed at a fast enough rate to prevent the formation of "cold joints". If the surface of a layer of concrete in place sets to the degree that it will not flow and merge with the succeeding layer when vibrated, the Contractor shall discontinue placing concrete and shall make a construction joint according to the procedure specified in Section 15.

If placing is discontinued when an incomplete layer is in place, the unfinished end of the layer shall be formed by a vertical bulkhead.

14. CONSOLIDATING

Unless otherwise specified, concrete shall be consolidated with internal type mechanical vibrators capable of transmitting vibration to the concrete at frequencies not less than 6000 impulses per minute.

The location, manner and duration of the application of the vibrators shall be such as to secure maximum consolidation of the concrete without causing segregation of the mortar and coarse aggregate, and without causing water or cement paste to flush to the surface.

The Contractor shall provide a sufficient number of vibrators to properly consolidate the concrete immediately after it is placed in the work. Vibration shall be applied to the freshly deposited concrete by slowly inserting and removing the vibrator at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibily effective. The vibrator shall extend into the previously placed layer of fresh concrete, at all points, to insure effective bond between layers.

Vibration shall not be applied directly to the reinforcement steel or the forms nor to concrete that has hardened to the degree that it does not become plastic when vibrated.

The use of vibrators to transport concrete in the forms or conveying equipment will not be permitted.

Vibration shall be supplemented by spading and hand tamping as necessary to insure smooth and dense concrete along form surfaces, in corners and around embedded items.

15. CONSTRUCTION JOINTS

Construction joints shall be made at the locations shown on the drawings. If construction joints are needed which are not shown on the drawings, they shall be placed in locations approved by the Engineer.

Where a feather edge would be produced at a construction joint, as in the top surface of a sloping wall, an insert form shall be used so that the resulting edge thickness on either side of the joint is not less than 6 inches.

In walls and columns as each lift is completed, the top surfaces shall be immediately and carefully protected from any condition that might adversely affect the hardening of the concrete.

Steel tying and form construction adjacent to concrete in place shall not be started until the concrete has cured at least 12 hours. Before new concrete is deposited on or against concrete that has hardened, the forms shall be retightened. New concrete shall not be placed until the hardened concrete has cured at least 12 hours.

Surfaces of construction joints shall be cleaned of all unsatisfactory concrete, laitance, coatings, stains or debris by either wet sandblasting after the concrete has gained sufficient strength to resist excessive cutting, or air-water cutting as soon as the concrete has hardened sufficiently to prevent the jet from displacing the coarse aggregates, or both. The surface of the concrete in place shall be cut to expose clean, sound aggregate but not so deep as to undercut the edges of larger particles of the aggregate. After cutting, the surface shall be thoroughly washed to remove all loose material. If the surface is congested by reinforcing steel, is relatively inaccessible, or it is considered undesirable to disturb the concrete before it is hardened, cleaning of the joint by air-waterjets will not be permitted and the wet sandblasting method will be required after the concrete has hardened.

The surfaces shall be kept moist for at least one hour prior to placement of new concrete. The new concrete shall be placed directly on the cleaned and washed surface.

16. EXPANSION AND CONTRACTION JOINTS

Expansion and contraction joints shall be made only at locations shown on the drawings.

Exposed concrete edges at expansion and contraction joints shall be carefully tooled or chamfered, and the joints shall be free of mortar and concrete. Joint filler shall be left exposed for its full length with clean and true edges.

When open joints or weakened plane "dummy" joints are specified, the joints shall be constructed by the insertion and subsequent removal of a wood strip, metal plate or other suitable template in such a manner that the corners of the concrete will not be chipped or broken. The edges of the concrete at the joints shall be finished with an edging tool prior to removal of the joint strips.

Preformed expansion joint filler shall be held firmly in the correct position as the concrete is placed.

17. WATERSTOPS

Waterstops shall be held firmly in the correct position as the concrete is placed. Joints in metal watershops shall be brazed or welded. Joints in rubber or plastic waterstops shall be cemented, welded or vulcanized as recommended by the manufacturer.

18. REMOVAL OF FORMS

Forms shall be removed only when the Engineer is present and shall not be removed without his approval. Forms shall be removed in such a way as to prevent damage to the concrete. Supports shall be removed in a manner that will permit the concrete to take the stresses due to its own weight uniformly and gradually.

Forms shall not be removed sooner than the following minimum times after the concrete is placed. These periods represent the cumulative number of days and fractions of days, not necessarily consecutive, during which the temperature of the air adjacent to the concrete is above 50°F.

Element	Time
Beams, arches - supporting forms and shoring	14 days
Conduits, deck slabs - supporting (inside) forms and shoring	7 days
Conduits (outside forms), sides of beams, small structures	24 hours
Columns, walls, spillway riser - with side or vertical load	7 days

Concrete supporting more than 30 feet of wall in place above it 1/	7 days
Concrete supporting 20 to 30 feet of wall in place above it 1	3 days
Concrete supporting not more than 20 feet of wall in place above it 1/	24 hours

1/ Age of stripped concrete shall be at leat 7 days before any load is applied other than the weight of the column or wall, forms and scaffolds for succeeding lifts.

19. FINISHING FORMED SURFACES

All concrete surfaces shall be true and even, and shall be free from open or rough spaces, depressions or projections.

Immediately after the removal of forms:

All bulges, fins, form marks or other irregularities which in the judgment of the Engineer will adversely affect the appearance or function of the structure shall be removed. All form bolts and ties shall be removed to a depth at least 1 inch below the surface of the concrete. The cavities produced by form ties and all other holes of similar size and depth shall be thoroughly cleaned and, after the interior surfaces have been kept continuously wet for at least 3 hours, shall be carefully packed with a dry patching mortar mixed not richer than 1 part cement to 3 parts sand. Patching mortar shall be mixed in advance and allowed to stand without addition of water until it has reached the stiffest consistency that will permit placing. Manipulation of the mortar with a trowel during this period shall be performed as required to insure the proper consistency.

Holes left by form bolts or straps which pass through the wall shall be filled solid with mortar.

Patching mortar shall be thoroughly compacted into place to form a dense, well-bonded unit, and the in-place mortar shall be sound and free from shrinkage cracks.

All repaired areas shall be cured as specified in Section 21.

20. FINISHING UNFORMED SURFACES

All exposed surfaces of the concrete shall be accurately screeded to grade and then float finished.

After placing and consolidating the concrete, all exposed surfaces shall be accurately struck off to grade. Following strike-off, the surfaces shall be immediately smoothed by darbying or bull floating before any free water has bled to the surface. The concrete will then be allowed to rest until the bleed water and water sheen has left the surface and the concrete has stiffened to where it will sustain foot pressure with only about 1/4 inch (6mm) indentation. At this time all joints and edges that will be exposed to view that are not chamfered shall be finished with edging and/or molding tools. After edging and hand-jointing is complete, all exposed surfaces shall be floated with wood or magnesium floats. The floating should work the concrete no more than necessary to remove screed, edger and jointer marks and produce a compact surface, uniform in texture.

Joints and edges on unformed surfaces shall be chamfered or finished with molding tools.

21. CURING

Concrete shall be cured in accordance with the recommended practice of ACI 308, of which some specific interpretations are set forth below.

Concrete shall be prevented from drying for a period of at least 7 days after it is placed. Exposed surfaces and concrete in formed absorbative wood forms shall be kept continually wet during the entire curing period or until the forms have been removed. After forms have been removed, the exposed surface shall be kept continuously wet until patching and repair are complete and until the curing period iscompleted or until a curing compound is applied.

Moisture can be maintained by sprinkling, flooding or fog spraying or by covering with continuously moistened canvas, cloth mats, straw, sand or an approved material. Water and/or covering shall be applied in such a way that the concrete surface is not eroded or otherwise damaged.

Curing compound may be used for exposed surfaces or formed surfaces after patching and repair have been completed. Unless otherwise specified, the curing compound shall be white pigmented and conform to ASTM C 309 Type 2, Class A or B. If surface coatings are to be applied to concrete where curing compound is used, Type 2, Class B shall be used and allowed to age a minimum of 30 days prior to the application of the coating. Clear curing compound (Type 1) or clear with fugitive dye (Type 10) may only be used when specified in Section 26.

Curing compound shall be thoroughly mixed before applying and agitated during application. It shall be applied at a uniform rate of not less than one gallon per 150 square feet of surface. It shall form a uniform continuous, adherent film that shall not check, crack or peel and shall be free from pinholes or other imperfections.

All surfaces covered with curing compound shall be continuously protected from damage to the protective film during the required curing period.

Surfaces subjected to heavy rainfall or running water within 3 hours after the compound has been applied, or surfaces damaged by subsequent construction operations during the curing period shall be resprayed in the same manner as for the original application.

Unless otherwise specified in Section 26, curing compound shall not be applied to construction joints or other areas that are to receive additional concrete, paint or other material that require a positive bond.

Water for curing shall be clean and free from any substances that will cause discoloration of the concrete.

22. REMOVAL OR REPAIR

When concrete is honeycombed, damaged or otherwise defective, the Contractor shall remove and replace the structure or structural member containing the defective concrete, or correct or repair the defective parts. The Engineer will determine the required extent of removal, replacement or repair.

Prior to starting repair work the Contractor shall obtain the Engineer's approval of his plan for making the repair. Such approval shall not be considered a waiver of the Contracting Officer's right to require complete removal of defective work if the completed repair does not produce concrete of the required quality and appearance.

Repair work shall be performed only when the Engineer is present.

Repair of formed surfaces shall be started within 24 hours after removal of the forms.

Except as otherwise approved by the Engineer, the appropriate methods described in Chapter VII of the Concrete Manual, Bureau of Reclamation, U.S. Department of the Interior, shall be used. If approved in writing by the Contracting Officer, proprietary compounds for adhesion or as patching ingredients may be used. Such compounds shall be used in accordance with the manufacturer's recommendations.

Curing as specified in Section 21 shall be applied to repaired areas immediately after the repairs are completed.

23. CONCRETING IN COLD WEATHER

Concreting in cold weather shall be performed in accordance with ACI 306 Recommended Practice for Cold Weather Concreting, of which some specific interpretations are set forth below.

When the atmospheric temperature may be expected to drop below 40°F at the time concrete is delivered to the work site, during placement, or at any time during the curing period, the following provisions also shall apply:

a. The temperature of the concrete at time of placing shall not be less than 50°F nor more than 90°F. The temperature of neither aggregates nor mixing water shall be more than 140°F just prior to mixing with the cement.

b. When the daily minimum temperature is less than 40°F, concrete structures shall be insulated or housed and heated after placement. The temperature of the concrete and air adjacent to the concrete shall be maintained at not less than 50°F nor more than 90°F for the duration of the curing period.

c. Methods of insulating, housing and heating the structure shall conform to "Recommended Practice for Cold Weather Concreting" ACI Standard 306.

d. When dry heat is used to protect concrete, means of maintaining an ambient humidity of at least 40 percent shall be provided unless the concrete has been coated with curing compound as specified in Section 21 or is covered tightly with an approved impervious material.

24. CONCRETING IN HOT WEATHER

Concreting in Hot Weather shall be in accordance with the recommended practice of ACI 305, of which some specific interpretations are set forth below.

For the purpose of the specification, hot weather is defined as any combination of high temperature, low relative humidity and wind velocity tending to impair the quality of fresh or hardened concrete or otherwise resulting in abnormal properties.

When climatic or other conditions are such that the temperature of the concrete may reasonably be expected to exceed 90°F at the time of delivery at the work site, during placement, or during the first 24 hours after placement, the following provisions shall apply;

a. The Contractor shall maintain the temperature of the concrete below 90°F during mixing, conveying, and placing.

b. The concrete shall be placed in the work immediately after mixing. Truck mixing shall be delayed until only time enough remains to accomplish it before the concrete is placed.

c. Exposed concrete surfaces which tend to dry or set too rapidly shall be continuously moistened by means of fog sprays or other means acceptable to the Engineer to maintain adequate moisture during the time between placement and finishing, and after finishing.

d. Finishing of slabs and other exposed surfaces shall be started as soon as the condition of the concrete allows and shall be completed without delay. The subgrade shall be prewetted or sealed with a vapor barrier and either wet cure or a white pigmented curing compound ASTM C309 Type 2 applied promptly to the fresh concrete.

e. Formed surfaces shall be kept completely and continuously wet for the duration of curing period (prior to, during and after form removal) or until curing compound is applied as specified in subsection g, below.

f. Concrete surfaces, especially flatwork placed with large areas of surface, shall be covered as soon as the concrete has sufficiently hardened and shall be kept continuously wet for at least 72 hours of the curing period. This protective method may be continued for the required curing period or until curing compound as specified in (g) below is applied:

g. Moist curing may be discontinued before the end of the curing period if white pigmented curing compound is applied immediately, following the procedures specified in Section 21.

h. In extreme conditions it may be necessary to (1) restrict placement to late afternoon or evening (2) restrict the depth of layers to assure coverage of the previous layer while it will still respond readily to vibration, (3) suspend placement until conditions improve, and (4) remove forms, repair, patch and reapply wet curing by small areas at a time.

25. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, concrete will be measured to the neat lines or pay limits shown on the drawings, and the volume of concrete will be computed to the nearest 0.1 cubic yard. No deduction in volume will be made for chamfers, rounded or beveled edges, or for any void or embedded item that is less than five cubic feet in volume. Where concrete is placed against the sides or bottom of an excavation without intervening forms, drainfill, or bedding, the volume of concrete required to fill voids resulting from over excavation outside the neat lines or pay limits will be included in the measurement for payment where such over excavation is directed by the Engineer to remove unsuitable foundation material; but only to the extent that the unsuitable condition is not a result of the Contractor's improper construction operations, as determined by the Engineer.

Payment for each item of concrete will be made at the contract unit price for that item. The payment for concrete will constitute full compensation for all labor, materials, equipment, transportation, tools, forms, falsework, bracing and all other items necessary and incidental to completion of the concrete work, such as joint fillers, waterstops, dowels or dowel assemblies and shear plates, but not including reinforcing steel or other items listed for payment elsewhere in the contract.

Measurement and payment for furnishing and placing reinforcing steel will be made as specified in Construction Specification 34.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 26 of this specification.

26. ITEMS OF WORK AND CONSTRUCTION DETAILS-Bulldog Floodway/Apache Junction Outlet

a. Bid Item 9, Concrete, Class 4000

(1) This item shall consist of furnish, forming and placing all concrete required to construct the Bulldog Floodway and Apache Junction Outlet Channel, as shown on drawings.

(2) Concrete shall be Class 4000 as described in Section 3.

(3) Cement shall be Tye II or IIA.

(4) Coarse aggregate shall be size number 57 in accordance with ASTM C-33.

(5) Preformed expansion joint filler shall conform to ASTM D-1752 and shall be either Type I or Type II.

(6) Waterstops for the emergency spillway shall be Class II, Type B or D, size designation 20 with a center bulb diameter of not less than two inches.

(7) Joint sealing compound shall be Type II, Class A, conforming to Material Specification 536 and Federal Specification TT-5-227.

(8) Curing compound shall meet the requirements of ASTM C309-81 for Type ID, Class B. If concrete is placed during hot weather (Section 24), treated surfaces shall be shaded for at least the first three days after application. The curing compound shall be continuously stirred or agitated during application.

(9) Payment for Bid Item 9 will include compensation for Subsidiary Items Metalwork and Cleaning and Painting.

b. Subsidiary Item, Concrete, Class 2500

(1) This item shall consist of furnishing, forming and placing all concrete to construct post anchors for fences, guardposts and signs; and sag weights.

(2) Concrete shall be Class 2500 as described in Section 3.

(3) Cement shall be Type II of Type IIA.

(4) Coarse aggregate shall be Size No. 57 in accordance with ASTM-C-33.

(5) No separate payment will be made for Concrete, Class 2500. Compensation for this item will be included in Bid Items 13 and 14.

BULLDOG FLOODWAY/APACHE JUNCTION OUTLET

34. STEEL REINFORCEMENT

1. SCOPE

The work shall consist of furnishing and placing steel reinforcement for reinforced concrete or pneumatically applied mortar.

2. MATERIALS

Steel reinforcement shall conform to the requirements of Material Specification 539. Before reinforcement is placed, the surfaces of the bars and fabric and any metal supports shall be cleaned to remove any loose, flaky rust, mill scale, oil, grease or other coatings or foreign substances. After placement, the reinfor cement shall be maintained in a clean condition until it is completely embedded in the concrete.

3. BAR SCHEDULE, LISTS AND DIAGRAMS

Any supplemental bar schedules, bar lists or bar-bending diagrams required to accomplish the fabrication and placement of reinforcement shall be provided by the Contractor. Prior to placement of reinforcement, the Contractor shall furnish three prints or copies of any such lists or diagrams to the Contracting Officer. Acceptance of the reinforcement will not be based on approval of these lists or diagrams but will be based on inspection of the reinforcement after it has been placed.

4. BENDING

Reinforcement shall be cut and bent in compliance with the requirements of the American Concrete Institute Standard 315. Bars shall not be bent or straightened in a manner that will injure the material. Bars with kinks, cracks or improper bends will be rejected.

5. SPLICING BAR REINFORCEMENT

Splices of reinforcement shall be made only at locations shown on the drawings and provided by the steel schedule. Placement of bars at the lap splice locations shown, when not in contact, shall not be farther apart than one-fifth the shown lap length and in any case no greater than 6 inches.

6. SPLICING WELDED WIRE FABRIC

Unless otherwise specified, welded wire fabric shall be spliced in the following manner:

a. Adjacent sections shall be spliced end to end (longitudinal lap) by overlapping a minimum of one full mesh plus 2 inches plus the length of the two end overhangs. The splice length is measured from the end of the longitudinal wires in one piece of fabric to the end of the longitudinal wires in the lapped piece of fabric.

b. Adjacent sections shall be spliced side to side (transverse lap) a minimum of one full mesh plus 2 inches. The splice length shall be measured from the centerline of the first longitudinal wire in one piece of fabric to the centerline of the first longitudinal wire in the lapped piece of fabric.

7. PLACING

Reinforcement shall be accurately placed and secured in poistion in a manner tht will prevent its displacement during the placement of concrete. Tack welding of bars will not be permitted. Metal chairs, metal handers, metal spacers and concrete chairs may be used to support the reinforcement. Metal handers, spacers and ties shall be placed in such a manner that they will not be exposed in the finished concrete surface. The legs of metal chairs or side form spacers that may be exposed on any face of slabs, walls, beams or other concrete surfaces shall have a protective coating or finish by means of hot dip galvanizing, epoxy coating, plastic coating, or by stainless steel. Metal chairs and spacers not fully covered by a protective coating or finish shall have a minimum cover of 3/4 inch of concrete over the unprotected metal portion except for those with plastic coatings may have a minimum cover of 1/2 inch of concrete over the unprotected metal portion. Precast concrete chairs shall be manufactured of the same class of concrete as that specified for the structure and shall have tie wires securely anchored in the chair or a V-shaped groove at least 3/4 inch in depth molded into the upper surface to receive the steel bar at the point of support. Precast concrete chairs shall be moist at the time concrete is placed.

Reforcement shall not be placed until the prepared site has been inspected and approved by the Engineer. After placement of the reinforcement, concrete shall not be placed until the reinforcement has been inspected and approved by the Engineer.

8. STORAGE

Steel reinforcement stored at the work site shall be placed above the ground surface on platforms, skids or other supports and protected from mechanical damage or corrosion.

9. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the weight of reinforcement placed in the concrete in accordance with the drawings will be determined to the nearest pound by computation from the placing drawings. Measurement of hooks and bends will be based on the requirements of ACI Standard 315. Computation of weights of reinforcement will be based on the unit weights established in Tables 34-1 and 34-2. Computation of weights for welded wire fabric not shown in Table 34-2 shall be based on ACI Standard 315. The area of welded wire fabric reinforcement placed in the concrete in accordance with the drawings will be determined to the nearest square foot by computation from the placing drawings with no allowance for laps. The weight of steel reinforcing in extra splices of extra-length splices approved for the convenience of the Contractor or the weight of supports and ties will not be included in the measurement for payment.

Payment for furnishing and placing reinforcing steel will be made at the contract unit price. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the completion of the work including preparing and furnishing bar schedules, lists or diagrams; furnishing and attaching ties and supports; and furnishing, transporting, storing, cutting, bending, cleaning and securing all reinforcements.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items to which they are made subsidiary are identified in Section 10 of this specification.

34-4

TABLE 34-1. STANDARD REINFORCING BARS

Bar Size No.	Wt. (lb./ft).
3	0.376
4	0.668
5	1.043
6	1.502
7	2.044
8	2.670
9	3.400
10	4.303
11	5.313
14	7.65
18	13.60

TABLE 34-2. RECTANGULAR WELDED WIRE FABRIC[1]

Style Designation By Steel Wire Gauge	By W-Number	Weight, lb. Per 100 Sq. Ft.
6 x 6 - 10 x 10	6 x 6 - WI.4 x W1.4	21
6 x 6 - 8 x 8	6 x 6 - W2.1 x W2.1	30
6 x 6 - 6 x 6	6 x 6 - W2.9 x W2.9	42
6 x 6 - 4 x 4	6 x 6 - W4.0 x W4.0	58
4 x 4 - 10 x 10	4 x 4 - W1.4 x W1.4	31
4 x 4 - 8 x 8	4 x 4 - W2.1 x W2.1	44
4 x 4 - 6 x 6	4 x 4 - W2.9 x W2.9	62
4 x 4 - 4 x 4	4 x 4 - W4.0 x W4.0	85
[2]4 x 12 - 8 x 12	4 x 12 - W2.1 x W0.9	25
[2]4 x 12 - 7 x 11	4 x 12 - W2.5 x W1.1	31

[1]Style designation is defined in ACI Standard 315 of the American Concrete Institute.

[2]Welded smooth wire fabric with wires smaller than Size WI.4 is manufactured from galvanized wire.

10. Items of Work and Construction Details-Bulldog Floodway/Apache Junction Outlet

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 10, Steel Reinforcement

1. This item shall consist of furnishing and installing all steel reinforcement required in the construction of:

   a. The Bulldog Floodway

   b. The Apache Junction Outlet Channel

2. All steel bars shall be Grade 40 or 60.

VI BID SCHEDULE

VI. BID SCHEDULE

The Bid Schedule follows the pattern established for other project units of the Buckhorn-Mesa Watershed. All items will be bid on a unit price basis except mobilization, surveys and identification sign. Certain small items and required procedures are included as subsidiary to other bid categories.

BID SCHEDULE
BULLDOG FLOODWAY & APACHE JUNCTION OUTLET

ITEM NO.	WORK OR MATERIAL	SPEC. NO.	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1.	Mobilization	8	1	Lump Sum		
2.	Clearing & Grubbing	2		Acres		
3.	Water	10				
	a. First 40,000 MG		40,000	MG	$5.25	$210,000
	b. Over 40,000 MG		XXX	MG	4.25	XXX
4.	Structure Excavation, Common	21		Cu. Yd.		
5.	Channel Excavation, Common	21		Cu. Yd.		
6.	Earthfill	23		Cu. Yd.		
7.	Structure Backfill	23		Cu. Yd.		
8.	Drainfill	24		Cu. Yd.		
9.	Concrete, Class 4000	31		Cu. Yd.		
10.	Steel Reinforcement	34		Lbs.		
11.	Bedding	61		Ton		
12.	Loose Rock Riprap	61		Ton		
13.	Grouted Rock Riprap	62		Cu. Yd.		
14.	Fence	92	40	L.F.		
15.	Identification Sign	93	1	Lump Sum		
16.	Surveys	401	1	Lump Sum		_____
				TOTAL		_____

Radius of bend $R_2' = 1.2 \frac{V_2^2 b_2}{g \delta}$ δ = superelevation
Assume 1:0

$= \frac{1.2 \times 18.4^2 \times 8}{32.2 \times 1}$

$= 100.9$ use $R_2' = 101'$

Height of wall $= 1.2 d_2 + 0.23 d_{c2} \left[1 - 11.1 \left(\frac{S_2}{S_0} - 1\right)^2\right] + 1.2 \frac{V_2^2 b_2}{g R_2}$

$= 1.2 \times 3.31 + .25 \times 4.14 \left[1 - 11.1 \left(\frac{.0085}{.0045} - 1\right)^2\right] + 1$

(neglected being < 0)

$= 3.97 - 0 + 1$

$= 4.97$ use 5'-0

Height of splitter wall = $d_2 = 2.7' > d_1$ use 2'-9"
" lower end = 6"

Height of wall for inlet $= 1.2 \times 2.7 + \frac{1.2 V_2^2 b_2}{g R_2}$

$= 3.24 + 1 = 4.24$ use 4'-3

Provide beginning of Junction at STA 115+10

EL. at Junction $= 1783 - (11510 - 10150) \cdot 017$

$= 1766.68$

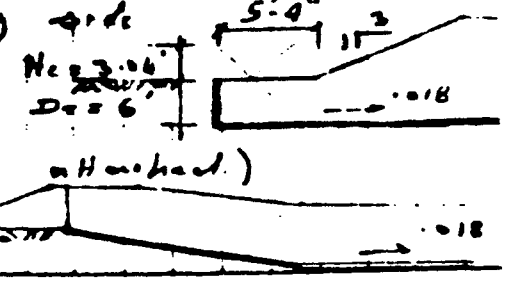
Provide 30° curve in the side inlet

EL at beginning of curve $= 1766.68 + \frac{2\pi \times 101}{360} \times 30 \times .018$

$= 1767.63$

The bed elevation is lower than the ground contours by about 2 or 3'. Provide drop inlet as in sheet 1 of 2 attached with sloping side

Ref Engineering Handbook Section 11
chute spillways
or Straight inlet (sheet 1 of 2 attached)



Channel STA 115+63 to 121+63

El. at STA 115+63 = 1766.68 − .85 = 1766.83

Q = 478
S = .0085
b = 10'
d = 3.31'

Height of wall = 1.2 × 3.31
= 3.97 or 3.31+1 = 4.35
Provid. 4.5' high

El at STA 121+63
= 1766.83 − (121+63 − 115+63) × .0085
= 1761.33

Channel STA 121+63 To 128+54.11

Q = 478
S = .014
b = 10'
Assume d = 2.77' A = 27.7 R = 1.78
∴ V = 17.3
d = 2.774 ok
d_c = 2.55' S_{cr} = .0079 < $\frac{S}{1.3}$
Height of wall = 1.2 × 2.77
= 3.32 or 2.77+1 = 3.77
Use 4.0 high

El at STA 128+54.11 = 1761.33 − (128+54.11 − 121+63) × .014 = 1751.65

Channel STA 128+54.11 to PC STA 129+23.99

Q = 478
S = .0085
b = 10'
d = 3.31'
Height of wall = 4.5' as between STA 115+63 & 121+63

El at Sta 129+23.99 = 1751.65 − [129+23.99 − 128+54.11] × .0085
= 1751.06

VII COST ESTIMATE

VII. COST ESTIMATE

Good cost estimates for the type of construction involved in this Project are available as a result of recently contracted work of a similar nature. This includes other projects units of the Buckhorn-Mesa Watershed.

Cost estimates are based upon contract conditions which can be met by small to medium-sized contractors.

The engineer's cost estimate for the preliminary design is intended for budgetary purposes. It will be reviewed and refined for the final design.

BID SCHEDULE
BULLDOG FLOODWAY & APACHE JUNCTION OUTLET

ITEM NO.	WORK OR MATERIAL	SPEC. NO.	UNIT QUANTITY	UNIT	PRICE	AMOUNT
1.	Mobilization	8	1	Lump Sum	$41,600	$41,600
2.	Clearing & Grubbing	2	24	Acres	728	17,472
3.	Water	10				
	a. First 40,000 MG		40,000	MG	$5.25	$210,000
	b. Over 40,000 MG		XXX	MG	4.25	XXX
4.	Structure Excavation, Common	21	108,100	Cu. Yd.	4.16	449,696
5.	Channel Excavation, Common	21	84,800	Cu. Yd.	1.56	132,288
6.	Earthfill	23	8,577	Cu. Yd.	0.52	4,460
7.	Structure Backfill	23	7,153	Cu. Yd.	11.44	81,830
8.	Drainfill	24	2,631	Cu. Yd.	21.84	57,461
9.	Concrete, Class 4000	31	12,130	Cu. Yd.	312.00	3,784,560
10.	Steel Reinforcement	34	1,233,00	Lbs.	0.57	702,810
11.	Bedding	61	330	Ton	13.52	4,462
12.	Loose Rock Riprap	61	550	Ton	10.40	5,720
13.	Grouted Rock Riprap	62	3,960	Cu. Yd.	55.12	218,275
14.	Fence	92	40	L.F.	2.60	104
15.	Identification Sign	93	1	Lump Sum	1,560	1,560
16.	Surveys	401	1	Lump Sum	49,920	49,920
				Subtotal		$5,762,218
				15% Contingency		864,333
						$6,626,550

EBASCO SERVICES INCORPORATED

BY DG DATE 12-4-85 SHEET 3 OF 3

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT QUANTITY TAKEOFF LOCATION SUMMARY – BULLDOG

Bid Item No	Descr.	Spec No	Locations
2	Clearing & Grubbing	2	Limits of floodway and road Limits of earth channels
4	Structure, Excav, Comm	21	Apache Junction outlet Bulldog Floodway Inlet Structures
5	Channel Excav, Comm	21	Energy Dissipator Earth channel Approaches to Inlets
6	Earth Fill	23	Maintenance do. Inlet Approach Dikes
7	Structure Backfill	23	Floodway walls A.J. outlet walls
8	Drainfill	24	Behind Floodway walls Under Grouted Riprap - Energy Dissipator do - Approach Channels
9	Concrete	31	Floodway AJ outlet
10	Steel Reinf	34	Floodway AJ outlet
11	Bedding	61	End of Energy Diss in Earth Channel
12	Loose Riprap	61	do
13	Grouted Riprap	62	Energy Dissipator Approach Channels to Inlets
14	Fence	92	Along Easement Lines
15	Identif. Sign	93	
16	Surveys	4d	

881/8-81

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SHEET ____ OF ____

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT UNIT PRICE SUMMARIES

OFS NO. ____ DEPT. NO. ____

BY DG DATE 12-3 & 4-85

CHECKED BY ____ DATE ____

12-3-85 • Phonecon between D. Groner and John DeFeis, Estimating Supervisor, Ebasco Bellevue office:

- J. DeFeis advises that the Ebasco projection for escalation from June, 1985 to June, 1986 in the Arizona area is 4% for Labor and Materials
- ∴ Unit prices to be used for Apache-Bulldog will be based upon Signal Butte/Pass Mtn. values multiplied by 1.04 See procedure below.

	Unit	UNIT PRICES FRS				UNIT PRICES FLOODWAY			
		Signal Butte Est	Signal Butte Contract's Ave	Use Base	4% Adj	Pass Mtn Est	Pass Mtn Contract's Ave	Use Base	4% Adj
Mobilization	LS	$80,000	55,500	$70,000	72,800	$32,530	32,038	40,000	41,600
Clearing & Grubbing	AC	380.	$659.	700	728.	800	682.18	700	728
Cutoff Trench. Excav	CY	1.20	2.45	2.50	2.60	0.90	2.10		
Struct Excav, Comm	CY	4.00	5.32	6.00	6.24	3.50	3.82	4.00	4.16
Channel Excav, Comm	CY	1.50	1.47	1.50	1.56	1.20	1.40	1.50	1.56
Earth Fill	CY	1.20	1.36	1.40	1.46	0.50	0.47	Fldwy .50	0.52
Struct. Backfill	CY	6.00	10.11	11.-	11.44	6.35	13.79		
Filter Diaphragm	CY	30.00	26.17	30.	31.20				
Drain Fill	CY					17.25	20.95	21.00	21.84
Transition Zone	CY				20.				
Concrete	CY	229.00	397.64	300	312.				
Steel Reinf.	Lbs	0.35	0.59	0.55	0.57				
30-in pipe 36-in	LF	200.-	168.05						
24-in slide gate 12-in	LS	9.000	20,702.						
Bedding	TON					8.00	13.24	13.00	13.52
Loose Riprap	TON					20.00	8.68	10.00	10.40
Grouted Riprap	CY					50.00	52.64	53.00	55.12
1.0 Sign	LS	2.000	1.768	1,500	1,560	1,000	1.470		
Gate & Guard Fence	LS	4,000	3,326	3,350	3,484				
Fence	LF	1.50	2.36	2.50	2.60	2.00	26.13		
Emergency Spillway Drain	LF	10.20	21.78	22.00	22.88				
Surveys	LS	50,000	46,242	48,000	49,920	30,225	36,190		
4" ϕ Plastic Pipe	LF					10.	11.45		

5810/5-74

USDA-SOIL CONSERVATION SERVICE
APACHE-BULLDOG FLOOD CONTROL PROJECT

INLET LOCATION SUMMARY

Inlet - Types & No. On Dwgs.					
Drop No.	Weir No.	Sidec No.	Design No.	Sta (±)	Dwg No.
1				12+00	1-7
	1			15+50	1-8
	2			22+90	1-9
		1	4A	115+10	2-6
		2	4B	131+50	2-15
		3	5A	183+85	2-16
		4	4C	137+16	2-17
	3		4D	147+67	2-18
	4		4E	154+55	2-19
	5		4F	164+70	2-20
		5	4G	168+35	2-21
	6		4H	171+50	2-22
		6	5B	187+25	2-23
	7		5C	189+30	2-24
		7	6A	194+20	2-25
	8		6B	202+70	2-26
	9		6C	207+50	2-27

VIII CONSTRUCTION SCHEDULE

VIII. CONSTRUCTION SCHEDULE

The Project construction schedule provides for starting construction in September, 1986, during the 1986 fiscal year.

There are no serious constraints upon construction related to weather or seasonal conditions. Control of concrete placement requires more care in the hottest part of the summer, but construction need not be curtailed during that period.

The schedule will be based upon what is considered achievable by a small contractor with two concurrent operations, one for excavation and one for concrete placement.

The Final Design Report will contain recommendations for special procedures and tests for SCS construction monitoring.

IX OPERATION & MAINTENANCE

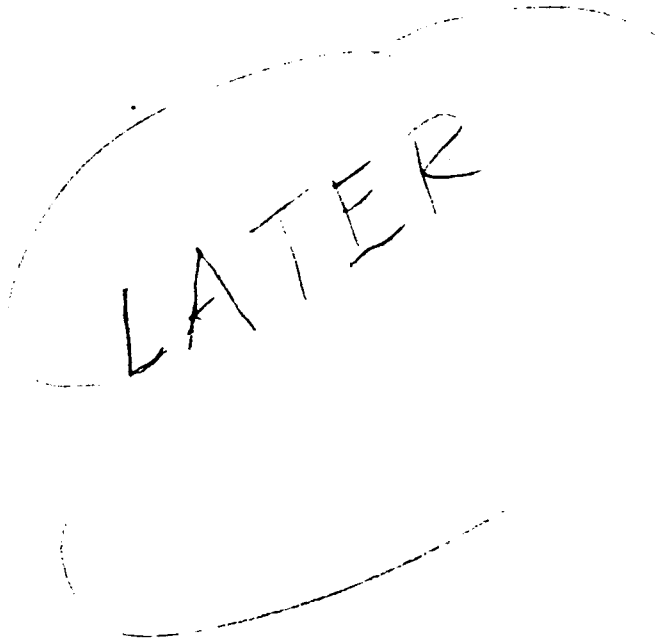
IX. OPERATION AND MAINTENANCE

Operation and maintenance procedures for the Project will be discussed in the "Final Design Report."

APPENDIX A

SUPPORTING DATA

INDEX
TO SUPPORTING DATA



Bulldog

EBASCO SERVICES INCORPORATED

BY N. Hung DATE 9/19/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 293

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT

REFERENCES:

(1) DESIGN OF RECTANGULAR STRUCTURAL CHANNEL (USDA TR-50)

(2) DESIGN OF SMALL CANAL STRUCTURES (USDI, BUREAU OF RECLAMATION)

(3) ENGINEERING HANDBOOK. SECT. 14 CHUTE SPILLWAYS (USDA, UCS)

(4) SAMPLE CALCULATIONS OF DETERMMING THICKNESS OF GROUTED ROCK DROP STRUCTURES, LETTER BY JACK STEVENSON DATED JUNE 27, 1983.

(5) DESIGN OF OPEN CHANNELS (USDA. UCS TR 25)

(6) BEAM ON ELASTIC FOUNDATION (BY M. HETENYI)

EBASCO SERVICES INCORPORATED

BY S GOYAL DATE 10-29-85 SHEET 2 OF 8

CHKD. BY N K DATE 11/4/85 OFS NO. USDA 3767.3 DEPT. NO. 550

CLIENT USDA - SCS - PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT APACHE JUNCTION FRS OUTLET CHANNEL & BULLDOG FLOODWAY

INLETS

The flows in the main channel at the inlets have decreased by 39 cfs as compared to the flows indicated in the PHASE I Report due to change in outlet diameter from 36" to 30" diameter in the final stages of the PHASE I study.

The hydraulic computations for the junctions and the channels are revised in this phase II

Channel FRS outlet to 4A inlet

$Q = 81$ c/s

$S = .012$

$b = 3.5'$

$V = \frac{1.486}{n} R^{2/3} S^{1/2}$

$n = .015$

Assumed $d = 2.18'$ $P = 7.86$ $A = 7.63$ $R = 0.97$

$\therefore V = 10.64$

$\therefore d = 2.175'$ o.k

$d_{cr} = [(\frac{Q}{b})^2/g]^{1/3} = 2.55'$ $A_c = 8.93$ $R_c = 1.04$

$S_{cr} = \left[\frac{Q/A}{1.486} \frac{n}{R^{2/3}}\right]^2$

$= .00796$

$\therefore S > 1.3 S_{cr}$

$\therefore$ Freeboard $= .2 \times d$

$= .2 \times 2.18$

$= .44'$ Provide 1' minimum.

Height of wall $= 2.18 + 1$

$= 3.18$ Provide 3'-3" wall.

INLET 4A

$Q_1 = 81$ cfs $b_1 = 3.5'$ $d_1 = 2.18'$ $A_1 = 7.62$ $V_1 = 10.62$

$Q_2 = 397$ cfs $b_2 = 8'$

$d_2 = 2.7$

$V_2 = 18.4$ $A_2 = 21.6$ $R_2 = 1.61$

$S_2 = \left[\frac{V}{1.486} n R^{2/3}\right]^2 = .018$

$d_{c_2} = 4.84$ $S_{c_2} = .0053 < \frac{S_2}{1.3}$

$Q_3 = Q_1 + Q_2 = 478$ cfs

$b_3 = 10' > 0.8(b_1 + b_2)$ i.e. $> 9.2'$

$S_3 = 0.0085$

Assume $d_3 = 3.31$ $A_3 = 33.1$ $R = 1.99$

$V_3 = 14.46$ fps

$\therefore d_3 = 3.306$ O.K

$d_{c_3} = 4.14$ $Sc_3 = .0045 < \frac{S_3}{1.3}$

$l = CV_2 (b_1 + b_2 - b_3)^{1/3}$ for $d_2 = 2.7$

$= 2.5 \times 18.4 (3.5 + 8 - 10)^{1/3}$

$= 52.66'$ say $53'$

Length of splitter wall $= l/2 = 26'-6"$

$b_m = \frac{(b_1 + b_2)}{2} + b_3 = 10.75$

$d_m = \frac{1}{2}\left[\frac{Q_1 + Q_2}{V_1 b_1 + V_2 b_2} + d_3\right] = 2.95$

$A_m = 31.73$ $P_m = 16.65$ $R_m = 1.906$

$V_m = \frac{Q_1 + Q_2}{b_m d_m} = 15.07$ fps

$b_s = \frac{b_1 (b_1 + b_2 + b_3)}{2 (b_1 + b_2)} = \frac{3.5 (3.5 + 8 + 10)}{2 (3.5 + 8)} = 3.27$ say $3'-3"$

Unequal width main channel

$$\frac{Q_3^2}{g A_3} + \frac{b_3 d_3^2}{2} - \frac{b_3 d_3 h}{2} = \frac{Q_1^2}{g A_1} + \frac{Q_2^2}{g A_2} + \frac{b_2 d_1 h}{2} + \frac{b_1 d_1^2}{2} + \left(\frac{b_2 - b_1}{3}\right) d_1^3 - \frac{P_m l n^2 V_m^2}{2.21 R_m^{4/3}}$$

$\therefore 214.37 + 54.78 - 16.55h = 2670 + 226.61 + 10.9h + 832 + 23.69 - 16.46$

$27.45h = 0.29$

$h = .91$ Provide 3" drop

Channel STA 123+23.99 to 130+20.15

$Q = 478$
$S = .0085$
$b = 10'$
$d = 3.31'$ $V = 14.46$ $R = 2.995'$

Height of wall $= 1.2 \times 3.31 + \frac{1.2 V^2 b}{g R}$
$= 3.97 + .78$
$= 4.75' > (3.31 + 1.0)$

Provide 4'-9" outer curve wall
and 4'-6" inner curve wall

EL of STA 130+20.15 = 1751.06 − (13020.15 − 12323.99) × .0085
= 1750.24

Channel STA 130+20.15 to 132+20

$Q = 478$
$S = .0085$
$b = 10'$
$d = 3.31$
Height of wall = 4'-6"

EL at 132+20 = 1750.24 − (13220 − 13020.15) × .0085
= 1748.54

Inlet QB

$Q_1 = 478$ $b_1 = 10'$ $d_1 = 3.31$ $A_1 = 33.1$ $V_1 = 14.46$
$Q_2 = 525$ $b_2 = 9'$
$d_2 = 3.75$
$V_2 = 17.95$ $A_2 = 29.25$ $R_2 = 1.89$
$S_2 = .018$
$d_{c_2} = 4.72 > d_2$ $S_{c_2} = .0051 < \frac{S_2}{1.5}$

$Q_3 = 1003$ cfs
$b_3 = 18' > 0.8(b_1 + b_2)$
$S_3 = .0061$
Assume $d_3 = 3.76$ $A_3 = 67.68$ $R = 2.65$
$\therefore V_3 = 14.82$
$\therefore d_3 = 3.76$ O.K
$d_{c_3} = 4.59$ $S_{c_3} = .0034 < \frac{S_3}{1.5}$

$L = CV_1 (b_1 + b_2 + b_3)^{1/3}$ for $d_3 > D'$

$= 2.66 (10 + 9 + 18)^{1/3} \times 1.944$

$= 51.8$ say 52'

Splitter wall length $= L/2 = 26'$

$b_m = 18.5'$

$d_m = 3.52$

$A_m = 65.08$ $P_m = 25.54$ $R_m = 2.55$

$V_m = 15.41$

$b_3 = 9.74'$

$$\frac{Q_3^2}{gA_3} + \frac{b_3 d_3^2}{2} - \frac{b_3 d_3 \Delta}{2} = \frac{Q_1^2}{gA_1} + \frac{Q_2^2}{gA_2} + \frac{b_3 d_1 \Delta}{2} + \frac{b_1 d_1^2}{2} + \left(\frac{b_3 - b_1}{2}\right) d_2^2 - \frac{P_m L n^2 V_m^2}{2.21 R_m^{1/3}}$$

$\therefore 461.62 + 127.24 - 33.84\Delta = 214.37 + 292.64 + 29.79\Delta + 54.78 + 42.25 - 23.5$

or $63.63\Delta = 8.32$

$\Delta = 0.13$

$R_2' = 1.2 \times \frac{17.95^2 \times 9}{32.2 \times 1} = 108.47$ say 110'

Height of wall $= 1.2 \times 3.76 + .25 \times 4.59\left[1 - 11.1\left(\frac{.0485}{.0234} - 1\right)^2\right] + 1$

$= 4.5 + 0 + 1 = 5.5'$

Height of splitter wall $= d_1 = 3.91 > d_2$ use 5'-6"

" lower end = 6"

Height of wall for inlet $= 1.2 \times 3.25 + \frac{1.2 \times 17.95^2 \times 9}{32.2 \times 110}$

$= 3.9 + 1 = 4.9$ use 5'-0"

Beginning of Junction at STA 132+20 EL 1748.54

End of Junction at STA 132+72 EL 1748.54 − .13 = 1748.41

Provide 45° curve in the inlet

EL of beginning of curve $= 1748.54 + \frac{2\pi \times 110}{360} \times 45 \times .014$

$= 1749.75$

The inlet elevation is almost at the natural ground level. To minimize flooding in the arroyo provide straight inlet. (See sheet 2 of 9-24-85)

CHANNEL STA 132+72 & 137+00

$Q = 1001$ ≈ 1003 Sheet 6
$\therefore b = 18'$
$S = .0061$
$d = 3.76$

EI at Sta 137+00 = 1748.41 − (13700 − 13272) × .0061
= 1745.80 as in the Phase I Report.

Below station 137+00 the change in rate of flow due to FRS outlet discharge reduction is a small percentage the hydraulic parameters in the phase I report will be used.

Maximum deviation is at the inlet
$= \frac{1040 - 1001}{1001} \times 100 = 3.7\ \%$
the deviation is in the conservation direction.

Since the box inlets will have vertical drop D_r and then the depth of water at will cause large submergence u/s of the inlet. Straight inlets can therefore be used to reduce submergence.

For box inlet for 1A Ref E-Hand book chut spillways Section 14

$\frac{B}{W} = \frac{1}{8} = 1.125$

$Q/W^{5/2} = \frac{397}{8^{5/2}} = 2.193$

From ES-90 Sheet 5 This will depend upon site elevations

$6 = .75 = \frac{D_r}{W}$

$\therefore D_r = .75 \times 8 = 6'$

Submergence $= 6 + 3.04 = 9.04'$

For Straight inlet ges 2.10

$Q = 3.1 W H_e^{3/2}$

$\therefore H_e = \left(\frac{397}{3.1 \times 8}\right)^{2/3} = 6.35$ feet

Submergence is only 6.35 feet

Therefore use straight inlet

Provide a 12 feet bottom width channel with $z = 3:1$

$V_c = \frac{397}{(12 + 3 \times 6.28) 6.28} = 2.05$ $\quad v^2/2g = .065$

$H_e = 6.28 + .065 = 6.345'$ O.K

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BY [illegible] DATE 9-24-85 SHEET 2 OF 2

CHKD. BY [illegible] DATE 9-30-85 OPS NO. USDA 3767-3m DEPT. NO. 551

CLIENT USDA SCS PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY SIDE INLETS

Provide straight inlet as shown on ES-82 for
$h = 6.25 + 1.0$ freeboard
$= 7.25$ say 7.5 feet

For inlet 4B

$W = 9$ feet $Q = 525$ cfs

$\therefore H_c = \left(\frac{525}{3.1 \times 9}\right)^{2/3} = 7.07$

Provide a 15' wide channel with $Z = 3.0$

$V_a = \frac{525}{(15 + 3 \times 7)7} = 3.08$ $V^2/2g = .07$

$H_c = 7 + .07 = 7.07$ o.k.

Provide straight inlet for $h = 8.25'$

For inlet 5A.

$W = 27.5$ $Q = 2348$ cfs

$H_c = \left(\frac{2348}{3.1 \times 27.5}\right)^{2/3} = 9.12'$ Submergence is only 9.12' < 12.92' for box inlet.

Provide a 60 foot wide channel

$V_a = \frac{2348}{(60 + 3 \times 8.98)8.98} = 3.01$

$V^2/2g = .14$ $H_c = 8.98 + .14 = 9.12$

Provide straight inlet for $h = 10.25'$

For box inlet for 5A for $\frac{D}{W} = 1.167$ & $\frac{Q}{W^{5/2}} = .592$ ES-90 Sht 6
$S = .315$ $\therefore D = 8.16'$ and submergence = 8.16 + 4.76
= 12.92'

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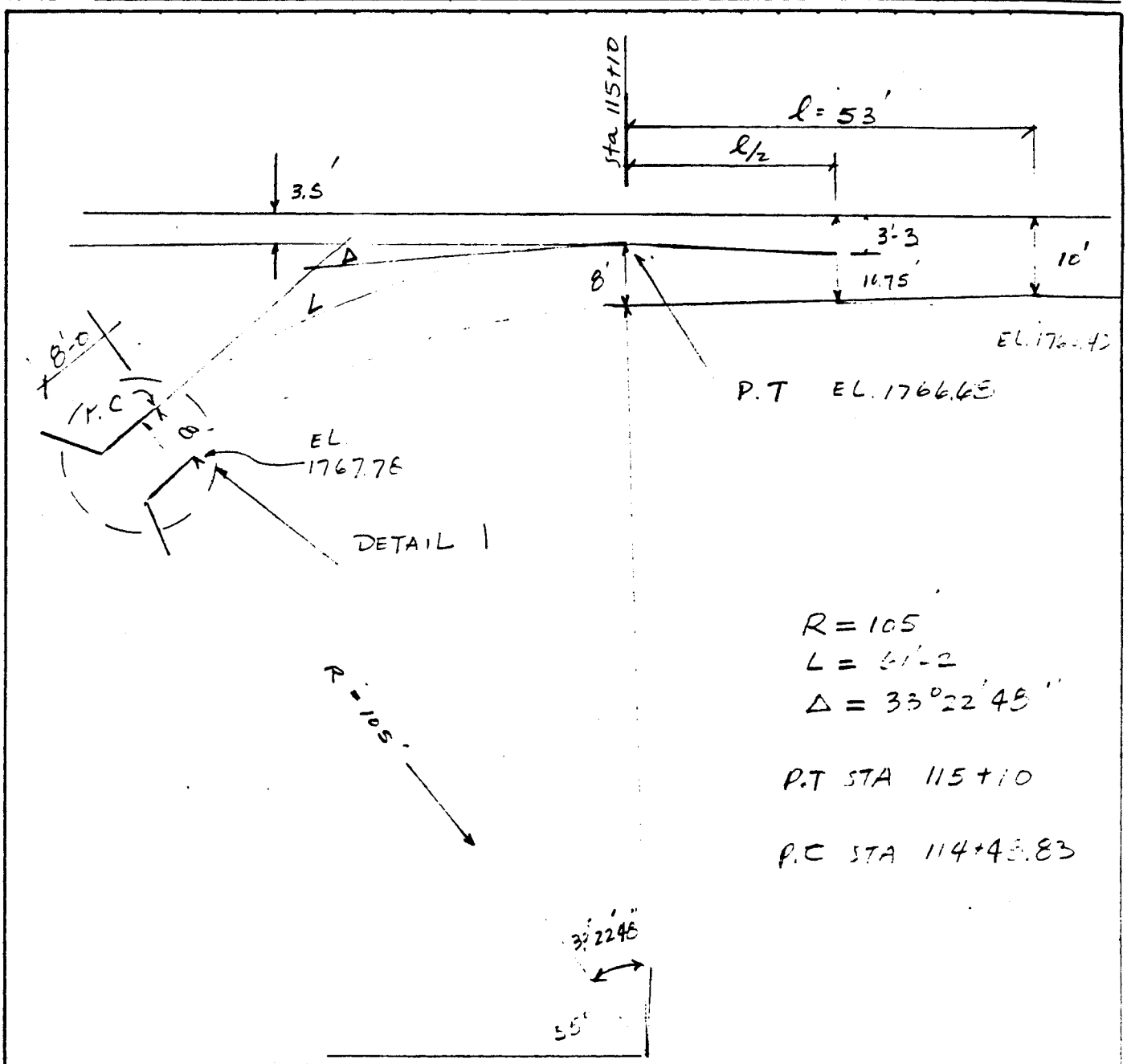
CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT SIDE CHANNEL INLET 4A



581/8-81

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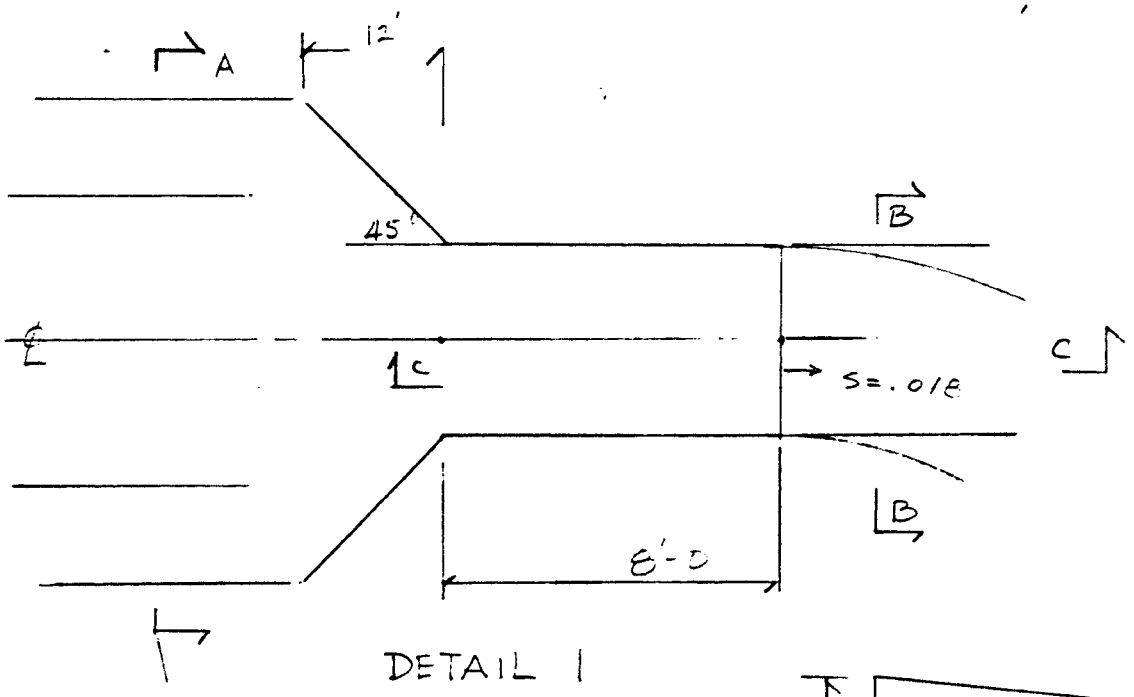
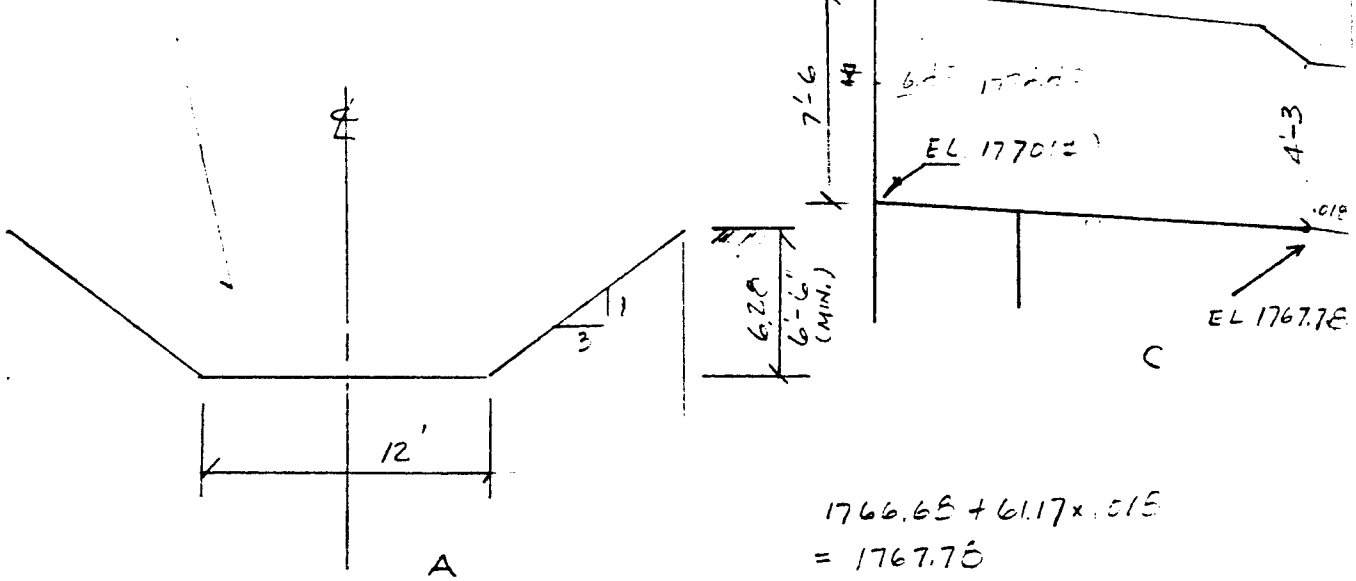
CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT INLET 4A

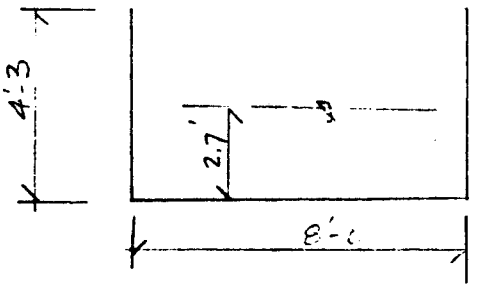


DETAIL 1



$1766.65 + 61.17 \times .01\ell$
$= 1767.7\ell$

REF



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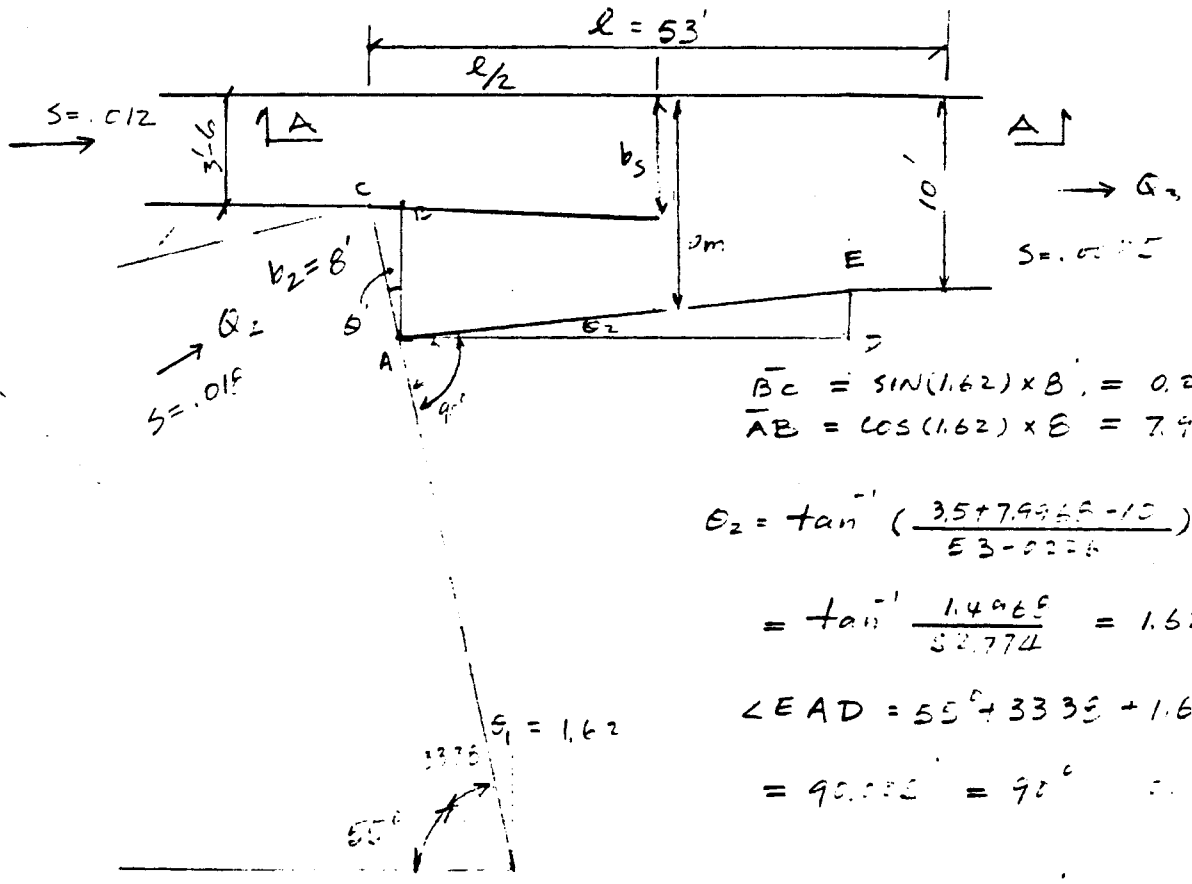
CLIENT ____

PROJECT ____

SUBJECT SIDE CHANNEL INLET 4A

$$\frac{2\pi \times 105}{360} = \frac{61.17}{\theta} = L$$

$\theta = 33.38^\circ$ $\quad L = 61'-2''$



$\bar{BC} = \sin(1.62) \times 8' = 0.226$

$\bar{AB} = \cos(1.62) \times 8 = 7.9963$

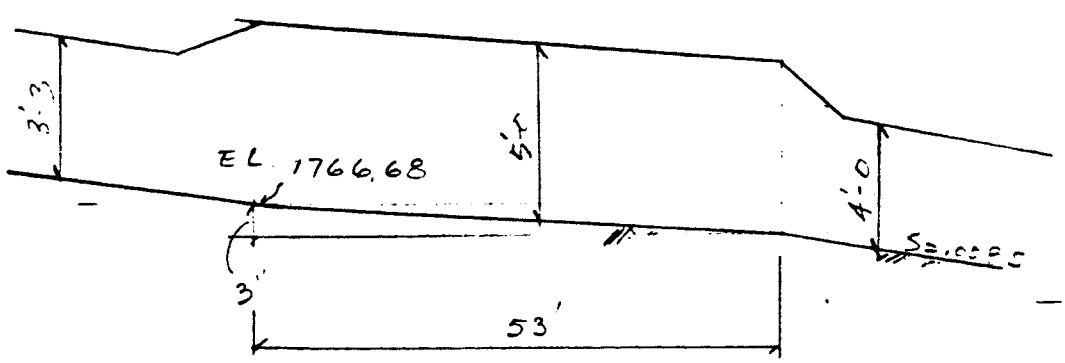
$$\theta_2 = \tan^{-1}\left(\frac{3.5 + 7.9963 - 10}{53 - 0.226}\right)$$

$$= \tan^{-1}\frac{1.4963}{52.774} = 1.625$$

$\angle EAD = 55^\circ + 33.38 + 1.625$

$= 90.005 = 90^\circ$

$3.5 + 7.9963 = 11.5'$



SECT. A

581/8-81

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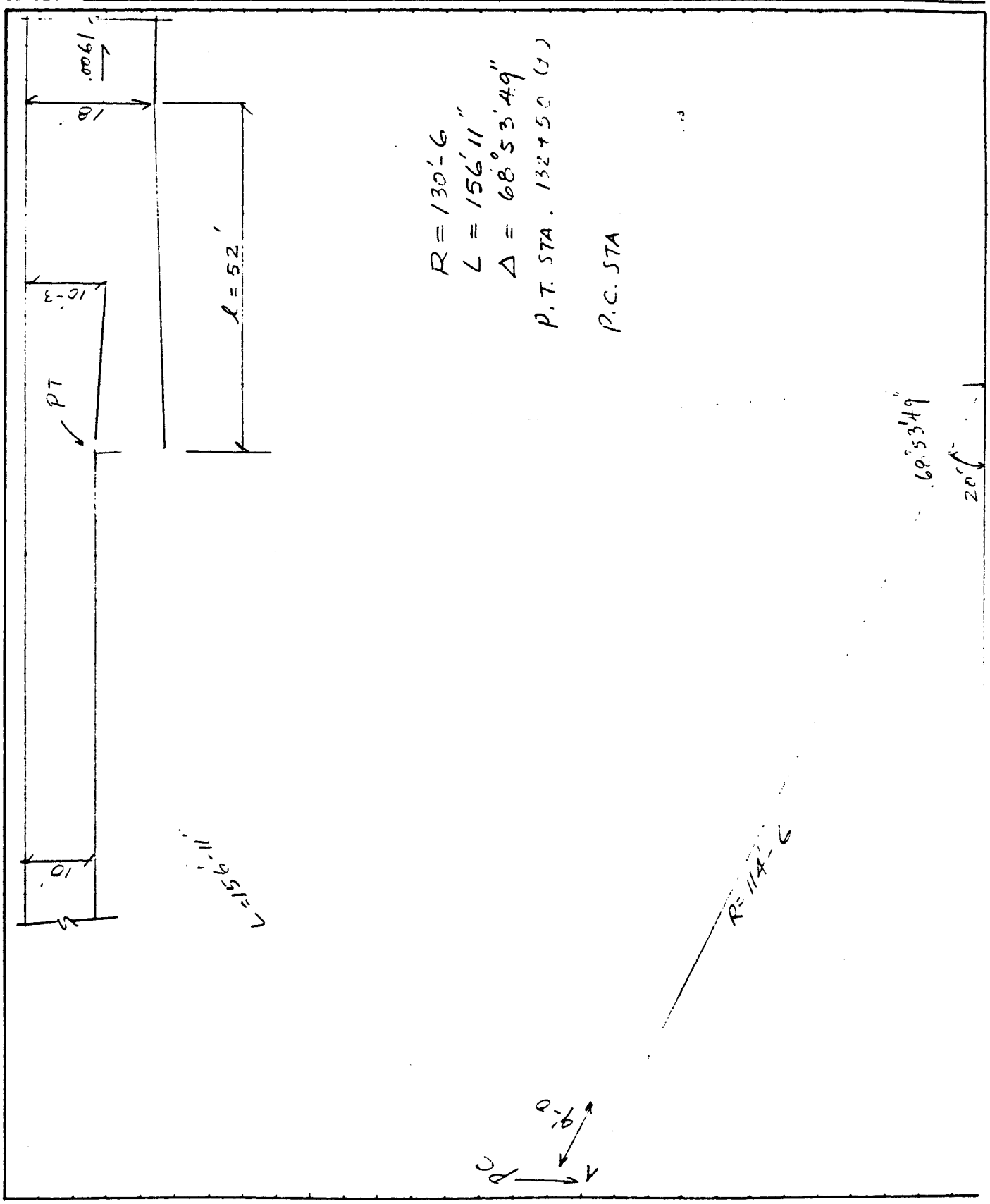
CLIENT ____

PROJECT ____

SUBJECT SIDE CHANNEL INLET 4B



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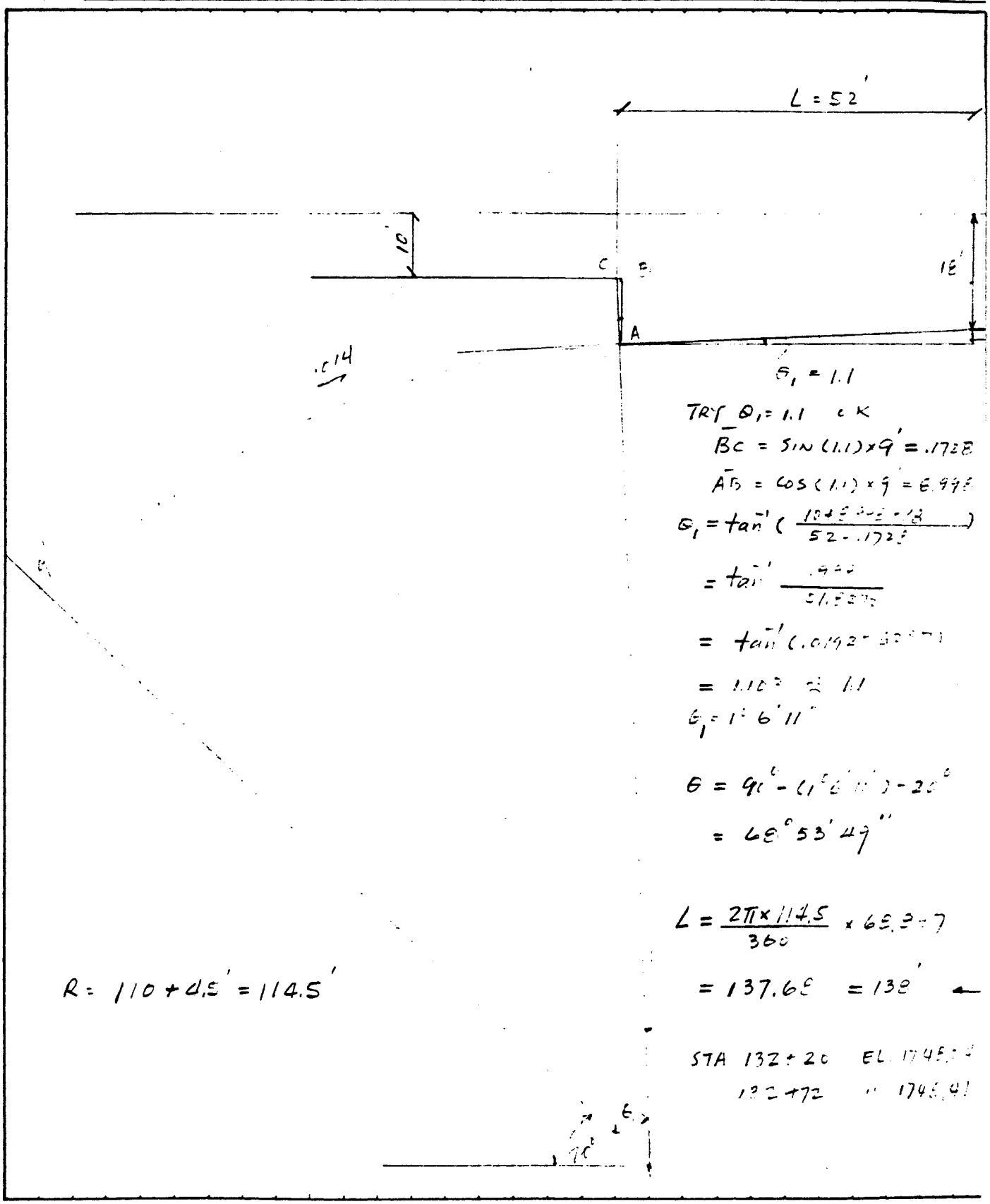
CLIENT ____

PROJECT ____

SUBJECT SIDE CHANNEL INLET 4B



$\theta_1 = 1.1$

TRY $\theta_1 = 1.1$ OK

$BC = \sin(1.1) \times 9' = .172'$

$AB = \cos(1.1) \times 9 = 8.99'$

$\theta_1 = \tan^{-1}\left(\frac{18' - .172' + 10'}{52 - .172'}\right)$

$= \tan^{-1}\frac{.99'}{51.83'}$

$= \tan^{-1}(.019^{\circ}\ 10'\ 57'')$

$= 1.10^{\circ} \approx 1.1$

$\theta_1 = 1^{\circ}\ 6'\ 11''$

$\theta = 91^{\circ} - (1^{\circ}\ 6'\ 11'') - 20^{\circ}$

$= 69^{\circ}\ 53'\ 49''$

$L = \frac{2\pi \times 114.5}{360} \times 69.9 = 7$

$= 137.69' = 138'$ ←

STA 132+20 EL. 1745.0

132+72 " 1745.41

SA1/A-81

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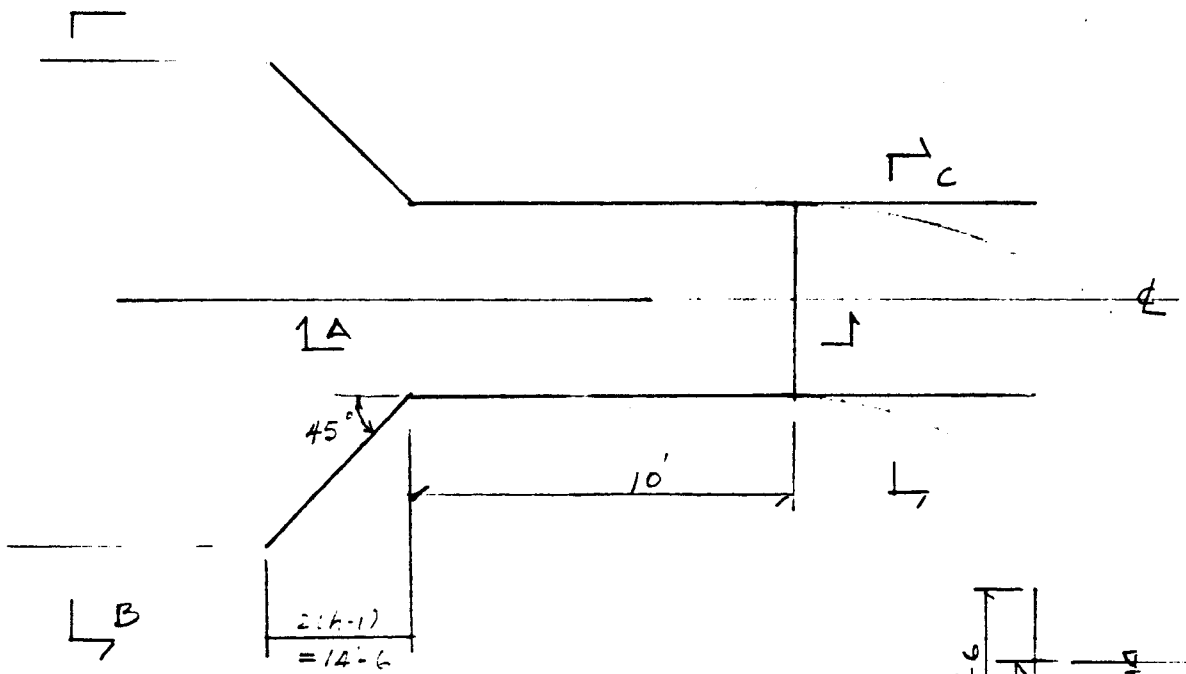
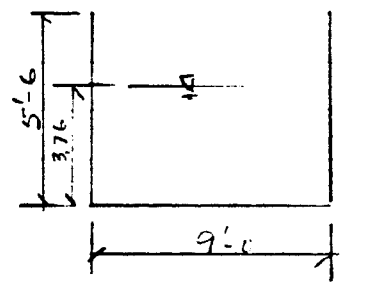
CLIENT USDA SOIL CONSERVATION SERVICE

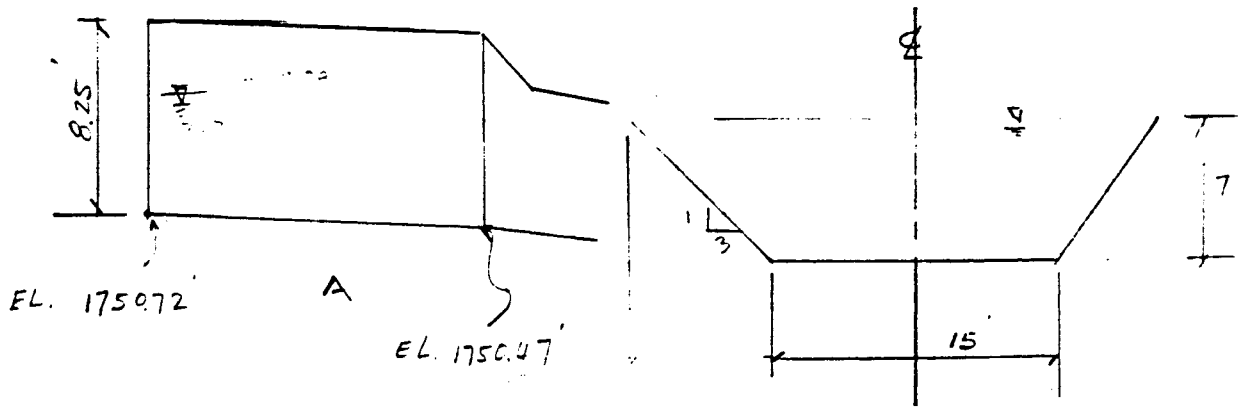
PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT INLET 4B





C



B

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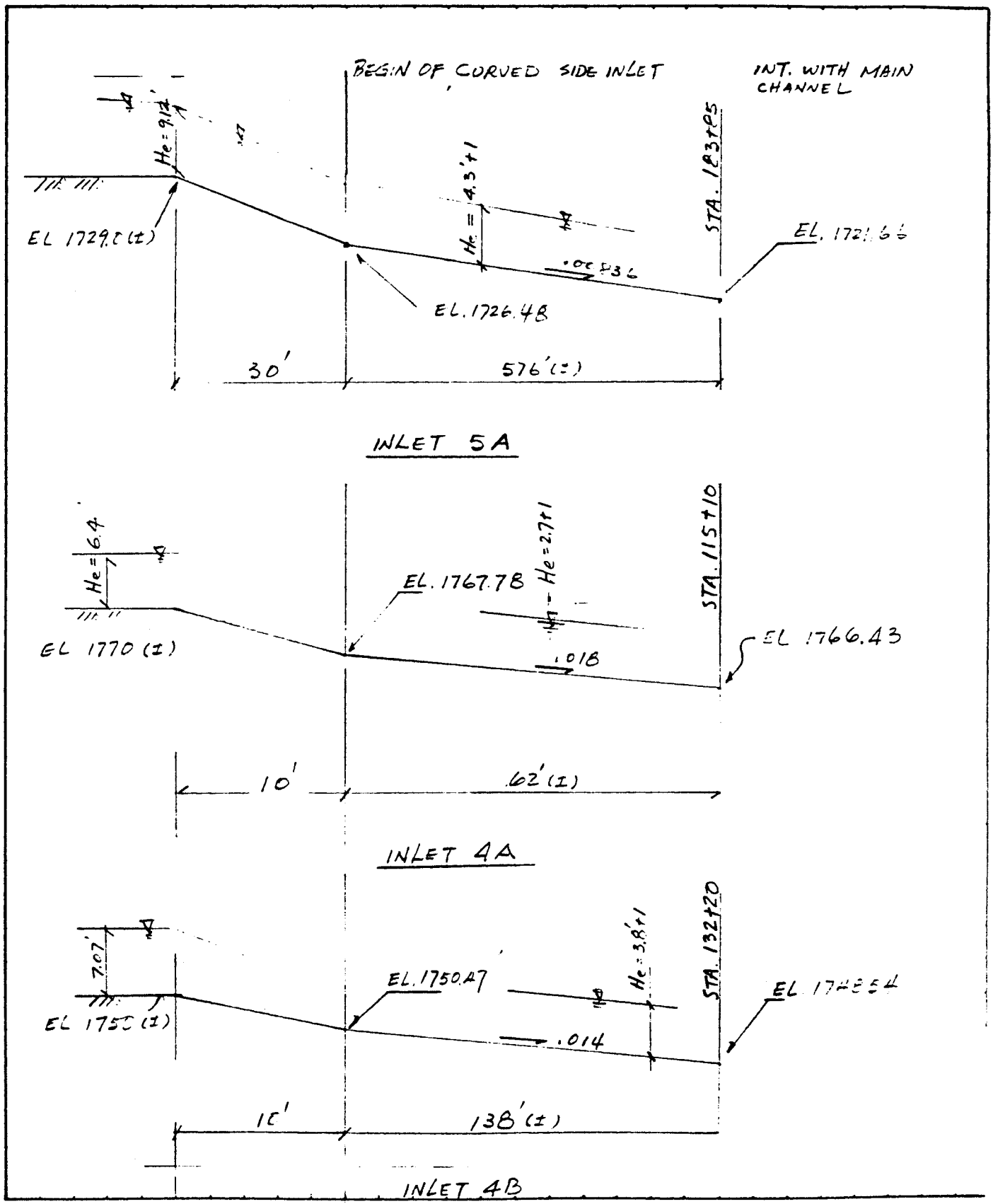
CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT ____



cc N.H
C.C
D.G.

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CLIENT USDA - SCS - PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY INLET SA

$b_1 = 35'$

$b_2 = 27.5'$

$b_3 = 50'$

$$bs_1 = \frac{b_1(b_1+b_2+b_3)}{2(b_1+b_2)} \quad \text{when } b_1 > b_2$$

$b_1 (=35') > b_2 (=27.5')$

$$\therefore bs_1 = \frac{35(35+27.5+50)}{2(35+27.5)} = 31.5'$$

The distance 'bs,' is measured from the outer wall of 35' channel. If the calculations are done the way done in PHASE I Report

$$bs_2 = \frac{27.5(35+27.5+50)}{2(35+27.5)} = 24.75'$$

The distance 'bs$_2$' is measured from the outer wall of 27.5 feet wide channel.

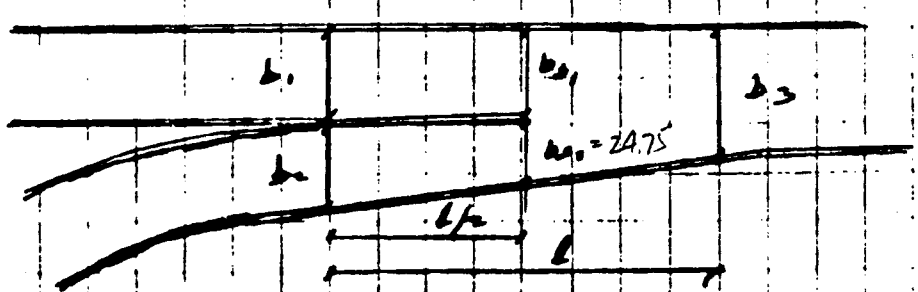
$bs_1 + bs_2 = 31.5 + 24.75 = 56.25'$ which is an end average of $b_1 + b_2$ on the upstream and b_3 on the downstream, at the end of $l/2$

$b_1 + b_2 = 35 + 27.5 = 62.5$

$b_3 = 50$

Average at $l/2$

$$= \frac{62.5+50}{2} = 56.25'$$



$bs_1 < b_1$ $\quad bs_2 < b_2$

The calculations can be done for either channel

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CLIENT USDA SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT INLET 5A

HEIGHT OF WALL @ TRANSITION AREA

$$d_{cr} = \left[\frac{(Q/b)^2}{g}\right]^{\frac{1}{3}} = \left[\frac{(\frac{4436}{50})^2}{32.2}\right]^{\frac{1}{3}} = 6.25'$$

$$A = 50 \times 6.25 = 312.57 \text{ ft}^2 \qquad P = 50 + 2 \times 6.25 = 62.5$$

$$R = A/P = \frac{312.57}{62.5} = 5.0$$

$$S_{cR} = \left[\frac{\frac{Q}{A}}{1.486} \cdot \frac{n}{R^{2/3}}\right]^2$$

$$= \left[\frac{\frac{4436}{312.57}}{1.486} \cdot \frac{.015}{5^{2/3}}\right]^2 = \left(\frac{.014327}{2.92271}\right)^2 = .0024$$

$$\text{HT. OF SIDE WALL} = 1.2 d_3 + 0.25 d_3 \left[1 - 11.1\left(\frac{S_3}{S_{c3}} - 1\right)^2\right] + 1.2\,\frac{V_2^2 b_2}{g R_2^2}$$

$$= 1.2 \times 4.9 + 0 + 1. = 6.88$$

say 7'-0

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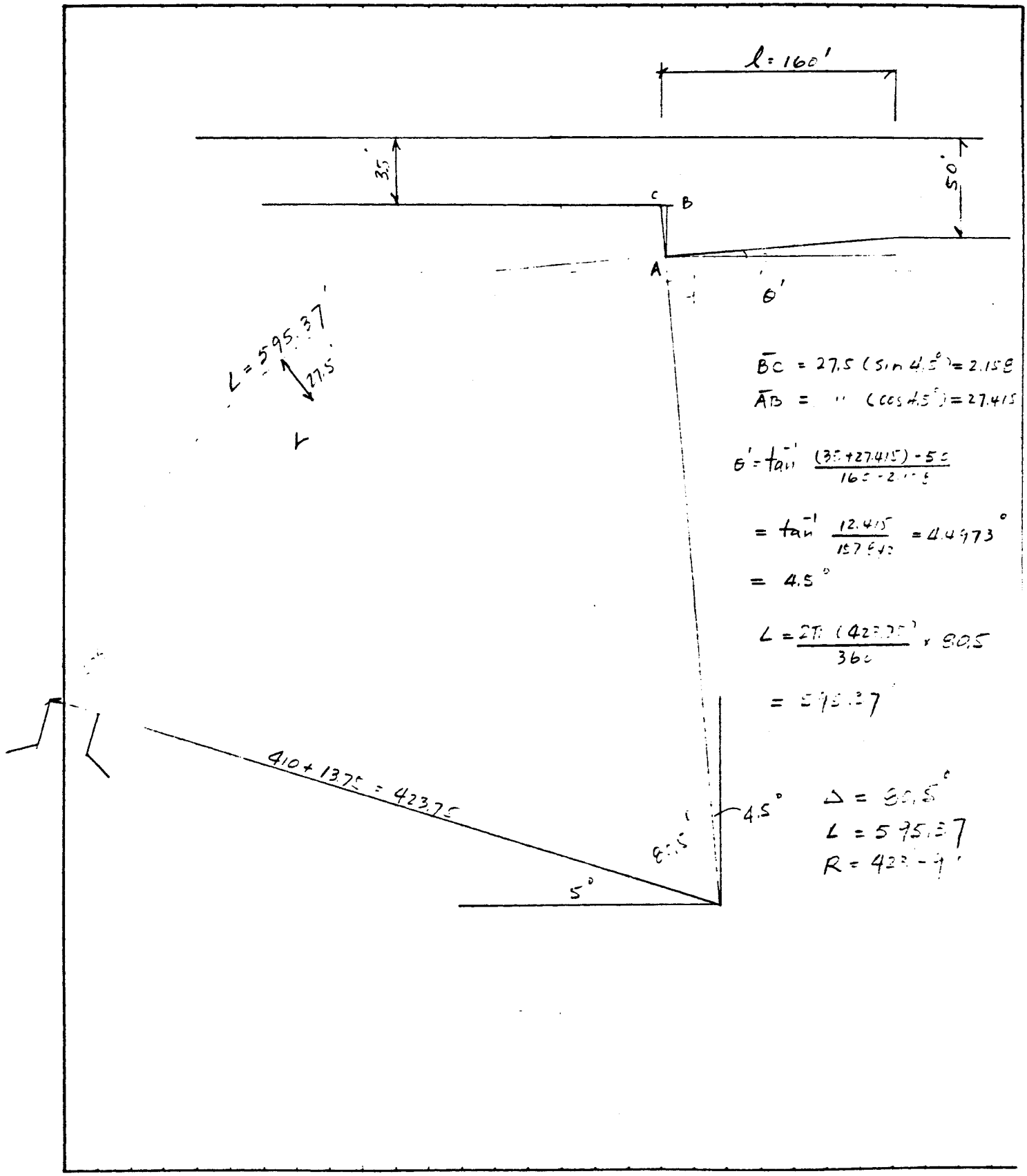
CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT SIDE CHANNEL INLET 5A



$\bar{BC} = 27.5 (\sin 4.5^\circ) = 2.158$

$\bar{AB} = " (\cos 4.5^\circ) = 27.415$

$\theta' = \tan^{-1} \frac{(35 + 27.415) - 50}{160 - 2.158}$

$= \tan^{-1} \frac{12.415}{157.842} = 4.4973^\circ$

$= 4.5^\circ$

$L = \frac{2\pi (423.75)}{360} \times 80.5$

$= 595.37$

$\Delta = 90.5^\circ$

$L = 595.37$

$R = 423.75'$

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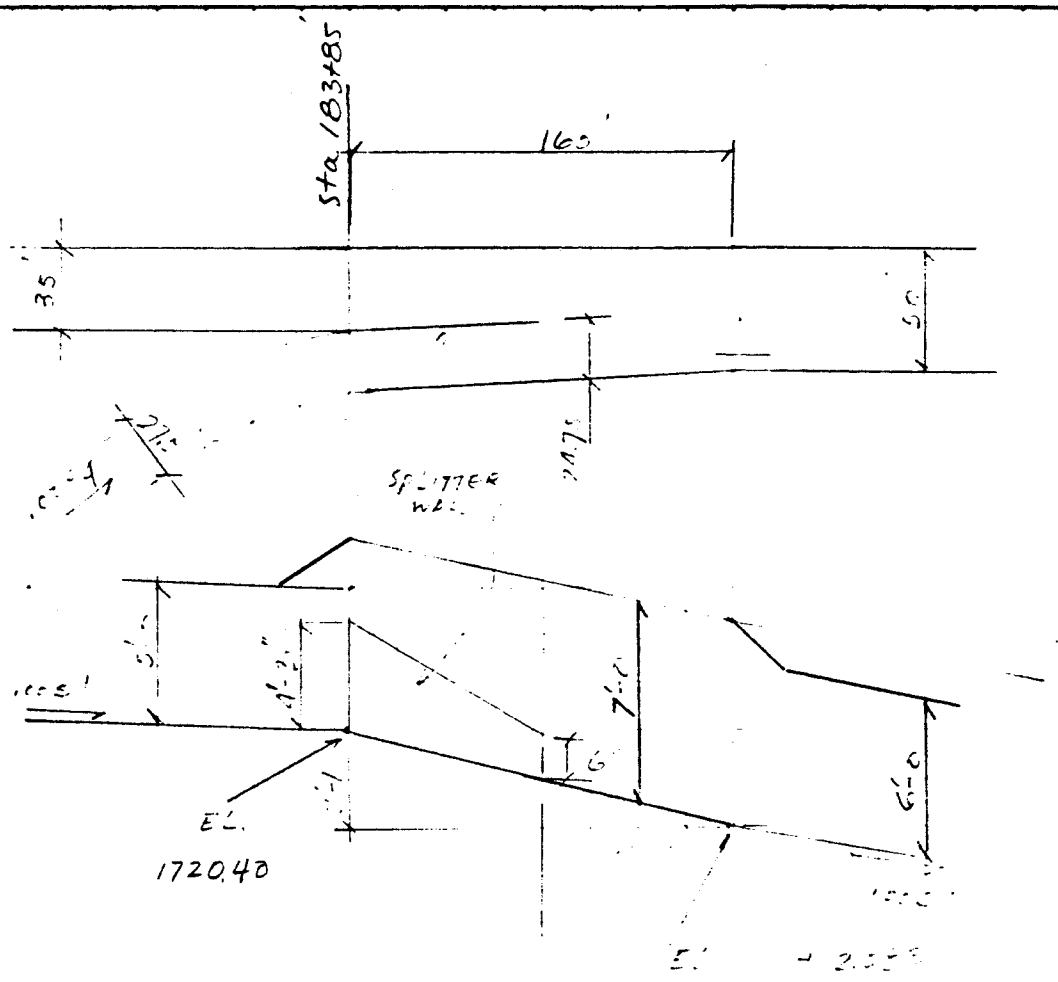
CHKD. BY ____ DATE ____ OFS NO. [illegible] DEPT. NO. [illegible]

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT INLET 5A



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EBASCO SERVICES INCORPORATED

BY N. Hung DATE 11/3/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT ~~USDA-SOIL CONSERVATION SERVICE~~

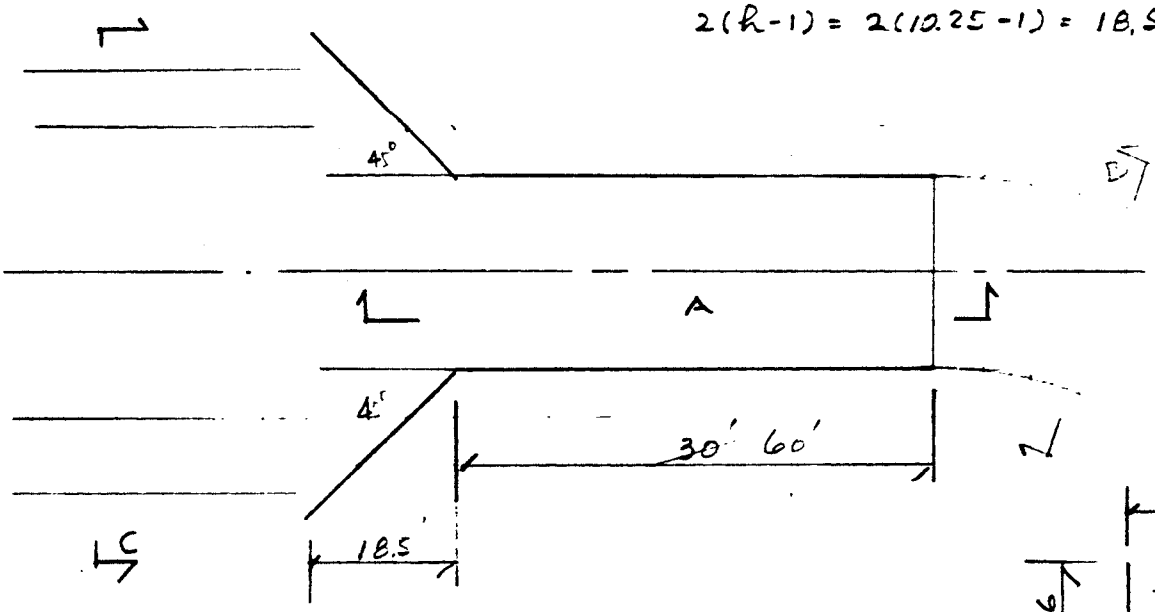
PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

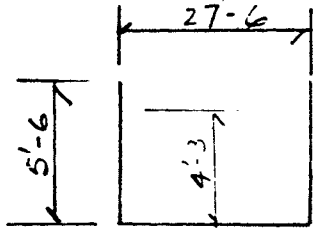
SUBJECT SIDE CHANNEL INLET 5A

INLET 5A

$14 + 3(h-M) = 14 + 3(10.25 - 5.5) = 28.25'$

$2(R-1) = 2(10.25-1) = 18.5$





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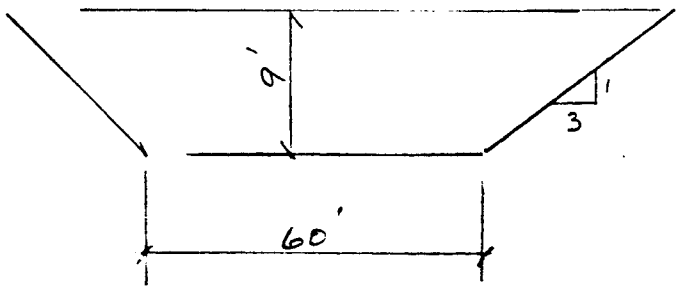
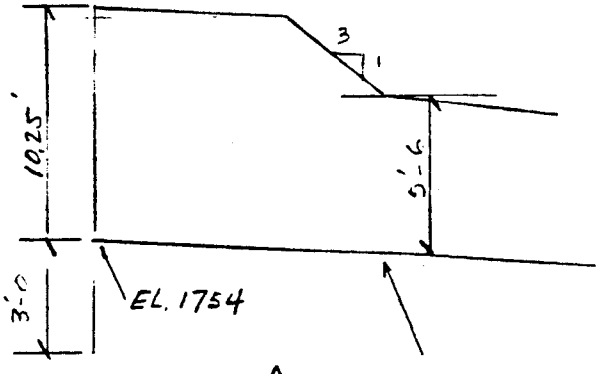


C



A EL. 1725.24

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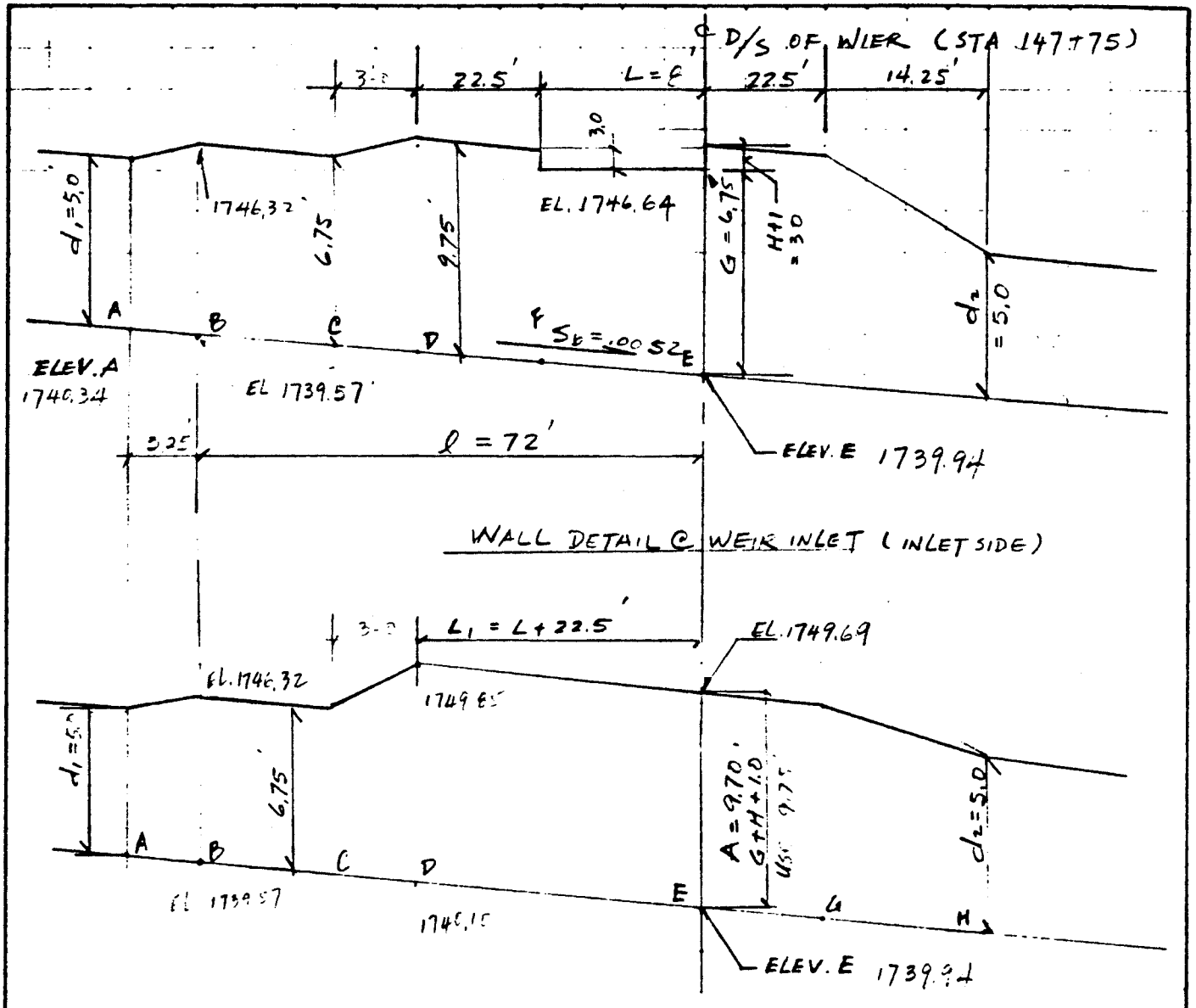
CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT WEIR NO. 3 4D



9.75 - 6.7 =

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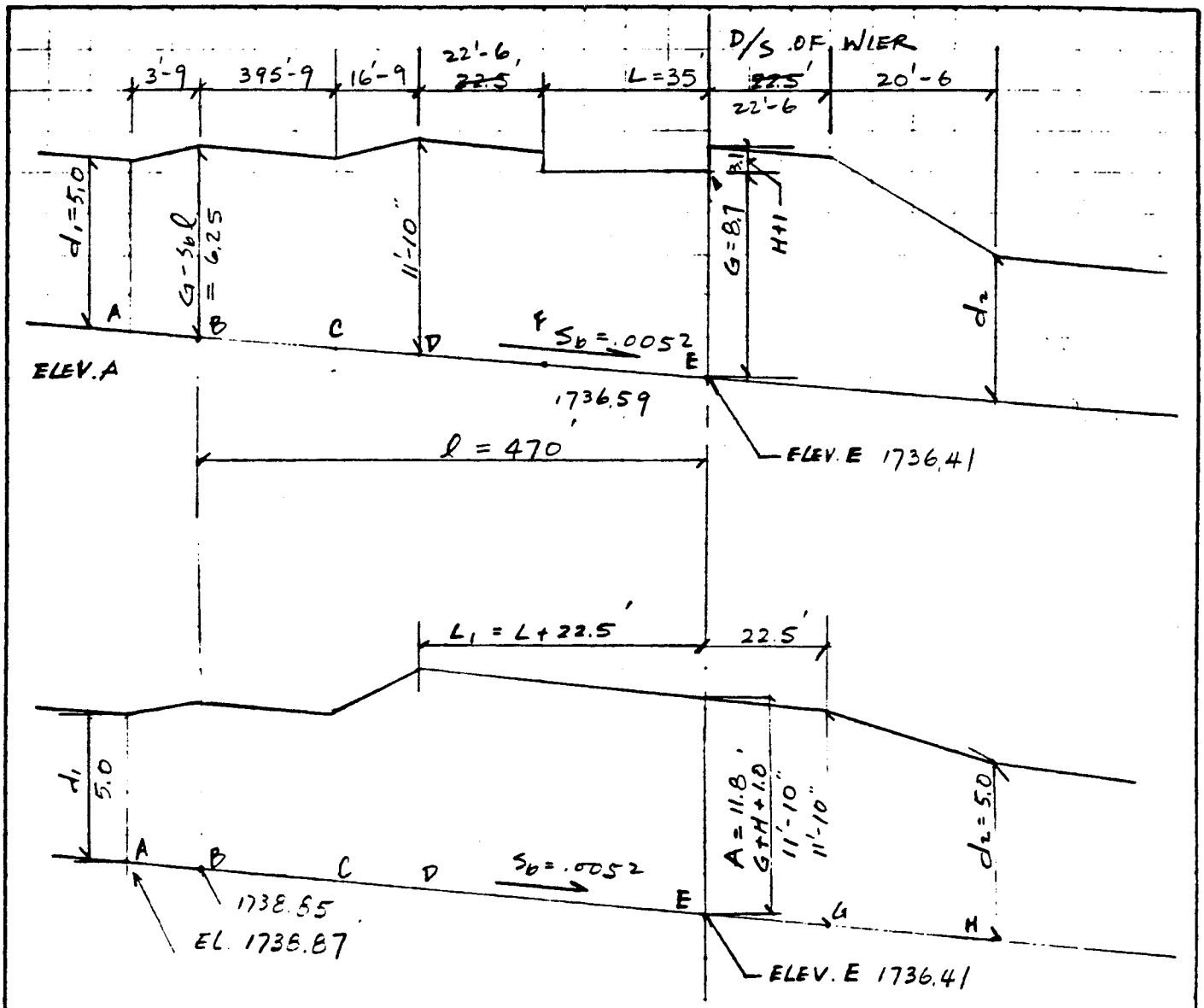
CLIENT USDA SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT WEIR NO. 4 4E



$3[(11'-10'') - (5'-0'')] = 20'-6''$

$3[(11'-10'') - (6'-3'')] = 16'-9''$

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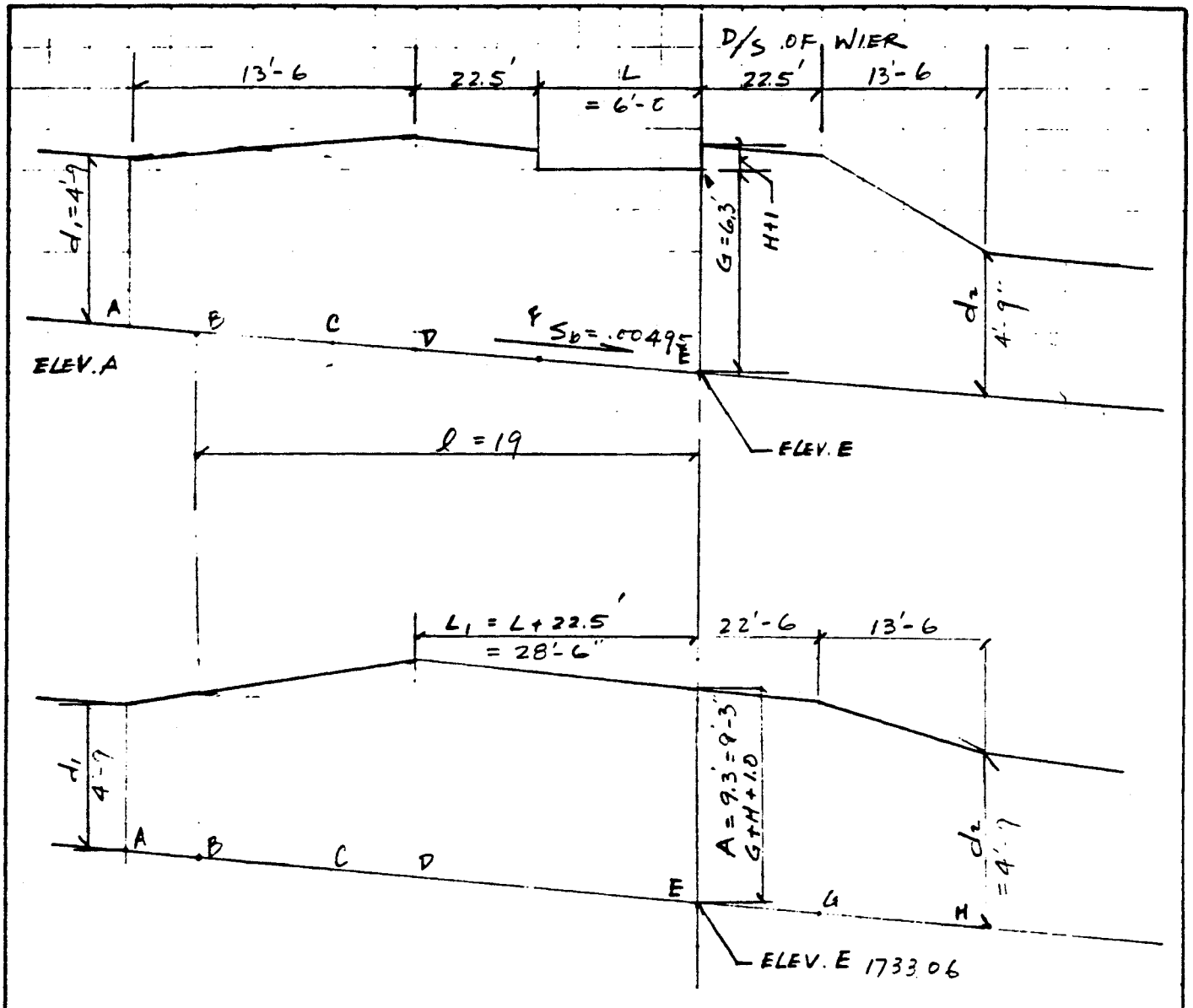
CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT WEIR NO.5 4F



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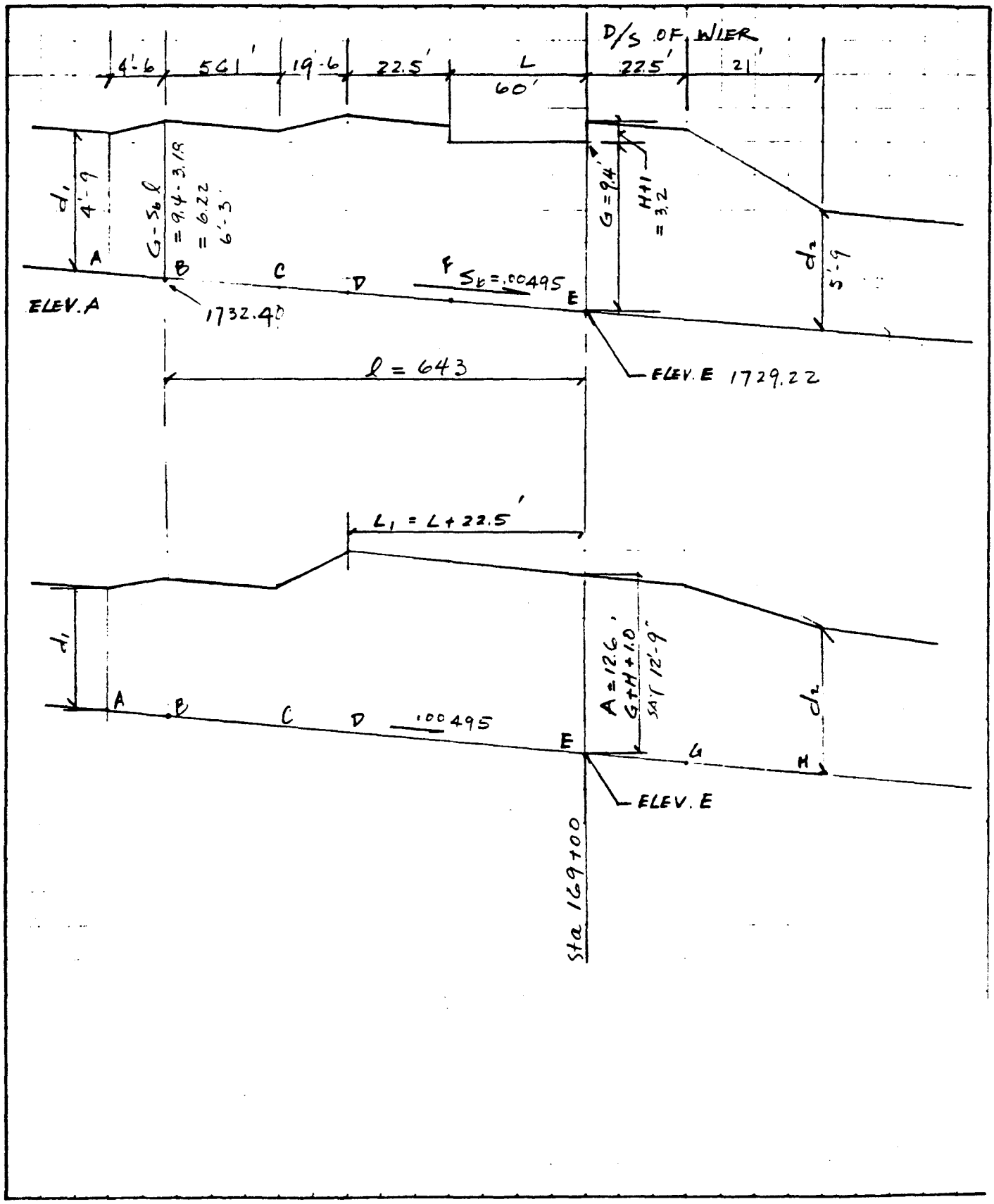
CHKD. BY ___ DATE ___ OFS NO. 3767-30c DEPT. NO. 243

CLIENT USDA SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT WEIR 6 4G



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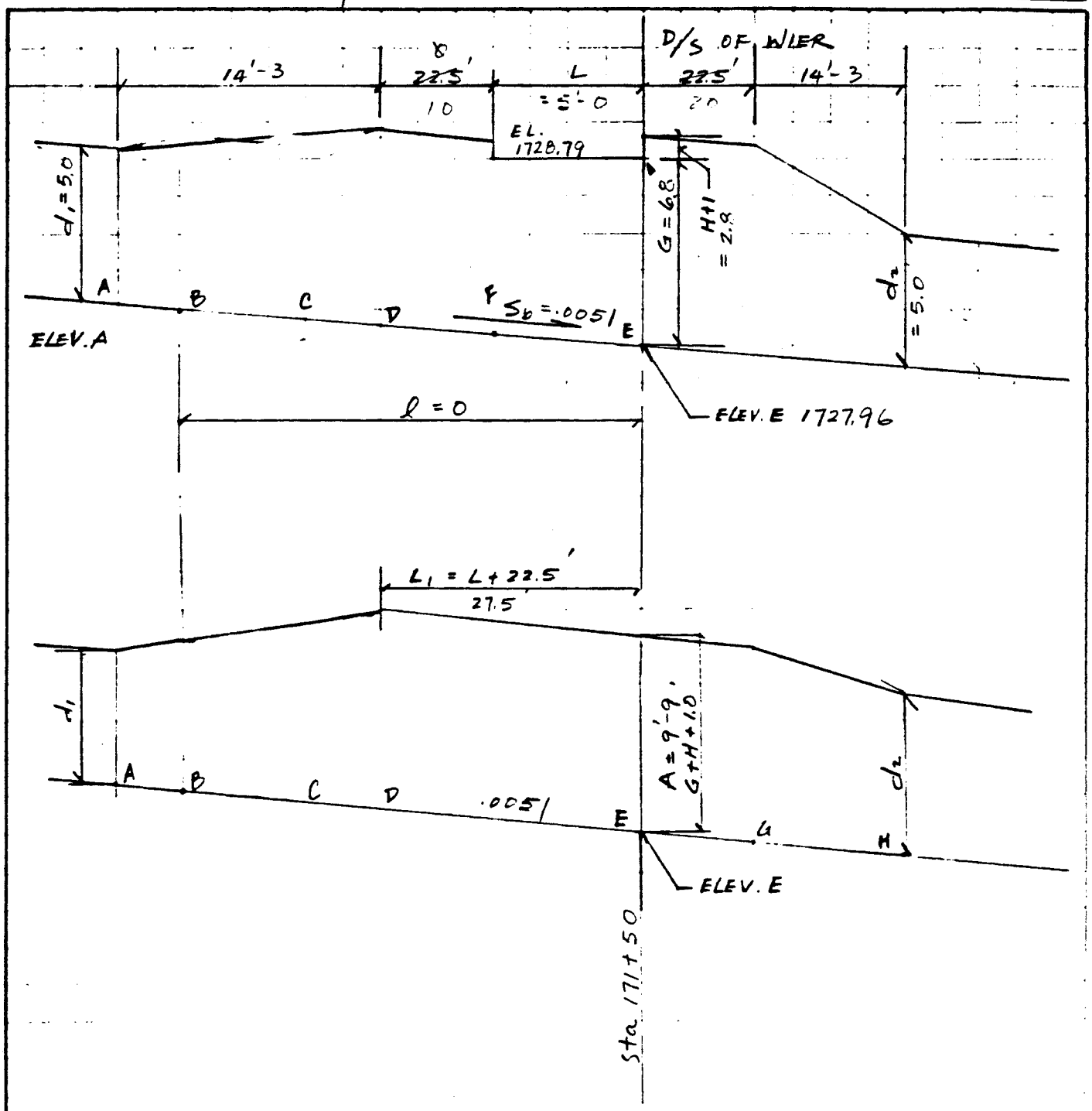
CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT WEIR 7 4H



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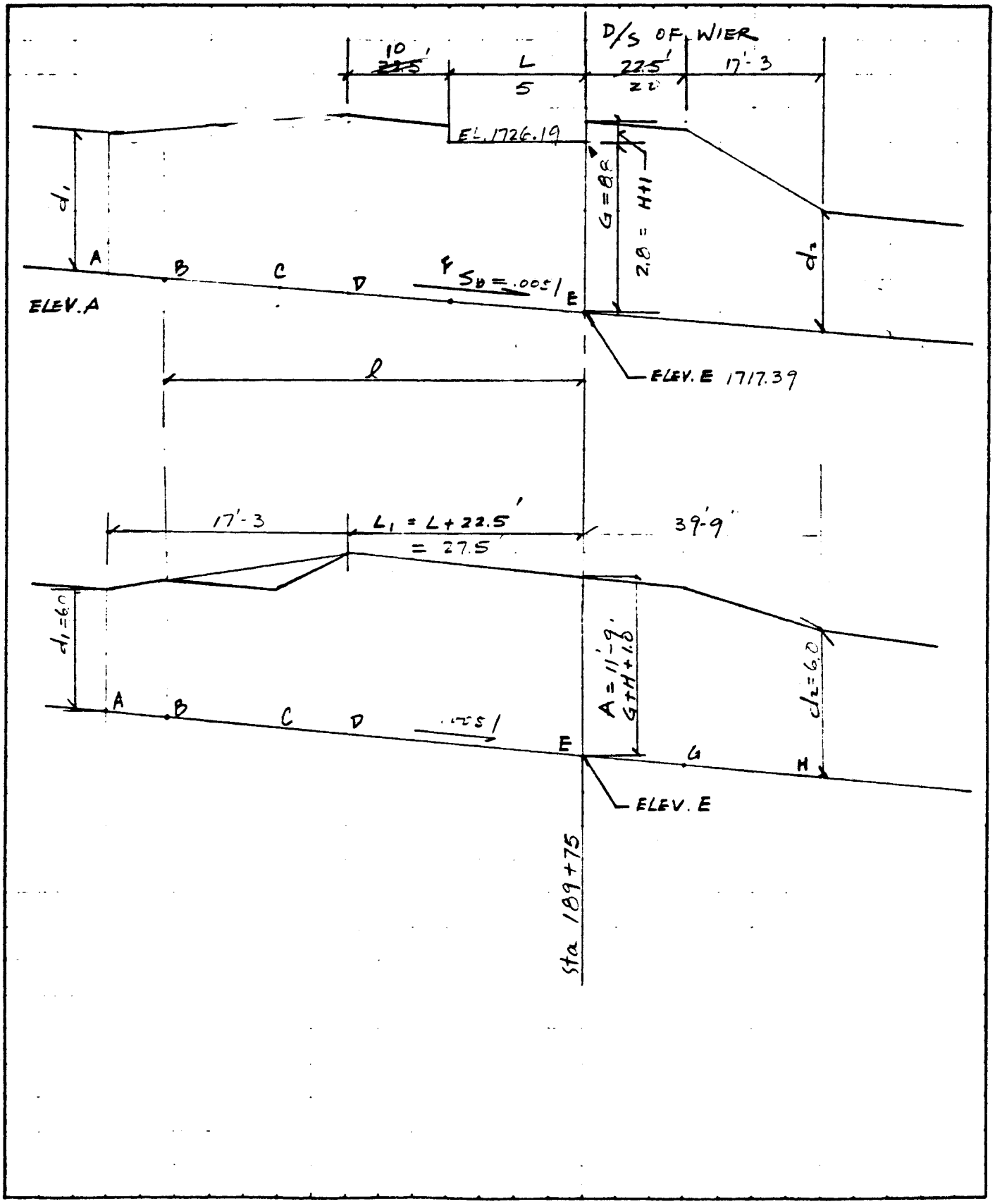
CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT WEIR NO. B 5C



INLETS

The flows in the main channel at the inlets have decreased by 39 cfs as compared to the flows indicated in the PHASE I Report due to change in outlet diameter from 36" to 30" diameter in the final stages of the PHASE I study.

The hydraulic computations for the junctions and the channels are revised in this phase II

Channel FRS outlet to 4A inlet

$Q = 81$ cfs

$S = .012$

$b = 3.5'$

$V = \frac{1.486}{n} R^{2/3} S^{1/2}$

$n = .015$

Assumed $= 2.18'$ $P = 7.86$ $A = 7.63$ $R = 0.97$

$\therefore V = 10.64$

$\therefore d = 2.175'$ 0.k

$d_{cr} = \left[\left(\frac{Q}{b}\right)^2/g\right]^{1/3} = 2.55'$ $A_c = 8.93$ $R_c = 1.04$

$S_{cr} = \left[\frac{Q/A}{1.486} \frac{n}{R^{2/3}}\right]^2$

$= .00796$

$\therefore S > 1.3\, S_{cr}$

$\therefore$ Freeboard $= .2 \times d$

$= .2 \times 2.18'$

$= .44'$ Provide 1' minimum.

$\therefore$ Height of wall $= 2.18 + 1$

$= 3.18$ Provide 3'-3" wall.

INLET 4A

$Q_1 = 81$ cfs $b_1 = 3.5'$ $d_1 = 2.18'$ $A_1 = 7.63$ $V_1 = 10.62$

$Q_2 = 397$ cfs $b_2 = 8'$

$d_2 = 2.7$

$V_2 = 18.4$ $A_2 = 21.6$ $R_2 = 1.61$

$S_2 = \left[\frac{V}{1.486} n R^{2/3}\right]^2 = .018$

$d_{c_2} = 4.24$ $S_{c_2} = .0053 < \frac{S_2}{1.3}$

$Q_3 = Q_1 + Q_2 = 478$ cfs

$b_3 = 10' > 0.8(b_1 + b_2)$ i.e. $> 9.2'$

$S_3 = 0.0085$

Assume $d_3 = 3.31$ $A_3 = 33.1$ $R = 1.99$

$V_3 = 14.46$ fps

$\therefore d_3 = 3.306$ O.K

$d_{c_3} = 4.14$ $S_{c_3} = .0045 < \frac{S_3}{1.3}$

$l = C V_2 (b_1 + b_2 - b_3)^{1/3}$ for $d_2 = 2.7'$

$= 2.5 \times 18.4 (3.5 + 8 - 10)^{1/3}$

$= 52.66'$ say 53'

length of splitter wall $= l/2 = 26'-6"$

$b_m = \frac{(b_1 + b_2)}{2} + b_3 = 10.75$

$d_m = \frac{1}{2}\left[\frac{Q_1 + Q_2}{V_1 b_1 + V_2 b_2} + d_3\right] = 2.95$

$A_m = 31.73$ $P_m = 16.65$ $R_m = 1.906$

$V_m = \frac{Q_1 + Q_2}{b_m d_m} = 15.07$ fps

$b_s = \frac{b_1 (b_1 + b_2 + b_3)}{2 (b_1 + b_2)} = \frac{3.5 (3.5 + 8 + 10)}{2 (3.5 + 8)} = 3.27$ say 3'-3"

Unequal width main channel

$$\frac{Q_3^2}{g A_3} + \frac{b_3 d_3^2}{2} - \frac{b_3 d_3 h}{2} = \frac{Q_1^2}{g A_1} + \frac{Q_2^2}{g A_2} + \frac{b_3 d_1 h}{2} + \frac{b_1 d_1^2}{2} + \left(\frac{b_3 - b_1}{2}\right) d_2^2 - \frac{P_m l n^2 V_m^2}{2.21 R_m^{1/3}}$$

$\therefore 214.37 + 54.78 - 16.55 h = 26.70 + 226.61 + 10.9 h + 8.32 + 23.69 - 16.46$

$27.45 h = 0.29$

$h = .01$ Provide 3" drop

Radius of bend $R_2' = 1.2 \frac{V_2^2 b_2}{g S}$ S is superelevation

Assume 1:0

$= \frac{1.2 \times 18.4^2 \times 8}{32.2 \times 1}$

$= 100.9$ Use $R_2' = 101'$

Height of wall $= 1.2 d_2 + 0.23 d_{c3} \left[1 - 11.1 \left(\frac{S_3}{S_2} - 1\right)^2\right] + \frac{1.2 V_2^2 b_2}{g R_2}$

$= 1.2 \times 3.31 + .25 \times 4.14 \left[1 - 11.1 \left(\frac{.0085}{.0045} - 1\right)^2\right] + 1$

↑ neglected being < 0

$= 3.97 - 0 + 1$

$= 4.97$ → say 5'-0

Height of spillway wall $= d_2 = 2.7' > d_1$ Use 2'-9"

" lower end = 6"

Height of wall for inlet $= 1.2 \times 2.7 + \frac{1.2 V_2^2 b_2}{g R_2}$

$= 3.24 + 1 = 4.24$ Use 4'-3

Provide beginning of Junction at STA 115+10

EL. at Junction $= 1783 - (11510 - 10150) \cdot 012$

$= 1766.68$

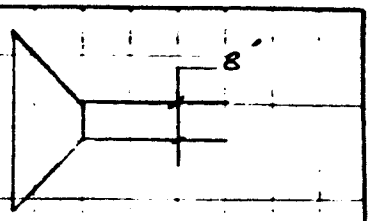
Provide a 45° curve and a 20' straight reach in the side inlet

Length of channel $= \frac{2\pi \times 101}{360} \times 45 + 20 = 99.33'$

Bed EL at inlet $= 1766.68 + 99.33 \times .018 = 1768.47$

The bed elevation is lower than the ground contours by about a foot

Provide straight inlet



$Q = 397$ cfs

$b = 8'$

Make inlet 8' wide with wing walls 20' WIDE channel 2:1 side slope

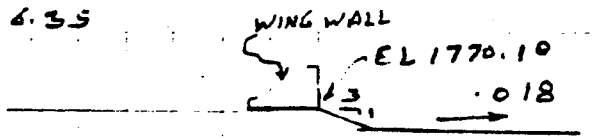
$\therefore Q = 3.1 \times 8 \times H_e^{3/2}$

$H_e = 6.35$

Provide the inlet at a higher level to approximately match the ground contours. Say at EL 1770.10

U/s Energy level = $1770.10 + 6.35$

$= 1776.45'$



$D_c = \left[\left(\frac{397}{8}\right)^2 / 32.2\right]^{1/3} = 4.244$ $\quad V_c = 11.69$

Total energy at inlet $= 1770.10 + 4.244 + \frac{11.69^2}{64.4} = 1776.47$

For normal flow energy line in the channel

$= 1768.47 + d_2 + \frac{V_2^2}{2g}$

$= 1768.47 + 2.7 + \frac{18.4^2}{64.4}$

$= 1776.43 < 1776.47$ o.k

Water level for submergence of land = $1776.45'$

Top of dike $= 1776.47 + 1 = 1777.47$ say 1777.50

EL at the end of inlet junction at STA 115+63

$= 1766.68 - .25$

$= 1766.43$

Inlet velocity in the arroyo $= \frac{397}{(20 + 2 \times 6.25)\,6.25} = 1.95$ cfs

Depth of flow assumed 6.25'

$H_e = 6.25 + \frac{1.95^2}{64.4} = 6.31 < 6.35$ ok

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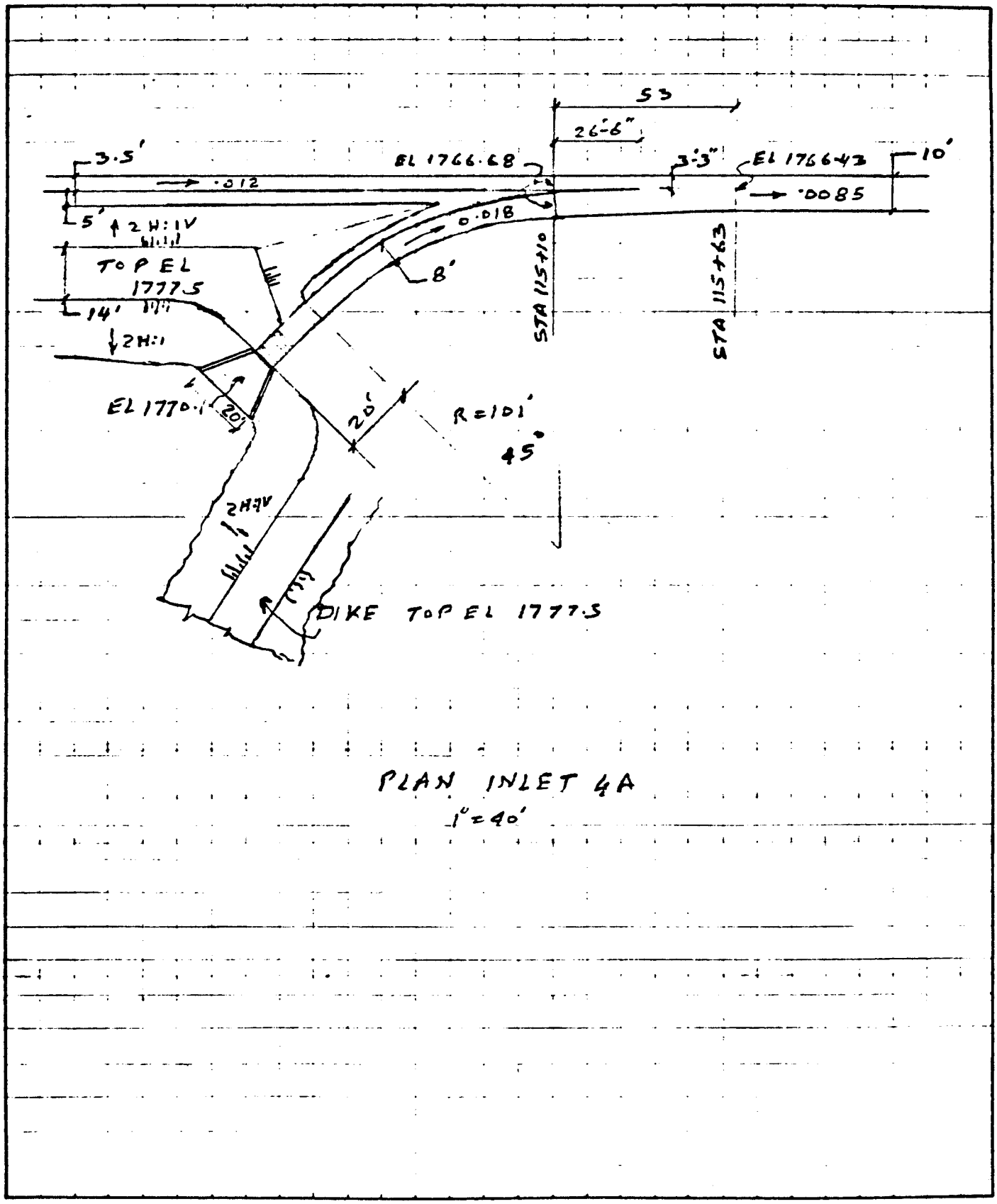
CLIENT USDA - SCS PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT APACHE JUNCTION FRS OUTLET CHANNEL



PLAN INLET 4A

1"=40'

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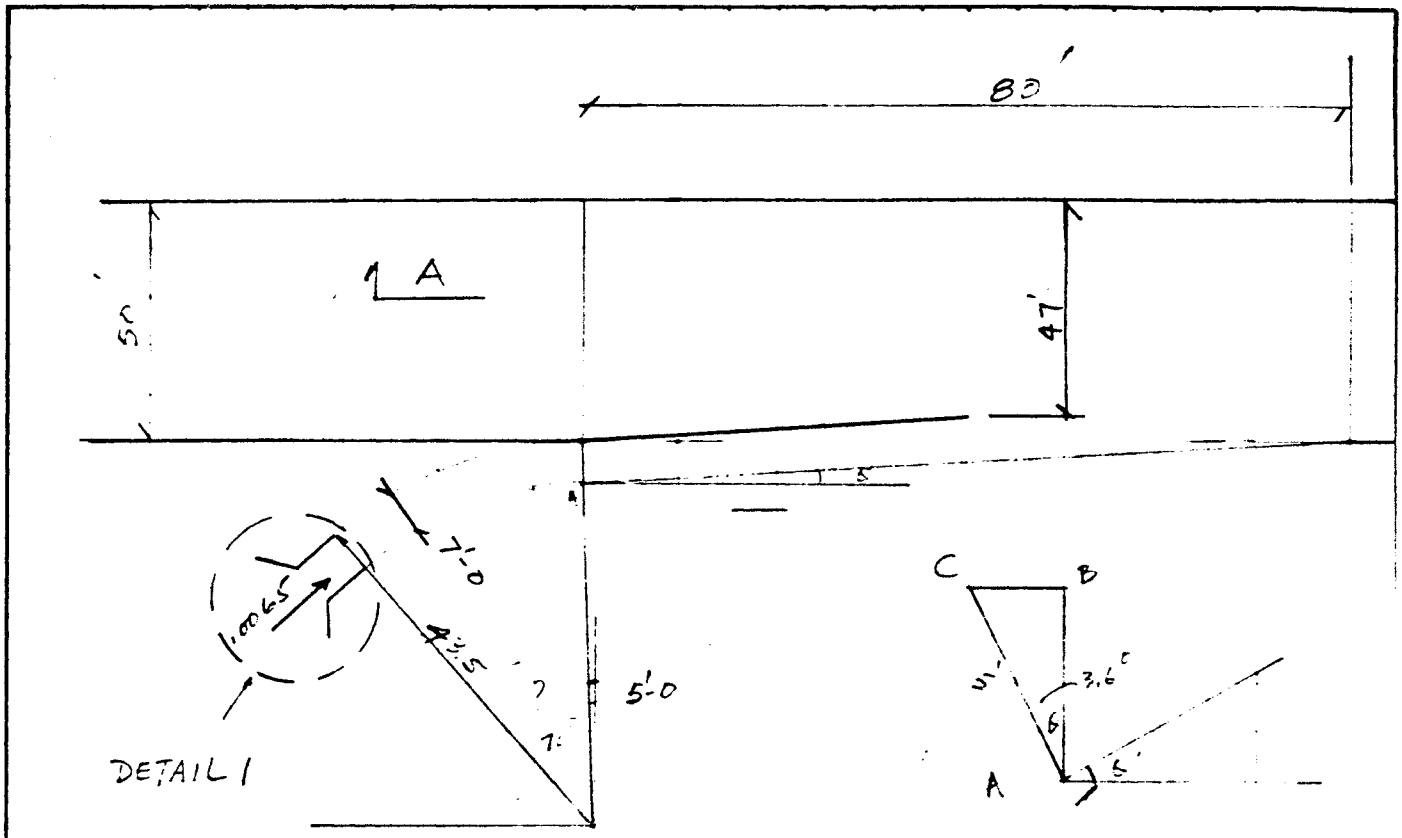
CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT INLET 6A



$\overline{BC} = 7' (\sin 5.0 = 0.61$

$\overline{AB} = 7' (\cos 5.0) = 6.97$

$\theta' = \tan^{-1} \frac{(50+6.97)-50}{80-.61} = \tan^{-1} \frac{6.97}{79.39} = 5.01$ SAY 5.0

$R = 43.5'$

$\frac{2\pi \times 43.5}{360} \times 70 = 53'$

581/8-81

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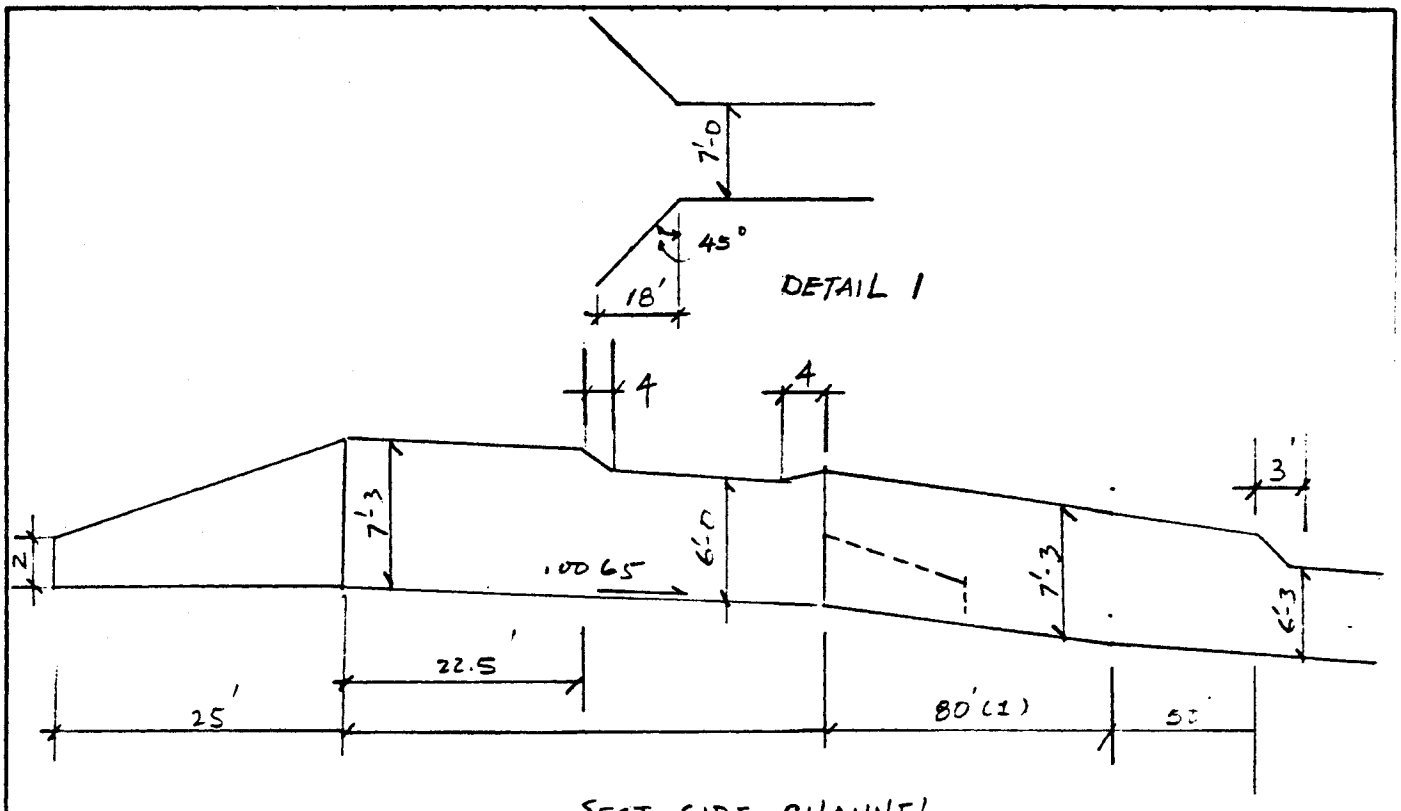
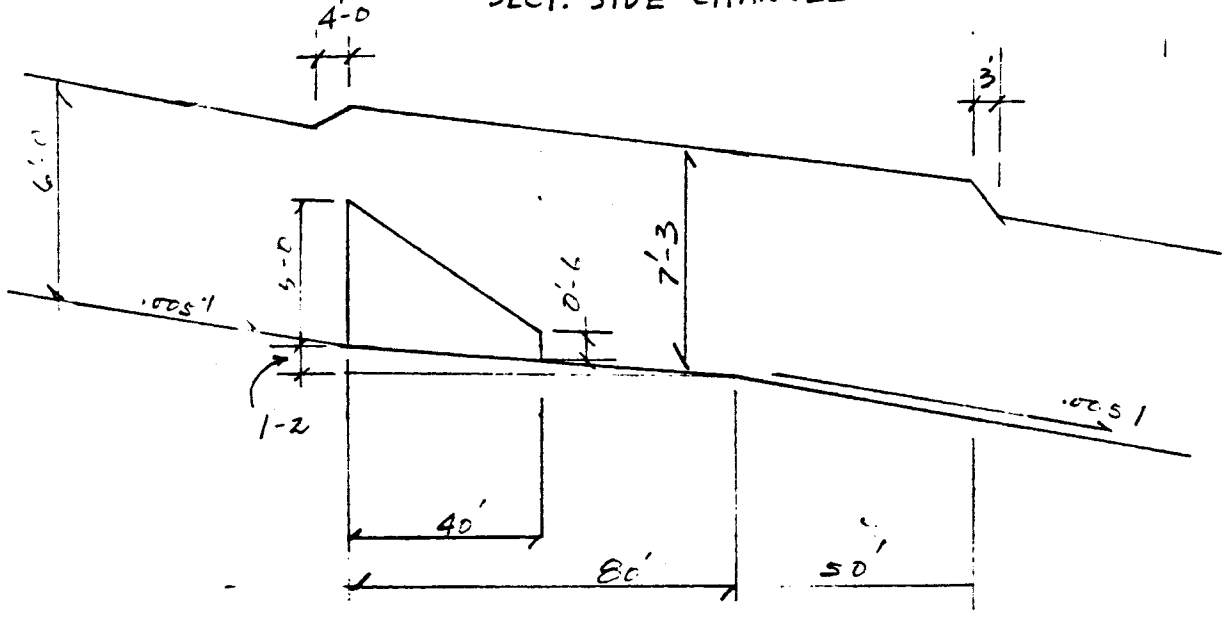
CLIENT USDA SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT INLET 6A



SECT. SIDE CHANNEL



SECT MAIN CHANNEL

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BY S GOYAL DATE 10-21-85 SHEET 1 OF 8

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CLIENT USDA - SCS - PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY INLET 6A

Inlet 6A

Channel bed el = 1715.17 — From Phase I Report Tables VI-5 and VI-4

G = 9.3

H = 2.0

Water Level in inlet 1726.47

Q_1 = 4366 cfs — corrected for 30% FRS outlet

b_1 = 50'

S_1 = .0051

d_1 = 4.85 $\quad V_1 = \frac{1.486}{n} R_1^{2/3} S_1^{1/2} = 18.01$; $d_1 = \frac{Q}{b_1 V_1} = 4.8$ o.k

$d_c = \left[\left(\frac{Q}{b}\right)^2/g\right]^{1/3} = 6.19'$

$S_{c1} = \left[\frac{Q}{b d_1} \cdot \frac{n}{1.486} \cdot \frac{1}{R_1^{2/3}}\right]^2 = .0029 < 0.7 S_1$

Freeboard = $2 d_1$ = .976

Height of wall = 4.85 + 1.0 = 5.85 say 6.0

Q_2 = 345 cfs

Q_3 = 47.11 cfs

b_3 = 50'

S_3 = .0051

d_3 = 5.09 $\quad V_3 = 18.50$ $\quad d_3 = 5.09$ o.k

d_c = 6.51

S_{c2} = .0024 $< 0.7 S_3$

Freeboard = $.2 d_3$ = 1.02

Height of wall = 5.09 + 1.02 = 6.11 say 6.25'

$Q_1 = 4366$ $b_1 = 50$ $d_1 = 4.85$ $V_1 = 18.01$ $S_1 = .0051$

$Q_3 = 4711$ $b_3 = 54$ $d_3 = 5.09$ $V_3 = 18.15$ $S_2 = .0051$

$Q_2 = 345$

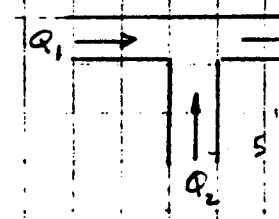
$b_2 = 5$

$d_c = 5.29$

$d_2 = 4.5$

$V_2 = 15.33$

$S_2 = 0.0127$



Try $b = 7.0$

7.0

4.23

4.05 $\geq \frac{d_1}{1.2}$

12.17

.0065

$R' = .037\, b_2 V_2^2 = 63.7'$ say 45'

28.36 say 28

$c = 2.31$

$l = c V_2 (b_1 + b_2 - b_3)^{1/3}$

$= 2.55 \times 15.33 (50 + 5 - 54)^{1/3} = 92'$

77.06 say 80

40'

$l/2 = 46.5'$

46.9 say 47

$b_3 = \frac{b_1 (b_1 + b_2 + b_3)}{2(b_1 + b_2)} = 47.73'$ say 147.75'

$b_m = \frac{b_1 + b_2 + b_3}{2} = 52.5$

53.5

$d_m = \frac{1}{2}\left[\frac{Q_1^2 + Q_2}{V_1 b_1 + V_2 b_2} + d_3\right] = 4.955$

4.93

$V_m = \frac{Q_1 + Q_2}{b_m d_m} = 18.11$

17.86

$R_m = \frac{b_m d_m}{b_m + 2 d_m} = 4.168$ 4.163

$P_m = b_m + 2 d_m = 62.41$ 62

$\frac{Q_3^2}{\partial A_3} + \frac{b_3 d_3^2}{2} - \frac{b_3 d_3 \Lambda}{2} = \frac{Q_1^2}{\partial A_1} + \frac{Q_2^2}{\partial A_2} + b_2 \frac{d_1}{2} \Lambda + \frac{b_1 d_1^2}{2} - \frac{P_{m1}}{3.9}$

$2708.21 + 6477 - 127.35\Lambda = 2441.18 + 164.39 + 121.25\Lambda + 588.06$

$+ 120.43$

$\therefore \Lambda = 1.14'$

For $b = 7.0$: $2708.21 + 6477.7 - 127.25\Lambda = 2441.18 + 80.39 + 121.25\Lambda + 588.06 - 10$

$\Lambda = 1.20'$

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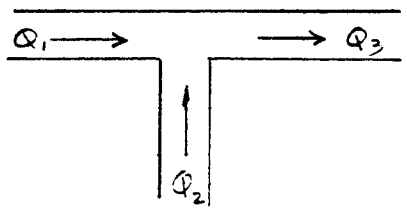
CLIENT USDA SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT BULLDOG FLOODWAY INLET 6A



$Q_1 = 4366.$ $b_1 = 50'$ $d_1 = 4.85$

$V_1 = 18.0$ $S_1 = .0051$

$Q_3 = 4711,$ $b_3 = 50'$ $d_3 = 5.09$

$V_3 = 18.5$ $S_3 = .0051$

$Q_2 = 345$ $b_2 = 7'\text{-}0$ $d_2 = 4.05$

$V_2 = 345/7 \times 4.05 = 12.17$

$S_2 = .0065$, $P = 7 + 2 \times 4.05 = 15.1$

$A = 7 \times 4.05 = 28.35$ $R = \frac{28.35}{15.1} = 1.877$

$$V_2 = \frac{1.486}{.015} \times R^{2/3} (S)^{1/2} =$$

$$= \frac{1.486}{.015} (1.877)^{2/3} (.0065)^{1/2} = 12.14 \simeq 12.17 \text{ fps} \quad \text{O.K}$$

$$R = 1.2 \frac{V^2 b}{g(1')} = 1.2 \times 12.14^2 \times 7 / 32.2 = 38.5' \quad \text{SAY } 40'$$

$$\ell = C V_2 (b_1 + b_2 - b_3)^{1/2} = 3.31 \times 12.14 (50 + 7 - 50)^{1/3} = 76.3' \quad \text{SAY } \ell = 80'$$

$\ell/2 = 40'$

$$b_s = \frac{b_1 (b_1 + b_2 + b_3)}{2(b_1 + b_2)} = \frac{50(50 + 7 + 50)}{2(50 + 7)} = 47'$$

$b_m = b_1 + b_2 + b_3 / 2 = 53.5'$

$d_1/d_2 = 4.85/4.05 = 1.19$

$$d_m = \frac{1}{2}\left[\frac{Q_1 + Q_3}{V_1 b_1 + V_2 b_2} + d_3\right] = \frac{1}{2}\left[\frac{4711}{18 \times 50 + 12.17 \times 7} + 5.09\right] = 4.936'$$

$$V_m = \frac{Q + Q_2}{b_m d_m} = \frac{4711}{53.5 \times 4.936} = 17.84$$

$$R_m = \frac{b_m d_m}{b_m + 2 d_m} = \frac{53.5 \times 4.936}{53.5 + 2 \times 4.936} = 4.167$$

$P_m = b_m + 2 d_m = 63.37$

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CLIENT USDA SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT BULLDOG FLOODWAY INLET 6A

$$\frac{Q_3^2}{gA_3} + \frac{b_3 d_3^2}{2} - \frac{b_3 d_3 h}{2} = \frac{Q_1^2}{gA_1} + \frac{Q_2^2}{gA_2} + \frac{b_3 d_1 h}{2} + \frac{b_3 d_1^2}{2} - \frac{f_m l n^2 V_m^2}{2.21 R_m^{1/3}}$$

$$\frac{4711^2}{32.2 \times (50 \times 5.09)} + \frac{50 \times 5.09^2}{2} - \frac{50 \times 5.09 \times h}{2}$$

$$= \frac{4366^2}{32.2 \times (50 \times 4.85)} + \frac{345^2}{32.2 \times (7 \times 4.05)} + \frac{50 \times 4.85 h}{2} + \frac{50 \times 4.85^2}{2} - \frac{63.37 \times 80 \times .015 \times 17.8^2}{2.21 \times (4.167)^{1.3}}$$

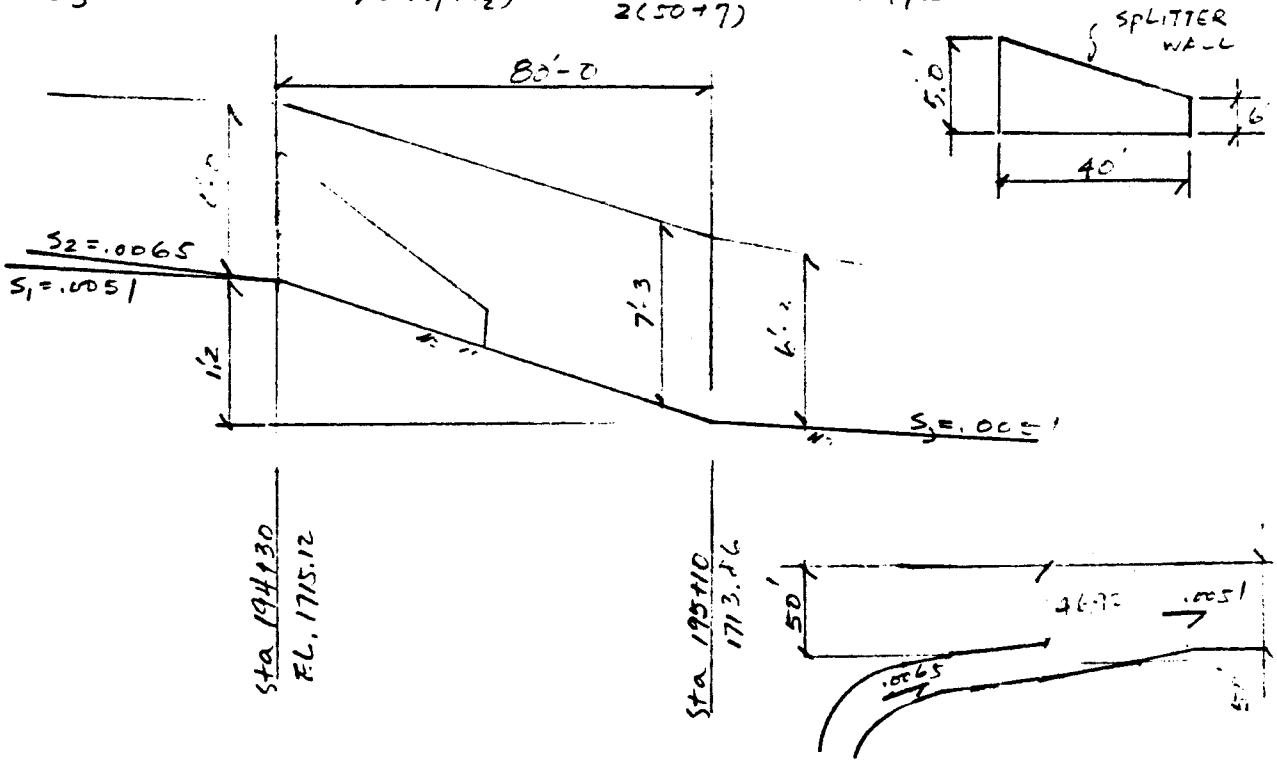
$$2708.211 + 647.70 - 127.25h = 2441.18 + 130.39 + 121.25h + 585.06 - 102.09$$

$$298.37 = 248.5h \qquad h = 1.20$$

$$F_1 = V_1/\sqrt{gd_1} = 18.01/(32.2 \times 4.85)^{1/2} = 1.44$$

$$F_2 = 12.17/(32.2 \times 4.05)^{1/2} = 1.07$$

$$b_5 = b_1(b_1 + b_2 + b_3)/2(b_1 + b_2) = \frac{50(50+2+7)}{2(50+7)} = 46.92'$$



EBASCO SERVICES INCORPORATED

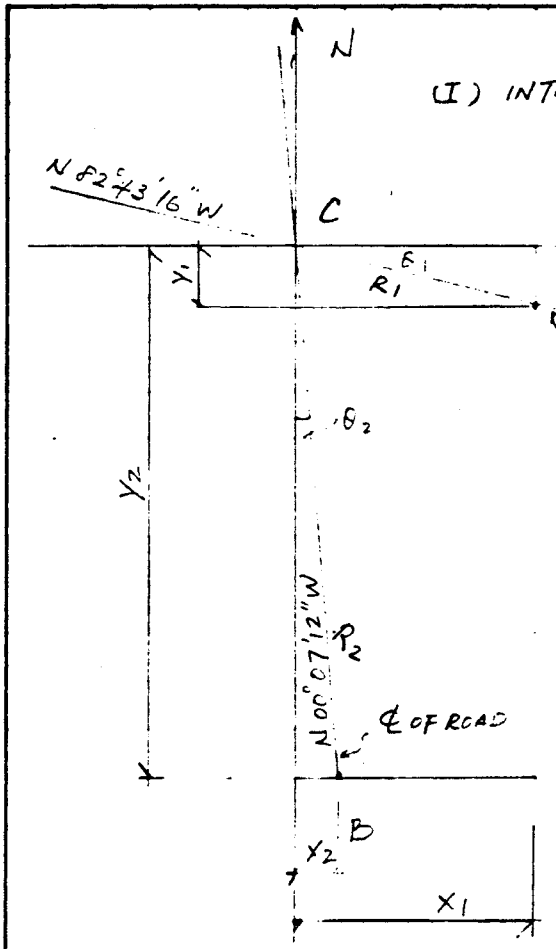
BY N. Hung DATE 11/18/85 SHEET ____ OF ____

CHKD. BY [illegible] DATE 11/20/85 OFS NO. 3757-305 DEPT. NO. 243

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT MERIDIAN ROAD BRIDGE LOCATION



(I) INTERSECTION OF ℄ MERIDIAN ROAD & FLWY REF. LINE

A: N 888,980.73
E 606,685.89
$\theta_1 = 90° - (82°43'16") = 7°16'44"$
$= 7.2788889$

B: N 886,563.54
E 602,616.89
$\theta_2 = 00°07'12" = 0.12°$

$\tan\theta_1 = 0.1277284$, $\tan\theta_2 = .0020943$

$X_1 - X_2 = 606,685.89 - 602,616.89$
$= 4069'$
$Y_2 - Y_1 = 886,980.73 - 886,563.54$
$= 2417.19$

$X_2 = Y_2 \tan\theta_2$. $X_1 = Y_1 / \tan\theta_1$

$X_1 - X_2 = Y_1/\tan\theta_1 - Y_2\tan\theta_2 = 4069.0$

$Y_1/\tan\theta_1 - (2417.19 + Y_1)\tan\theta_2 = 4069.0$
$7.8291124 Y_1 - 5.062321 - .0020943 Y_1 = 4069.0$
$7.8270181 Y_1 = 4074.0623$, $Y_1 = 520.51$
$X_1 = Y_1/\tan\theta_1 = 4075.13$, $X_2 = 6.13'$
$Y_2 = 2937.70$

COORDINATION C N 888,980.73 + 520.51 = N 889,501.24
E 606,685.89 − 4075.13 = E 602610.76

$R_1 = (X_1^2 + Y_1^2)^{1/2} = (4075.13^2 + 520.51^2)^{1/2} = 4108.24'$
$R_2 = (X_2^2 + Y_2)^{1/2} = (6.13^2 + 2937.70)^{1/2} = 2937.71$

EBASCO SERVICES INCORPORATED

BY D. Hu... DATE 11/18/85 SHEET ____ OF ____

CHKD. BY [illegible] DATE 11/20/85 OFS NO. 3767-3[illegible] DEPT. NO. [illegible]

CLIENT ~~USDA SOIL CONSERVATION SERVICE~~

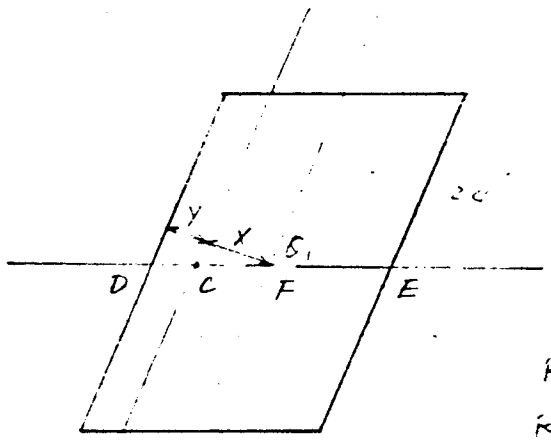
PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT MERIDIAN ROAD BRIDGE LOCATION

F sta C : F sta 154 + 80.87 + (4108.24) = F sta 195 + 89.11 ←

R sta C R sta 00 + 00 + (2937.71) = R sta 29 + 37.71 ←

(II) LOCATION OF BRIDGE



LENGTH OF BRIDGE = 53.12'

$X = 25 - 1.75' = 23.25'$

$\theta_1 = 82°43'36" - 00°07'12" = 82°36'24"$

$= 82.6067°$

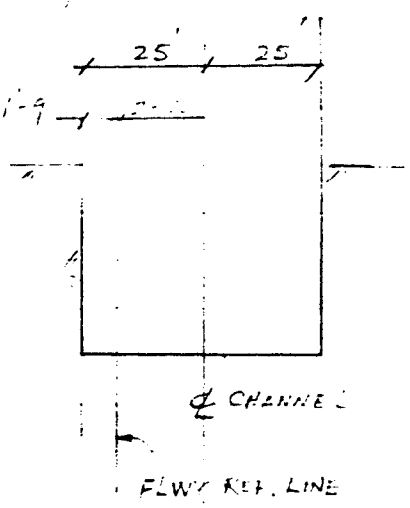
$DF = 53.12/2 = 26.56'$

$CF = X/\sin\theta_1 = 23.25/.9916736 = 23.45'$

$DC = 26.56 - 23.45 = 3.11'$

R sta C sta 29 + 37.71 − (3.11) = sta 29 + 34.60

R sta E sta 29 + 34.60 + 53.12 = sta 29 + 87.72



581/8-81

EBASCO SERVICES INCORPORATED

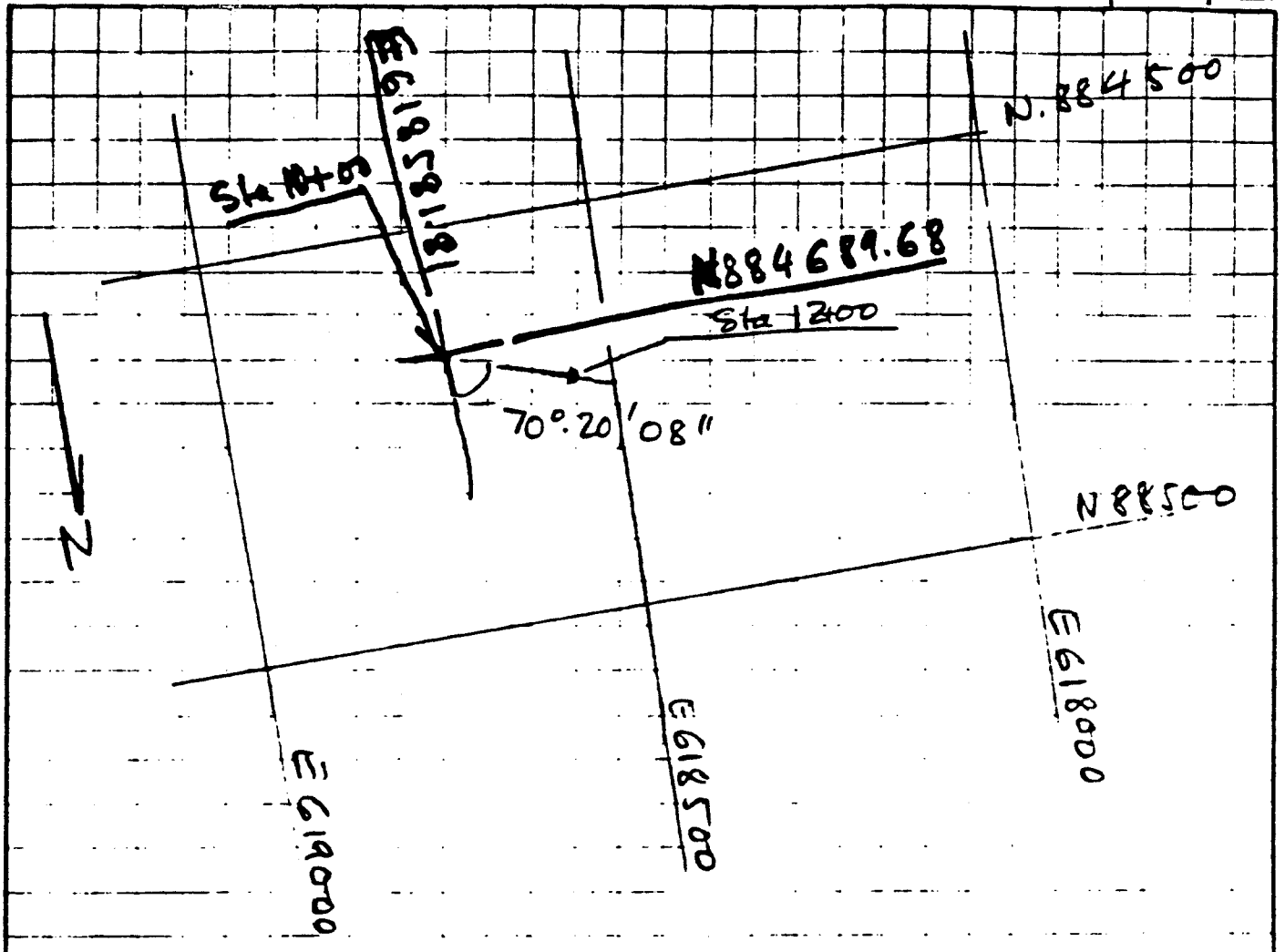
BY [illegible] 6-85 SHEET 1 OF 6

CHKD. BY AL M. DATE 11-26-85 OPS NO. 3767-300 DEPT. NO. 243

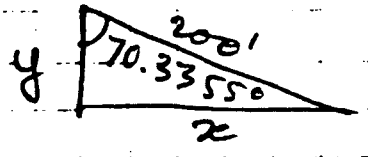
CLIENT

PROJECT ARIZONA FLD CNTROL

SUBJECT CALC. COORD OF STA 12+00 & PI



70°20'08" = 70.3355°



$y = \cos 70.3355 \times 200 = 67.30'$ (0.3365)

$x = \sin 70.3355 \times 200 = 188.3358$ (0.941679)

So $E = 618,581.81 - 188.3358 = 618,393.47$

$N = 884,689.68 + 67.30 = 884,756.98$

Sta 12+00 { N = 884,756.98, E = 618,393.47

EBASCO SERVICES INCORPORATED

BY LN DATE 11-06-85 SHEET 2 OF 6

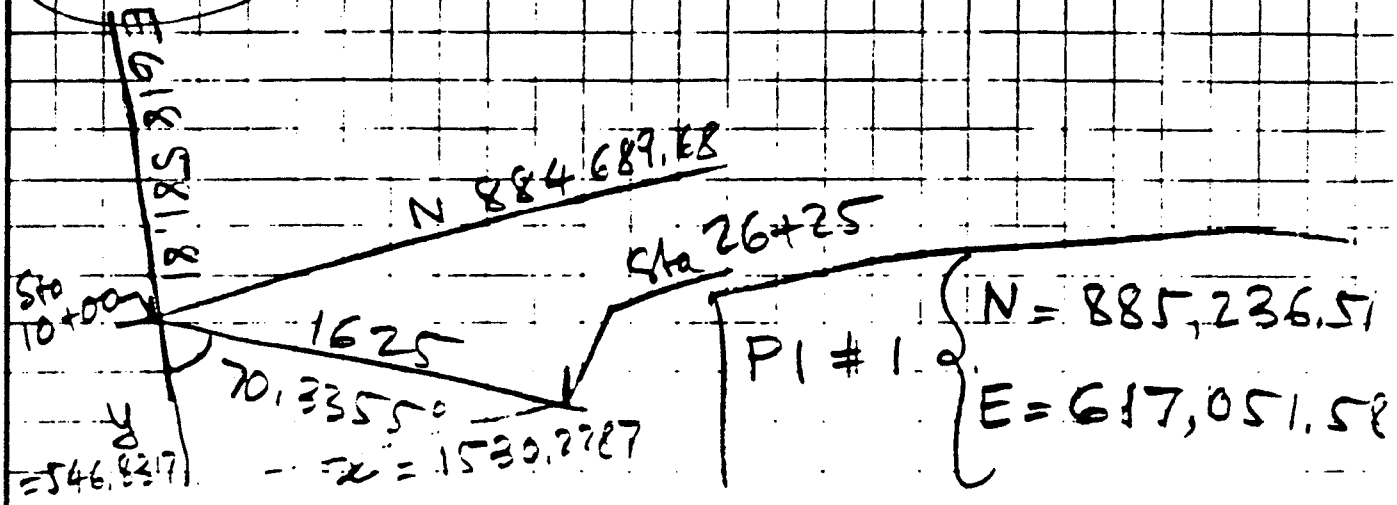
CHKD. BY _____ DATE 11-26-85 OPS NO. 3767-300 DEPT. NO. 243

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

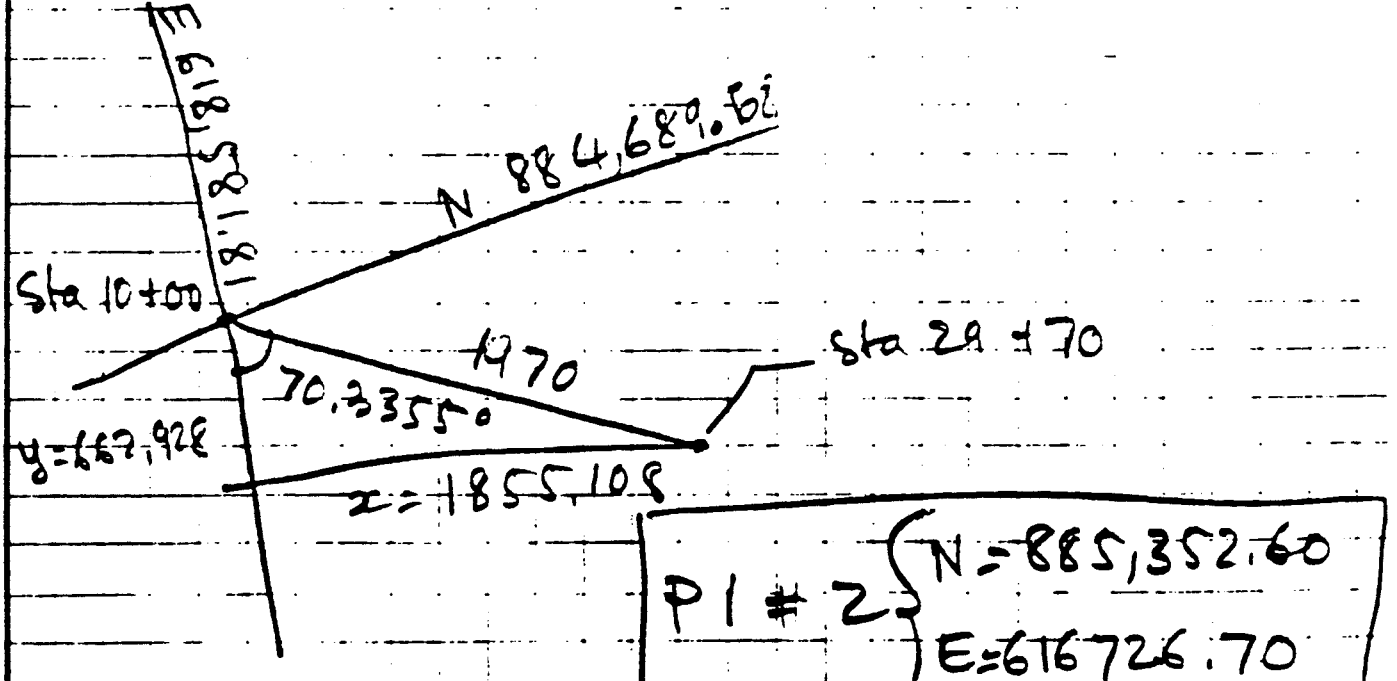
SUBJECT

PI #1 Sta 26+25



PI #1 { N = 885,236.51
E = 617,051.58

PI #2 Sta 29+70



PI #2 { N = 885,352.60
E = 616726.70

EBASCO SERVICES INCORPORATED

BY LN DATE 11-06-85 SHEET 3 OF 6

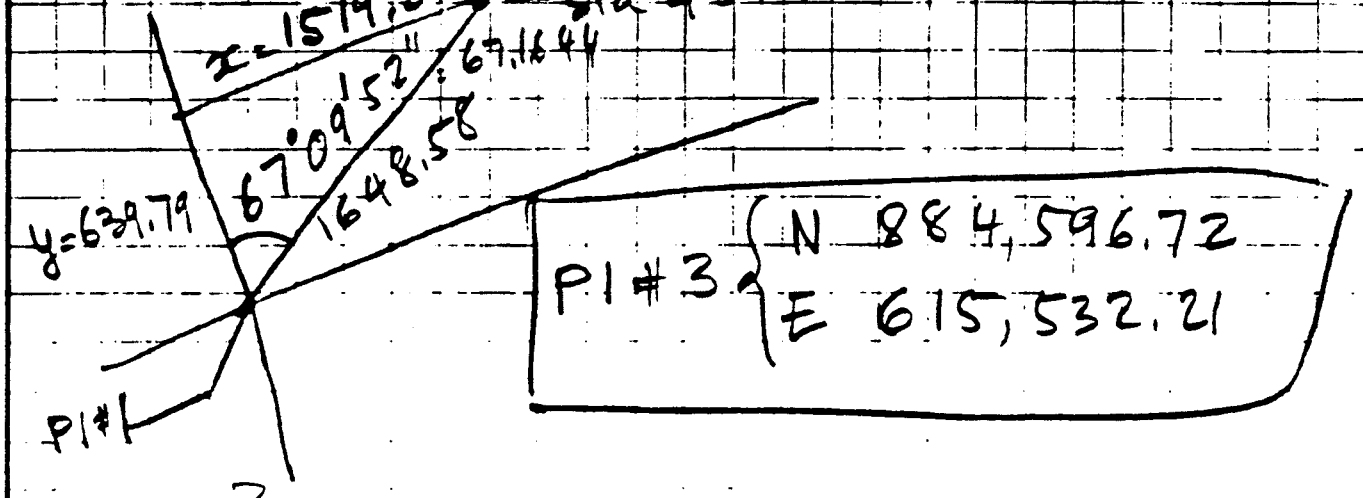
CHKD. BY N.H DATE 11-26-85 OPS NO. 3767-300 DEPT. NO. 243

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

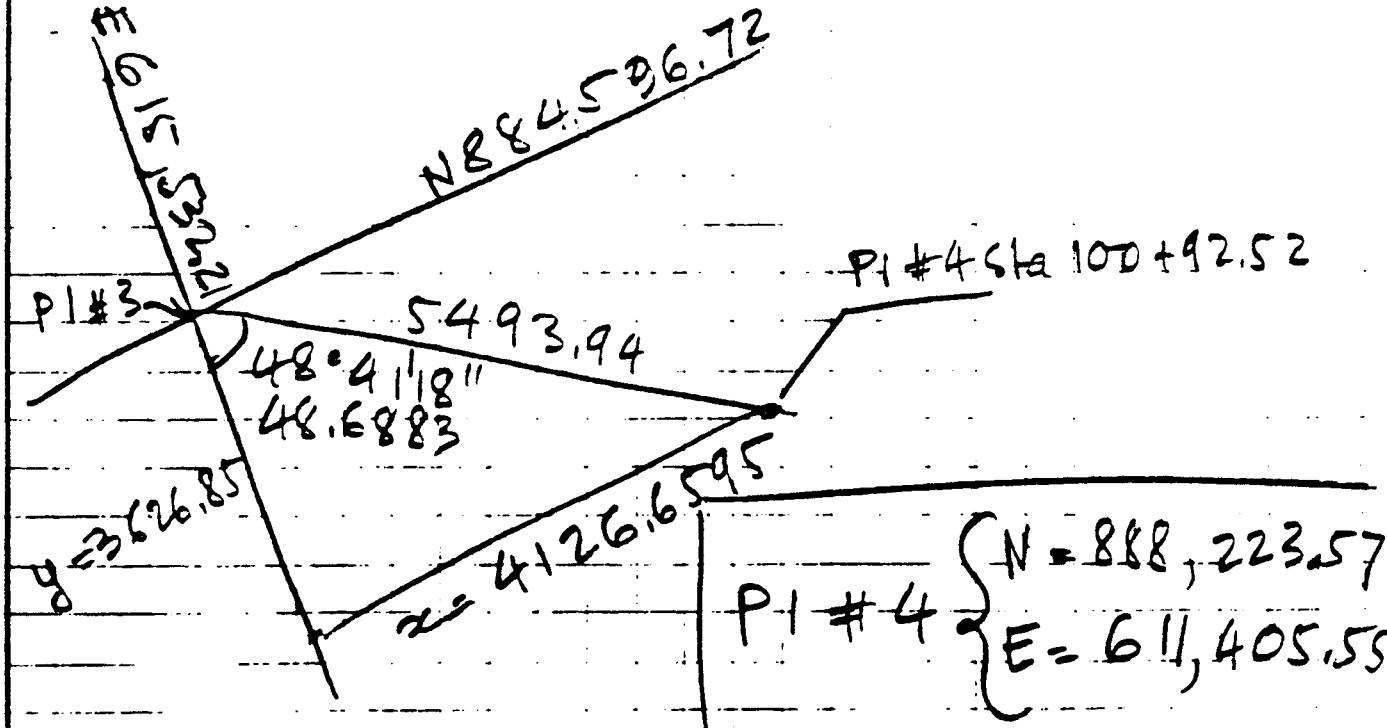
SUBJECT

P1 #3 Sta 45+98.58



P1 #3 { N 884,596.72
E 615,532.21

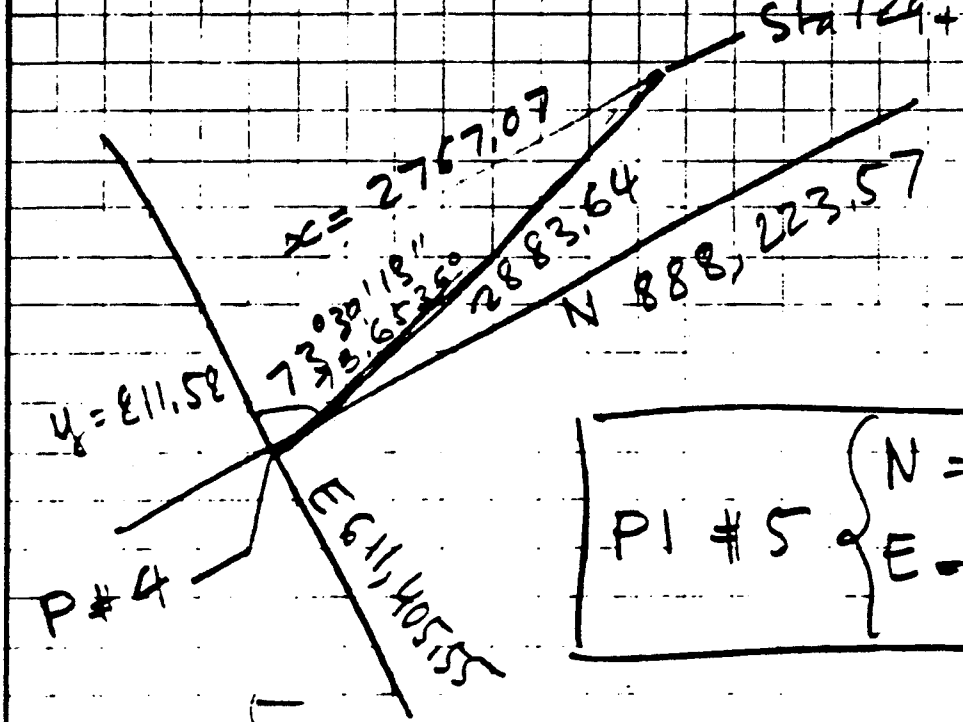
P1 #4 Sta 100+92.52



P1 #4 { N = 888,223.57
E = 611,405.55

4

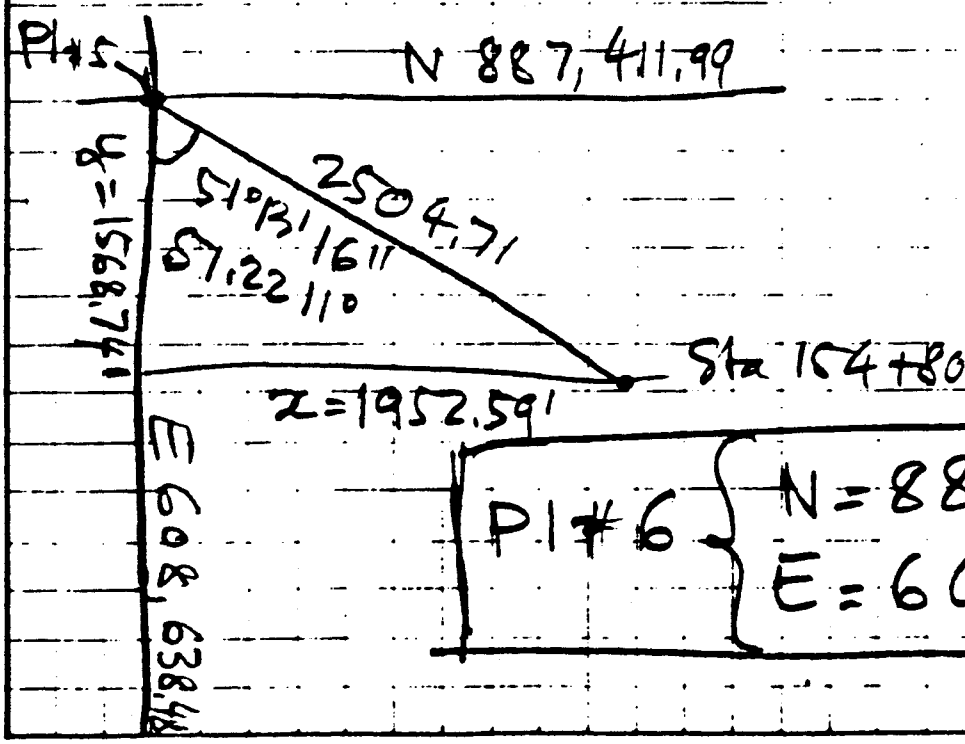
PI # 5 Sta 129+76.16



PI # 5 { N = 887,411.99
E = 608,638.48

5

PI # 6 Sta 154+80.87



PI#6 { N = 888,980.73
E = 606,685.89

EBASCO SERVICES INCORPORATED

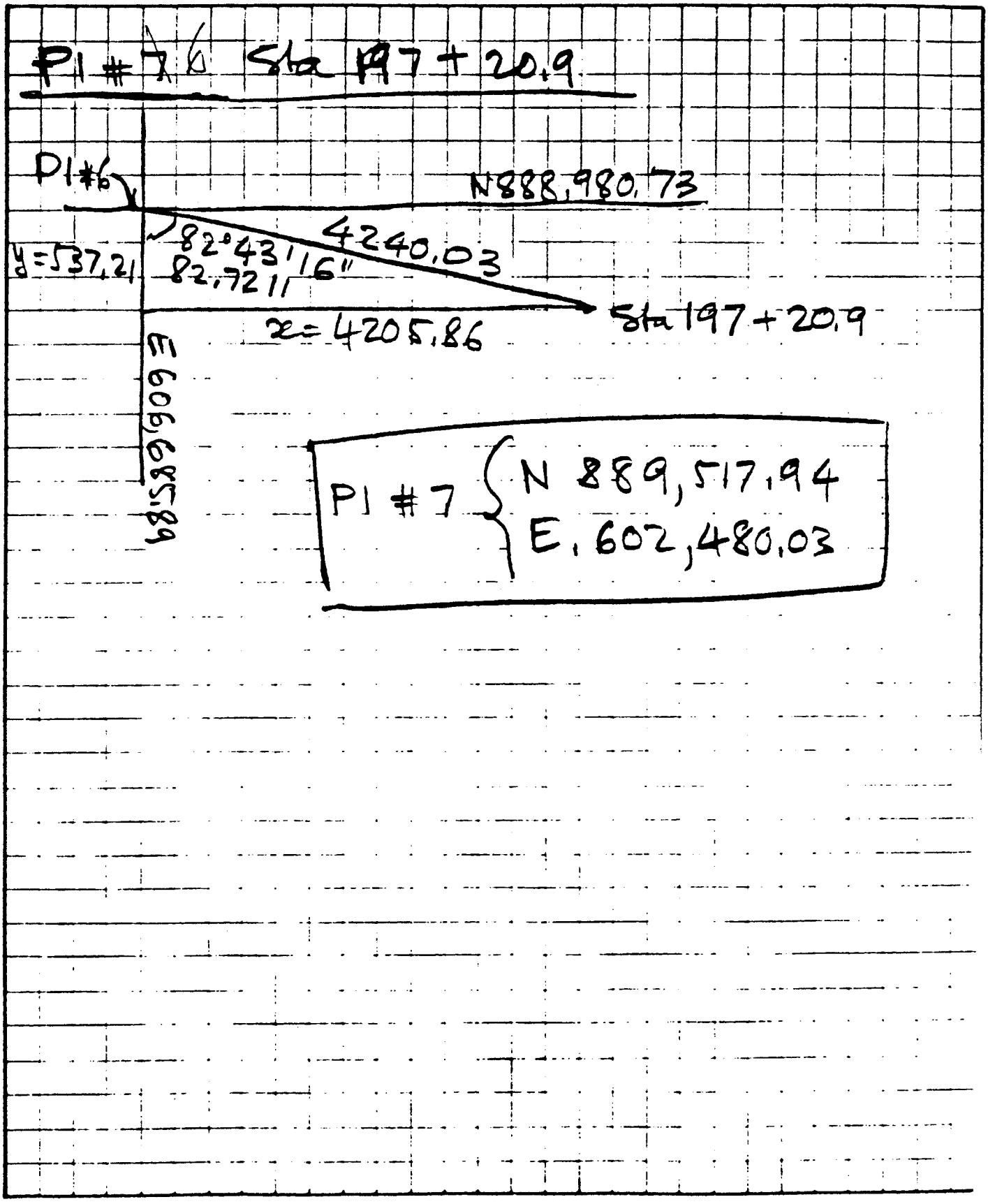
BY LN DATE 11-06-85 SHEET 5 OF 6

CHKD. BY N.V. DATE 11-26-85 OPS NO. 3767-300 DEPT. NO. 243

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT



EBASCO SERVICES INCORPORATED

BY LN DATE 11-06-85 SHEET 6 OF 6

CHKD. BY N.H. DATE 11-26-85 OPO NO. 3767-300 REPT. NO. 243

CLIENT

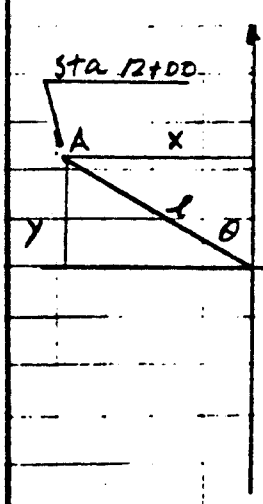
PROJECT ARIZONA FLOOD CONTROL — USDA-SOIL CONSERVATION SERVICE

SUBJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

	N	E	
Sta 12+00	N 884,756.98	E 618,393.47	
I-1 Sta 26+25	N 885,236.57	E 617,051.58	Sta 29+50 ℄ A.J FRS
PI #1 Sta 29+70	N 885,352.60	E 616,726.70	
PI #2 Sta 45+98.58	N 884,592.72	E 615,532.21	
PI #3 Sta 100+92.52	N 888,223.57	E 611,405.55	
PI #4 Sta 129+76.16	N 887,411.99	E 608,638.48	
PI #5 Sta 154+80.87	N 888,980.73	E 606,685.89	
PI #6 Sta 197+20.9	N 889,517.94	E 602,480.03	

Sta 10+00 N 884,689.68 E 618,446.48

sta 1200



$l = 1200 - 1000 = 200'$

$\theta = 70°20'08'' = 70.33556$

$x = l \cdot \sin\theta = 67.30'$

$y = l \cdot \cos\theta = 188.34$

Sta 1200 N 884,689.68 + 67.30 = N 884,756.98

E 618,393.47 - 188.34 = E 618,393.47

EBASCO SERVICES INCORPORATED

BY S GOYAL DATE 10-29-85 SHEET 1 OF _____

CHKD. BY _____ DATE _____ OFS NO. USDA 3767306 DEPT. NO. 554

CLIENT USDA - SCS - PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT APACHE JUNCTION FRS OUTLET CHANNEL & BULLDOG FLOODWAY

PEAK DISCHARGES FOR INLET JUNCTIONS

			APACHE JUNCTION OUTLET	TYPE	DISCHARGE FOR CHANNEL
INLET	4A	→ 397 CFS	↓ 81 CFS ↓ 478	S	DESIGN 478 CFS
	4B	→ 525	↓ 478 ↓ 1003	S	1001
	4C	→ 155	↓ 1001 ↓ 1156	S	1142
	4D	→ 71	↓ 1142 ↓ 1213	W	1144
	4E	→ 327	↓ 1144 ↓ 1471	W	1441
	4F	→ 56	↓ 1441 ↓ 1497	W	1447
	4G	→ 611	↓ 1447 ↓ 2058	S	2048
	4H	→ 37	↓ 2048 ↓ 2085	W	2049
	5A	→ 2348	↓ 2049 ↓ 4397	S	4254
	5B	→ 157	↓ 4254 ↓ 4411	S	4369
	5C	→ 36	↓ 4369 ↓ 4405		4366
	6A	→ 345	↓ 4366 ↓ 4711		4670
	6B	→ 126	↓ 4670 ↓ 4796		4674
	6C	→ 753	↓ 4674 ↓ 5427		

The channel flows are less than those furnished by SCS by 18 cfs (99 - 81) due to lower flow from the 30° FRS outlet

881/8-81

EBASCO SERVICES INCORPORATED

BY S GOYAL DATE 11-13-85 SHEET 2 OF 2

CHKD. BY _____ DATE _____ OFS NO. USDA 3767.300 DEPT. NO. 550

CLIENT USDA. SCS - PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY INLET 6B

If flow in main channel is less than 4 670 c/s hydraulic jump can form in the main channel.

By Trials assume $d_1 = 4$ $A = 20$ $P = 5.8$ $R = 3.45$

$$V = \frac{1.486}{.015} 3.45^{2/3} (.0051)^{1/2}$$

$$= 16.15$$

$$Q_1 = 3229.6$$

$$Q_2 = 3229.6 + 126$$

$$= 3355.6$$

$$\frac{Q_2}{Q_1} = 1.039$$

$$F_1 = \frac{16.15}{\sqrt{32.2 \times 4}} = 1.423$$

Conjugate depth $= d_1 \frac{1}{2}\left(\sqrt{1 + 8F_1^2} - 1\right)$

$= 6.296$

$h/d_1 = 0$

$h = 0$

$F_2 = 1 = \frac{3355.6}{50 \times d} \frac{1}{\sqrt{32.2 \times d}}$

$\therefore d_2 = 5.19$

For flows lower than 3229 ± cfs hydraulic jump may form in the main channel. Therefore the weir should be located above $6.29' < 6.83'$ o.k.

Provide inlet at STA 202+00

Bed EL at STA 194+20 = 1715.12

* " " " 202 = 1715.12 - (20200 - 19420) .005

= 1711.14

Top of weir = 1711.14 + 6.83

= 1717.97

T.J of wall = 1717.97 + 1.01 +1

= 1719.98 say 1720

* This elevation may change in the final layout.

EBASCO SERVICES INCORPORATED

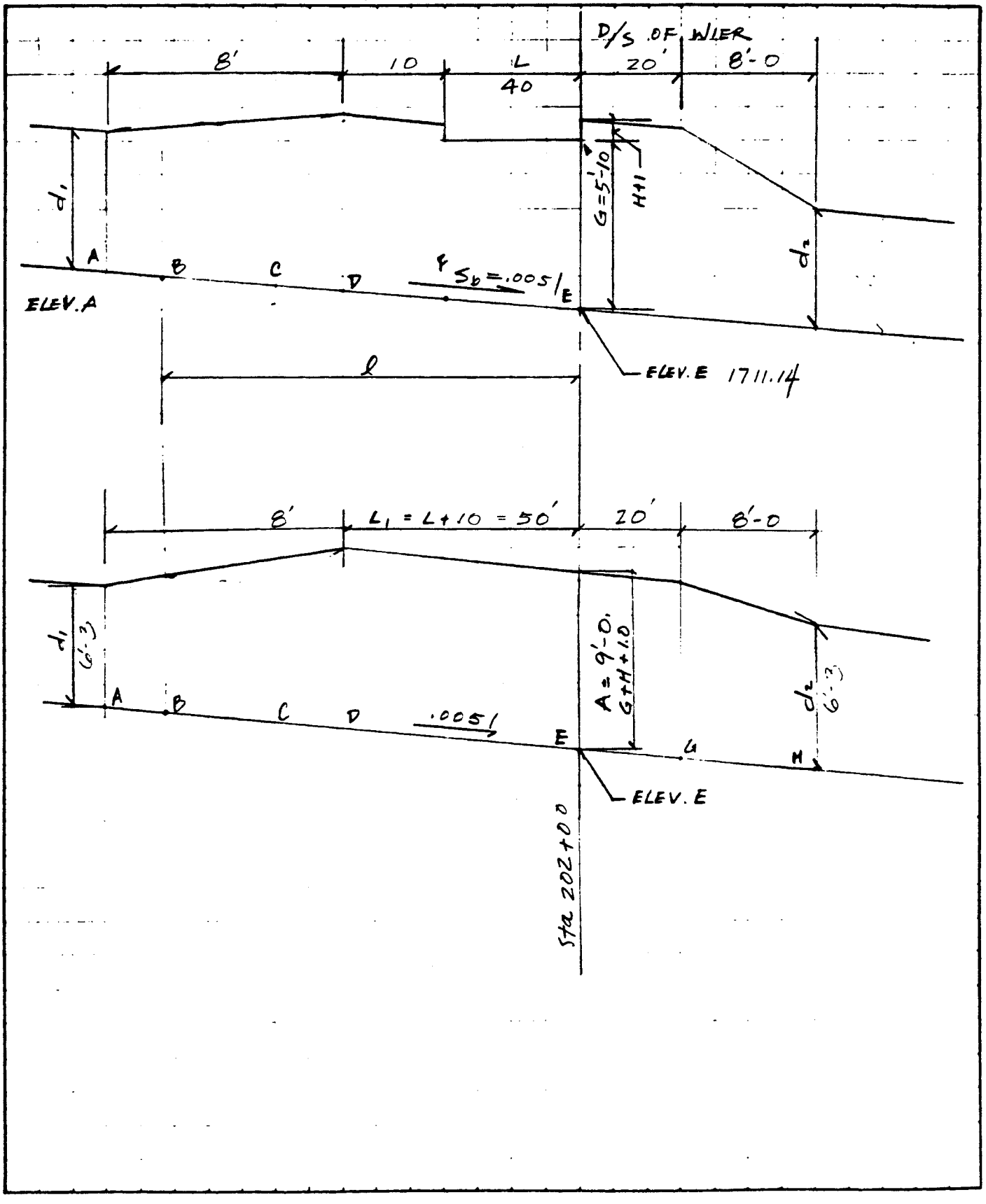
BY N Hung DATE 11/25/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT WEIR NO. 9 6B



EBASCO SERVICES INCORPORATED

BY N. Hicks DATE 11/18/85 SHEET ____ OF ____

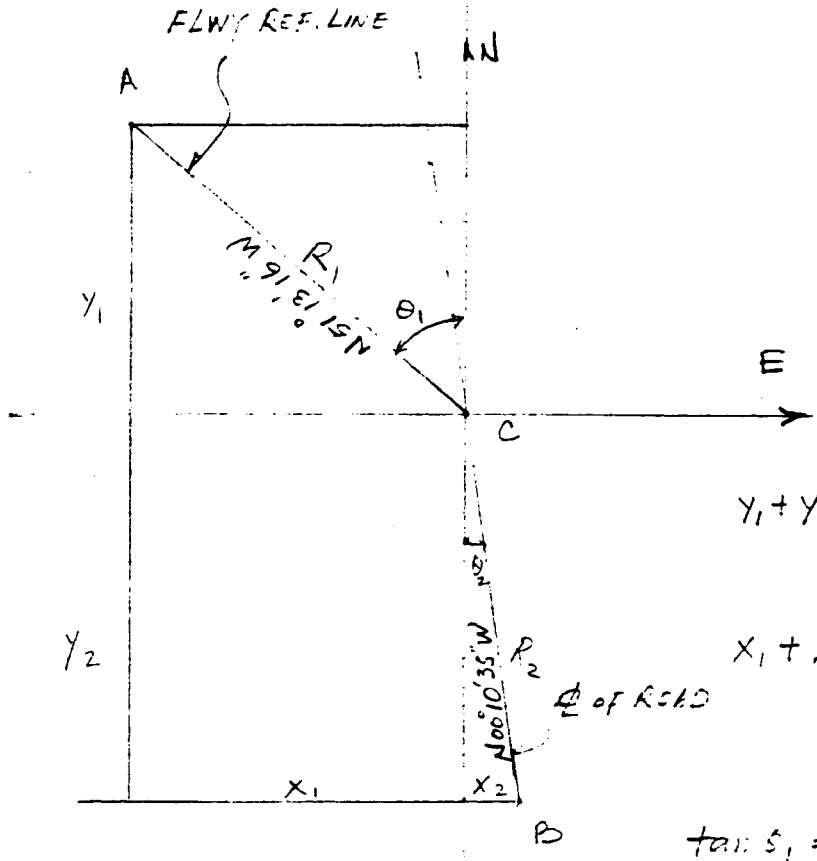
CHKD. BY [illegible] DATE 11/20/85 OFS NO. 3767-300 DEPT. NO. 243

CLIENT USDA SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT IRONWOOD DRIVE BRIDGE LOCATION

I) INTERSECTION OF ℄ ROAD & FLWY. REF. LINE



A: N 855,950.73
E 606,685.89

$\theta_1 = 51°13'16" = 51.22111$

B: N 853,571.62
E 607,874.56

$\theta_2 = 00°10'35"$
$= 0.176388$

$Y_1 + Y_2 = 855,950.73 - 853,571.62$
$= 2379.11'$

$X_1 + X_2 = 607,874.56 - 606,685.89$
$= 1188.67$

$\tan S_1 = 1.244688$
$\tan S_2 = .003765$

$X_1 = Y_1 \tan S_1 = (2379.11 - Y_2) \tan S_1$, $X_2 = Y_2 \tan S_2$

$X_1 + X_2 = (2379.11 - Y_2) \tan S_1 + Y_2 \tan S_2 = 1188.67$

$2379.11 \times 1.244688 - Y_2 \times 1.244688 + .003765\, Y_2 = 1188.67$

$1.241688\, Y_2 = 1785.2265$

$Y_2 = 1437.67'$

$X_2 = Y_2 \tan S_2 = 4.42286'$, $X_1 = 1184.244$

$Y_1 = 2379.11 - 1437.67 = 941.44$

COORDINATION C: N 855,950.73 − 941.44 = N 85[illegible]
E 606,685.89 + 1184.24 = E 60[illegible]

BY S GOYAL DATE 10-30-85 SHEET 7 OF

CHKD. BY DATE OFS NO. USDA 3767.30 DEPT. NO. 550

CLIENT USDA - SCS - PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY AND APACHE JUNCTION FLOOD CONTROL

SUBJECT APACHE JUNCTION FRS OUTLET CHANNEL & BULLDOG FLOODWAY

Channel STA 115+63 to 121+63

El. at STA 115+63 = 1766.68 − .25 = 1766.43

Q = 478

S = .0085

b = 10'

d = 3.31'

Height of wall = 1.2 x 3.31

= 3.97 or 3.31+1 = 4.35

Provide 4.5' high

El at STA 121+63

= 1766.43 − (121+63 − 115+63) x .0085

= 1761.33

Channel STA 121+63 To 128+54.11

Q = 478

S = .014

b = 10'

Assume d = 2.77' A = 27.7 R = 1.78

∴ V = 17.23

d = 2.774 ok

d_{cr} = 2.55' S_{cr} = .0079 < $\frac{S}{1.3}$

Height of wall = 1.2 x 2.77

= 3.32 or 2.77+1 = 3.77

Use 4.0 high

El at STA 128+54.11 = 1761.33 − (12854.11 − 12163) .014 = 1751.65

Channel STA 128+54.11 to PC STA 129+23.99

Q = 478

S = .0085

b = 10'

d = 3.31'

Height of wall = 4.5' as between STA 115+63 to 121+63

El at Sta 129+23.99 = 1751.65 − (12923.99 − 12854.11) x .0085

= 1751.06

BY S GOYAL DATE 10.30.85 SHEET 6 OF

CHKD. BY DATE OFS NO. USDA 3767.30 DEPT. NO. 550

CLIENT USDA - SCS - PHOENIX - ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT APACHE JUNCTION FRS OUTLET CHANEL & BULLDOG FLOODWAY

Channel STA 129+23.99 to 130+20.15

$Q = 478$

$S = .0085$

$b = 10'$

$d = 3.31'$ $\quad V = 14.46$ $\quad R = 9.995'$

Height of wall $= 1.2 \times 3.31 + \frac{1.2\, V^2 b}{g R}$

$= 3.97 + .78$

$= 4.75' > (3.31 + 1.0)$

Provide 4:9" outer curve wall

and 4'-6" inner curve wall

EL of STA 130+20.15 $= 1751.06 - (13020.15 - 12923.99) \times .0085$

$= 1750.24$

Channel STA 130+20.15 to 132+20

$Q = 478$

$S = .0085$

$b = 10'$

$d = 3.31$

Height of wall = 4:6

EL at 132+20 $= 1750.24 - (13220 - 13020.15) \times .0085$

$= 1748.54$

Inlet 4B

$Q_1 = 478$ $\quad b_1 = 10'$ $\quad d_1 = 3.31$ $\quad A_1 = 33.1$ $\quad V_1 = 14.46$

$Q_2 = 525$ $\quad b_2 = 9'$

$d_2 = 3.25$

$D_2 = 17.95$ $\quad A_2 = 29.25$ $\quad R_2 = 1.89$

$S_2 = .014$

$d_{c_2} = 4.73$ $\quad S_{c_2} = .0051 < \frac{S_2}{1.3}$

$Q_3 = 1003$ cfs

$b_3 = 18' > 0.8(b_1 + b_2)$

$S_3 = .0061$

Assume $d_3 = 3.76$ $\quad A_3 = 67.68$ $\quad R = 2.65$

$\therefore V_3 = 14.82$

$\therefore d_3 = 3.76$ O.K

$d_{c_3} = 4.59$ $\quad S_{c_3} = .0034 < \frac{S_3}{1.3}$

$Q = CV_1 (b_1 + b_2 - b_3)^{1/3}$ for $d_3 = 3.25$

$= 2.83 (10 + 9 - 18)^{1/3} \times 17.96$

$= 50.8$ say 52'

Splitter wall length $= l/3 = 26'$

$b_m = 18.5'$

$d_m = 3.52$

$A_m = 65.08$ $P_m = 25.54$ $R_m = 2.55$

$V_m = 15.41$

$b_s = 9.74'$

$$\frac{Q_3^2}{gA_3} + \frac{b_3 d_3^2}{2} - \frac{b_3 d_3 h}{2} = \frac{Q_1^2}{gA_1} + \frac{Q_2^2}{gA_2} + \frac{b_3 d_1 h}{2} + \frac{b_1 d_1^2}{2} + \left(\frac{b_3 - b_1}{2}\right) d_2^2 - \frac{P_m l n^2 V_m^2}{2.21 R_m^{1/3}}$$

$\therefore 461.62 + 127.24 - 33.84h = 214.37 + 292.64 + 29.79h + 54.78 + 42.25 - 23.5$

or $63.63h = 8.32$

$h = 0.13$

$R_2' = \frac{1.2 \times 17.95^2 \times 9}{32.2 \times 1} = 108.07$ say 110'

Height of wall $= 1.2 \times 3.76 + .25 \times 4.59 \left[1 - 11.1 \left(\frac{.0061}{.0034} - 1\right)^2\right] + 1$

$= 4.5 + 0 + 1 = 5.5'$

Height of splitter wall $= d_1 = 3.31 > d_2$ use 3'-6"

" lower end = 6"

Height of wall for inlet $= 1.2 \times 3.25 + \frac{1.2 \times 17.95^2 \times 9}{32.2 \times 110}$

$= 3.9 + 1 = 4.9$ use 5'-0

Beginning of Junction at STA 132+20 EL 1748.54

End of Junction at STA 132+72 EL $1748.54 - .13 = 1748.41$

Provide 45° curve in the inlet plus 20' straight.

length of channel $= \frac{2\pi \times 110}{360} \times 45° + 20 = 106.39'$

EL at the inlet $= 1748.54 + 106.39 \times .014 = 1750.03$

BY S GOYAL DATE 11-22-85 SHEET 10 OF

CHKD. BY DATE OFS NO. USDA376730 DEPT. NO. 550

CLIENT USDA - SCS PHOENIX ARIZONA

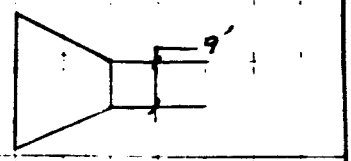
PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY INLET 4B

Provide straight inlet

$Q = 525$ cfs

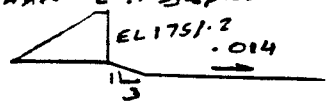
$b = 9'$



Make inlet 9' wide with wing walls 25' channel 2:1 slopes

$Q = 3.1 \times 9 \, H_c^{3/2}$

$\Rightarrow H_c = 7.07'$



Provide the inlet at a higher level say at EL 1751.2

U/S energy level $= 1751.2 + 7.07$

$= 1758.27$

$D_c = \left[\left(\frac{525}{9}\right)^2 / 32.2\right]^{1/3} = 4.728$ $\quad V_c = 12.338$

Total energy at the inlet $= 1751.2 + 4.728 + \frac{12.338^2}{64.4}$

$= 1758.29$

For normal flow in the channel energy line is

$= 1750.03 + 3.25 + \frac{17.95^2}{64.4}$

$= 1758.28 < 1758.29$ o.k

Water level for submergence of land $= 1758.27$

Top of Dike $= 1758.19 + 1 = 1759.29$ say 1759.50

EL at the end of Junction at STA 137+72

$= 1748.54 - .13$

$= 1748.41$

Velocity in the arroyo $= \frac{525}{(25 + 2 \times 7)7} = 1.92$ (Assumed $d = 7'$)

$H_c = 7 + \frac{1.92^2}{2g} = 7.06 < 7.07$ o.k

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BY S GOYAL DATE 11-19-85 SHEET 11 OF

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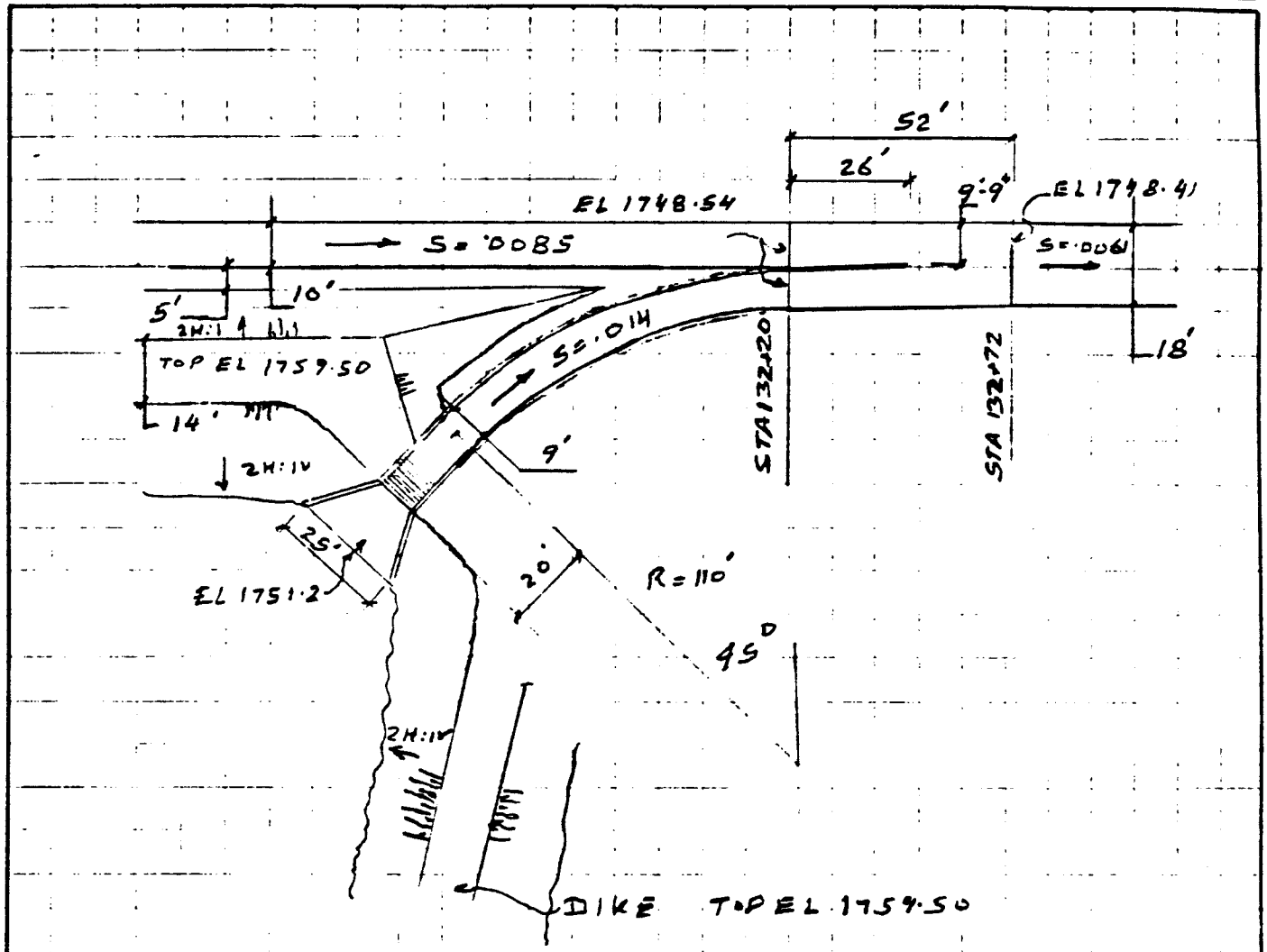
CLIENT USDA - SCS PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT



PLAN INLET AB

1" = 40'

581/8-81

BY S GOYAL DATE 10-31-85 / 11-25 85 SHEET 12 OF

CHKD. BY DATE OFS NO. USDA 3767.350 DEPT. NO. 550

CLIENT USDA - SCS - PHOENIX

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT APACHE JUNCTION FRS OUTLET CHANNEL & BULLDOG FLOODWAY

CHANNEL STA 132+72 to 137+75

Q = 1001 ≈ 1003 Sheet 6

∴ b = 18'

S = .0061

d = 3.76

El at Sta 137+00 = 1748.41 − (13700 − 13272) x .0061

= 1745.80 as in the Phase 5

Height of wall = 1.2 x 3.76

= 4.51

or 3.76 + 1 = 4.76 provide 4'-9"

El. at STA 137+75 = 1748.41 − (13775 − 13272) x .0061

= 1745.34

INLET 4C

$Q_1 = 1001$ cfs $b_1 = 18'$ $d_1 = 3.76'$ $A_1 = 67.68$ $V_1 = 14.79$

$Q_2 = 155$ cfs $b_2 = 3.0$

Assume $d_2 = 3.13$

$V_2 = 16.51$ $A_2 = 9.39$ $R_2 = 1.014$

$S_2 = \left[\frac{Vn}{1.486 R^{2/3}}\right]^2 = .0273$

$d_{c_2} = 4.36$ $S_{c_2} = .0124 < \frac{S_2}{1.3}$

$Q_3 = Q_1 + Q_2 = 1156$ cfs

$b_3 = 18. > .8(b_1 + b_2) = 16.8$

$S_3 = .0052$

Assume $d_3 = 4.375$ $A_3 = 78.75$ $R = 2.944$ $V_3 = 14.67$

$\therefore d_3 = 4.377$ O.K

$d_{c_3} = 5.04$ $S_{c_3} = .0035 < \frac{S_3}{1.3}$

$\ell = C V_2 (b_1 + b_2 - b_3)^{1/3}$ for $d_2 = 3.13$

$= 2.75 \times 16.51 (18 + 3 - 18)^{1/3}$

$= 65.48$ say 66

length of splitter wall $= \ell/2 = 33.0'$

$b_m = \frac{(b_1 + b_2) + b_3}{2} = 19.5$

$d_m = \frac{1}{2}\left[\frac{Q_1^2 + Q_2}{V_1 b_1 + V_2 b_2} + d_3\right] = \frac{1}{2}\left[\frac{1001 + 155}{14.79 \times 18 + 16.51 \times 3.0} + 4.375\right] = 4.018$

$A_m = 78.35$ $P_m = 27.54$ $R_m = 2.845$

$V_m = \frac{Q_1 + Q_2}{b_m d_m} = 14.75$

$b_3 = \frac{b_1(b_1 + b_2 + b_3)}{2(b_1 + b_2)} = 16.71$ say $16.8\frac{1}{2}$

constant width main channel

$$\frac{Q_3^2}{g A_3} + \frac{b_3 d_3^2}{2} - \frac{b_3 d_3 h}{2} = \frac{Q_1^2}{g A_1} + \frac{Q_2^2}{g A_2} + \frac{b_3 d_1 h}{2} + \frac{b_3 d_1^2}{2} - \frac{P_m L n^2 V_m^2}{2.21 R_m^{1/3}}$$

$\therefore 527.00 + 172.27 - 39.38h = 459.78 + 79.46 + 33.84h + 127.24 - 28.41$

$73.22h = 61.19$

$h = 0.84'$

Radius of bend $R_c' = \frac{1.2 V_2^2 b_2}{g S}$ S is superelevation .5'

$= \frac{1.2 \times 16.51^2 \times 4.0}{32.2 \times .5}$

$= 60.9$ use 60'

Height of wall $= 1.2 d_3 + 0.25 d_{c3}\left[1 - 11.1\left(\frac{S_3}{S_{c3}} - 1\right)^2\right] + \frac{1.2 V_3^2 b_2}{2 R_2}$

$= 1.2 \times 4.375 + 0 + .5$

$= 5.75 \rightarrow$ say $5'-9''$

Height of splitter wall $= d_1 = 3.76' > d_2$ use $3'-9''$

" " lower end $= 0.5'$ i.e $6''$

Height of inlet wall $= 1.2 \times 3.13 + .5$ for the curve

$= 4.256$ use $4'-3''$

Provide beginning of Junction at STA 13775

EL. of Junction $= 1745.80 - (13775 - 13700) \times .0061$

$= 1745.34$

Provide a 45° curve in the side channel plus 20' straight

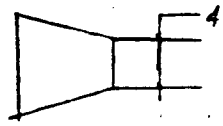
Length of channel $= \frac{\pi \times 60}{360} \times 45 + 20 = 67.12'$

EL at the inlet $= 1745.34 + 67.12 \times .0273$

$= 1747.17$

which is close to ground elevation.

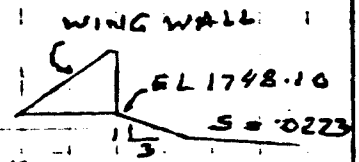
Provide a straight inlet



$Q = 3.1 W H_e^{3/2}$

$\therefore H_e = \left(\frac{155}{3.1 \times 3.0}\right)^{2/3}$

$= 6.52'$



Provide the inlet at a higher level at 1748.10

U/s energy level $= 1748.10 + 6.52 = 1754.62$

$D_c = \left[\left(\frac{155}{3}\right)^2 / 32.2\right]^3 = 4.36$ $V_c = 11.85$

Total energy at the inlet $= 1748.10 + 4.36 + \frac{11.85^2}{64.4}$

$= 17$:

For normal flow in the channel energy line is

$= 1747.17 + 3.13 + \frac{16.51^2}{64.4}$

$= 1754.53 < 1754.62$ O.K

S GOYAL DATE 11-19-85 / 11-25-85 / 12-02-85 SHEET 15 OF _____

BY _____ DATE _____ OFS NO. USDA 3767.300 DEPT. NO. 550

CLIENT USDA - SCS - PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY INLET 4C

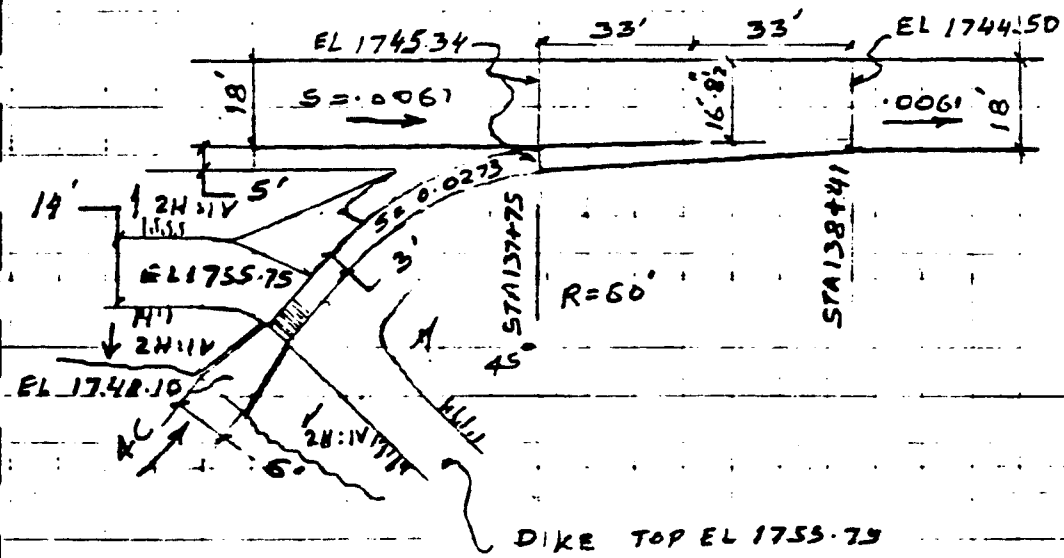
Water level for submergence of land = 1754.64 say 1754.75

Top of Dike = 1754.64 + 1 = 1755.64 say 1755.75

EL at the end of Junction at STA 138+41
= 1745.34 - .84 = 1744.50

Velocity in the arroyo = $\frac{155}{(6+2\times6.5)6.5}$ = 1.26
(Assumed d = 6.5)

∴ He = $6.5 + \frac{1.26^2}{64.4}$ = 6.52 O.K.



PLAN 4C

1" = 40'

CHANNEL 138+41 To 140+00

$Q = 1142$

$b = 18'$

$S = .0052$

Assume $d = 4.34$ $A = 78.12$ $R = 2.93$ $V = 14.62$ $d = 4.34$ o.k

$d_c = \left[\left(\frac{1142}{18}\right)^2/32.2\right]^{1/3} = 5.00$

$\therefore S_c = .0035 < \frac{S}{1.3}$

Height of wall $= 1.2 \times 4.34 = 5.208$

or $4.34 + 1 = 5.34'$ use $5'-6"$

Bed El. at STA $140+00 = 1744.50 - [14000 - 13841] \times .0052$

$= 1743.69$

TRANSITION FROM STA 140+00 To 140+20

$Q = 1142$ $b_1 = 18'$ $S_1 = .0052$ $V_1 = 14.62$ $d_1 = 4.34$

$b_2 = 22'$ $S_2 = .0052$

Assume $d_2 = 3.69$ $A_2 = 81.18$ $R_2 = 2.76$ $V_2 = 14.07$ $d_2 = 3.69$ o.k

Average $d = (4.34 + 3.69)\frac{1}{2} = 4.02$

$V = (14.62 + 14.07)\frac{1}{2} = 14.35$

$F = \frac{V}{\sqrt{g}d} = 1.26$

$\therefore$ Transition angle $\tan\alpha = \frac{1}{3F} = .26$

Transition provided 1 in 10 is O.K

Bed EL at STA $140+20 = 1743.69 - [14020 - 14000] \times .0052$

$= 1743.59$

BY S GOYAL DATE 11-21-85 / 12-02/85 SHEET 17 OF _____

CHKD. BY _____ DATE _____ OFS NO. USDA 3767.30 DEPT. NO. 55

CLIENT USDA - SCS - PHOENIX ARIZONA

PROJECT BULDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY

CHANNEL STA 140+20 TO 149+75

$Q = 1142$, $S = .052$, $b = 22'$, $d = 3.69'$

$$d_c = \left[\left(\frac{1142}{22}\right)^2 / 32.2\right]^{1/3} = 4.37$$

$S_c = .0313 < \frac{S}{1.3}$

Height of wall = $1.2 \times 3.69 = 4.43$

or $3.69 + .3 = 4.69$ Use 4'-9"

For height of wall near inlet 4D see sheet 19

Bed El. at STA $149+75 = 1743.59 - [14975 - 14020] \times .052$

$= 1738.62'$

INLET 4D

$Q_1 = 1142$ $b_1 = 22'$ $S_1 = .052$, $d_1 = 3.69$ $V_1 = 14.07$

$Q_3 = 71$

$Q_2 = 1213$ $b_2 = 22'$

$$\therefore F_1 = \frac{V_1}{\sqrt{g d_1}} = \frac{14.07}{\sqrt{32.2 \times 3.69}} = 1.29$$

Conjugate depth $= d_1 \frac{1}{2}\left(\sqrt{1 + 8F_1^2} - 1\right) = 5.14'$

$$\frac{Q_2}{Q_1} = \frac{1213}{1142} = 1.06$$

From Fig 9 of the draft copy of Report for ASCE

$h/d = .1$

or $h = .1 \times 3.69 = .37'$

$L = \frac{.37}{.052} = 7.115$ say 7.2'

F_2 (just below inlet) $= .98 = \frac{V_2}{\sqrt{g d_2}} = \frac{Q_2}{b_2 d_2 \sqrt{g d_2}}$

$$\therefore d_2 = \left[\frac{1213}{22 \times \sqrt{32.2}} \cdot \frac{1}{.98}\right]^{2/3} = 4.62'$$

Provide 8' long weir

$Q_3 = 71$

$= C L H^{3/2}$

$\therefore 71 = 3.1 \times 8 \; H^{3/2}$

$\therefore H = 2.02$

Provide 3ft high dike

G = Conjugate depth + h + 1

$= 5.14 + .37 + 1_{min} = 6.51$ say 6.5'

$\therefore$ Water level = 1738.62 + 6.5 = 1745.12

Ground level is approx 1746. Provide wall at EL 1746.0

Q D/S channel = 1144 b = 22' S = .0052

Assumed $d = 3.69$ $A = 81.18$ $R = 2.76$ $V = 14.07$ $d = 3.697$ OK

$d_c = \left[\left(\frac{1144}{22}\right)^2 / 32.2\right]^{1/3} = 4.38$

$S_c = .00314 < \frac{S}{3}$ O.K

$\therefore$ Height of wall = $1.2 \times 3.69 = 4.42$

$= 3.69 + 1 = 4.69$ Use 4'-9"

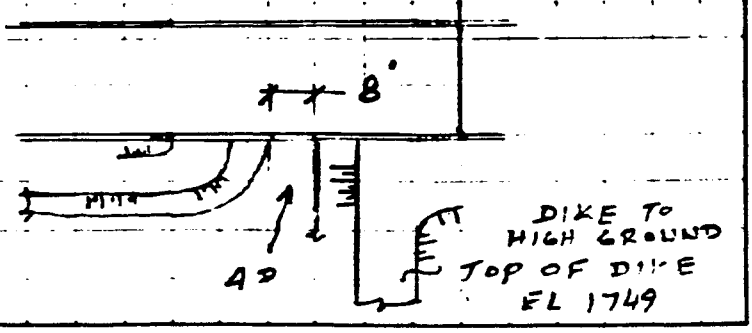
For inlet see Sheet 19

Water level for submergence of dike

$= 1746 + H$

$= 1746 + 2.02 = 1748.02$ say 1748.5

Top of dike at EL 1749'



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BY Y.C. YANG DATE 9-30-85 S Goyal 11/2/85/12-07-85 SHEET 19 OF

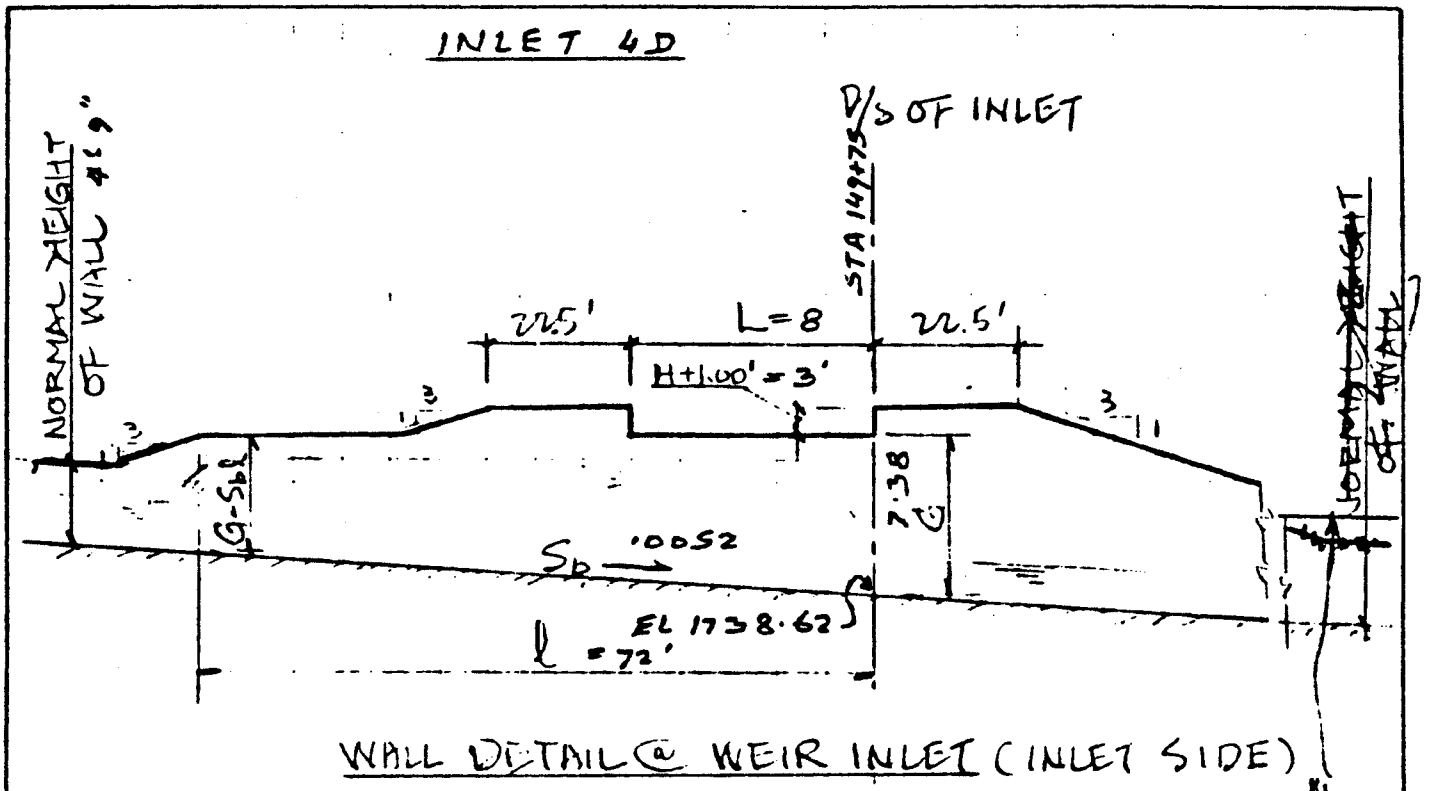
CHKD. BY S Goyal DATE 10-1-85 OFS NO. 3767.202 DEPT. NO. 650

CLIENT USDA

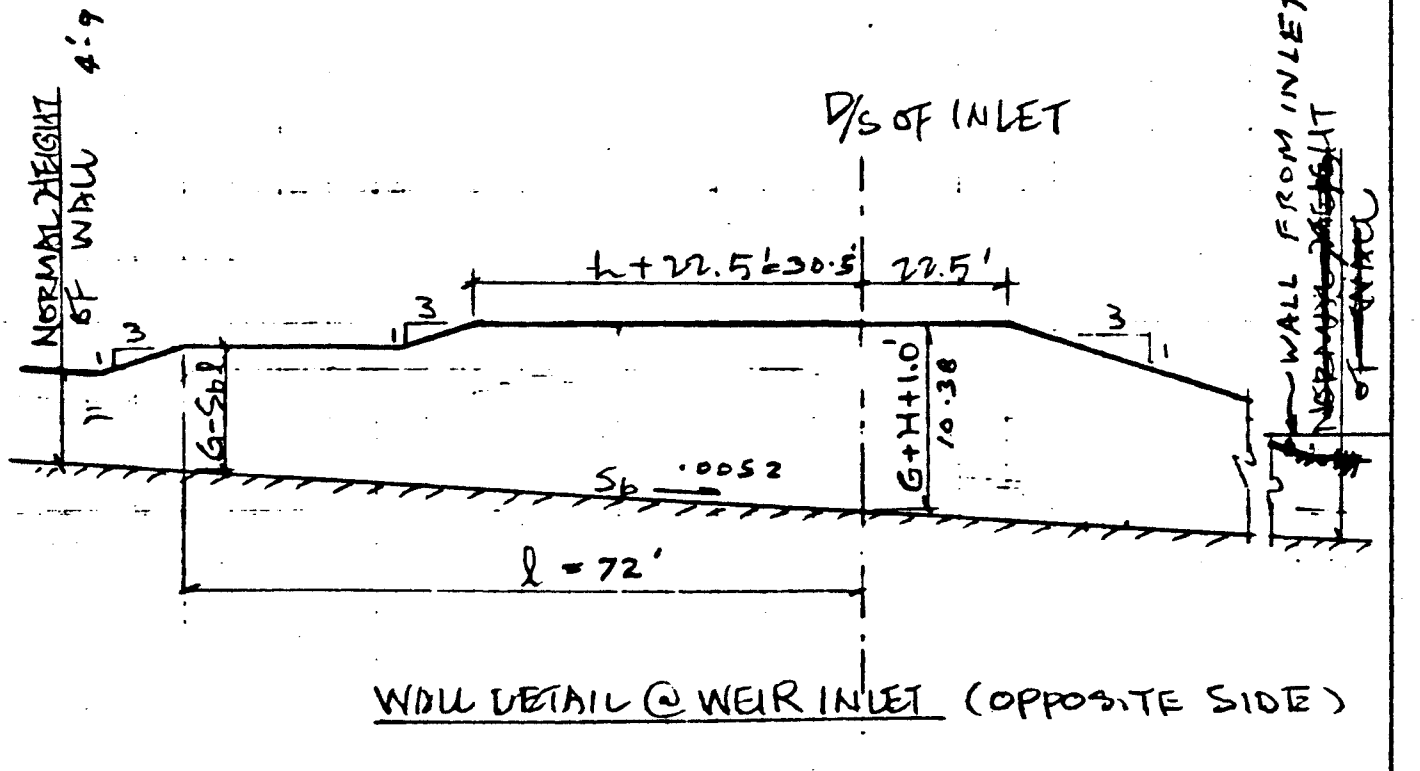
PROJECT BULLDOG FLOODWAY & APACHE JTN FLOOD PROTECTION

SUBJECT BULLDOG FLOODWAY — CHANNEL WALL DETAIL

INLET 4D



WALL DETAIL @ WEIR INLET (INLET SIDE)



WALL DETAIL @ WEIR INLET (OPPOSITE SIDE)

581/8-81

USDA - SCS - PHOENIX ARIZONA

BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

BULLDOG FLOODWAY

CHANNEL STA 149+75 TO STA 154+55

$Q = 1144 \quad b = 22' \quad S = .0052$

bed El at STA 154+55 = 1738.62 - [15455 - 14975] x .0052
= 1736.12

The height of wall is governed by inlet 4E.

INLET 4E

$Q_1 = 1144 \quad b_1 = 22' \quad S_1 = .0052 \quad d_1 = 3.69 \quad V_1 = 14.07$

$Q_2 = 327$

$Q_3 = 1471 \quad b_2 = 22'$

$\therefore F_1 = \frac{14.07}{\sqrt{32.2 \times 3.69}} = 1.29$

Conjugate depth = 5.14'

$\frac{Q_2}{Q_1} = \frac{1471}{1144} = 1.286$

∴ From Fig 9

$h/d = .65$

$h = .65 \times 3.69 = 2.4'$

$L = 2.4 \div .0052 = 461.25$ say 462'

Fr just below rnld = .9 = $\frac{V_2}{\sqrt{g d_2}} = \frac{Q_2}{b_2 d_2 \sqrt{g d_2}}$

$\therefore d_2 = \left[\frac{1471}{22 \times \sqrt{32.2}} \cdot \frac{1}{.9}\right]^{2/3} = 5.55'$

G = Conjugate depth + h + 1
= 5.14 + 2.4 + 1 = 8.54'

EL of Weir = 1736.12 + 8.54 = 1744.66

provide 50' long weir to reduce submergence of land and height of dike

$Q_3 = 327 = 3.1 \times 50\, H^{3/2}$

$\therefore H = 1.645$

water level for submergence of land

$= 1744.66 + 1.645 = 1746.305$

say 1746.5

Top of Dike $= 1747.50$

Q in channel D/s $= 1441$ $b_2 = 22'$ $S = .0052$

Assume $d = 4.315$, $A = 94.93$, $R = 3.099$, $V = 15.186$ $d = 4.313$ O.K

$d_c = \left[\left(\frac{1441}{22}\right)^2 / 32.2\right]^{1/3} = 5.11$

$S_c = .00317 < S/3$

$\therefore$ Height of wall $= 1.2 \times 4.315 = 5.176$

or $4.315 + 1 = 5.315$

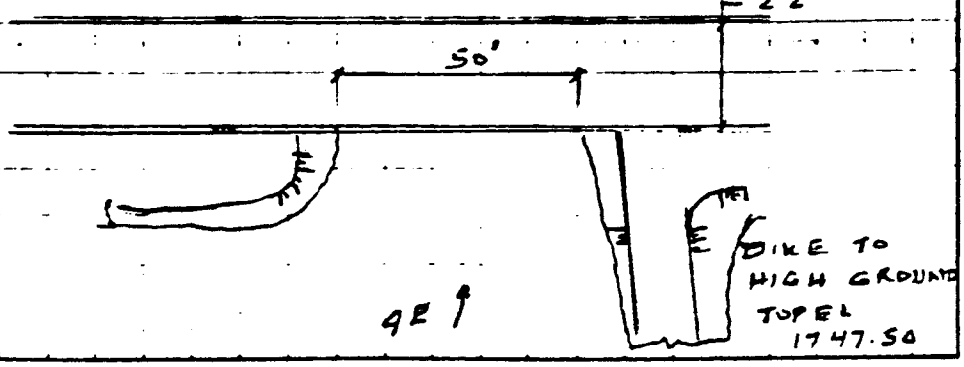
Effect of curve in channel

Extra free board $= \frac{1.2\, V^2 b}{g R}$ $R = 2097.35'$

$= \frac{1.2 \times 15.186^2 \times 22}{32.2 \times 2097.35}$

$= .09'$

Height of wall $= 5.315 + .09 = 5.405$ use 5'-6"



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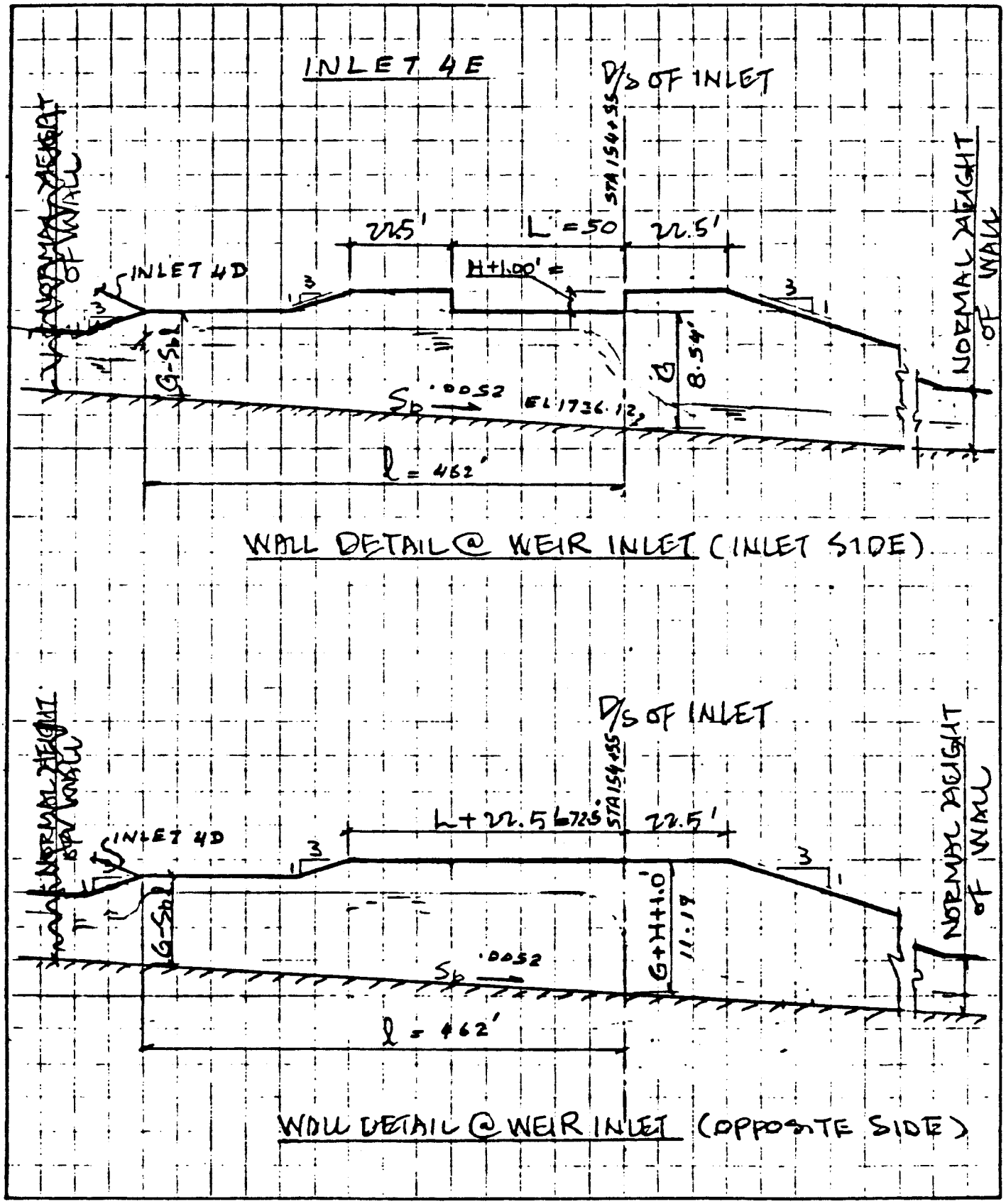
BY Y.C. YANG DATE 9-30-85 S GOYAL 11/21/85/12-02-85 SHEET 22 OF _____

CHKD. BY S Goyal DATE 10-1-85 OFS NO. 3767.203 DEPT. NO. 1650

CLIENT USDA

PROJECT BULLDOG FLOODWAY & APACHE JTN FLOOD PROTECTION

SUBJECT BULLDOG FLOODWAY — CHANNEL WALL DETAIL



WALL DETAIL @ WEIR INLET (INLET SIDE)

WALL DETAIL @ WEIR INLET (OPPOSITE SIDE)

581/8-81

CHANNE STA 154+55 TO 156+00

$Q = 1441$ $b = 22'$ $S = .0052$ $d = 4.315'$

Height of wall 5'-6"

Bed El at STA 156+00 = 1736.12 - [15600 - 15455] x .0052

= 1735.37

TRANSITION STA 156+00 TO STA 156+30

$Q = 1441$ $b_1 = 22'$ $d_1 = 4.315$ $V_1 = 15.186$

$b_2 = 28'$ $S_2 = .00495$

Assume $d_2 = 3.64$ $A_2 = 101.92$, $R_2 = 2.89$ $V_2 = 14.14$ $d_2 = 3.64$ ok

Average $V = (15.186 + 14.14)\frac{1}{2} = 14.663$

$d = (4.315 + 3.64)\frac{1}{2} = 3.978$

$F = \frac{V}{\sqrt{g}\,d} = 1.29$

Transition angle $\tan\alpha = \frac{1}{3F} = .258$

Transition provide 1 in 10 is ok

Bed El at STA 156+30 = 1735.37 - [15630 - 15600] x .0495

= 1735.12

CHANNEL STA 156+30 TO STA 164+70

$Q = 1441$ $b = 28$ $S = .00495$ $d = 3.64$

$d_c = \left[\left(\frac{1441}{28}\right)^2 / 32.2\right]^{1/3} = 4.35$

$S_c = .0029 < \frac{S}{1.3}$

Height of walls = 1.2 x 3.64 = 4.37'

= 3.64 + 1 = 4.64 use 4'-9"

Bed El of STA 164+70 = 1735.22 - [16470 - 15630] x .00495

= 1731.06

INLET 4F

$Q_1 = 1441$ $b_1 = 28'$ $S_1 = .00495$ $d_1 = 3.64$ $V_1 = 14.14$

$Q_3 = 56$

$Q_2 = 1497$ $b_2 = 28'$

$\therefore F_1 = \frac{V}{\sqrt{g d}} = \frac{14.14}{\sqrt{32.2 \times 3.64}} = 1.306$

Conjugate depth $= d_1 \frac{1}{2}\left(\sqrt{1+8F_1^2} - 1\right) = 5.145$

$\frac{Q_2}{Q_1} = \frac{1497}{1441} = 1.039$

From Fig 9 of draft copy of Report for ASCE

$h/d = .04$

$h = .04 \times 3.64 = 0.15'$

$L = \frac{0.15'}{.00495} = 30.3' \rightarrow$ say $30'$

F_2 just below inlet $= .992 = \frac{V_2}{\sqrt{g d_2}} = \frac{Q_2}{b_2 d_2 \sqrt{g d_2}}$

$\therefore d_2 = \left[\frac{1497}{28\sqrt{32.2}} \cdot \frac{1}{.992}\right]^{2/3} = 4.48'$

Provide 6' long weir

$Q = C L H^{3/2} = 56$

$H = \left(\frac{56}{3.1 \times 6}\right)^{2/3} = 2.08$

G = conjugate depth + h + 1

$= 5.145 + 0.15 + 1_{min} = 6.295$

$\therefore$ Weir EL $= 1731.06 + 6.295 = 1737.355$

Ground level is approx at EL 1739

$\therefore$ Provide weir at EL 1739.00

Water level for submergence of bend $= 1739 + 2.08$

$= 1741.00$ say 1741.00

EBASCO SERVICES INCORPORATED

BY S GOYAL DATE 11-21-85 / 12-02-85 SHEET 25 OF _____

CHKD. BY _____ DATE _____ OFS NO. USDA 3767.3 DEPT. NO. 53

CLIENT USDA SCS PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY

Top of Dike at EL 1742 feet

Q D/S channel = 1447 $b = 28'$ $S = .0495$

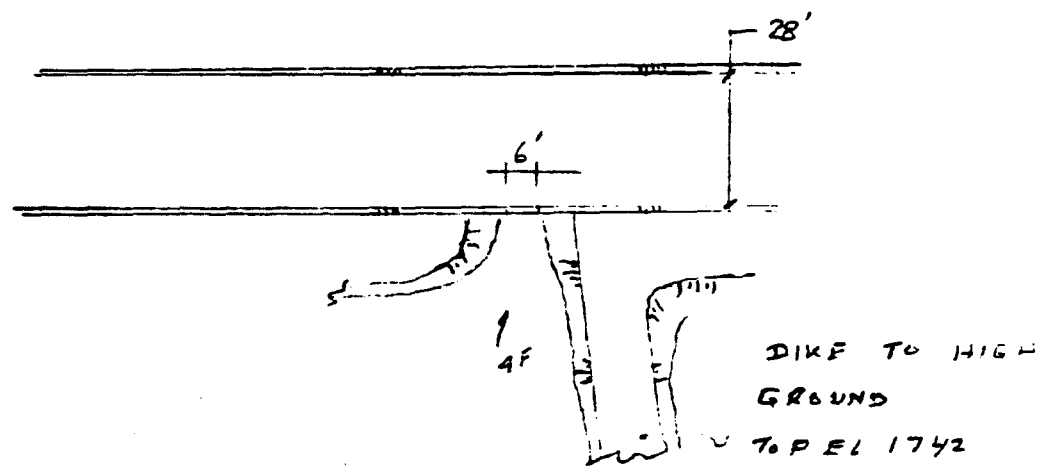
Assume $d = 3.65$ $A = 102.2$ $R = 2.895$ $V = 14.158$ $d = 3.65$ O.K

$$d_c = \left[\left(\frac{1447}{28}\right)^2 / 32.2\right]^{1/3} = 4.36$$

$S_c = .0029 < \frac{S}{1.3}$ O.K

Weight of wall = $1.2 \times 3.65 = 4.38$

$w = 3.65 + 1 = 4.65$ Use 4'-9"



For inlet see Sh 26.

CHANNEL STA 164+70 TO STA 168+86

Q = 1447 $b = 28$ $S = .0495$ $d = 3.65$

Bed EL. at STA 169+ = 1731.06 - [16886 - 16470] x .0495

= 1729.00

Height of wall 4'-9"

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BY Y.C. YANG DATE 9-30-85 S.C. YAL 11/2/85 12-02-85 SHEET 26 OF _____

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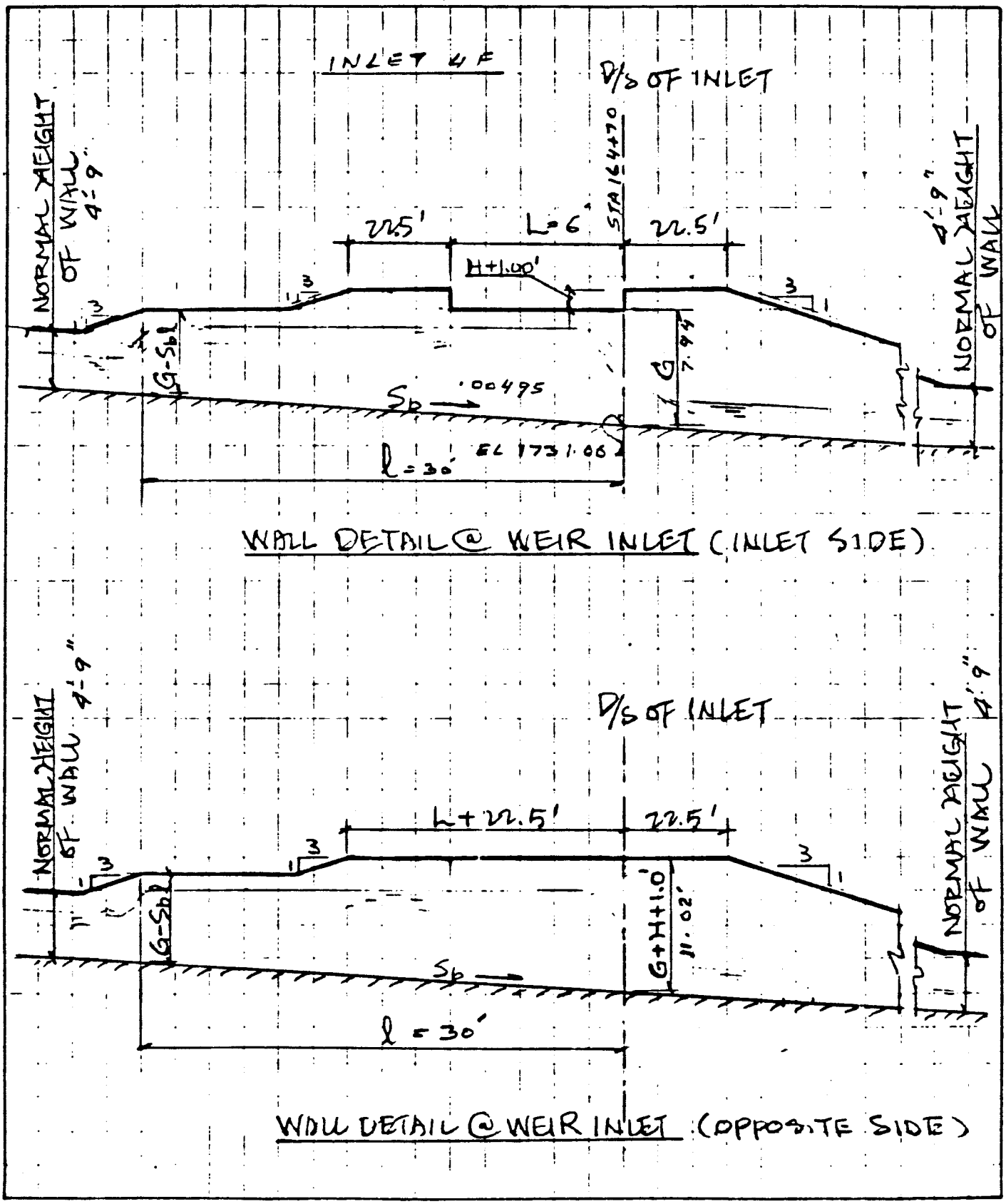
CLIENT USDA

PROJECT BULLDOG FLOODWAY & APACHE JCT FLOOD PROTECTION

SUBJECT BULLDOG FLOODWAY — CHANNEL WALL DETAIL



INLET 4G

To avoid the interference of 4G on 4F in the hydraulic performance, the inlet 4G should be made as a side channel inlet

Q_1 = [illegible] $b_1 = 28$ $d_1 = 3.65$ $A_1 = 102.2$ $V_1 = 14.58$

$Q_2 = 611$ $b_2 = 85$

Assume $d_2 = 3.8$

$V_2 = 18.92$ $A_2 = 32.3$ $K_2 = 2.006$

$$S_2 = \left[\frac{Vn}{1.486 R^{2/3}}\right]^2 = .0144$$

$d_{c_2} = 5.43$ $S_{c_2} = .0056 < \frac{S_2}{1.3}$

$Q_3 = 2058$

$b_3 = 35 > .8(b_1 + b_2)$ i.e. 29.2

$S_3 = .0051$

Assume $d_3 = 3.86$ $A_3 = 135.1$ $R_3 = 3.16$ $V_3 = 15.24$

$\therefore$ $d_3 = 3.858$ o.k.

$d_{c_3} = 4.75$ $S_{c_3} = .0027 < \frac{S_3}{1.3}$

$L = C V_2 (b_1 + b_2 - b_3)^{1/3}$ for $d_2 = 3.8$

$= 3.425 \times 18.92 (28 + 8.5 - 35)^{1/3} = 67.68$ say 68

length of splitter wall = $l_{f_3} = 32'$

$$b_m = \frac{(b_1 + b_2) + b_3}{2} = 35.75'$$

$$d_m = \frac{1}{2}\left[\frac{Q_1 + Q_2}{V_1 b_1 + V_2 b_2} + d_3\right] = 3.78$$

$A_m = 135.01$ $P_m = 43.31$ $R_m = 3.12$

$V_m = 15.243$

$$b_3 = \frac{b_1 (b_1 + b_2 + b_3)}{2 (b_1 + b_2)} = 27.42 \text{ use } 27'-5''$$

Unequal width channel

$$\frac{Q_3^2}{g A_3} + \frac{b_3 d_3^2}{2} + \frac{b_3 d_3 h}{2} = \frac{Q_1^2}{g A_1} + \frac{Q_2^2}{g A_2} + \frac{b_3 d_1 h}{2} + \frac{h_1 d_1^2}{2} + \frac{b_3 - b_1}{2}(d_3^2) - \frac{\bar{s}_m L r^2 V_m^2}{2.21 R_m^{4/3}}$$

$\therefore$ $973.60 + 260.74 - 67.55 h = 636.25 + 352.04 + 63.88 h + 180.52 + 50.54 - 47.68$

$\Rightarrow$ $131.43 h = 49.75 \Rightarrow h = 0.38$

Provide a drop of 0.38' in the length of the Junction.

$R_2' = \frac{1.2 \times 16.92^2}{32.2} \times 8.5 = 113.37$ say 114'

Height of wall channel $= 1.2 \times 3.86 + .25 \times 4.75 \left[1 - 11.1 \left(\frac{.0051}{.0027} - 1\right)^3\right] + 1$

$= 4.63 + 1 = 5.63$ use 5'-9"

Height of splitter wall = $d_2 = 3.8' > d_1$

" " " at end = 6"

Height of wall for inlet = $1.2 \times 3.8 + 1$

$= 4.56 + 1 = 5.56$ Use 5'-9"

Beginning of Junction at STA = 169+00 less 14

= 168+86

Bed EL of channel = 1731.06 - [16886 - 16470] × .0049

= 1729.00

End of Junction at STA 169+54

Bed EL of channel = 1729.00 - .38

= 1728.62

Provide a 55° curve for the side inlet channel

EL at the beginning of curve = $1729.00 + \left(\frac{2\pi \times 114}{360} \times 55\right) \times .0144$

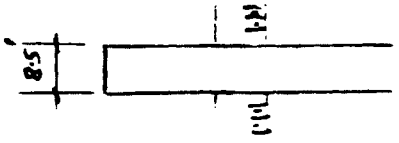
= 1730.58

The ground level is very high. Provide a drop inlet

$\frac{W}{B} = \frac{25.5}{8.5} = 3$

$Q = 611$

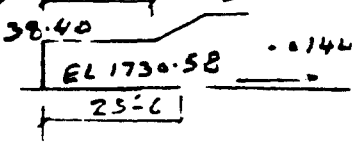
$Q/W^{5/2} = 2.90$



From Fig ES-90 Sheet 5 chute spillway

$\delta = 0.92$ $\gamma = 0.26$

$\therefore D_2 = 0.92 \times 8.5 = 7.82'$ $He = .26 \times 8.5 = 2.21'$



Top of crest = 1730.58 + 7.82

= 1738.40

Provide a 80' wide channel with 2H:1V side slopes

Effective B = 25.5'

∴ B' = B − .4 2 He

= 25.5 − .4 x 2 x 2.21 = 23.73 say 23'-9"

B/W = 3

$K = \frac{80 + .8 \times 2 \times 2.21}{8.5} = 9.8$

∴ From Fig ES-9e sheet 10 K = .87

Assume $Q = \frac{611}{.87} = 702$ → Hence $Q_K = .87 \times 702$

= 611

∴ For Q = 702 i.e $\frac{Q}{W^{5/3}} = 3.33$ W/B = 3

from Fig ES-9e sheet 5

Yc = .29

$H_c = .29 \times 8.5 = 2.47'$

∴ Water level for submergence = 1738.40 + 2.47

= 1740.86

→ say 1741.00

Top of Dike at EL 1742.00

Velocity in the arroyo

$= \frac{611}{(80 + 2 \times 2.47) 2.47} = 2.91$

Provide riprap

Channel STA 115+63 to 121+63

El. at STA 115+63 = 1766.68 − .25 = 1766.43

Q = 478

S = .0085

b = 10'

d = 3.31'

Height of wall = 1.2 x 3.31

= 3.97 or 3.31+1 = 4.35

Provide 4.5' high

El at STA 121+63

= 1766.43 − (121+63 − 115+63) x .0085

= 1761.33

Channel STA 121+63 To 128+54.11

Q = 478

S = .014

b = 10'

Assume d = 2.77' A = 27.7 R = 1.78

∴ v = 17.23

d = 2.774 ok

d_{cr} = 2.55' S_{cr} = .0079 < $\frac{S}{1.3}$

Height of wall = 1.2 x 2.77

= 3.32 or 2.77+1 = 3.77

Use 4.0 high

El at STA 128+54.11 = 1761.33 − (12854.11 − 12163) .014 = 1751.65

Channel STA 128+54.11 to PC STA 129+23.99

Q = 478

S = .0085

b = 10'

d = 3.31'

Height of wall = 4.5' as between STA 115+63 to 121+63

El at Sta 129+23.99 = 1751.65 − (12923.99 − 12854.11] x .0085

= 1751.06

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PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT APACHE JUNCTION FRS OUTLET CHANNEL & BULLDOG FLOODWAY

Channel STA 129+23.99 to 130+20.15

$Q = 478$

$S = .0085$

$b = 10'$

$d = 3.31'$ $\quad v = 14.46$ $\quad R = 9.995'$

Height of wall $= 1.2 \times 3.31 + \frac{1.2\, v^2 b}{g R}$

$= 3.97 + .78$

$= 4.75' > (3.31 + 1.0)$

Provide 4'-9" outer curve wall

and 4'-6" inner curve wall

EL of STA 130+20.15 $= 1751.06 - (13020.15 - 12923.99) \times .0085$

$= 1750.24$

Channel STA 130+20.15 to 132+20

$Q = 478$

$S = .0085$

$b = 10'$

$d = 3.31$

Height of wall = 4'-6"

EL at 132+20 $= 1750.24 - (13220 - 13020.15) \times .0085$

$= 1748.54$

Inlet 9B

$Q_1 = 478$ $\quad b_1 = 10'$ $\quad d_1 = 3.31$ $\quad A_1 = 33.1$ $\quad v_1 = 14.46$

$Q_2 = 525$ $\quad b_2 = 9'$

$d_2 = 3.25$

$v_2 = 17.95$ $\quad A_2 = 29.25$ $\quad R_2 = 1.89$

$S_2 = .014$

$d_{c_2} = 4.72 > \quad S_{c_2} = .0051 < \frac{S_2}{1.3}$

$Q_3 = 1003$ cfs

$b_3 = 18' > 0.8(b_1 + b_2)$

$S_3 = .0061$

Assume $d_3 > 3.76$ $\quad A_3 = 67.68$ $\quad R = 2.65$

$\therefore v_3 = 14.82$

$\therefore d_3 = 3.76$ $\quad$ O.K.

$d_{c_3} = 4.59$ $\quad S_{c_3} = .0034 < \frac{S_3}{1.3}$

$l = CV_1 (b_1 + b_2 - b_3)^{1/3}$ for $d_3 = 3.25$

$= 2.83 (10 + 9 - 18)^{1/3} \times 17.96$

$= 50.8$ say 52'

Splitter wall length $= l/2 = 26'$

$b_m = 18.5'$

$d_m = 3.52$

$A_m = 65.08$ $P_m = 25.54$ $R_m = 2.55$

$V_m = 15.41$

$b_s = 9.74'$

$$\frac{Q_3^2}{gA_3} + \frac{b_3 d_3^2}{2} - \frac{b_3 d_3 h}{2} = \frac{Q_1^2}{gA_1} + \frac{Q_2^2}{gA_2} + \frac{b_3 d_1 h}{2} + \frac{b_1 d_1^2}{2} + \left(\frac{b_3 - b_1}{2}\right) d_2^2 - \frac{P_m l n^2 V_m^2}{2.21 R_m^{1/3}}$$

$\therefore 461.62 + 127.24 - 33.84h = 214.37 + 292.64 + 29.79h + 54.78 + 42.25 - 23.5$

or $63.63h = 8.32$

$h = 0.13$

$R_2' = \frac{1.2 \times 17.95^2 \times 9}{32.2 \times 1} = 108.07$ say 110'

Height of wall $= 1.2 \times 3.76 + .25 \times 4.59 \left[1 - 11.1 \left(\frac{.0061}{.0034} - 1\right)^2\right] + 1$

$= 4.5 + 0 + 1 = 5.5'$

Height of splitter wall $= d_1 = 3.31 > d_2$ use 3'-6"

" lower end = 6"

Height of wall for inlet $= 1.2 \times 3.25 + \frac{1.2 \times 17.95^2 \times 9}{32.2 \times 110}$

$= 3.9 + 1 = 4.9$ use 5'-0

Beginning of Junction at STA 132+20 EL 1748.54

End of Junction at STA 132+72 EL 1748.54 - .13 = 1748.41

Provide 45° curve in the inlet plus 20' straight.

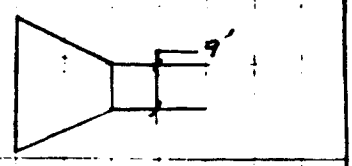
length of channel $= \frac{2\pi \times 110}{360} \times 45° + 20 = 106.39'$

EL at the inlet $= 1748.54 + 106.39 \times .014 = 1750.03$

Provide straight inlet

$Q = 525$ cfs

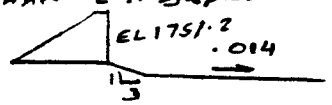
$b = 9'$



Make inlet 9' wide with wing walls 25' channel 2:1 slopes

$Q = 3.1 \times 9 \times H_c^{3/2}$

$\therefore H_c = 7.07'$



Provide the inlet at a higher level say at EL 1751.2

U/S energy level $= 1751.2 + 7.07$

$= 1758.27$

$D_c = \left[\left(\frac{525}{9}\right)^2/32.2\right]^{1/3} = 4.728 \qquad V_c = 12.338$

Total energy at the inlet $= 1751.2 + 4.728 + \frac{12.338^2}{64.4}$

$= 1758.29$

For normal flow in the channel energy line is

$= 1750.03 + 3.25 + \frac{17.95^2}{64.4}$

$= 1758.28 < 1758.27$ O.K

Water level for submergence of land $= 1758.27$

Top of Dike $= 1758.19 + 1 = 1759.29$ say 1759.50

EL at the end of Junction at STA 137+72

$= 1748.54 - .13$

$= 1748.41$

Velocity in the arroyo $= \frac{525}{(25+2\times7)7} = 1.92$

(Assumed $d = 7'$)

$H_c = 7 + \frac{1.92^2}{2g} = 7.06 < 7.07$ O.K

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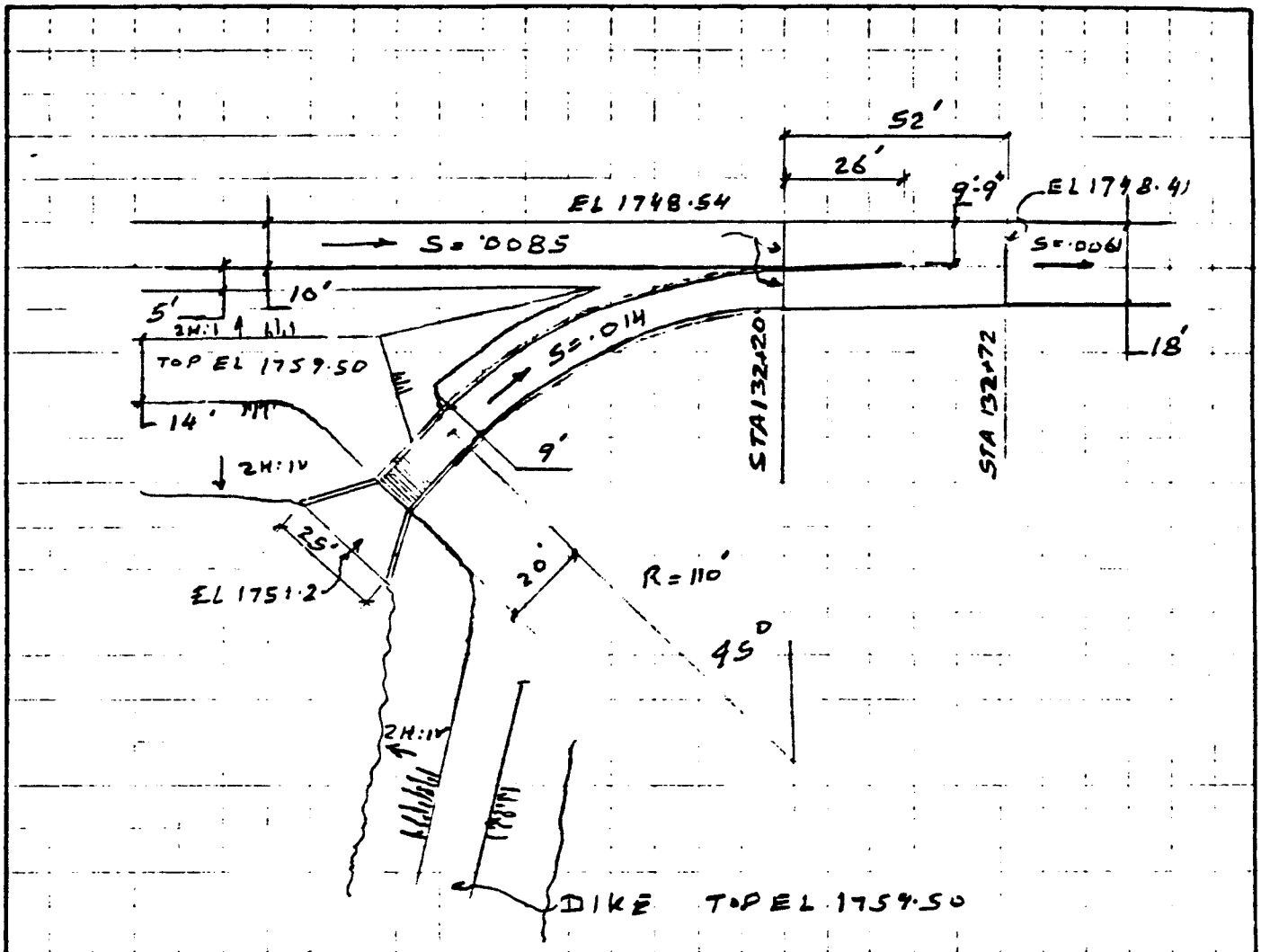
PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT



PLAN INLET AB

1" = 40'

581/8-81

CHANNEL STA 132+72 & 137+75

Q = 1001 ≈ 1003 Sheet 6

∴ b = 18'

S = .0061

d = 3.76

El at sta 137+00 = 1748.41 − (13700 − 13272) x .0061

= 1745.80 as in the Phase I

Height of wall = 1.2 x 3.76

= 4.51

or 3.76 + 1 = 4.76 provide 4'-9"

El. at STA 137+75 = 1748.41 − (13775 − 13272) x .0061

= 1745.34

BY S GOYAL DATE 11-19-85 / 12-2-85 SHEET 13 OF

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PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY INLET 4C

INLET 4C

$Q_1 = 1001$ cfs $b_1 = 18'$ $d_1 = 3.76'$ $A_1 = 67.68$ $V_1 = 14.79$

$Q_2 = 155$ cfs $b_2 = 3.0$

Assume $d_2 = 3.13$

$V_2 = 16.51$ $A_2 = 9.39$ $R_2 = 1.014$

$S_2 = \left[\frac{Vn}{1.486 R^{2/3}}\right]^2 = .0273$

$d_{c_2} = 4.36$ $S_{c_2} = .0124 < \frac{S_2}{1.3}$

$Q_3 = Q_1 + Q_2 = 1156$ cfs

$b_3 = 18 > .8(b_1 + b_2) = 16.8$

$S_3 = .0052$

Assume $d_3 = 4.375$ $A_3 = 78.75$ $R = 2.944$ $V_3 = 14.67$

$\therefore d_3 = 4.377$ O.K

$d_{c_3} = 5.04$ $S_{c_3} = .0035 < \frac{S_3}{1.3}$

$\ell = C V_2 (b_1 + b_2 - b_3)^{1/3}$ for $d_2 = 3.13$

$= 2.75 \times 16.51 (18 + 3 - 18)^{1/3}$

$= 65.48$ say 66

length of splitter wall $= \ell/2 = 33.0'$

$b_m = (b_1 + b_2) + b_3 = 19.5$

$d_m = \frac{1}{2}\left[\frac{Q_1^2 + Q_2}{V_1 b_1 + V_2 b_2} + d_3\right] = \frac{1}{2}\left[\frac{1001 + 155}{14.79 \times 18 + 16.51 \times 3.0} + 4.375\right] = 4.018$

$A_m = 78.35$ $P_m = 27.54$ $R_m = 2.845$

$V_m = \frac{Q_1 + Q_2}{b_m d_m} = 14.75$

$b_3 = \frac{b_1(b_1 + b_2 + b_3)}{2(b_1 + b_2)} = 16.71$ say 16'-8"

constant width main channel

$$\frac{Q_3^2}{g A_3} + \frac{b_3 d_3^2}{2} - \frac{b_3 d_3 h}{2} = \frac{Q_1^2}{g A_1} + \frac{Q_2^2}{g A_2} + \frac{b_2 d_1 h}{2} + \frac{b_2 d_1^2}{2} - \frac{P_m d n^2 V_m^2}{2.21 R_m^{1/3}}$$

$\therefore 527.00 + 172.27 - 39.38h = 459.78 + 79.46 + 33.84h + 127.24 - 28.41$

$73.22h = 61.19$

$h = 0.84'$

Radius of bend $R_c' = \frac{1.2 V_c^2 b_2}{g S}$ S is superelevation .5'

$= \frac{1.2 \times 16.51^2 \times 4.0}{32.2 \times .5}$

$= 60.9$ use 60'

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PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY INLET 4C

Height of wall $= 1.2 d_3 + 0.25 d_{c_3}\left[1 - 11.1\left(\frac{3.3}{S_{c_3}} - 1\right)^3\right] + \frac{1.2 V_2^2 b_2}{3 R_2}$

$= 1.2 \times 4.375 + 0 + .5$

$= 5.75 \rightarrow$ say $5'-9''$

Height of splitter wall $= d_1 = 3.76' > d_2$ use $3'-9''$

" " lower end $= 0.5'$ i.e $6''$

Height of inlet wall $= 1.2 \times 3.13 + .5$ for the curve

$= 4.256$ use $4'-3''$

Provide beginning of Junction at STA 137+75

EL. of Junction $= 1745.80 - (13775 - 13700) \times .0061$

$= 1745.34$

Provide a 45° curve in the side channel plus 20' straight

Length of channel $= \frac{\pi \times 60}{360} \times 45 + 20 = 67.12'$

El at the inlet $= 1745.34 + 67.12 \times .0273$

$= 1747.17$

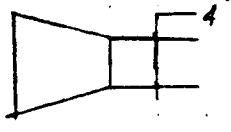
which is close to ground elevation.

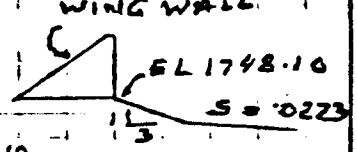
Provide a straight inlet

$Q = 3.1 W He^{3/2}$

$\therefore He = \left(\frac{155}{3.1 \times 3.0}\right)^{2/3}$

$= 6.52'$





Provide the inlet at a higher level at 1748.10

U/S energy level $= 1748.10 + 6.52 = 1754.62$

$Dc = \left[\left(\frac{155}{3}\right)^2 / 32.2\right]^3 = 4.36$ $Vc = 11.85$

Total energy at the inlet $= 1748.10 + 4.36 + \frac{11.85^2}{64.4}$

$= 17:$

For normal flow in the channel energy line is

$= 1747.17 + 3.13 + \frac{16.51^2}{64.4}$

$= 1754.53 < 1754.62$ O.K

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J. BY _____ DATE _____ OFS NO. USDA 3767.300 DEPT. NO. 550

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ECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

JECT BULLDOG FLOODWAY INLET 4C

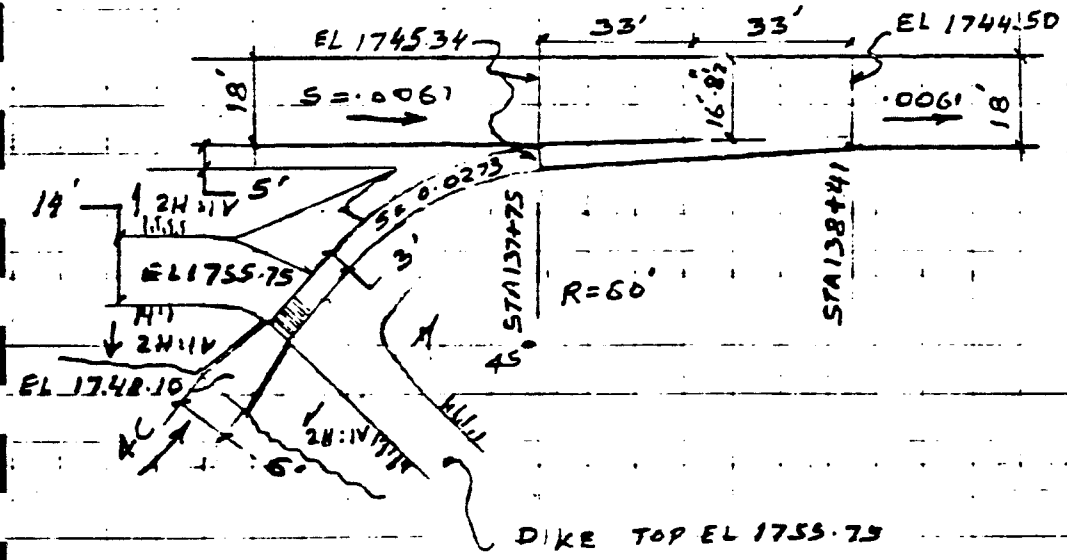
Water level for submergence of land = 1754.64 Say 1754.75

Top of Dike = 1754.64 + 1 = 1755.64 say 1755.75

EL at the end of Junction at STA 138+91
= 1745.34 − .84 = 1744.50

Velocity in the arroyo = $\frac{155}{(6+2\times6.5)6.5}$ = 1.26
(Assumed d = 6.5)

∴ He. $6.5 + \frac{1.26^2}{64.4}$ = 6.52 O.K.



PLAN 4C

1" = 40'

CHANNEL 138+41 To 140+00

$Q = 1142$

$b = 18'$

$S = .0052$

Assume $d = 4.34$ $A = 78.12$ $R = 2.93$ $V = 14.62$ $d = 4.34$ o.k

$d_c = \left[\left(\frac{1142}{18}\right)^2/32.2\right]^{1/3} = 5.00$

$\therefore S_c = .0035 < \frac{S}{1.3}$

Height of wall $= 1.2 \times 4.34 = 5.208$

or $4.34 + 1 = 5.34'$ use $5'-6''$

Bed El. at STA $140+00 = 1744.50 - [14000 - 13841] \times .0052$

$= 1743.69$

TRANSITION FROM STA 140+00 To 140+20

$Q = 1142$ $b_1 = 18'$ $S_1 = .0052$ $V_1 = 14.62$ $d_1 = 4.34$

$b_2 = 22'$ $S_2 = .0052$

Assume $d_2 = 3.69$ $A_2 = 81.18$ $R_2 = 2.76$ $V_2 = 14.07$ $d_2 = 3.69$ o.k

Average $d = (4.34 + 3.69)\frac{1}{2} = 4.02$

$V = (14.62 + 14.07)\frac{1}{2} = 14.35$

$F = \frac{V}{\sqrt{g}d} = 1.26$

$\therefore$ Transition angle $\tan\alpha = \frac{1}{3F} = .26$

Transition provided 1 in 10 $>$ O.K

Bed EL at STA $140+20 = 1743.69 - [14020 - 14000] \times .0052$

$= 1743.59$

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PROJECT BULDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY

CHANNEL STA 140+20 TO 149+75

$Q = 1142$, $S = .052$, $b = 22'$, $d = 3.69'$

$$d_c = \left[\left(\frac{1142}{22}\right)^2 / 32.2\right]^{1/3} = 4.37$$

$S_c = .0313 < \frac{S}{1.3}$

Height of wall = $1.2 \times 3.69 = 4.43$

or $3.69 + = 4.69$ use $4'-9"$

For height of wall near inlet 4D see sheet 19

Bed El. at STA $149+75 = 1743.59 - [14975 - 14020] \times .052$

$= 1738.62'$

INLET 4D

$Q_1 = 1142$ $b_1 = 22'$ $S_1 = .052$, $d_1 = 3.69$ $V_1 = 14.07$

$Q_3 = 71$

$Q_2 = 1213$ $b_2 = 22'$

$$\therefore F_1 = \frac{V_1}{\sqrt{g d_1}} = \frac{14.07}{\sqrt{32.2 \times 3.69}} = 1.29$$

Conjugate depth $= d_1 \frac{1}{2}\left(\sqrt{1 + 8F_1^2} - 1\right) = 5.14'$

$$\frac{Q_2}{Q_1} = \frac{1213}{1142} = 1.06$$

$\therefore$ From Fig 9 of the draft copy of Report for ASCE

$h/d = .1$

or $h = .1 \times 3.69 = .37'$

$L = \frac{.37}{.052} = 7.115 \rightarrow$ say $7.2'$

F_2 (just below inlet) $= .98 = \frac{V_2}{\sqrt{g d_2}} = \frac{Q_2}{b_2 d_2 \sqrt{g d_2}}$

$$\therefore d_2 = \left[\frac{1213}{22 \times \sqrt{32.2}} \cdot \frac{1}{.98}\right]^{2/3} = 4.62'$$

Provide 8' long weir

$Q_3 = 71$

$= C L H^{3/2}$

$\therefore 71 = 3.1 \times 8 \; H^{3/2}$

$\sim H = 2.02$

Provide 3ft high dike

G = Conjugate depth + h_v + 1

= 5.14 + .37 + 1 = 6.51 say 6.5'

$\therefore$ Water level = 1738.62 + 6.5 = 1745.12

Ground level is approx 1746. Provide wall at EL 1746.00

Q d/s channel = 1144 b = 22' S = .0052

Assume d = 3.69 A = 81.18 R = 2.76 V = 14.07 d = 3.697 OK

$d_c = \left[\left(\frac{1144}{22}\right)^2 / 32.2\right]^{1/3} = 4.38$

$S_c = .00314 < \frac{S}{3}$ O.K

$\therefore$ Height of wall = 1.2 x 3.69 = 4.42

$\sim$ 3.69 + 1 = 4.69 use 4'-9"

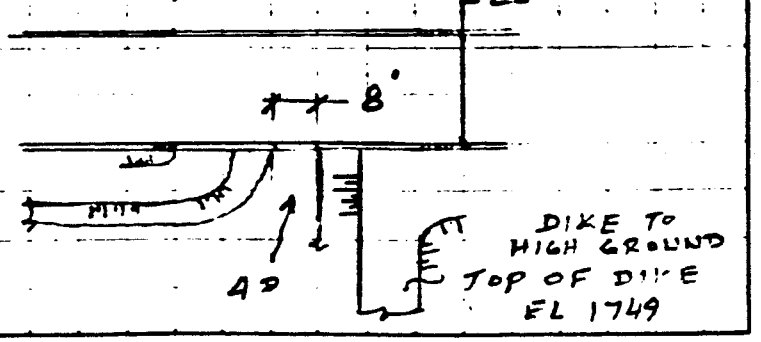
For inlet see Sheet 19

Water level for submergence of bend

= 1746 + H

= 1746 + 2.02 = 1748.02 say 1748.5

Top of dike at EL 1749'



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BY Y.C. YANG DATE 9-30-85 S Goyal 11/21/85/12-07-85 SHEET 19 OF

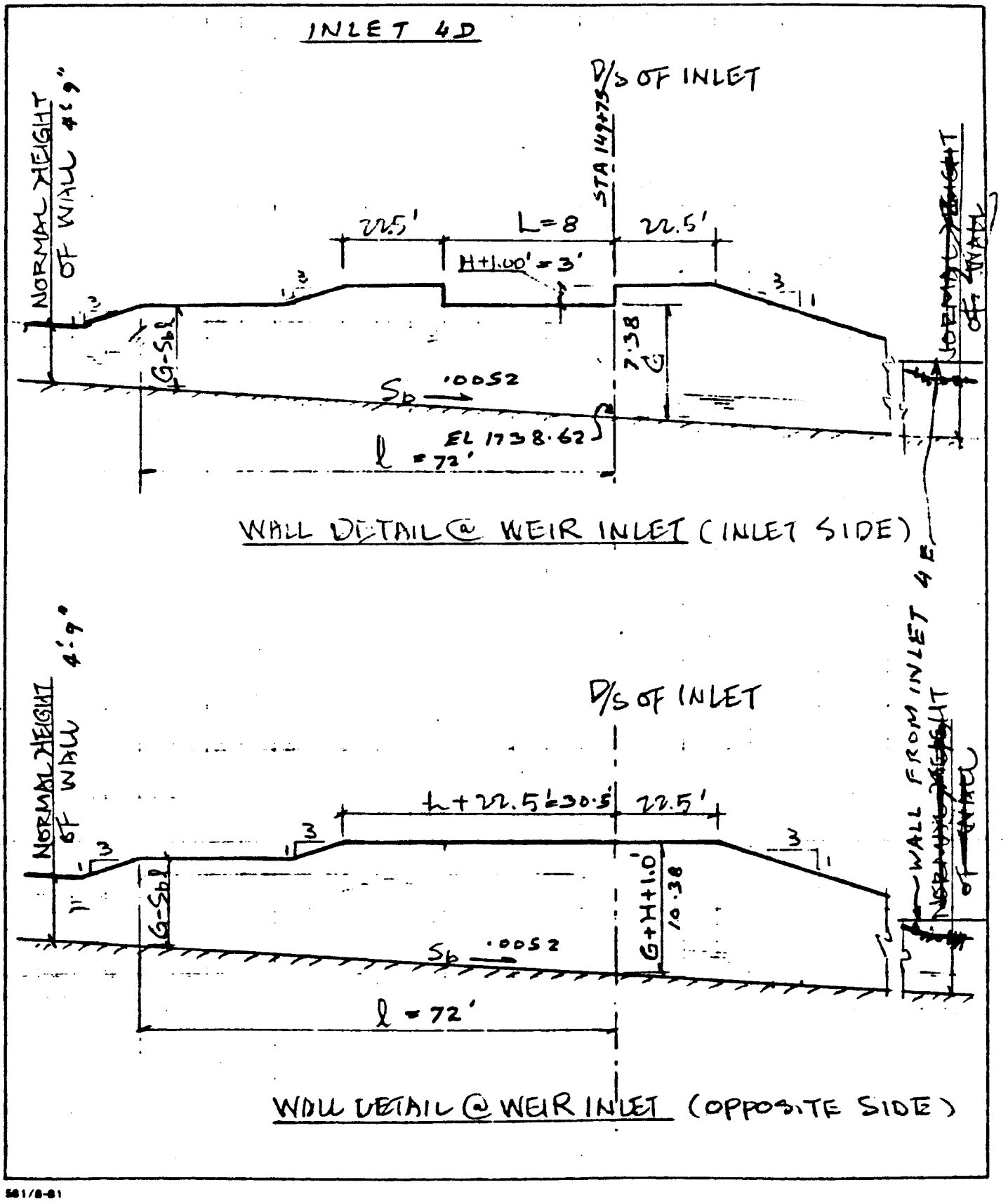
CHKD. BY S Goyal DATE 10-1-85 OFS NO. 3767.203 DEPT. NO. 650

CLIENT USDA

PROJECT BULLDOG FLOODWAY & APACHE JCT FLOOD PROTECTION

SUBJECT BULLDOG FLOODWAY — CHANNEL WALL DETAIL

INLET 4D



561/8-81

USDA - SCS - PHOENIX ARIZONA

BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

BULLDOG FLOODWAY

CHANNEL STA 149+75 TO STA 154+55

$Q = 1144$ $b = 22'$ $S = .0052$

bcd El at STA 154+55 = 1738.62 - [15455 - 14975] x .0052

= 1736.12

The height of wall is governed by inlet AE.

INLET AE

$Q_1 = 1144$ $b_1 = 22'$ $S_1 = .0052$ $d_1 = 3.69$ $V_1 = 14.07$

$Q_2 = 327$

$Q_2 = 1471$ $b_2 = 22'$

$\therefore F_1 = \frac{14.07}{\sqrt{32.2 \times 3.69}} = 1.29$

Conjugate depth = 5.14'

$\frac{Q_2}{Q_1} = \frac{1471}{1144} = 1.286$

∴ From Fig 9

$h/d = .65$

$h = .65 \times 3.69 = 2.4'$

$l = 2.4 \div .0052 = 461.25$ say 462'

Fr just below inlet = .9 = $\frac{V_2}{\sqrt{g d_2}} = \frac{Q_2}{b_2 d_2 \sqrt{g d_2}}$

$\therefore d_2 = \left[\frac{1471}{22 \times \sqrt{32.2}} \cdot \frac{1}{.9}\right]^{2/3} = 5.55'$

G = Conjugate depth + h + 1

= 5.14 + 2.4 + 1 = 8.54'

El. of Weir = 1736.12 + 8.54 = 1744.66

Provide 50' long weir to reduce submergence of land and height of dike

$Q_3 = 327 = 3.1 \times 50\, H^{3/2}$

$\therefore H = 1.645$

water level for submergence of land

$= 1744.66 + 1.645 = 1746.305$

say 1746.5

Top of Dike $= 1747.50$

Q in channel D/S $= 1441$ $b_2 = 22'$ $S = .0052$

Assume $d = 4.315$, $A = 94.93$, $R = 3.099$, $V = 15.186$ $d = 4.313$ O.K

$d_c = \left[\left(\frac{1441}{22}\right)^2 / 32.2\right]^{1/3} = 5.11$

$S_c = .00317 < S/3$

$\therefore$ Height of wall $= 1.2 \times 4.315 = 5.176$

or $4.315 + 1 = 5.315$

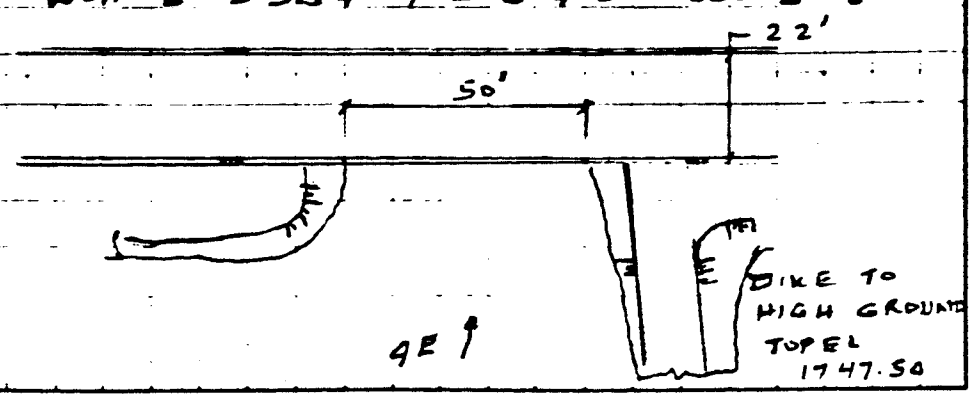
Effect of curve in channel

Extra free board $= \frac{1.2\, V_b^2}{g R}$ $R = 2097.35'$

$= \frac{1.2 \times 15.186^2 \times 22}{32.2 \times 2097.35}$

$= .09'$

Height of wall $= 5.315 + .09 = 5.405$ use $5'-6''$



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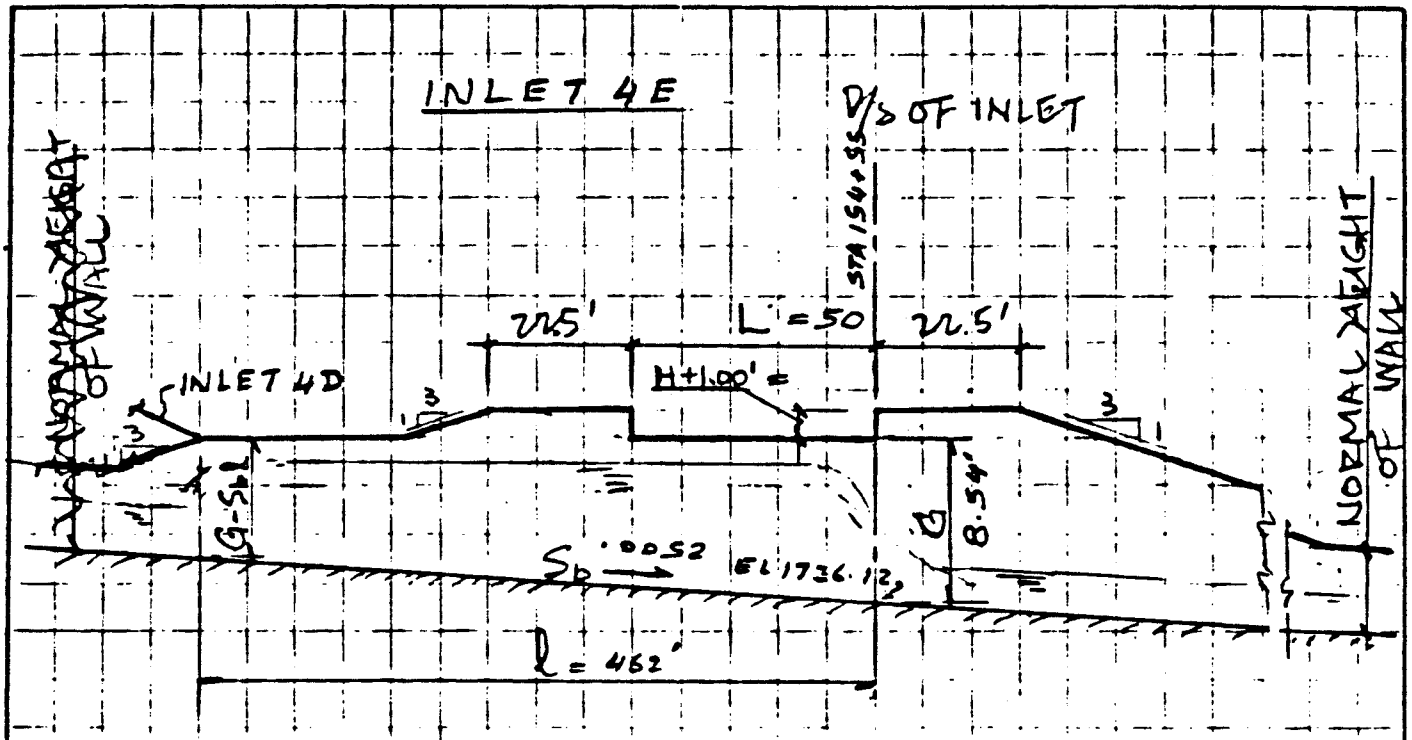
BY Y.C. YANG DATE 9-30-85 S GOYAL 11/21/85/12-02-85 SHEET 22 OF _____

CHKD. BY S Goyal DATE 10-1-85 OFS NO. 3767.200 DEPT. NO. 650

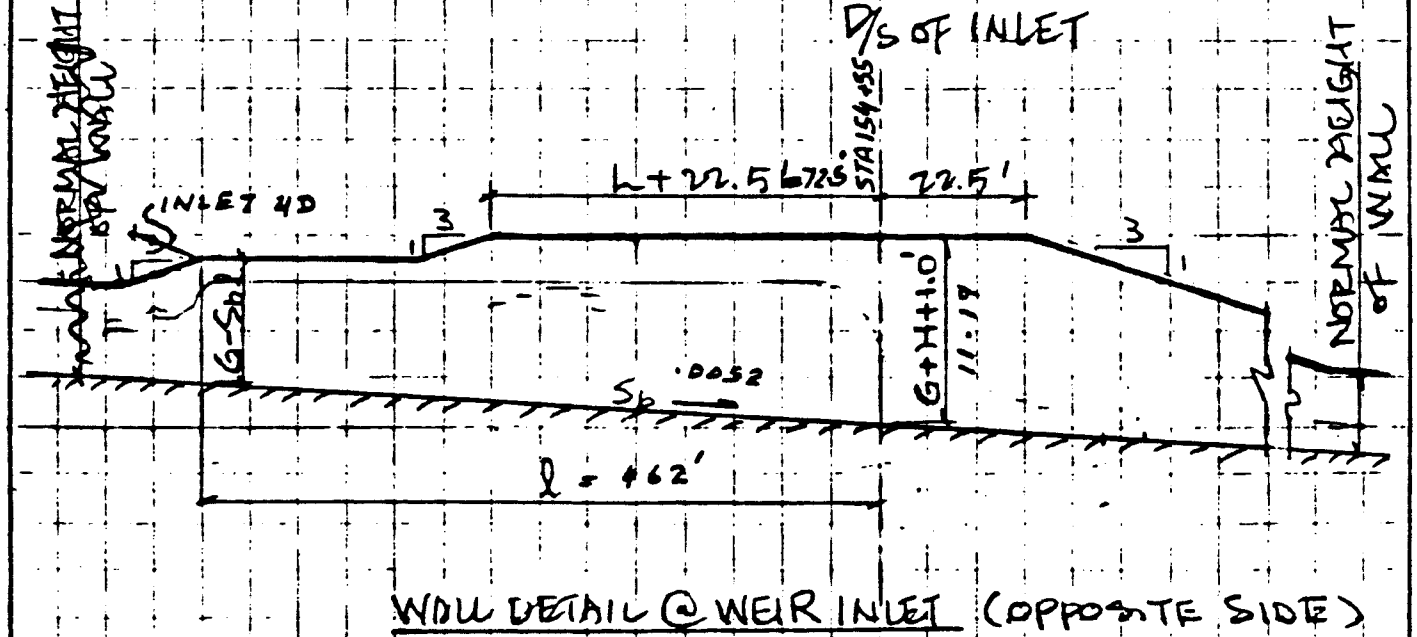
CLIENT USDA

PROJECT BULLDOG FLOODWAY & APACHE JTN FLOOD PROTECTION

SUBJECT BULLDOG FLOODWAY — CHANNEL WALL DETAIL



WALL DETAIL @ WEIR INLET (INLET SIDE)



WALL DETAIL @ WEIR INLET (OPPOSITE SIDE)

CHANNE STA 154+55 TO 156+00

$Q = 1441$ $b = 22'$ $S = .0052$ $d = 4.315'$

Height of wall 5'-6"

Bed El at STA 156+00 = 1736.12 - [15600 - 15455] x .0052

= 1735.37

TRANSITION STA 156+00 TO STA 156+30

$Q = 1441$ $b_1 = 22'$ $d_1 = 4.315$ $V_1 = 15.186$

$b_2 = 28'$ $S_2 = .00495$

Assume $d_2 = 3.64$ $A_2 = 101.92$, $R_2 = 2.87$ $V_2 = 14.14$ $d_2 = 3.64$ ok

Average $V = (15.186 + 14.14)\frac{1}{2} = 14.663$

$d = (4.315 + 3.64)\frac{1}{2} = 3.978$

$F = \frac{V}{\sqrt{g}\,d} = 1.29$

Transition angle $\tan\alpha = \frac{1}{3F} = .258$

Transition provided 1 in 10 is ok

Bed El at STA 156+30 = 1735.37 - [15630 - 15600] x .0495

= 1735.12

CHANNEL STA 156+30 TO STA 164+70

$Q = 1441$ $b = 28$ $S = .00495$ $d = 3.64$

$d_c = \left[\left(\frac{1441}{28}\right)^2/32.2\right]^{1/3} = 4.35$

$S_c = .0029 < \frac{S}{1.3}$

Height of walls = 1.2 x 3.64 = 4.37'

= 3.64 + 1 = 4.64 use 4'-9"

Bed El of STA 164+70 = 1735.22 - [16470 - 15630] x .00495

= 1731.06

INLET 4F

$Q_1 = 1441$ $b_1 = 28'$ $S_1 = .00495$ $d_1 = 3.64$ $V_1 = 14.14$

$Q_3 = 56$

$Q_2 = 1497$ $b_2 = 28'$

$\therefore F_1 = \frac{V}{\sqrt{g}\,d} = \frac{14.14}{\sqrt{32.2} \times 3.64} = 1.306$

Conjugate depth $= d_1 \frac{1}{2}\left(\sqrt{1+8F_1^2} - 1\right) = 5.145$

$\frac{Q_2}{Q_1} = \frac{1497}{1441} = 1.039$

From Fig 7 of draft copy of Report for ASCE

$h/d = .04$

$h = .04 \times 3.64 = 0.15'$

$L = \frac{0.15'}{.0049} = 30.3' \rightarrow$ say $30'$

F_2 just below inlet $= .992 = \frac{V_2}{\sqrt{g}\,d_2} = \frac{Q_2}{b_2 d_2 \sqrt{g}\,d_2}$

$\therefore d_2 = \left[\frac{1497}{28\sqrt{32.2}} \cdot \frac{1}{.992}\right]^{2/3} = 4.48'$

Provide 6' long weir

$Q = C L H^{3/2} = 56$

$H = \left(\frac{56}{3.1 \times 6}\right)^{2/3} = 2.08$

G = conjugate depth + h + 1

$= 5.145 + 0.15 + 1_{min} = 6.295$

$\therefore$ Weir EL $= 1731.06 + 6.295 = 1737.355$

Ground level is approx at EL 1739

$\therefore$ Provide weir at EL 1739.00

Water level for submergence of land $= 1739 + 2.08$

$= 1741.08$ say 1741.5

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CLIENT USDA SCS PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY

Top of Dike at EL 1742 feet

Q D/S channel = 1447 $b = 28'$ $S = .0495$

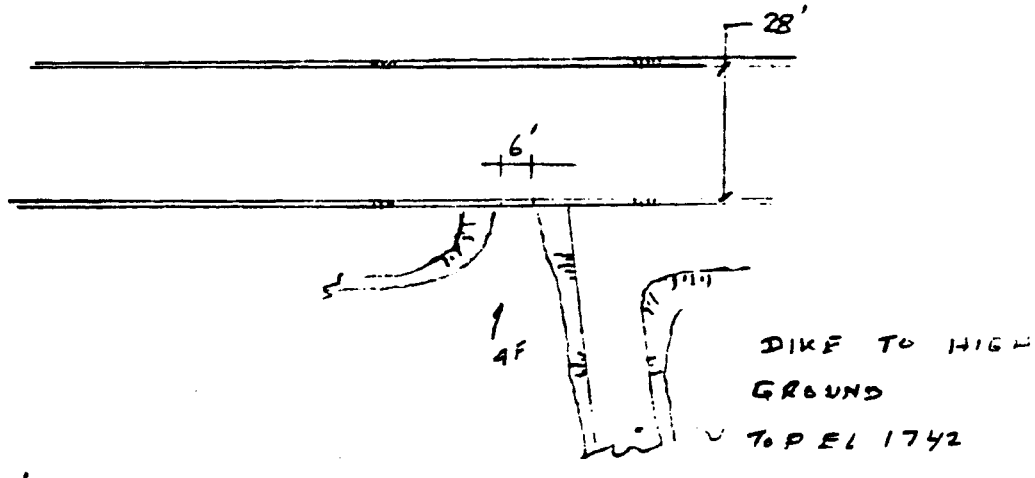
Assume $d = 3.65$ $A = 102.2$ $R = 2.895$ $V = 14.158$ $d = 3.65$ O.K

$d_c = [(\frac{1447}{28})^2 / 32.2]^{1/3} = 4.36$

$S_c = .0029 < \frac{S}{1.3}$ O.K

Weight of wall = $1.2 \times 3.65 = 4.38$

w $3.65 + 1 = 4.65$ Use 4'-9"



For inlet see Sh 26.

CHANNEL STA 164+70 TO STA 168+86

Q = 1447 $b = 28$ $S = .0495$ $d = 3.65$

Bed EL. at STA 169+ = $1731.06 - [16886 - 16470] \times .0495$

= 1729.00

Height of wall 4'-9"

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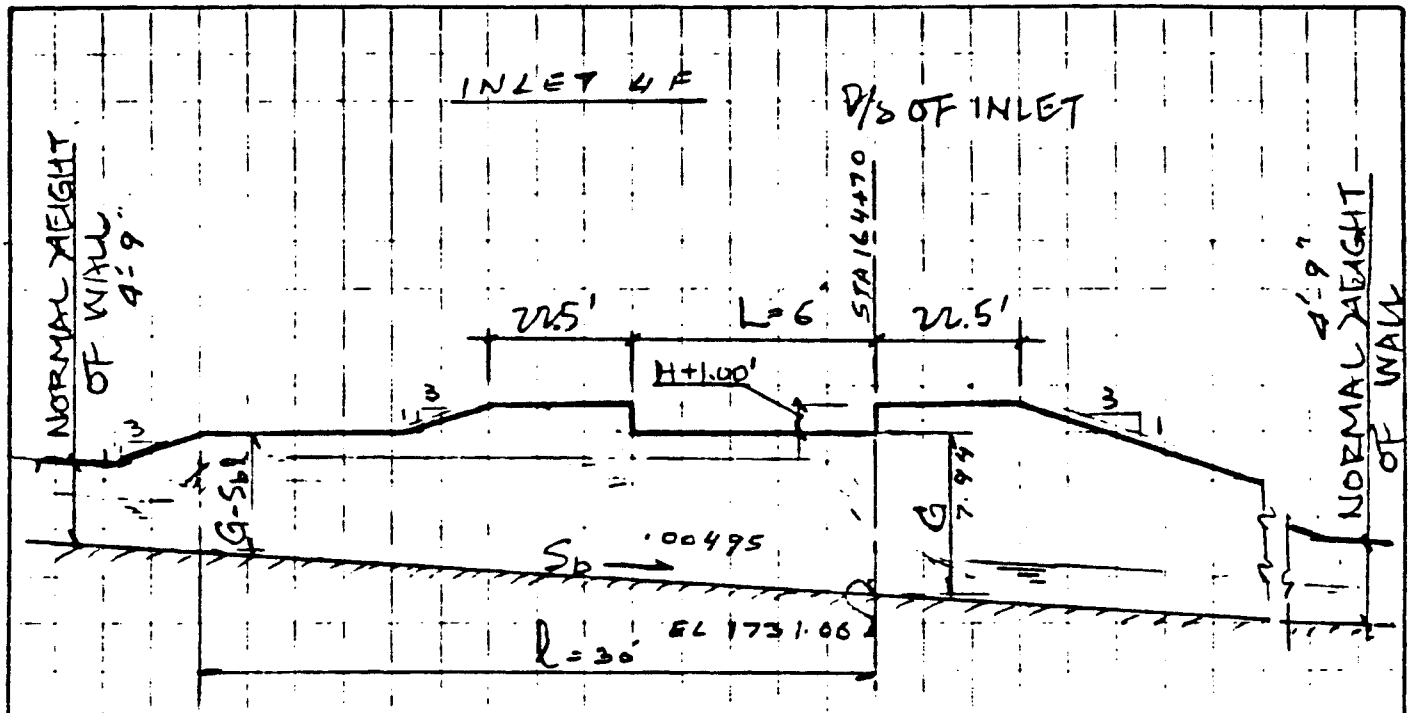
BY Y.C. YANG DATE 9-30-85 SG-YAL 11/2/185 /12-02-85 SHEET 2 OF

CHKD. BY SGoyal DATE 10-1-85 OFS NO. 3767.209 DEPT. NO. 1950

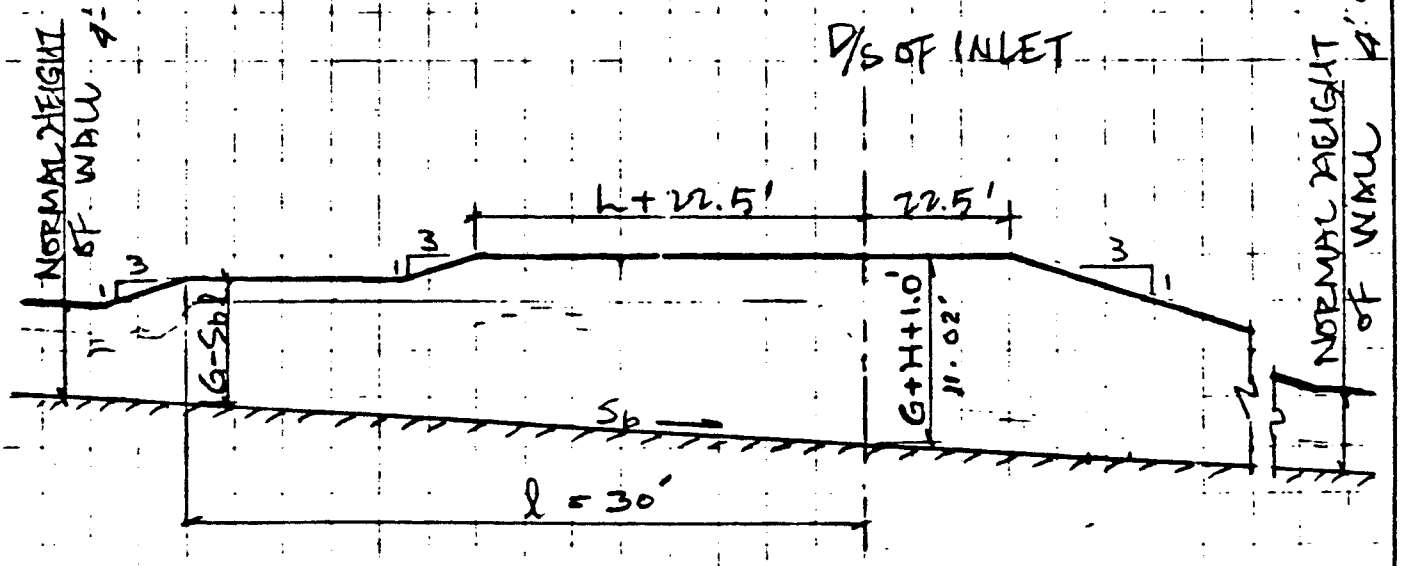
CLIENT USDA

PROJECT BULLDOG FLOODWAY & APACHE JTN FLOOD PROTECTION

SUBJECT BULLDOG FLOODWAY — CHANNEL WALL DETAIL



WALL DETAIL @ WEIR INLET (INLET SIDE)



WALL DETAIL @ WEIR INLET (OPPOSITE SIDE)

INLET 4G

To avoid the interference of 4G on 3-F in the hydraulic performance, the inlet 4G should be made as side channel inlet

Q_1 = [illegible] $b_1 = 28$ $d_1 = 3.65$ $A_1 = 102.2$ $V_1 = 14.58$

$Q_2 = 611$ $b_2 = 8.5$

Assume $d_2 = 3.8$

$V_2 = 18.92$ $A_2 = 32.3$ $R_2 = 2.006$

$$S_2 = \left[\frac{Vn}{1.486 R^{2/3}}\right]^2 = .0144$$

$d_{c_2} = 5.43$ $S_{c_2} = .0056 < \frac{S_2}{1.3}$

$Q_3 = 2058$

$b_3 = 35 > .8(b_1 + b_2)$ i.e. 29.2

$S_3 = .0051$

Assume $d_3 = 3.86$ $A_3 = 135.1$ $R_3 = 3.45$ $V_3 = 15.24$

$\therefore$ $d_3 = 3.858$ o.k.

$d_{c_3} = 4.75$ $S_{c_3} = .0027 < \frac{S_3}{1.3}$

$L = C V_2 (b_1 + b_2 - b_3)^{1/3}$ for $d_2 = 3.8$

$= 3.425 \times 18.92 (28 + 8.5 - 35)^{1/3} = 67.68$ say 68

length of splitter wall = $l/2 = 32'$

$$b_m = \frac{(b_1 + b_2) + b_3}{2} = 35.75'$$

$$d_m = \frac{1}{2}\left[\frac{Q_1 + Q_2}{V_1 b_1 + V_2 b_2} + d_3\right] = 3.78$$

$A_m = 135.01$ $P_m = 43.31$ $R_m = 3.12$

$V_m = 15.243$

$$b_3 = \frac{b_1 (b_1 + b_2 + b_3)}{2 (b_1 + b_2)} = 27.42 \text{ use } 27'-5"$$

Unequal width channel

$$\frac{Q_3^2}{g A_3} + \frac{b_3 d_3^2}{2} - \frac{b_3 d_3 h}{2} = \frac{Q_1^2}{g A_1} + \frac{Q_2^2}{g A_2} + \frac{b_3 d_1 h}{2} + \frac{b_1 d_1^2}{2} + \frac{b_3 - b_1}{2}(d_3^2) - \frac{\gamma_m L n^2 V_m^2}{2.2 R_m^{4/3}}$$

$\therefore$ $973.60 + 260.74 - 67.55h = 636.25 + 358.04 + 63.88h + 180.52 + 50.54 - 47.68$

or $131.43h = 49.75$ or $h = 0.38$

Provide a drop of 0.38' in the length of the junction.

$R_2' = \frac{1.2 \times 18.92^2}{32.2} \times 8.5 = 113.37$ say 114'

Height of wall channel $= 1.2 \times 3.86 + .25 \times 4.75 \left[1 - 11.1 \left(\frac{.0051}{.0027} - 1\right)^2\right] + 1$

$= 4.63 + 1 = 5.63$ use 5'-9"

Height of spitter wall = $d_2 = 3.8' > d_1$

" " " at end = 6"

Height of wall for inlet = $1.2 \times 3.8 + 1$

$= 4.56 + 1 = 5.56$ Use 5'-9"

Beginning of Junction at STA = 169+00 less 14

= 168+86

Bed EL of channel = 1731.06 − [16886 − 16470] × .0049

= 1729.00

End of Junction at STA 169+54

Bed EL of channel = 1729.00 − .38

= 1728.62

Provide a 55° curve for the side inlet channel

EL at the beginning of curve = $1729.00 + \left(\frac{2\pi \times 114}{360} \times 55\right) \times .0144$

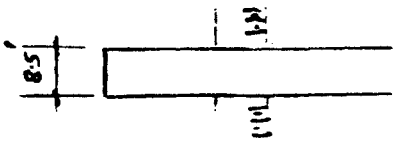
= 1730.58

The ground level is very high. Provide a drop inlet

$\frac{W}{B} = \frac{25.5}{8.5} = 3$

$Q = 611$

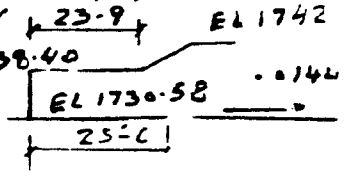
$Q/W^{5/2} = 2.90$



From Fig ES-90 Sheet 5 chute spillway

$\delta = 0.92$ $\gamma = 0.26$

$\therefore D_T = 0.92 \times 8.5 = 7.82'$ $H_e = .26 \times 8.5 = 2.21'$



Top of crest = 1730.58 + 7.82

= 1738.40

Provide a 80' wide channel with 2H : 1V side slopes

Effective $B = 25.5'$

$\therefore \quad B' = B - .42\,He$

$= 25.5 - .4 \times 2 \times 2.21 = 23.73 \rightarrow say\ 23'-9''$

$B/W = 3$

$K = \frac{80 + .8 \times 2 \times 2.21}{8.5} = 9.8$

$\therefore$ From Fig ES-9a Sheet 10 $K = .87$

Assume $Q = \frac{611}{.87} = 702$ $\rightarrow$ Then $Q_K = .87 \times 702 = 611$

$\therefore$ For $Q = 702$ i.e. $\frac{Q}{W^{5/2}} = 3.33$ $W/B = 3$

from Fig ES-9a Sheet 5

$Y = .29$

$He = .29 \times 8.5 = 2.47'$

$\therefore$ Water level for submergence $= 1738.40 + 2.47$

$= 1740.86$

$\rightarrow say\ 1741.00$

Top of Dike at EL 1742.00

Velocity in the arroyo

$= \frac{611}{(80 + 2 \times 2.47)2.47} = 2.91$

Provide riprap

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GOYAL DATE 11-25-85 / 12-02-85 SHEET 30 OF _____

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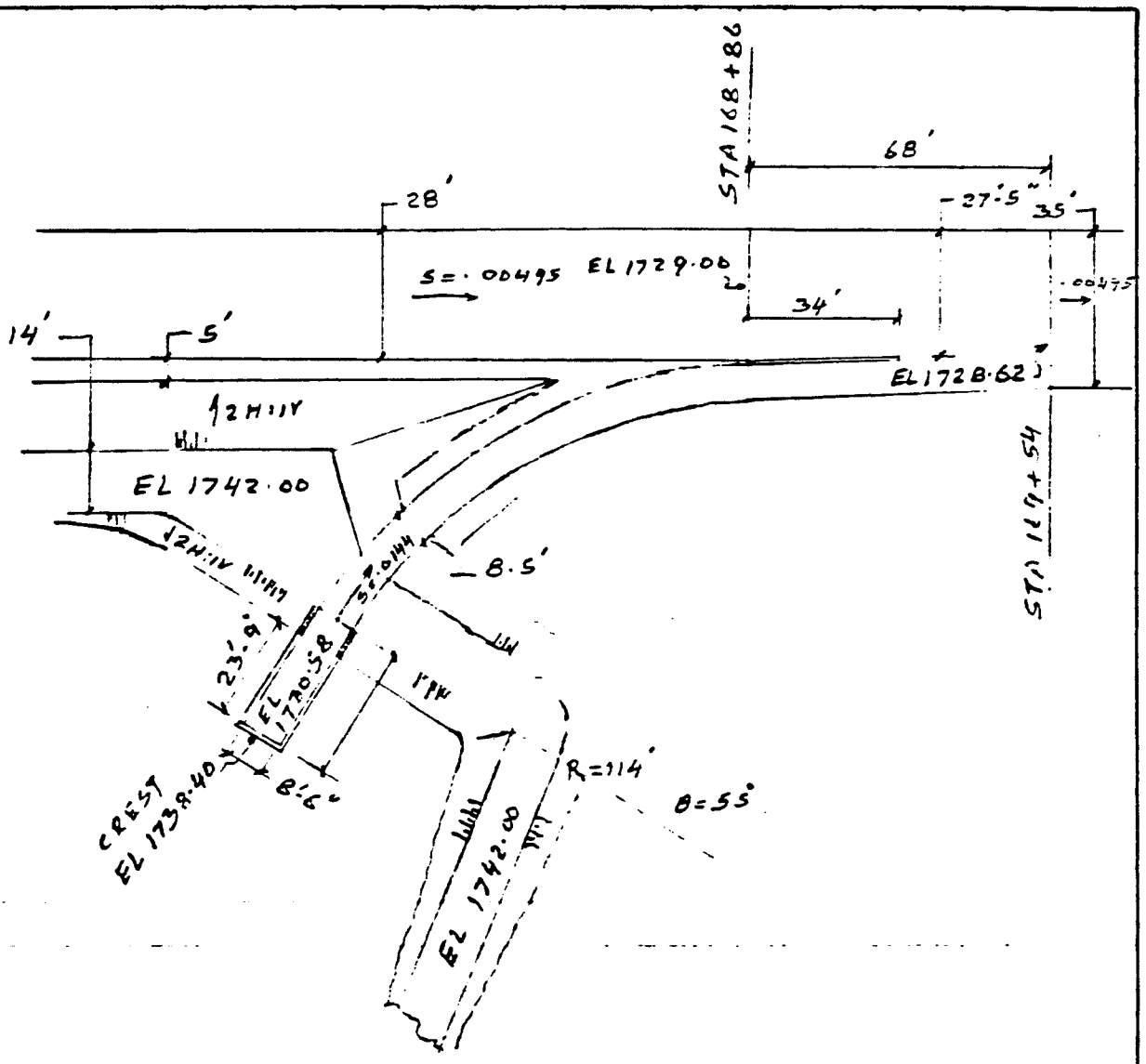
USDA SCS PHOENIX ARIZONA

BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

BULLDOG FLOODWAY INLET 4G



PLAN 4G

1" = 4'

CHANNEL STA 169+54 TO STA 171+55

$Q = 2048$ $b = 35'$ $S = .0051$

Assume $d = 3.845$ $A = 134.575$ $R = 3.152$ $V_c = 15.21$

$\therefore d = 3.847$ o.k

$d_c = 4.74$

$S_c = .00269 < \frac{S}{1.3}$ o.k

Height of wall = $1.2 \times 3.845 = 4.61'$

or $3.845 + 1 = 4.845$ use $5'-0$

Bed El at STA 171+55

$= 1728.62 - [17155 - 16954] \times .0051$

$= 1727.59$

INLET 4H

$Q_1 = 2048$ $b_1 = 35'$ $S_1 = .0051$ $d_1 = 3.845$ $V_1 = 15.21$

$Q_3 = 37$

$Q_2 = 2085$

$\therefore F_1 = \frac{V_1}{\sqrt{g d_1}} = 1.37$

Conjugate Depth = $d_1 \times \frac{1}{2}(\sqrt{1+8F_1^2} - 1) = 5.755$

$\frac{Q_2}{Q_1} = \frac{2085}{2048} = 1.018$

$\therefore h/d_1 = 0$ From Fig 9 of Draft copy of the Report for HSCE

$F_2 = 1.2 = \frac{V_2}{\sqrt{g d_2}} = \frac{2085}{b_2 d_2} \cdot \frac{1}{\sqrt{g d_2}} = \frac{2085}{35\sqrt{g}} \cdot \frac{1}{d_2^{3/2}}$

$\therefore d_2 = 4.25$

$\ell = \frac{h}{S} = 0$

No hydraulic jump is formed

Depth of water = 4.25

Provide weir at $4.25 + 1 = 5.25'$ above the bed of channel

$Q = 37$ cfs $= CL H^{3/2} = 3.1 L H_e^{3/2}$

Provide 5' long weir

$\therefore H_e = \left(\frac{37}{3.1 \times 5}\right)^{2/3} = 1.79'$

Provide 1' free board

If the flow in the main channel is less than 2048 cfs hydraulic jump may form in the main channel.

By trials assume $d_1 = 3'$ $A = 105$ $P = 41$ $R = 2.56$

$V_1 = 13.24$

$Q_1 = 1390.5$

$Q_2 = Q_1 + 37 = 1427.5$

$\frac{Q_2}{Q_1} = 1.027$

$F_1 = \frac{V_1}{\sqrt{g d_1}} = 1.347$

Conjugate depth $= 3 \times \frac{1}{2}\left(\sqrt{1 + 8 \times 1.347^2} - 1\right)$

$= 4.41$

$h/d_1 = 0$

$\therefore h = 0$

$F_2 = 1 = \frac{1427.5}{35\sqrt{32.2}\, d_2^{3/2}}$

$\therefore d_2 = 3.72$

For flows lower than 1390.5 cfs in the main channel hydraulic jump may form. Therefore the weir weir should be located above 4.41 which is less than 5.25'. 4.41' is less than height of u/s walls i.e 5'-0". O.K.

Provide inlet at STA 171+55
D/S End

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BY S COYLE DATE 11-26-85/12-02-85 SHEET 33 OF _____

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CLIENT USDA SCS PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

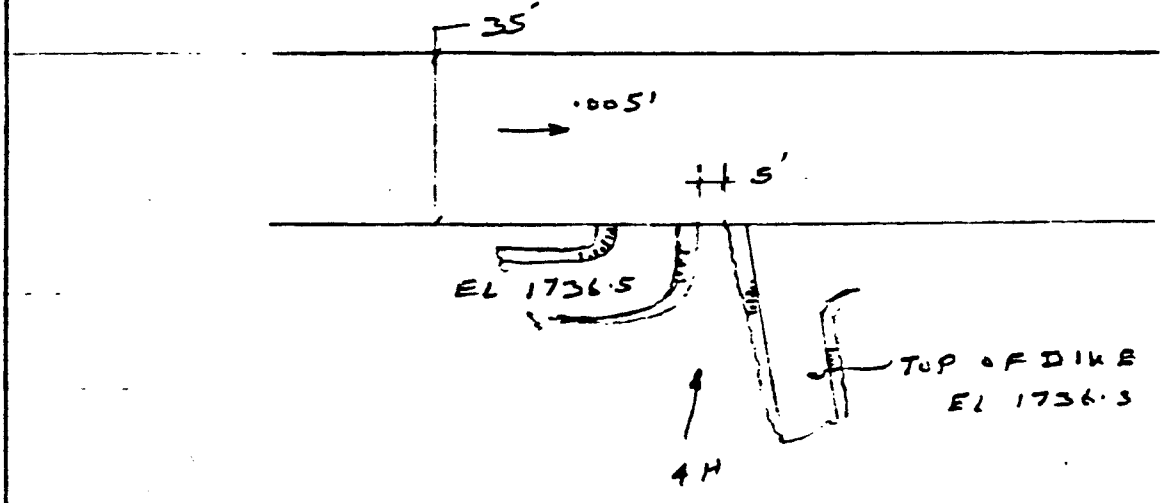
SUBJECT BULLDOG FLOODWAY INLET 4H

Bed El at STA 171+55 = 1727.59

El of weir = 1727.59 + 5.25 = 1732.84.
This is lower than the specified. Provide the
weir at El 1733.5
∴ Water level for submergence of band
= 1733.5 + 1.79
= 1735.29 say 1735.5
Top of Dike at El 1736.5

& D/S channel = 2049 b = 35' S = .005'
Assume d = 3.847 A = 134.645 R = 3.154 V = 15.215
∴ d = 3.848 o.k.
Use the height of wall 5'-0

For inlet see sheet 34



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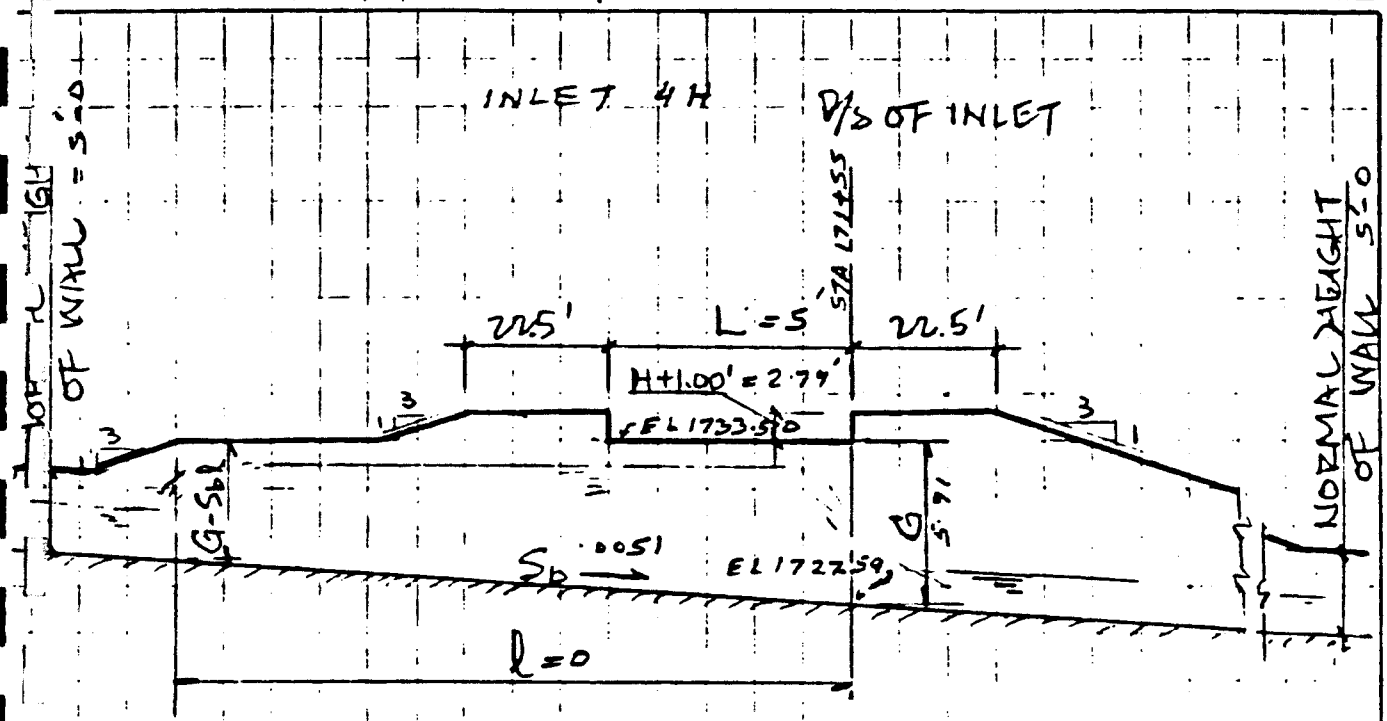
C. YANG DATE 9-30-85 S Goyal 11/26/85/12-02-85 SHEET 34 OF

KD. BY S Goyal DATE 10-1-85 OFS NO. 3767.202 DEPT. NO. 1650

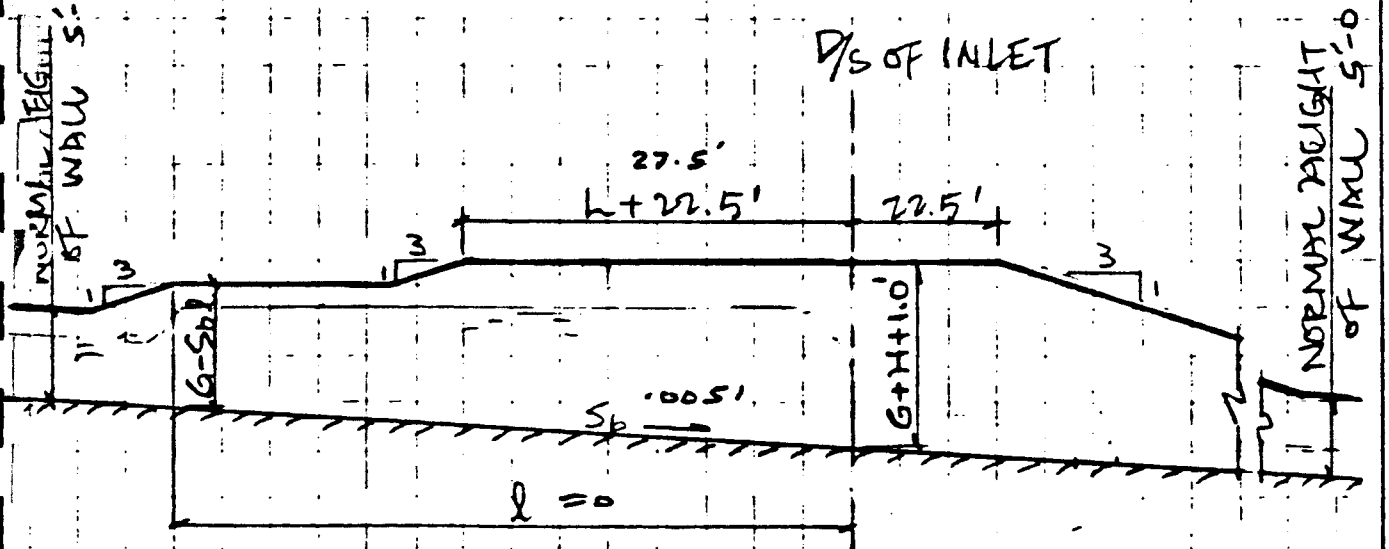
T USDA.

CT BULLDOG FLOODWAY & APACHE JTN FLOOD PROTECTION

JECT BULLDOG FLOODWAY — CHANNEL WALL DETAIL



WALL DETAIL @ WEIR INLET (INLET SIDE)



WALL DETAIL @ WEIR INLET (OPPOSITE SIDE)

1/80-81

EBASCO SERVICES INCORPORATED

BY S GOYAL DATE 11-26-85/12-02-85 SHEET 35 OF _____

CHKD. BY _____ DATE _____ OFS NO. USDA 27+30. DEPT. NO. _____

CLIENT USDA SCS PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY AT CENTRAL JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY

CHANNEL STA 171+55 TO STA 182+80

$Q = 2049$ $b = 35'$ $S = .0051$

Bed El at STA 182+80 = 1727.59 − [18280 − 17155] × .0051
= 1721.85

Height of wall is 5'

INLET SA

$Q_1 = 2049$ $b_1 = 35'$ $d_1 = 3.847$ $A_1 = 134.45$ $V_1 = 15.22$

$Q_2 = 2348$ $b_2 = 27.5'$

$d_2 = 4.3$

$V_2 = 19.86$ $A_2 = 118.25$ $R_2 = 3.076$

$S_2 = .00826$

$d_{c_2} = 6.095$ $S_{c_2} = .0029 < \frac{S_2}{1.3}$

$Q_3 = 4397$

$b_3 = 50' = .8(b_1 + b_2)$

$S_3 = .0051$

Assume $d_3 = 4.87$ $A_3 = 243.5$ $R_3 = 4.076$ $V_3 = 18.05$

$\therefore d_3 = 4.871$ O.K.

$d_{c_3} = 6.216$ $S_{c_3} = .0024 < \frac{S_3}{1.3}$ O.K

$l = C V_2 (b_1 + b_2 - b_3)^{1/3}$ for $d_2 = 4.3$

$= 3.42 \times 19.86 (35 + 27.5 - 50)^{1/3}$

$= 157.6$ say 160'

Length of splitter wall $= l/2 = 80'$

$b_m = \frac{(b_1 + b_2) + b_3}{2} = 56.25'$

$d_m = \frac{1}{2}\left[\frac{Q_1^2 + Q_2^2}{V_1 b_1 + V_2 b_2} + d_3\right] = 4.473$

$A_m = 251.60$ $P_m = 65.20$ $R_m = 3.86$

$V_m = 17.48$

$b_3 = \frac{35(35 + 27.5 + 50)}{2(35 + 27.5)} = 31.5'$

Unequal width main channel

$$\frac{Q_3^2}{g A_3} + \frac{b_3 d_3^2}{2} - \frac{b_3 d_3 h}{2} = \frac{Q_1^2}{g A_1} + \frac{Q_2^2}{g A_2} + \frac{b_3 d_1 h}{2} + \frac{b_1 d_1^2}{2} + \left(\frac{b_3 - b_1}{2}\right) d_2^2 - \frac{P_m l_{11}^2 V_m^2}{2.21 R_m^{1.33}}$$

$\therefore 2465.80 + 592.92 - 121.75\,h = 968.36 + 1447.90 + 96.18\,h + 258.99 + 138.69 - 206.88$

$\therefore 217.93\,h = 451.67$

$h = 2.07'$

Radius of bend $R_2' = \frac{1.2 \times 1986^2 \times 27.5}{32.2 \times 1} = 404.22$ say $410'$

Height of wall $= 1.2 \times d_3 + .25\,d_{c_2}\left[1 - 11.1\left(\frac{S_2}{S_{c_2}} - 1\right)^2\right] + \frac{1.2 V_2^2 b_2}{g R_2'}$ neglect

$= 5.844 + 0 + 1$

$= 6.844$ use $7'-0$

Height of splitter wall $= d_2 = 4.3 > d_1$ use $4'-4"$

" " lower end $= 6"$

Height of wall for inlet $= 1.2 \times 4.3 + \frac{1.2 V_2^2 b_2}{g R_2'}$

$= 5.16 + 1 = 6.16$ use $6'-3$

Provide beginning of junction at STA $182+80$

El at STA $182+80 = 1721.85$

Provide a $30°$ curve and $30'$ straight reach in the side inlet

Length of channel $= \frac{2\pi \times 410}{360} \times 30 + 30 = 246.68'$

El at the inlet $= 1721.85 + 246.68 \times .00826$

$= 1723.89$

This is about a foot lower than the ground.

Provide a straight inlet

$Q = 2348 = C_L H_e^{3/2} = 3.1 \times 27.5\, H_e^{3/2}$

$\therefore He = 9.12$

Total energy in the channel at the inlet

$= 1723.89 + 4.3 + \frac{1986^2}{2g} = 1734.31$

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BY S GOYAL DATE 11-26-85 / 12-02-85 SHEET 37 OF _____

CHKD. BY _____ DATE _____ OFS NO. USDA [illegible] DEPT. NO. 560

CLIENT USDA SCS PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY INLET SA

∴ Provide the inlet crest at 1734.31 − 9.12

= 1725.19

say 1725.25

Provide a 80' wid. channel 2:1 side slopes

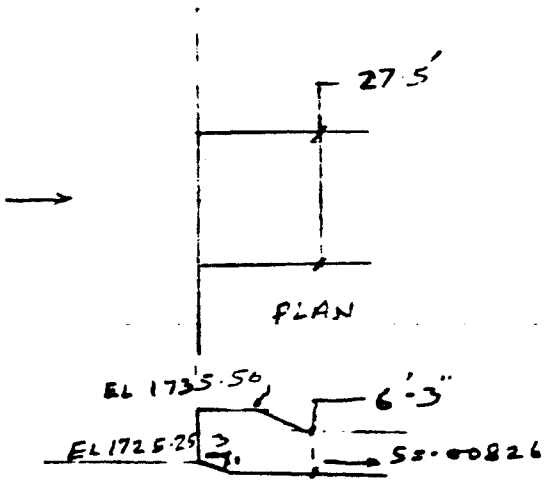
$$V = \frac{2348}{(80 + 2\times9)\,9} = 2.66$$

$$H_c = 9 + \frac{2.66^2}{64.4} = 9.11 < 9.12 \quad \text{O.K}$$

Water level for subcritical flow = 1725.25 + 9.12

= 1734.37 say 1734.50

Top of Dike at EL 1735.50



End of Junction at STA 184+40 SECT

Bed EL at STA 184+40 = 1721.85 − 2.07

= 1719.78

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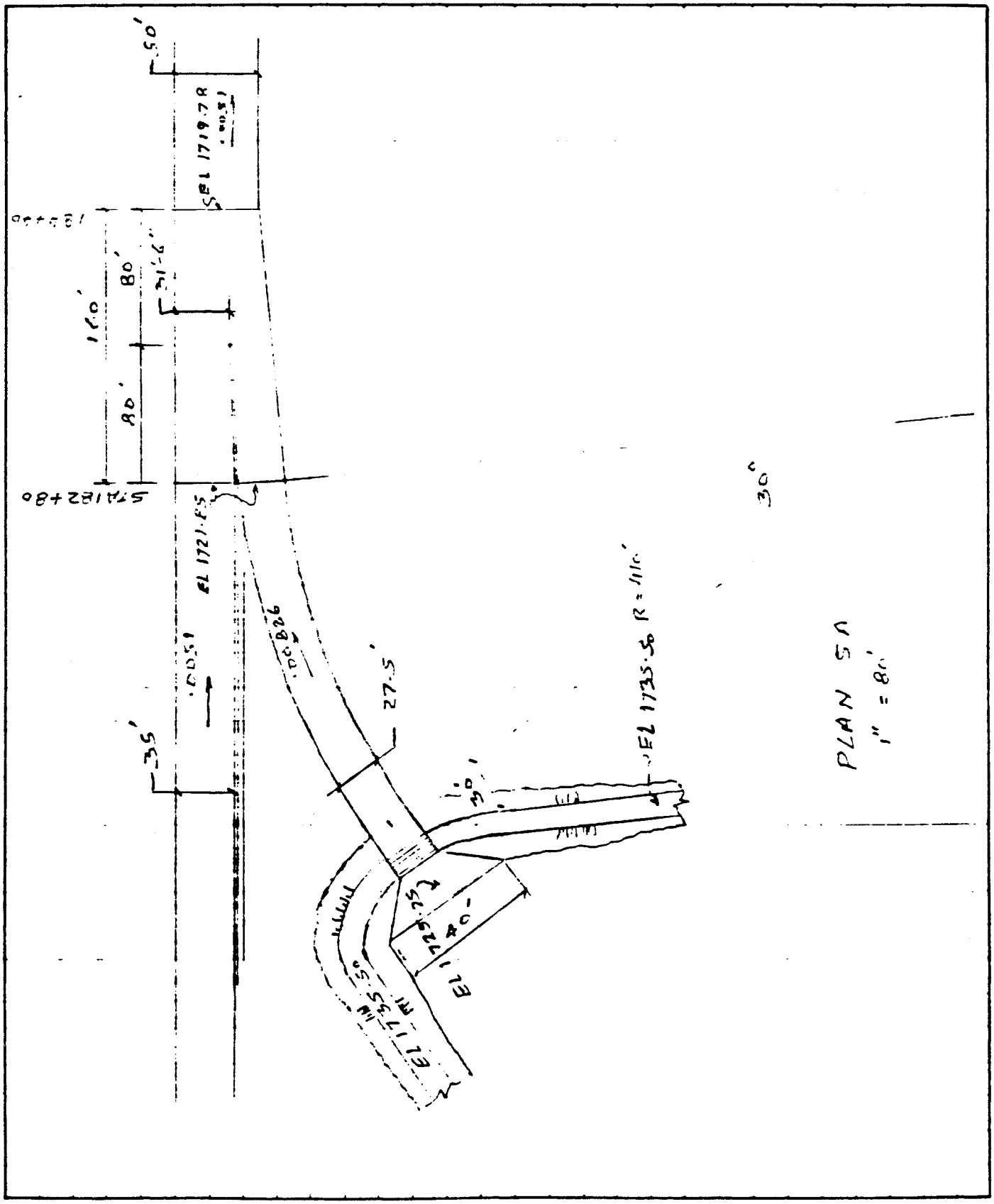
BY S GOYAL DATE 11-27-85 SHEET 38 OF _____

CHKD. BY _____ DATE _____ OFS NO. USDA [illegible] DEPT. NO. 550

CLIENT USDA SCS PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY INLET SA



CHANNEL STA 184+40 TO STA 187+00

$Q = 4254$ $b = 50'$ $S = .0051$

Assume $d = 4.77$ $A = 238.5$ $R = 4.01$ $V = 17.84$

$\therefore d = 4.768$ o.k

$d_c = 6.08$ $S_c = .0018 < \frac{S}{1.3}$ o.k

Height of walls $= 1.2 \times 4.77 = 5.72$

or $4.77 + 1 = 5.77$ use $5'-9"$

El at STA $186+30 = 1719.78 - [18700 - 18440] \times .0051$

$= 1718.45$

INLET SB

$Q_1 = 4254$ $b_1 = 50'$ $d_1 = 4.77$ $A_1 = 238.5$ $V_1 = 17.84$

$Q_2 = 157$ $b_2 = 3.00$

Assume $d_2 = 4.00$ $\frac{d_1}{d_2} = 1.19 < 1.2$ o.k

$V_2 = 13.08$ $A_2 = 12$ $R_2 = 1.09$

$S_2 = \left[\frac{Vn}{1.486 R^{2/3}}\right]^2 = .0155$

$d_{c_2} = 4.348$ $S_{c_2} = .0124$

$\frac{S_2}{1.3} < S_{c_2}$ will need additional freeboard

$F_2 = \frac{V}{\sqrt{gd}} = 1.153 < 1.2$

Inlet SB does not satisfy the requirements of side channel inlet for $\frac{d_1}{d_2} < 1.2$ and $F > 1.2$

For $F_2 = 1.2$ the flow should be approximately 165 cfs. which is not very much different from 157 cfs. Provide a side inlet for SB to properly drain the arroyo and avoid standing pool. Design the inlet for 165 cfs

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BY S GOYAL DATE 11-27-85 SHEET 40 OF _____

CHKD. BY _____ DATE _____ OFS NO. USDA 3767.300 DEPT. NO. 450

CLIENT USDA SCS PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY INLET SB

$Q_1 = 4254$ $b_1 = 50'$ $d_1 = 4.77$ $A_1 = 238.5$ $V_1 = 17.84$

$Q_2 = 165$ Assumed $b_2 = 3$

$d_2 = 4$ $\frac{d_1}{d_2} = 1.19 < 1.2$ o.k

$V_2 = 13.75$ $A_2 = 12$ $R_2 = 1.09$

$S_2 = \left[\frac{V_n}{1.486 R^{2/3}}\right]^2 = .0172$

$d_{c_2} = 4.55$ $S_{c_2} = .0127 < \frac{S_2}{1.3}$ o.k

$F_2 = \frac{V}{\sqrt{g d}} = 1.21 > 1.2$

$Q_3 = Q_1 + Q_2$

$= 4419$

$b_3 = 50' > .8(b_1 + b_2)$ i.e 42.4

$S_3 = .0051$

Assume $d_3 = 4.89$ $A_3 = 244.5$ $R_3 = 4.09$ $V_3 = 18.09$

i.e $d_3 = 4.885$ o.k

$d_{c_3} = 6.24$ $S_{c_3} = .0024 < \frac{S_3}{1.3}$ o.k

$l = c V_2 (b_1 + b_2 - b_3)^{1/2}$ for $d_2 = 4$

$= 3.25 \times 13.75 (3)^{1/3} = 64.45 \rightarrow$ say $65'$

Length of splitter wall $= l/2 = 32.5'$

$b_m = \frac{(b_1 + b_2) + b_3}{2} = 51.5$

$d_m = \frac{1}{2}\left[\frac{Q_1^2 + Q_2^2}{V_1 b_1 + V_2 b_2} + d_3\right] = 4.81$

$A_m = 247.85$ $P_m = 61.12$ $R_m = 4.06$

$V_m = 17.83$

$b_3 = \frac{50(50 + 3 + 50)}{2(50 + 3)} = 48.58$ $48'-7"$

Equal width main channel

$$\frac{Q_3^2}{g A_3} + \frac{b_3 d_3^2}{2} - \frac{b_3 d_3 \lambda}{2} = \frac{Q_1^2}{g A_1} + \frac{Q_2^2}{g A_2} + \frac{b_3 d_1 \lambda}{2} + \frac{b_1 d_1^2}{2} - \frac{P_m l n^2 V_m^2}{2.21 R_m^{4/3}}$$

$2480.35 + 597.80 - 122.25\lambda = 2356.4 + 70.46 + 122.25\lambda + 568.82 - 60.60$

$\therefore 241.5\lambda = 163.07$

$\lambda = .68'$

Use $S = .9'$

Radius of bend $R_2 = \frac{1.2 \times 13.75^2 \times 3}{32.2 \times .5} = 42.27$ say 45'

Height of wall $= 1.2 \times d_3 + .25 d_{c3} \left[1 - 11.1 \left(\frac{S_3}{S_{c3}} - 1\right)^2\right] + \frac{1.2 V_2^2 b_2}{2 R_2}$

$= 5.87 + 0 + .3$

$= 6.37'$ use 6'-6"

Height of splitter wall $= d_1 = 4.77 > d_2$

\ " " down end $= 6"$

Height of wall for inlet $= 1.2 \times 4 + \frac{1.2 V_2^2}{2 g} b_2$

$= 4.8 + .5$

$= 5.3$ use 5'-6"

Provide beginning of junction at STA 187+00

EL $= 1718.45$

For of a 45° curve with 20' straight provide in the inlet

Length of channel $= 2\pi \times 45 \cdot \frac{45}{360} + 20 = 55.34$

EL. at the inlet $= 1718.45 + 55.34 \times .0172$

$= 1719.40$

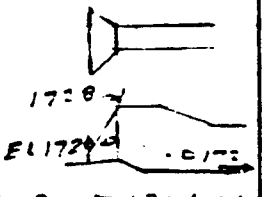
This is lower than ground contours

provide inlet crest at EL 1720 straight inlet

Total energy at the inlet in the channel

$= 1719.40 + d + \frac{13.75^2}{64.4}$

$= 1726.34$



$Q = 165 = 3.1 \times L \times H_e^{3/2}$

for $L = 3'$ $H_e = 6.80'$

\ Total energy u/s inlet $= 1720 + 6.8 = 1726.8$ > 1726.34 o.k.

Water level for submergence $= 1726.8$ say 1727

Top of Drke at EL 1728

Provide channel 3' wide with 2:1 side slope

$V = \frac{165}{(3 + 2 \times 6.7) 6.7} = 1.5$ fps o.k.

(d assumed 6.7' $H_e = 6.7 + \frac{1.5^2}{64.4} = 6.73 < 6.8$ o.k.)

End of Junction at STA 187+65

Bed El. $= 1718.45 - .68 = 1717.77$

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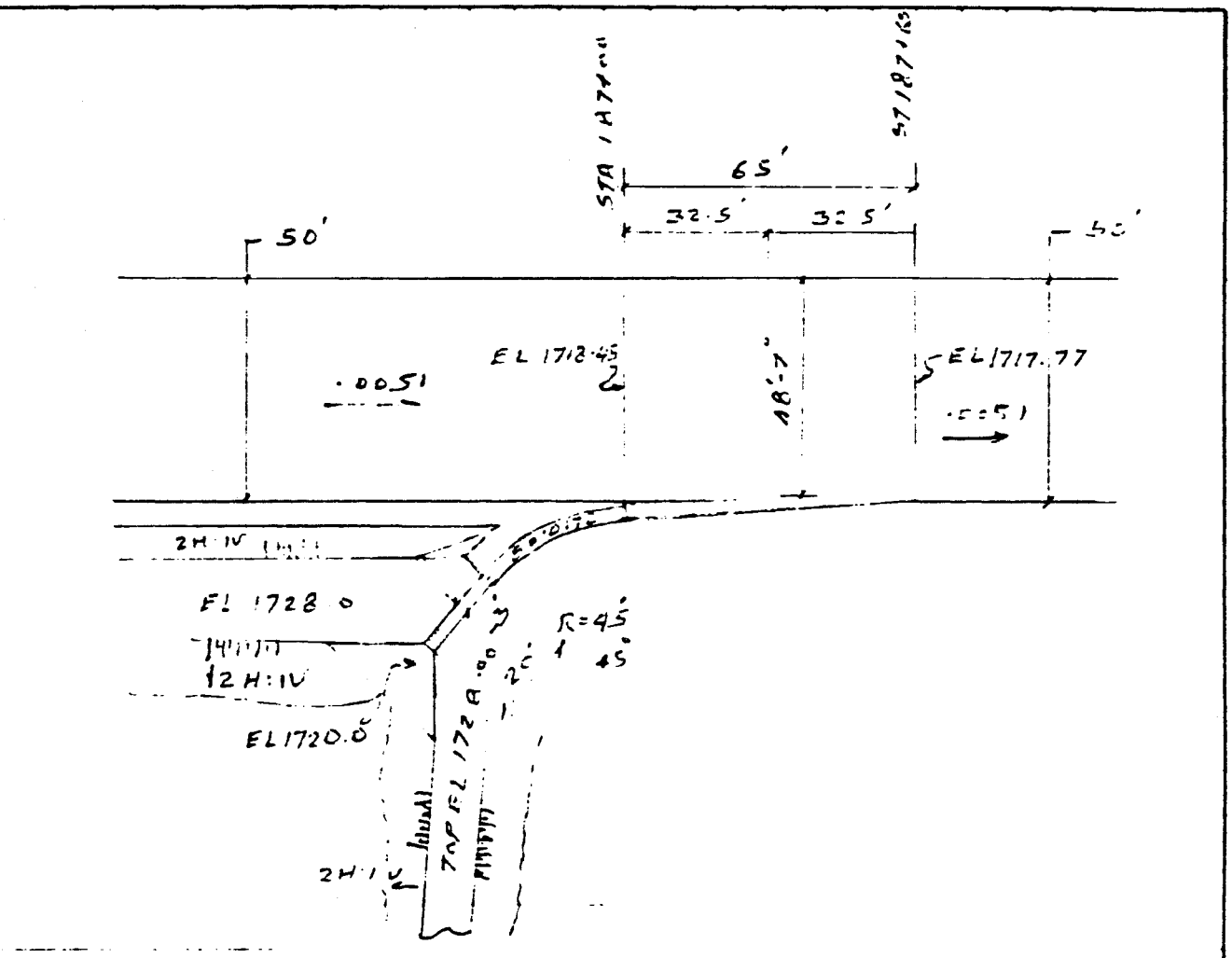
BY S Goyal DATE 12-02-85 SHEET 42 OF _____

CHKD. BY _____ DATE _____ OFS NO. USDA SCS PHOENIX AZ DEPT. NO. _____

CLIENT USDA SCS PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY INLET 5B



PLAN 5B

1" = 40'

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BY S GOYAL DATE 12-02-85 SHEET 12 OF _____

CHKD. BY _____ DATE _____ OFS NO. USDA-7[illegible] DEPT. NO. [illegible]

CLIENT USDA SCS PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY

CHANNEL STA 187+45 TO 189+40

$Q = 4369 \quad b = 50' \quad S = .0051$

Assume: $d' = 4.85 \quad A = 242.5 \quad R = 4.06 \quad V = 18.01$

$\therefore \quad d = 4.851$ O.K

$d_c = 6.19 \quad S_c = .0024 < \frac{S}{1.3}$ O.K

Height of wall = $1.2 \times 4.85 = 5.82$

or $4.85 + 1' = 5.85$ use $6'-0$

Bed El at STA 189+40 = $1717.77 - [18940 - 18765] \times .0051$

$= 1716.88$

INLET S.C.

$Q_1 = 4369 \quad b_1 = 50' \quad S_1 = .0051 \quad d_1 = 4.85 \quad V_1 = 18.01$

$Q_3 = 36$

$Q_2 = 4405$

$\therefore F_1 = \frac{V_1}{\sqrt{g d_1}} = 1.44$

conjugate depth = $d_1 \times \frac{1}{2}(\sqrt{1 + 8F_1^2} - 1) = 7.75'$

$Q_2/Q_1 = 1.008$

$\therefore h/d_1 = 0$ From Fig 9 of Draft copy of the report

$F_2 = 1.38 = \frac{V_2}{\sqrt{g d_2}} = \frac{4405}{50 \times d_2} \frac{1}{\sqrt{g d_2}} = \frac{4405}{50} \frac{1}{\sqrt{g}} d_2^{-3/2}$

$\therefore \quad d_2 = 5.02$

$R = \frac{h}{S} = 0$

No hydraulic jump is formed

Depth of water = 5.02

Provide weir at El = 1716.88 + 5.02 + 1' = 1722.90

$Q = 36$ cfs $= CLH^{3/2} = 3.1 L H_e^{3/2}$

Provide 5' long weir

$\therefore H_e = \left(\frac{36}{3.1 \times 5}\right)^{2/3} = 1.75$

Provide 1' free board

If the flow in the main channel is less than the hydraulic jump may form in the main channel

Assume $d = 3'$ $A = 1.5$ $R = 2.68$

$\therefore Q_1 = 2047$

$Q_2 = Q_1 + 36 =$

$\frac{Q_2}{Q_1} = 1.0176$

$F_1 = 1.39$

Conjugate depth $= 3 \times \frac{1}{2}(\sqrt{1 + 8 \times 1.39^2} - 1)$

$= 4.58'$

This is less than the height of wall in the channel and moreover no hydraulic jump is formed even with this low flow. Weir is located about (5.02 ±) ft 6.02 ft above the bed.

Provide inlet at STA 189+40
D/S end

Bed EL = 171682

Weir EL = 172290

Weir elevation is approximately at the ground level

Provide weir at EL 1723.00

Water level for submergence of land

$= 1723 + 1.75 = 1724.75$

Top of Dike at EL 1726.00

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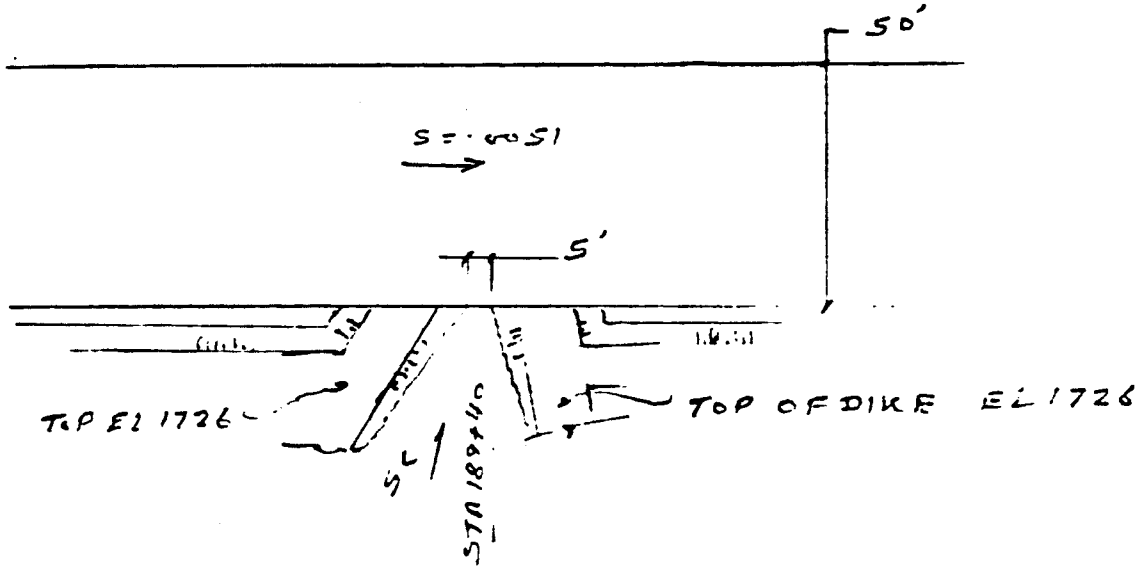
BY S Goyal DATE 12-02-85 SHEET 45 OF _____

CHKD. BY _____ DATE _____ OFS NO. USDA 3-[illegible] DEPT. NO. [illegible]

CLIENT USDA SCS PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY INLET SC



PLAN SC

For inlet SC see sheet 46

CHANNEL STA 189+40 TO 194+30

Q = 4366 b = 50' S = .0051

d = 4.85

use 6' height of walls on upstream of the inlet

Bed El at STA 194+30 = 1716.88 - [19430 - 18940] x .0051

= 1714.38

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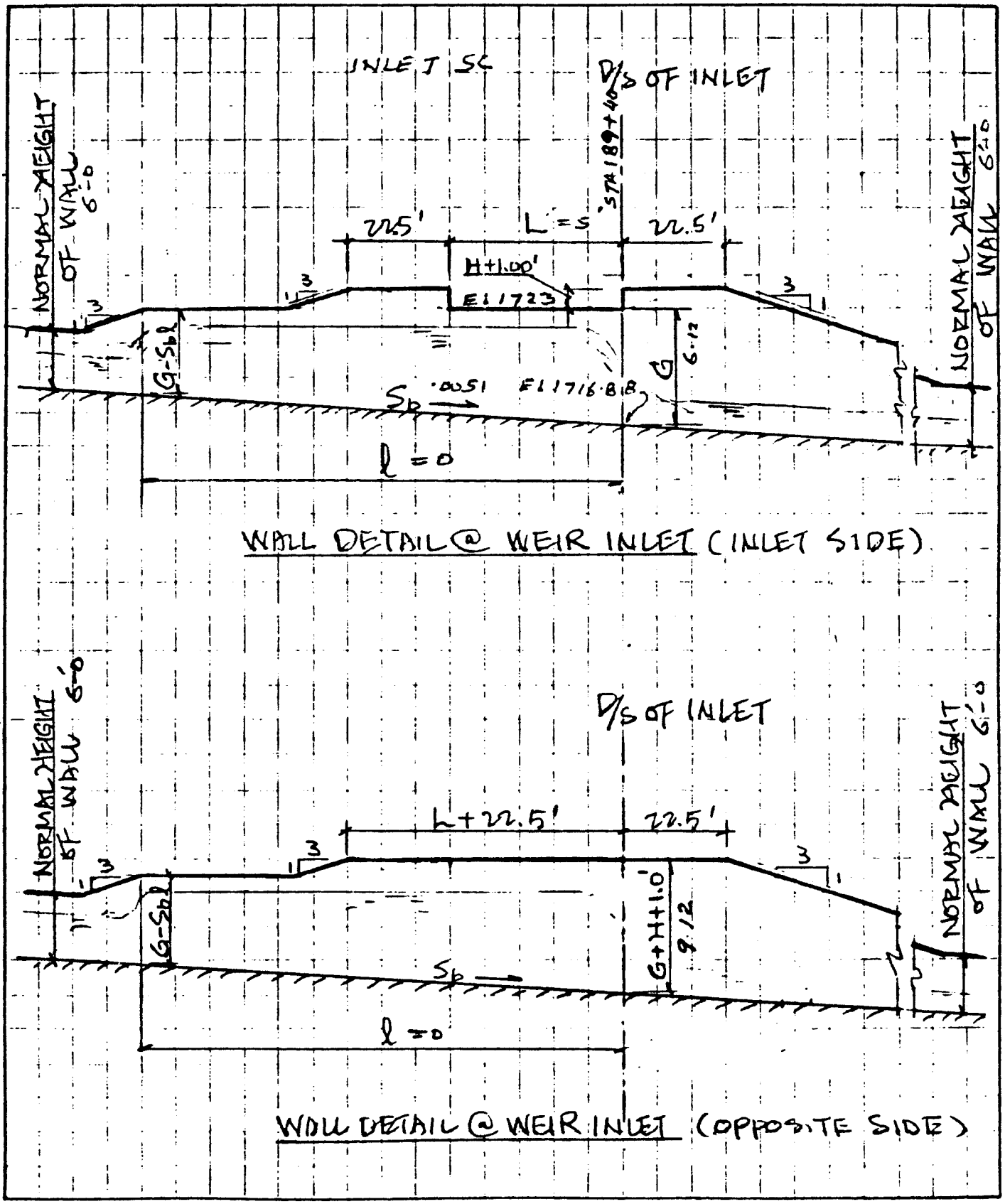
BY Y.C. YANG DATE 9-30-85 S GOYAL 12-02-85 SHEET 4/5 OF

CHKD. BY S Goyal DATE 10-1-85 OFS NO. 3767.200 DEPT. NO. 1950

CLIENT USDA

PROJECT BULLDOG FLOODWAY & APACHE JCT FLOOD PROTECTION

SUBJECT BULLDOG FLOODWAY — CHANNEL WALL DETAIL



581/8-81

$Q_1 = 4366$ $b_1 = 50'$ $d_1 = 4.85$ $A_1 = 242.5$ $V_1 = 18.01$

$Q_2 = 345$ $b_2 = 7$

$d_2 = 4.05$ $\frac{d_1}{d_2} = 1.20$ o.k

$V_2 = 12.17$ $A_2 = 28.35$ $R_2 = 1.88$

$S_2 = \left[\frac{Vn}{1.486\, R^{2/3}}\right]^2 = .0065$

$d_{c_2} = 4.23$ $S_{c_2} = .0058 > \frac{S_2}{1.3}$

Provide extra free board in the midinlet

$Q_3 = 4711$

$b_3 = 50' > .8(b_1 + b_2)$ i.e 45.6

$S_3 = .0051$

Assume $d_3 = 5.09$ $A_3 = 254.3$ $R_3 = 4.23$ $V_3 = 18.50$

$\therefore d_3 = 5.09$ o.k

$d_{c_3} = 6.51$ $S_{c_3} = .0024 < \frac{S_3}{1.3}$ o.k

$l = CV_2(b_1 + b_2 - b_3)^{1/3}$ for $d_2 = 4.05$

$= 3.3 \times 12.17 (7)^{1/3} = 76.8$ say $77'$

Length of splitter wall $= l/2 = 38.5'$

$b_m = (b_1 + b_2) + b_3 = 535'$

$d_m = \frac{1}{2}\left[\frac{Q_1^2 Q_2}{V_1 b_1 + V_2 b_2} + d_3\right] = 4.935$

$A_m = 264.0$ $P_m = 63.37$ $R_m = 4.166$

$V_m = 17.84$

$b_3 = \frac{50(50+7+50)}{2(50+7)} = 46.93$ $46'-11''$

Equal width channel

$$\frac{Q_3^2}{gA_3} + \frac{b_3 d_3^2}{2} - \frac{b_3 d_3 \Delta}{2} = \frac{Q_1^2}{gA_1} + \frac{Q_2^2}{gA_2} + \frac{b_3 d_1 \Delta}{2} + \frac{b_1 d_1^2}{2} - \frac{P_m l n^2 V_m^2}{2.21 R_m^{1/3}}$$

$\therefore 270821 + 647.70 - 127.25\Delta = 2441.18 + 130.39 + 121.25\Delta + 585.66 - 98.26$

$\Rightarrow 248.5\Delta = 294.55$

$\Delta = 1.19'$

EBASCO SERVICES INCORPORATED

BY S GOYAL DATE 12-02-85 SHEET 13 OF

CHKD. BY DATE OFS NO. DEPT. NO.

CLIENT USDA SCS PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY INLET 6A

for $S_2 = 1$

Radius of bend $R_2' = \frac{1.2 \times 12.17^2 \times 7}{32.2 \times 1} = 38.64$ use 40'

Height of wall $= 1.2 \times d_2 + .25\, d_{c_2}\left[1 - 11.1\left(\frac{S_3}{S_{c_2}} - 1\right)^2\right] + 1.2\,\frac{V_2^2 b_2}{g R_2'}$

$= 6.108 + 0 + .966$

$= 7.074$ use 7'-0

Height of upstream wall $= d_1 = 4.85 > d_0$

" " lower end $= 6''$

Height of wall for inlet $= 1.2 \times d_2 + .25\, d_{c_2}\left[1 - 11.1\left(\frac{S_2}{S_{c_2}} - 1\right)^2\right]$

$+ 1.2\,\frac{V_2^2 b_2}{g R_2'}$

$= 1.2 \times 4.05 + .25 \times 4.23\left[1 - 11.1\left(\frac{.0065}{.0158} - 1\right)\right]^2$

$+ 1.2 \times \frac{12.17^2 \times 7}{32.2 \times 40}$

$= 4.86 + .886 + .966$

$= 6.712$ use 6'-9"

Provide beginning of Junction at STA 194+30

EL = 1714.38

Provide a 60° curve

Length of channel $= 2\pi \times 40 \times \frac{60}{360} = 41.88'$

EL at inlet $= 1714.38 + 41.88 \times .0065$

$= 1714.65$

This is slightly lower than the ground contour

Provide inlet at EL 1714.75 straight inlet.

Total energy at inlet $= 1714.65 + 4.05 + \frac{12.17^2}{64.4} = 1721.00$

$Q = 345 = 3.1 \times L \times H_e^{3/2}$

for $L = 7'$ $H_e = 6.32$

∴ Total energy $= 1714.75 + 6.32 = 1721.07 > 1721.00$

Water level for submergence $= 1721.07$ say 1721.25

Top of dike at EL 1722.25

Provide channel 7' wide 2:1 side slopes

$V = \frac{345}{(7 + 2 \times 6.2)\,6.2} = 2.87$ fps

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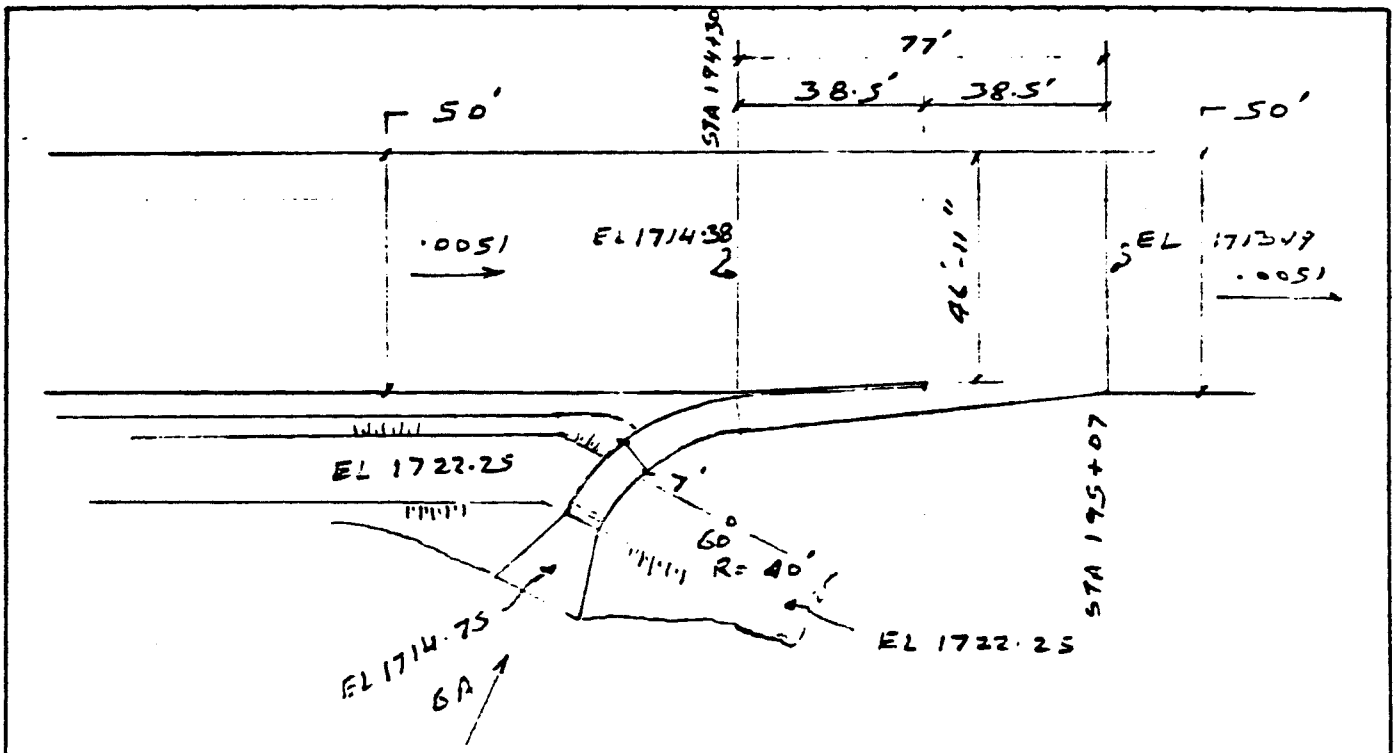
BY S GOYAL DATE 12-2-85 SHEET 49 OF _____

CHKD. BY _____ DATE _____ OFS NO. USDA 3767.20 DEPT. NO. 654

CLIENT USDA SCS PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

SUBJECT BULLDOG FLOODWAY INLET 6A



PLAN 6A
1"=40'

EL at the end of junction at STA 195+07
= 1714.38 - 1.19 = 1713.19'

CHANNEL STA 195+07 TO STA 202+00

Q = 4670 b = 50' S = .0051

Assume d = 5.063 A = 253.15 R = 4.21 V = 18.45

∴ d = 5.063 O.K

d_c = 6.47 S_c = .00239 $< \frac{S}{1.3}$ O.K

Height of wall = 1.2 x 5.063
= 6.07 use 6'-3"

EL STA 202+00 = 1713.19 - [20200 - 19507] x .0051
= 1709.66

INLET 6B

$Q_1 = 4670$ $b_1 = 50'$ $S_1 = .0051$ $d_1 = 5.063$ $V_1 = 18.45$

$Q_3 = 126$

$Q_2 = 4796$

$F_1 = \frac{V_1}{\sqrt{g} d_1} = 1.445$

Conjugat. depth $= d_1 \times \frac{1}{2}[\sqrt{1+8F_1^2} - 1] = 8.12$

$\frac{Q_2}{Q_1} = 1.027$

$\therefore h/d = 0$ From Fig 9 Draft copy of Report

$F_2 = 1.2 = \frac{V_2}{\sqrt{g} d_2} = \frac{Q_2}{b_2 \sqrt{g} d_2^{3/2}}$

$\therefore d_2 = \left(\frac{4796}{50 \times \sqrt{32.2}} \frac{1}{1.2}\right)^{2/3} = 5.83'$

$\ell = \frac{h}{S} = 0$

No hydraulic jump is formed

Depth of water $= 5.83'$

Provide weir at EL $= 1709.66 + 5.83 + 1$

$= 1716.49$

$Q = 126 = 3.1 \times 40 \times He^{3/2}$ for a 40' Long weir

$He = \left[\frac{126}{3.1 \times 40}\right]^{2/3} = 1.01'$

Provide 1' free board

Water level for submergence $= 1716.49 + 1.01$

$= 1717.5$ say 1717.75

Top of Dike at EL $1718.5'$

If the flow in the main channel is less than 4670 cfs a hydraulic jump may form in the main channel

Assume $d_1 = 4'$ $A_1 = 200$ $R_1 = 3.45$

$\therefore V_1 = 16.15$

$Q_1 = 3230$

$Q_2 = 3230 + 126$

$= 3356$

$\frac{Q_2}{Q_1} = 1.039$

$F_1 = \frac{V_1}{\sqrt{g d_1}} = 1.423$

$h/d = 0$ From Fig 9

$h = 0$

$F_2 = 1$

$\therefore d_2 = \left[\frac{Q_2}{F_2 b \sqrt{g}}\right]^{2/3} = \left[\frac{3356}{1 \times 50\sqrt{32.2}}\right]^{2/3}$

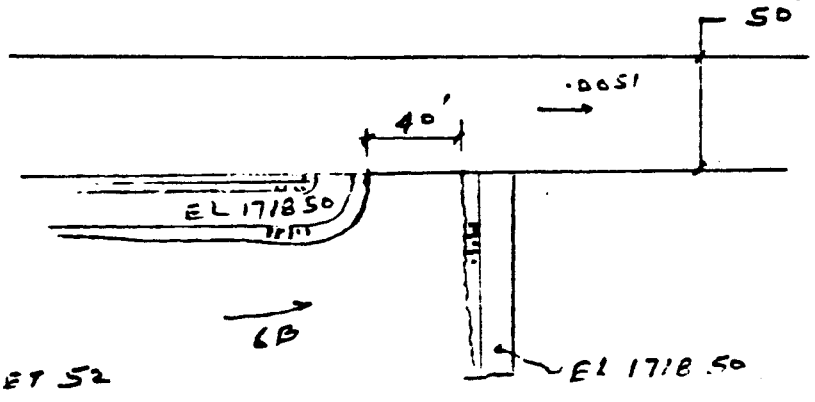
$= 5.19$

Conjugate depth for the main channel

$= 4 \times \frac{1}{2}\left(\sqrt{1 + 8 \times 1.423^2} - 1\right)$

$= 6.29 < (5.83 + 1)$

$\therefore$ The location of the weir at 6.83' is alright



SEE SHEET 52

PLAN 6C

EBASCO SERVICES INCORPORATED

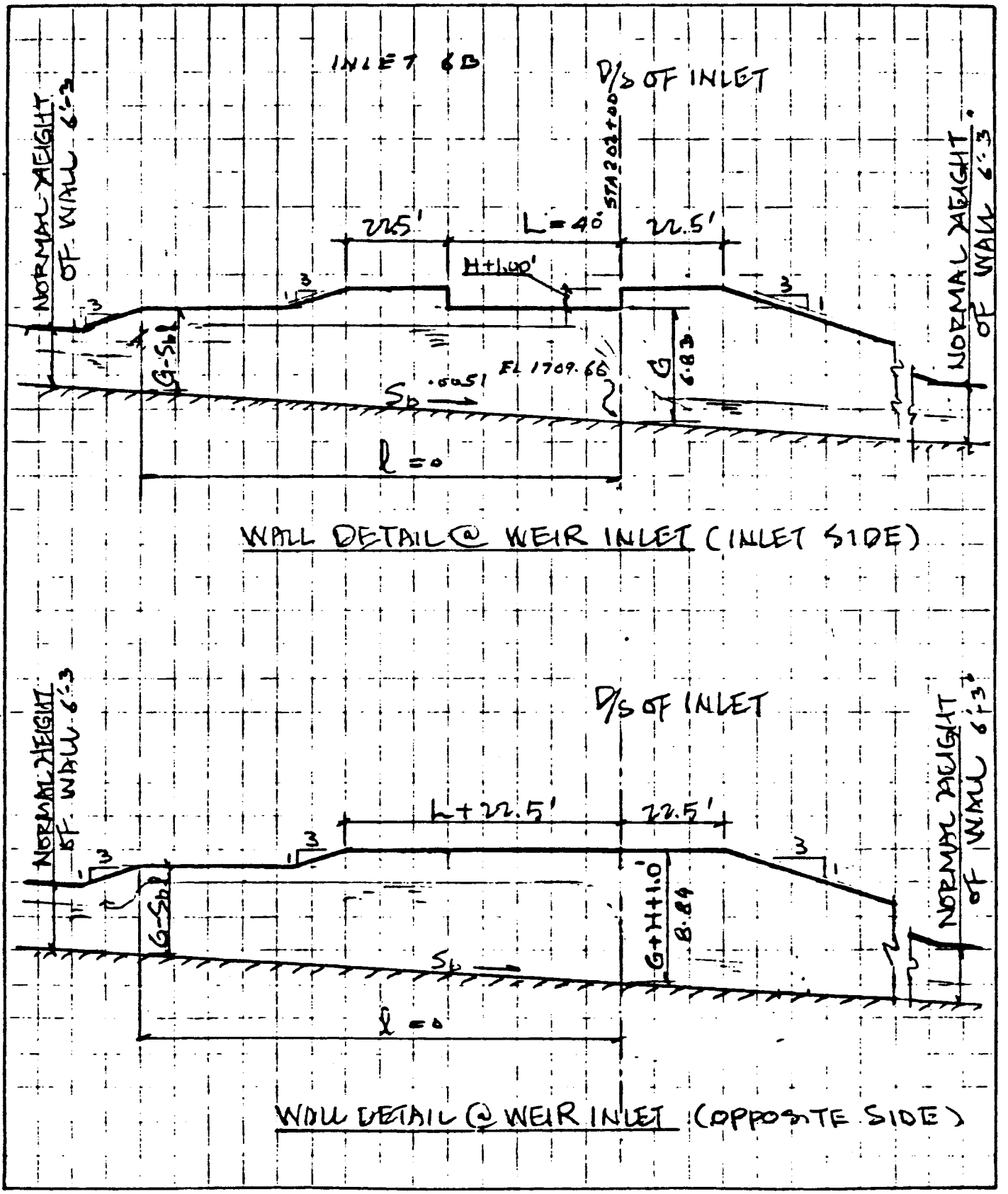
BY Y.C. YANG DATE 9-30-85 S.G.YAL 12/2/85 SHEET 52 OF _____

CHKD. BY S.Goyal DATE 10-1-85 OFS NO. 3767.202 DEPT. NO. 650

CLIENT USDA.

PROJECT BULLDOG FLOODWAY & APACHE JCT FLOOD PROTECTION

SUBJECT BULLDOG FLOODWAY — CHANNEL WALL DETAIL



581/8-81

CHANNEL STA 202+00 TO 203+00

$Q = 4674 \qquad b = 50' \qquad S = .0051$

$d = 5.063$

USE 6:3" Walls as U/S STA 202+00

BED EL = $1709.66 - [203.00 - 202.00] \times .0051$

$= 1709.15$

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BY S GOYAL DATE 12-2-85 SHEET 54 OF

CHKD. BY DATE OFS NO. USDA 3767.30 DEPT. NO. 550

CLIENT USDA SCS PHOENIX ARIZONA

PROJECT BULLDOG FLOODWAY & APACHE JUNCTION FLOOD CONTROL

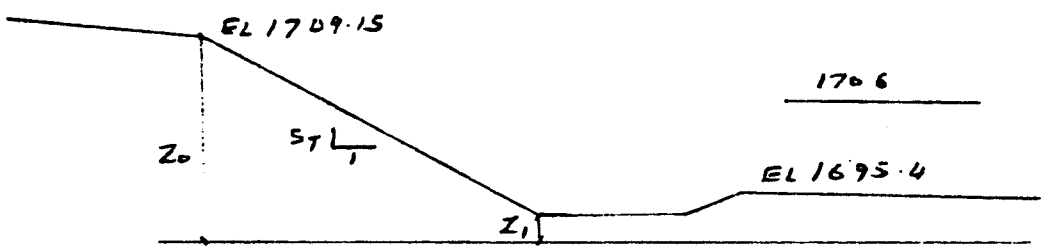
SUBJECT BULLDOG FLOODWAY DROP STRUCTURE

DROP STRUCTURE STA 203+00

$Q = 4674$ $b_0 = 50'$ $d_0 = 5.063$ $A_0 = 253.15$

$V_0 = 18.46$ fps

$F_0 = 1.446$ $S_0 = .0051$



From HE CIRCULAR NO 14 US DOT

$$4674 = 120 y_1 \left[2g (Z_0 - Z_1 + 5.063 - y_1) + 18.46^2\right]^{1/2}$$
$$= 120 y_1 \left[64.4 (1709.15 - 1694.4 + 5.063 - y_1) + 340.77\right]^{1/2}$$

for $y_1 = .99$ $Q = 4681.6$ O.K

$$V_1 = \frac{4674}{.99 \times 120} = 39.34$$

$F_1 = 6.97$

$$y_2 = \frac{.99}{2}\left[\sqrt{1 + 8F^2} - 1\right] = 9.27$$

$y_2 + Z_1 = 1694.4 + 9.27 = 1703.67 < 1706$ O.K

$$W_B = W_0 + 2 \frac{Z_0 - Z_1}{3 \times S_T} \sqrt{S_T^2 + 1}$$

$$\text{or } 120 = 50 + 2 \frac{(1709.15 - 1694.4)}{3 \times 1.446} \sqrt{\frac{S_T^2 + 1}{S_T^2}}$$

or $S_T = .0976$

$L_T = (Z_0 - Z_1)/S_T = 151.1$ say 150'

For $F_1 = 6.97$ Length of Jump $= 6.1 \times 9.27 = 56.5$ say 55'

The drop design in Phase I can be used with chang. in S_T

EBASCO SERVICES INCORPORATED

BY RCR DATE 12-4-85 SHEET 1 OF 2

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT _____

PROJECT BULLDOG FLOODWAY

SUBJECT ENERGY DISSIPATOR #2 & EARTH CHANNEL

STA	A_1 (FT^2)	A_2 (FT^2)	L (FT)	V (CU.YD)	REMARKS
203+50 TO 205+00	3448.9	2896.36	150.00	9003.47	ENERGY DISSIPATOR NO 2
205+00 TO 205+56	2896.36	2896.36	56	6007.26	
205+56 TO 207+50	2896.36	933.96	194.00	13760.78	EARTH CHANNEL
207+50 TO 209+00	933.96	1425.02	150.00	6552.73	
209+00 TO 212+00	1425.02	714.89	300.00	11888.39	
212+00 TO 215+00	714.89	777.56	300.00	8291.40	
215+00 TO 216+50	777.56	503.04	150.00	3557.22	
216+50 TO 218+50	503.04	508.52	200.00	3746.53	

581/8-81

EBASCO SERVICES INCORPORATED

BY RCR DATE 12-4-81 SHEET 2 OF 2

CHKD. BY _____ DATE _____ OFS NO. _____ DEPT. NO. _____

CLIENT _____

PROJECT BULLDOG FLOODWAY

SUBJECT ENERGY DISSIPATOR #2 & EARTH CHANNEL

STA	A_1(FT²)	A_2(FT²)	L(FT)	V(CU.YD)	
218+50 TO 219+77	508.52	0	127	1195.96	EARTH CHANNEL
			TOTAL V=	64003.74	

581/8-81

EBASCO SERVICES INCORPORATED

BY N.W. DATE 12/2/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT USDA SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT BULLDOG FLOODWAY CONCRETE QUANTITY

A): CONCRETE :

10.16 x (11510 - 10146)	=	13,859	3'-3 WALL
19.16 x (12163 - 11510)	=	12,511	4'-6 "
18.34 x (13272 - 12163)	=	20,340	4'-0 "
23.32 x (18385 - 13272)	=	119,235	5'-0 "
2.34 x (13272 - 14026)	=	1,764	SLAB
4.34 x (14026 - 15455)	=	6,201	"
7.34 x (15455 - 17050)	=	11,707	"
10.84 x (17050 - 18385)	=	14,471	"
44.84 x (20350 - 18385)	=	88,110	6'-0 WALL
		288,198 cu.ft	

288,198 + 23,705 = 311,903 cu ft = 11552 cu yd

11552 x 1.05 = 12,129 cu.yd.

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BY N.W DATE 12/2/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT BULLDOG FLOODWAY STEEL REINFORCEMENT QUANTITY

B): STEEL REINFORCEMENT;

3'-3 WALL	36.5 #/' (11510 - 10146)	=	49,786
4'-6 "	82.1 (12163 - 11563)	=	49,260
4'-0 "	73.04 (13272 - 12163)	=	81,001
5'-0 "	86.47 (18385 - 13272)	=	442,121
SLAB	7.13 (13272 - 14026.	=	5,376
"	11.81 (14026 - 15455)	=	16,876
"	19.81 (15455 - 17050)	=	31,596
"	29.17 (17050 - 18385)	=	38,941
6'-0 + SLAB	181.1 (20350 - 18385)	=	355,861
			1,070,818.

1070,818 + 103,133 = 1173,951 # × 1.05 = 1,232,648 #

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BY N.H DATE 12/2/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT BULLDOG FLOODWAY EXCAVATION QUANTITY

C) STRUCTURAL EXCAVATION:

$34.03 \times (11510 - 10146) = 46,417$

$(3.25 + 1.67 + 3)(10750 - 10146) = 4784$

$14.67 \times 3.5\ (12163 - 11510) = 33,528$

$14.67 \times 3\ (13272 - 12163) = 48,808$

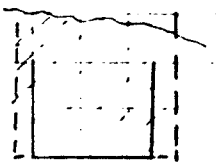
$136 \times (14026 - 13500) = 71,536$

$160 \times (15455 - 14026) = 228,640$

$196 \times (17050 - 15455) = 312,620$

$238 \times (18385 - 17050) = 317,730$

$382.67 \times (20350 - 18385) = 751,946$



$(22' + \frac{20}{12} + 3') \times 3' \times (15455 - 14500) = 76410$

$(28 + \frac{20}{12} + 3) \times 6' \times (17050 - 16000) = 205,821$

$(\quad " \quad) \times 4 \times (16000 - 15455) = 71,220$

$(35 + \frac{20}{12} + 3) \times 3.5 \times (17810 - 17050) = 105,522$

$(50 + \frac{20}{12} + 3) \times 4 \times (20075 - 18385) = 369,570$

$2,644,552$

↓ inlet

$2,644,552 + 134,612 = 2,779,164$ cu. ft

$\frac{2779164 \times 1.05}{27} = 108,078$ cu. yd ←

$(14 \times 2 - 3) \times 1 \times (10750 - 10146) = 15,100$

$(14 \times 2 - 3) \times 3 \times (15455 - 14500) = 71,625$

D) CHANNEL EXCAVATION: $25 \times 6 \times (17050 - 16000) = 157,500$

$" \times 4 \times (16000 - 15455) = 54500$

$" \times 3.5 \times (17810 - 17050) = 66,500$

$" \times 4 \times (20075 - 18385) = 169,000$

534225

$\frac{534225 \times 1.05}{27} = 20,775$ cu. yd

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BY N.W. DATE 12/2/85 SHEET ____ OF ____

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CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT BULLDOG FLOODWAY INLET 4A, 4B, 5A

INLET 4A

4'-6 CHANNEL

CONCRETE : 19.16 x 82.' = 1571. cu.ft

STEEL 82.1 x 82 = 6732 #

* 4B

5'-6 CHANNEL

19.83 x 148 = 2934

2934 x 4.7# = 13789

5A

5'-0 CHANNEL

CONCRETE 32 x 600 = 19200 cu.ft

STEEL 137.7 x 600 = 82,612#

1571 + 2934 + 19200 = 23705# cu.ft

STEEL : 6732 + 13789 + 82612 = 103,133#

* $\left(\frac{10}{12} \times 6.5 \times 2 + 9 \times 1\right) = 19.83$

** $25.67 + \frac{6}{12} \times 12.67 = 32$

$60.27 \times 2 + (13 + 12.67) \times .668 = 137.7$ #/'

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BY N.H. DATE 12/4/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT USDA-SOIL CONSERVATION SERVICE
APACHE-BULLDOG FLOOD CONTROL PROJECT

PROJECT ____

SUBJECT BULLDOG FLOODWAY

E) STRUCTURAL BACKFILL :

		cu.ft
3' x 4.25 x (11510' - 10146')	=	17391
" x 5.50 x (12163' - 11510')	=	10774
" x 5.0 x (13272' - 12163')	=	16635
" x 6.0 x (18385' - 13272')	=	92035
" x 7.0 x (20350 - 18385)	=	41265
" x 5.5 x 82'	=	1353
" x 6.5 x 148	=	2886
" x 6.0 x 600	=	10800
		193139 cu.ft

$193139 / 27 = 7153$ cu. yd ←

F) EARTHFILL

25' x 150' x 2'	=	7,500
31 x 3' (13200 - 11500)	=	158,100
33 x 4 (13700 - 13200)	=	66,000
		231,600 cu.ft

$\frac{231600}{27} = 8577$ cu yd

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BY N. Hung DATE 10/4/85 SHEET ____ OF ____

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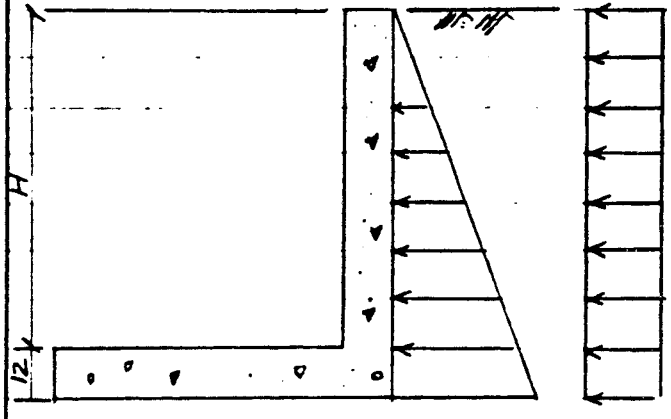
CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT FLOODWAY RECTANGULAR CHANNEL



EQUIVALENT FLUID PRESSURE = 78 PCF

SURCHARGE LOAD = 156 psf

A): WALL DESIGN UNEXPOSED

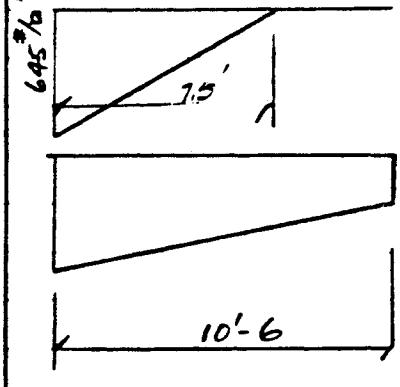
$H = 6.75'$

$M = \frac{1}{6} \times 78 \times 6.75^3 + \frac{1}{2} \times 156 \times 6.75^2$

$= 4000 + 3554 = 7554$ #/'

$P_h = \frac{1}{2} \times 78 \times 6.75^2 + 156 \times 6.75$

$= 1776 + 1053 = 2829$ #



$Mu = 1.8\,M = 1.8 \times 7554 = 13600$ '# $= 13.6$ 'K/'

$d = 10" - 3" = 7"$ $F = .0049$

$K_u = Mu/F = 13.6/.049 = 278$

$\rho = .0081$. $A_s = .0081 \times 12 \times 7 = .68$ □"/'

$.68 \times 12/0.44 = 7.75"$ * #6 @ 8" o/c

$Vu = 1.8\,P_h = 1.8 \times 2829 = 5092$

$v_u = 5092/12 \times 7 = 60.6$ #/□" $< 2\phi\sqrt{f_c'} = 2 \times .85 \times 63.2 = 108$ #/□

FOR H = 4'-0 #4 @ 10" o/c

EXPOSED FACE :

$M = \frac{1}{6} \times 62.4 \times 5.75^3 = 1980$ '# $= 2.0$ 'K/'

$Mu = 1.8\,M = 1.8 \times 2.0 = 3.6$ 'K/'

$K_u = Mu/F = 3.6/.049 = 73$ $\rho = .0021$

$A_s = .0021 \times 1.33 \times 12 \times 7 = 0.24$ □"/' — #4 @ 10" o/c

or $A_{s\,min} = .002 \times 12 \times 10 = 0.24$ □"/'

* By using $d = 10 - 2 - \frac{1}{2} = 7.5"$ $F = .05625$

$K_u = 13.6/.05625 = 242$ $\rho = .007$

$A_s = .007 \times 12 \times 7.5 = .63$ □"/' #6 @ 8" o/c $A_s = .66$ □"/'

EXPOSED FACE : $.002 \times 12 \times 10 = .24$ □"/' #5 @ 15" o/c

HORIZ BARS UNEXPOSED : $.001 \times 12 \times 10 = .12$ □"/' #4 @ 16" o/c

EBASCO SERVICES INCORPORATED

BY N. Hung DATE 10/4/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT ____

PROJECT [illegible] CONTROL PROJECT

SUBJECT FLOODWAY RECTANGULAR CHANNEL

B): FOOTING DESIGN : BOTTOM BARS

O.T.M. $M = \frac{1}{6} \times 78 \times 7.75^3 + \frac{1}{2} \times 15.6 \times 7.75^2 = 6051 + 4684 = 10735$ ft#/'

RESISTING MOMENT : 1. $150 \times \frac{10}{12} \times 6.75 = 844 \times 10.08 = 8510$

2. $150 \times 1 \times 10.5 = 1575 \times 10.5/2 = 8268$

2419 # 16778 ft#/'

S.F. AGAINST OTM $= \frac{16778}{10735} = 1.56 > 1.50$ O.K.

SOIL BEARING PRESSURE : $e' = \frac{16778 - 10735}{2419} = 2.50'$

$e = \frac{10.5}{2} - 2.5 = 2.75' > \frac{10.5}{6}$, $\ell = 2.5 \times 3 = 7.5'$

$f_b = \frac{2419}{\frac{1}{2} \times 7.5 \times 1} = 645$ #/ft²

REINFORCE BARS AT FACE OF WALL

$M = 2419 (10.5 - \frac{10}{12} - \frac{7.5}{3}) - \frac{1}{2}(150)(10.5 - \frac{10}{12})^2$

$= 2419 \times 7.166 - 7008 = 10328$ ft#/' = 10.3 ft K/'

$M_u = 1.8 M = 18.6$ ft K

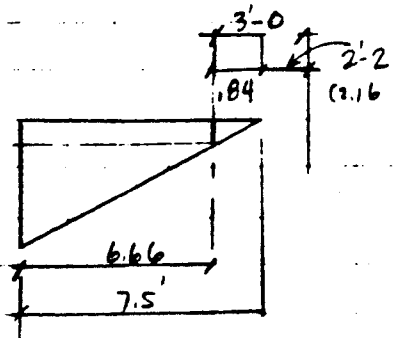
$F = 12 \times 8.5^2 / 12000 = .07225$ $K_u = \frac{M_u}{F} = 18.6/.07225 = 257$

$\rho = .0075$ $A_s = .0075 \times 12 \times 8.5 = 0.765$ in²/' ←

#6@8"c/c + #4@16"c/c $A_s = .81$ in²/'

REINFORCE BARS AT 3'-0 FROM FACE OF WALL

$M = -(150 - 72.) \times \frac{6.66^2}{2} + \frac{1}{3} \times (\frac{645}{7.5}) \times 6.66^3$



$= -1729 + 8468 = 6740$ ft#/' = 6.74 ft K/'

$M_u = 1.8 M = 12.1$ ft K/'

$K_u = 12.1/.07225 = 167$

$A_s = .005 \times 12 \times 8.5 = 0.51$ in²/' - #6@8"c/c

$A_s = .66$ in²/'

$(645/7.5) \times .84 = 72.$

EBASCO SERVICES INCORPORATED

BY N. Hung DATE 10/4/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT ____

TOP BARS :

WITH INTERNAL WATER

$OTM = 62.4\left(\frac{5.75}{8}+1\right) = 3008^{'\#/'}$

RESISTING MOMENT

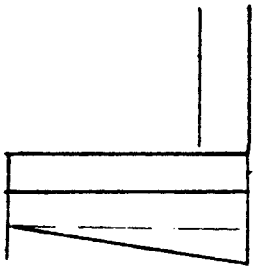
$62.4\times5.75\times9.66 = 3466$	$\times\left(\frac{9.66}{2}+\frac{10}{12}\right)$	$= 19629$
$.844 \times 5/12$		$= 351$
$1575 \times 10.5/2$		$= 8268$
5885		28248

$e = \frac{28248-3008}{5885} = 4.29'$

$10.5/2 - 4.29 = 0.96 < \frac{10.5}{6}$ #/0' #/2'

$f_b = \frac{5885}{10.5} \pm \frac{6\times0.96\times5885}{10.5^2} = 560 \pm 307 = 867 \text{ OR } 253$

$\omega^{\downarrow} = (150 + 62.4\times5.75) = 509^{\#/12'}$



$M = (508 - 253)\times\frac{1}{2}\times9.66^2 - \frac{1}{6}\times(9.66)^3\times\frac{867-253}{10.5}$

$= 11898 - 8785 = 3113^{'\#/'}$

$M_u = 1.8M = 5604^{'\#/'} = 5.6^{'K/'}$

$K_u = 5.6/.07225 = 77.5$ $K_u\times1.33 = 103$

$\rho = .0029$ $A_s = .0029\times12\times8.5 = 0.295^{D''/'}$

$A_{s\,min} = .002\times12\times12 = 0.288^{D''/'}$ #5@12"o/c

EBASCO SERVICES INCORPORATED

BY N. Hung DATE 10/4/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

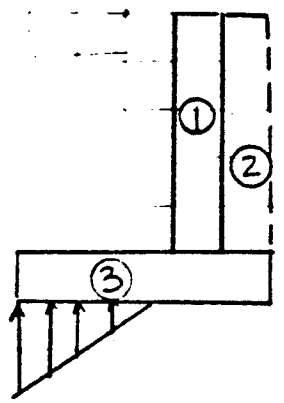
CLIENT USDA SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT FLOODWAY RECTANGULAR CHANNEL

C). FOOTING DESIGN : (OPTION)

1. O.T.M = 10735 #/' OPTION



RESISTING MOMENT :

1. $150 \times \frac{10}{12} \times 6.75 = 844 \times 6.5 = 5486$
2. $150 \times 1 \times 8 = 1200 \times 4 = 4800$
3. $120 \times 1 \times 6.75 = 810 \times 7.5 = 6075$

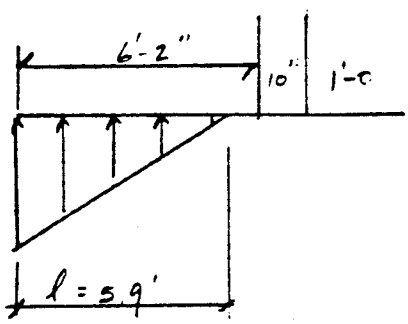
2854 # 16361 #/'

S.F. AGAWST OTM $= \frac{16361}{10735} = 1.52 > 1.5$

$e' = \frac{16361 - 10735}{2854} = 1.97'$

$e = \frac{8}{2} - 1.97 = 2.03' > 8/6' = 1.33'$ $\quad l = 1.97 \times 3 = 5.9'$

$f_b = 2854 / \frac{1}{2} \times 5.9 \times 1 = 967$ #/ft'



$M = 2854 \times (6.16 - \frac{5.9}{3}) - \frac{1}{2} \times 150 \times (6.16)^2$

$= 11968 - 2845 = 9123$ #/'

$Mu = 1.8 M = 16.42$ 'K/'

$K_u = 16.42 / .07225 = 227 \quad f = .00656$

$A_s = .00656 \times 12 \times 8.5 = 0.67$ □'/'

#6 @ 8"o/c

$A_s = .66$ □'/'

SHEAR O.K BY INSPECTION !

2 WITH INTERNAL WATER

$OTM = \frac{1}{2} \times 62.4 \times 5.75 \left(\frac{5.75}{3} + 1 \right) = 3008$ '#/'

RESISTING MOMENT : $2188 \times 4.91 = 10743$ (WATER WT

1. $844 \times 1.416 = 1195$ $= 62.4 \times 6.1 \times 5.75$
2. $1200 \times 4 = 4800$ $= 2188$
3. $810 \times 0.5 = 405$

5042 # 17143 '#/'

S.F AGAINST OTM $= 17143 / 3008 = 5.7 > 1.5$

$e' = \frac{17143 - 3008}{5042} = 2.80$

EBASCO SERVICES INCORPORATED

BY N. Hung DATE 10/4/85 SHEET ____ OF ____

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CLIENT USDA SOIL CONSERVATION SERVICE

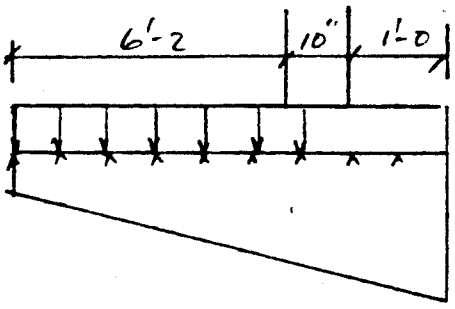
PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT FLOODWAY RECTANGULAR CHANNEL

$$e = \frac{B}{2} - 2.8 = 1.207\,\frac{B}{6}$$

$$= \frac{5043}{8} \pm \frac{6 \times 1.20 \times 5043}{8^2} = 630 \pm 567 = 1197 \text{ OR } 63 \ ^{\#}/_{\square'}$$

REINF. BARS AT EXPOSED FACE



$$M = (2188^{\#} + 150 \times 1 \times 6.16) \times \frac{6.16}{2} - 67 \times \frac{6.16^2}{2} - \left(\frac{1197-63}{8}\right) \times \frac{1}{6} \times 6.16^3$$

$$= 9584 - 1271 - 5522 = 2791 \ ^{'\#}/_{'}$$

$$M_u = 1.8 \times 2.8 = 5.04$$

$$F = .07225 \qquad K_u = \frac{M_u}{F} = \frac{5.04}{.07225} = 70$$

$$\rho = .002$$

$$A_s = .002 \times 1.33 \times 12 \times 6.5 = 0.27 \ ^{\square''}/_{'}$$

$$A_{s\,min} = .002 \times 12 \times 12 = 0.28 \ ^{\square''}/_{'}$$

\# 5 @ 12" o/c

* WITHOUT ADDITIONAL SURCHARGE

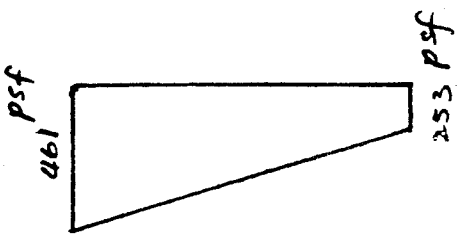
OTM = $6051 \ ^{'\#}/_{'}$

RESIST. MOMENT = $16361 \ ^{'\#}/_{'}$

$$e' = (16361 - 6051)/2854 = 3.61'$$

$$e = B/2 - 3.61 = 0.39' < B/6 = 1.33' \quad \text{(middle 1/3)}$$

$$f_b = \frac{2854}{8} \pm \frac{6 \times 0.39 \times 2854}{8^2} = 357 \pm 104 = 461 \ ^{\#}/_{\square'} \text{ OR } 253 \ ^{\#}/_{\square'}$$



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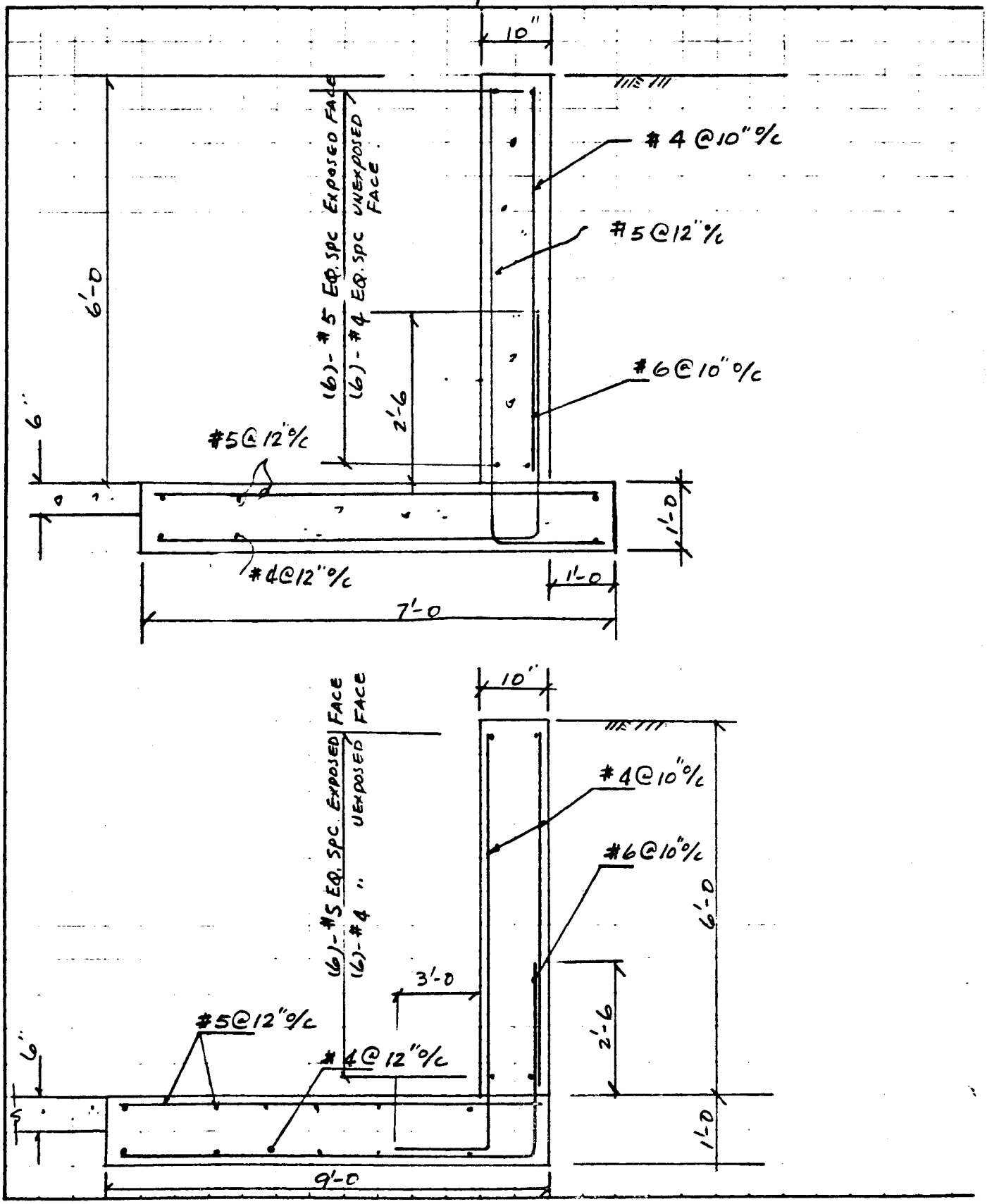
BY N. Hung DATE 10/7/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT FLOODWAY RECTANGULAR CHANNEL



EBASCO SERVICES INCORPORATED

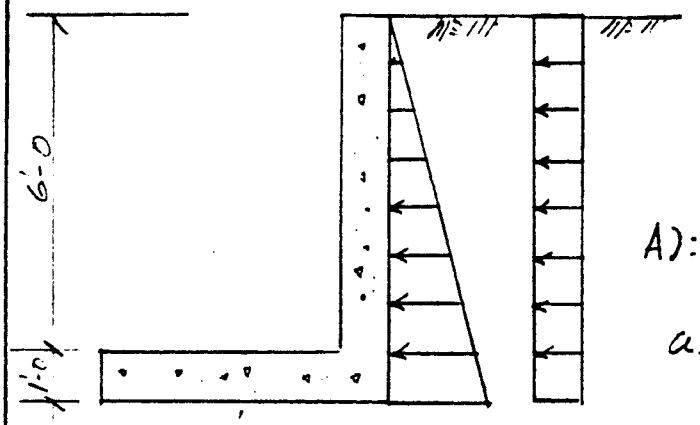
BY N Hung DATE 10/7/85 SHEET ____ OF ____

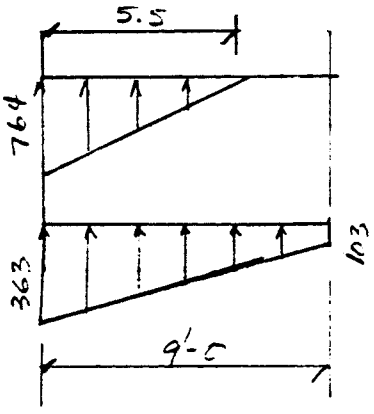
CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT ____

PROJECT ____

SUBJECT FLOODWAY RECTANGULAR CHANNEL





EQUIVALENT FLUID PRESSURE = 78 PCF

SURCHARGE LOAD = 156 PSF

A): WALL DESIGN

a): UNEXPOSED FACE 1): H = 6'-0

$M = \frac{1}{6} \times 78 \times 6^3 + 156 \times \frac{6^2}{2}$

$= 2808 + 2803 = 5616$ #/'

$P_a = 78 \times \frac{6^2}{2} + 156 \times 6 = 2340$ #

$M_u = 1.8M = 1.8 \times 5.62 = 10.11$ K/'

$V_u = 1.8 P_a = 1.5 \times 2.34 = 4.21$ K/'

$F = .049$ $K_u = M_u/F = 10.11/.049 = 206$

$f = .006$ $A_s = .006 \times 12 \times 7 = .504$ "

#6 @ 10" c/c

$v_c = V_u/bd = 4.21/12 \times 7 = .050$ K/" $= 50$ #/" $< 2\sqrt{f'_c}$

2) H: 3'-6 BY COMPARING WITH H. 4'-5 & H = 3'-6

USE #4 @ 10" c/c

b) EXPOSED FACE

$M = \frac{1}{6} \times 62.4 \times 5^3 = 1300$ #/' $= 1.3$ K/'

$M_u = 1.8M = 2.34$

$K_u = 2.34/.049 = 48$ $1.33 K_u = 64$ $f = .002$

$A_s = .002 \times 12 \times 7 = .17$ "/' #4 @ 10" c/c

$A_{s\,min} = .002 \times 12 \times 10 = .24$ "/' OR #5 @ 15" c/c

HORIZ. BARS: EXPOSED FACE: $.002 \times 12 \times 10 = .24$ "/' #5 @ 15" c/c

UNEXPOSED: $.001 \times$ " $= .12$ "/' #4 @ 15" c/c

BY N. Hung DATE 10/7/85 SHEET ____ OF ____

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CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT FLOODWAY RECTANGULAR CHANNEL

B) FOOTING DESIGN : $OTM = \frac{1}{6}\times 78\times 7^3 + \frac{1}{2}\times 156\times 7^2$

$= 4458 + 3822 = 8280^{\#/'} = 8.3^{K/'}$

RESISTING MOMENT:

WALL	$150\times\frac{10}{12}\times 6$	$= 750 \times 8.08$	$= 6060$
	$150\times 1\times 9$	$=1350\times\frac{9}{2}$	$=6075$
		2100	12135

S.F AGAINST OTM $= 12135/8280 = 1.47 \doteq 1.50$

$e' = \frac{12135-8280}{2100} = 1.836'$

$e = \frac{9}{2} - 1.836 = 2.664 > \frac{9}{6}$

$L = 1.836\times 3 = 5.5'$

SOIL BEARING PRESSURE $f_b = \frac{2100}{\frac{1}{2}\times 5.5\times 1} = 764^{\#/'}$

WITHOUT SURCHARGE: $OTM = 4458^{'\#/'}$

$e' = \frac{12135-4458}{2100} = 3.66'$

$e = \frac{9}{2} - 3.66 = 0.84'$ (middle ⅓)

$f_b = \frac{2100}{9} \pm \frac{6\times 2100\times .84}{9^2} = 233 \pm 130 = 363^{\#/'}$ OR $103^{\#/'}$

REINFORCING BARS: i) AT FACE OF WALL

$M = 2100\left(9-\frac{10}{12}-\frac{5.5}{3}\right) - \frac{1}{2}\times 150\times\left(9-\frac{10}{12}\right)^2$

$= 13370 - 5002 = 8368^{'\#/'} = 8.37^{'K/'}$

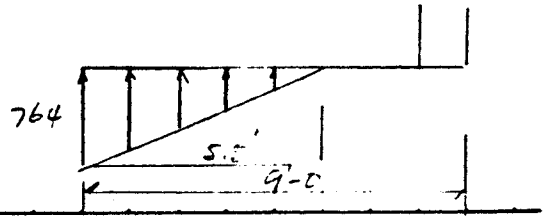
$M_u = 1.8M = 1.8\times 8.37 = 15.1^{'K/'}$

$K_u = 15.1/.07225 = 209$ $\quad \rho = .006$

$A_s = .006\times 12\times 8.5 = .612^{\square''/'}$ $\quad$ #6@10"c/c + #4@12

ii) AT 2'-8 FROM FACE OF WALL

$M = 2100\times\left(5.5\times\frac{2}{3}\right) - \frac{1}{2}\times 150\times(5.5)^2$



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BY N. Hung DATE 10/8/85 SHEET ____ OF ____

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CLIENT [illegible]

PROJECT [illegible] CONTROL PROJECT

SUBJECT FLOODWAY RECTANGULAR CHANNEL

$= 7700 - 2268 = 5432'^{\#} = 543'^{K}/'$

$M_u = 1.8M = 1.8 \times 5.43 = 9.78'^{K}/'$

$K_u = 9.78_{1.07225} = 135$ $\quad f = .0038$

$A_s = .0050 \times 12 \times 8.5 = 0.51$ $\quad$ #6 @ 10" o/c

OPTION (1):

RESISTING MOMENT:

$150 \times \frac{12}{12} \times 6 = 750 \times 7.08 = 5310$

$150 \times 1 \times 8 = 1200 \times 4 = 4800$

$135 \times \frac{1}{2} \times 6 = 390 \times 7.75 = 3022$

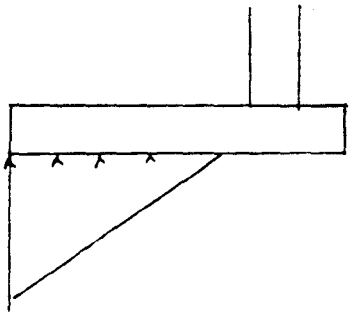
2340 $\quad$ 13132

S.F AGAINST OTM $\quad 13132/8363 = 1.57 > 1.50$ OK

$e' = \frac{8363 - 13132}{2340} = 2.036'$

$e = \frac{6}{2} - 2.036 = 1.962 > \frac{6}{6} \quad x = 2.036 \times 3 = 6.1'$

$f_c = 2340/\frac{1}{2} \times 6.1 \times 1 = 766\#/\square'$



$M = 2340 \times (8 - 0.5 - \frac{12}{12} - \frac{6.1}{3}) - \frac{1}{2} \times 150 \times (8 - 5 - \frac{6}{6}$

$= 2340 \times 4.63 - \frac{1}{2} \times 150 \times 6.66^2$

$= 10834 - 3326 = 7509'^{\#}/'$

$M_u = 1.8 M_u = 13514'^{\#}/' = 13.5'^{K}/'$

$K_u = 13514/1.07225 = 166 \quad f = .0053$

$A_s = .0053 \times 12 \times 8.5 = .54^{\square"}/'$

#6 @ 10" o/c

$A_s = .53^{\square"}/'$

EBASCO SERVICES INCORPORATED

BY N. Hung DATE 10/8/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

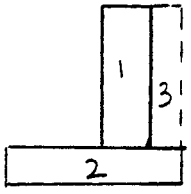
CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT FLOODWAY RECTANGULAR CHANNEL

* OPTION

RESISTING MOMENT:



1. $150 \times \frac{10}{12} \times 6 = 750 \times 5.58 = 4185$
2. $150 \times 1 \times 7.0 = 1050 \times 3.5 = 3675$
3. $130 \times 1 \times 6 = 780 \times 6.5 = 5070$

$2580^{\#/'}$ $12930^{\#/'}$

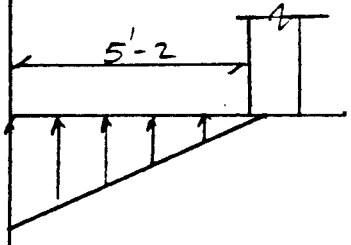
$e = \frac{12930 - 8363}{2580} = 1.77$

S.F. AGAINST OTM $= \frac{12930}{8250} = 1.56$

$\frac{7'}{2} - 1.77 = 1.73' < \frac{7}{6}'' = 1.17'$

$L = 1.77 \times 3 = 5.31'$

SOIL PRESSURE $= 2580 / \frac{1}{2} \times 5.31 \times 1 = 972^{\#/'}$



$M = 2580 \times (7 - 1 - \frac{10}{12} - \frac{5.31}{3}) - \frac{1}{2} \times 150 \times (7' - 1' - \frac{10}{12})^2$

$= 2580 \times 3.40 - 2002 = 6770^{\#/'} = 6.78^{K/'}$

$M_u = 6.78 \times 1.8 = 12.19^{K/'}$

$K_u = M_u / F = 12.19 / .07225 = 169$ $\rho = .005$

$A_s = .005 \times 12 \times 8.5 = 0.51^{\square''/'}$ #6 @ 10"o/c

$A_s = .528^{\square''/'}$

WITHOUT SURCHARGE : OTM $= 4458^{\#/'}$

$e' = \frac{12930 - 4458}{2580} = 3.28'$

$e = \frac{7}{2} - 3.28 = .216'$

$f_b = \frac{2580}{7} \pm \frac{6 \times 2580 \times .216}{7^2} = 368 \pm 68 = 436^{\#/ft^2}$ OR $300^{\#/ft^2}$

EBASCO SERVICES INCORPORATED

BY N Hung DATE 10/11/85

CHKD. BY _____ DATE _____

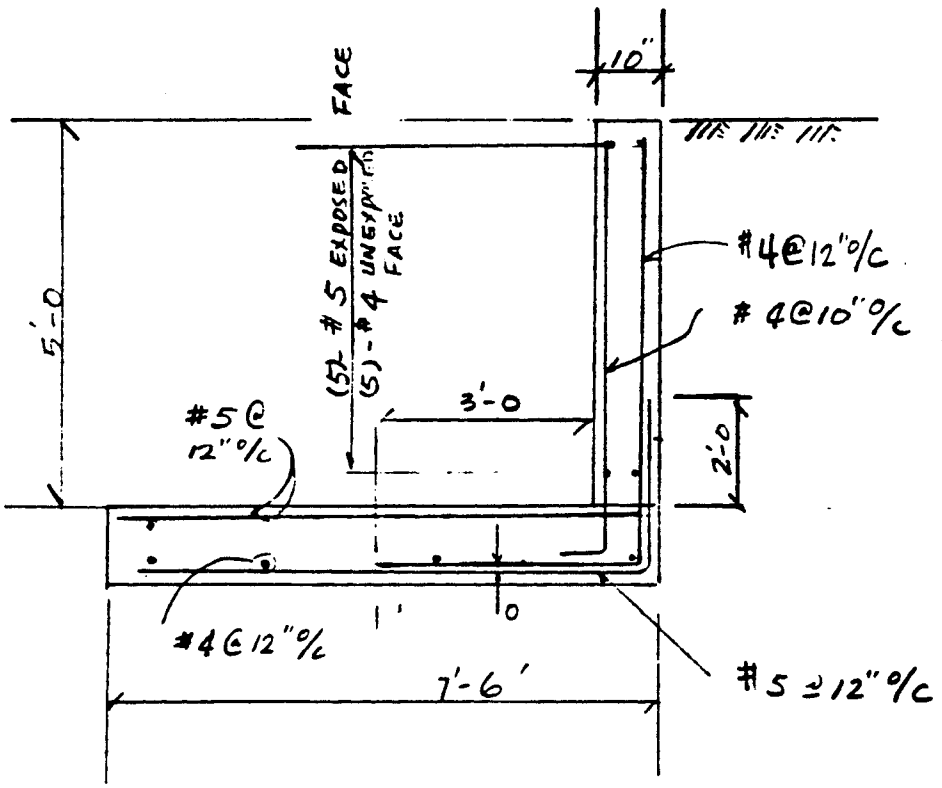
SHEET _____ OF _____

OFS NO. 3767-305 DEPT. NO. 213

CLIENT _____

PROJECT [illegible] SERVICE [illegible] PROJECT

SUBJECT FLOODWAY RECTANGULAR CHANNEL



EBASCO SERVICES INCORPORATED

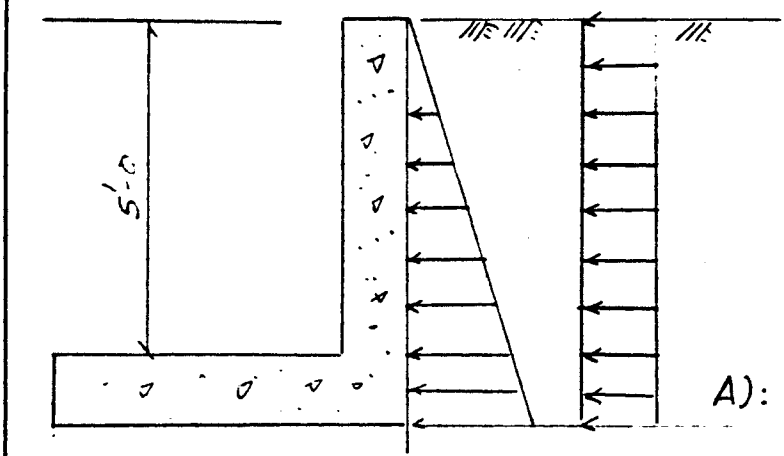
BY N Hung DATE 10/11/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT FLOODWAY RECTANGULAR CHANNEL



EQUIVALENT FLUID PRESSURE
= 78 PCF

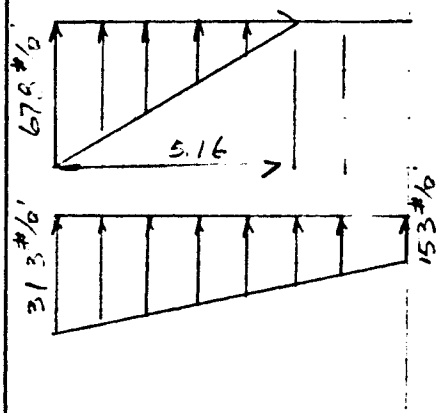
ADDITIONAL SURCHARGE LOAD
= 156 P.F

A): WALL DESIGN: UNEXPOSED WALL

$M = \frac{1}{6} \times 78 \times 5^3 + 156 \times \frac{5}{2}$

$= 1626 + 1950 = 3576$ '#/'

$= 3.58$ 'K/'



$P_h = \frac{1}{2} \times 78 \times 5^2 + 156 \times 5 = 975 + 780 = 1755$ #/'

$M_u = 1.8\,M = 1.8 \times 3.58 = 6.44$ 'K/'

$V_u = 1.8\,P_h = 1.8 \times 1755 = 3160$ #/'

$F = .049$ $K_u = M_u/F = 6.44/.049 = 132$

$\rho = .00375$ $A_s = .00375 \times 1.33 \times 12 \times 7 = 0.419$ "/'

#6 @ 12" o/c

EXPOSED FACE:

$\rho_{min} = .002$ $A_s = .002 \times 12 \times 10 = 0.24$ "/'

#5 @ 14" o/c or #4 @ 10" o/c

HORIZONTAL BARS

FOOTING DESIGN: O.T.M $= \frac{1}{6} \times 78 \times 6^3 + \frac{1}{2} \times 156 \times 6^2 = 2808 + 2808 = 5616$ '#/'

$P_h = \frac{1}{2} \times 78 \times 6^2 + 156 \times 6 = 1404 + 936 = 2340$ #/'

TYPE A: RESISTING MOMENT:

STEM	$150 \times \frac{10}{12} \times 5 = 625$	$\times 7.08$	$= 4406$
FOOTING	$150 \times 1 \times 7.5 = 1125$	$\times 3.75$	$= 4219$
	1750		8625 #

581/8-81

EBASCO SERVICES INCORPORATED

BY N. Hung DATE 10/11/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT [illegible] SERVICE

PROJECT [illegible] FLOOD CONTROL PROJECT

SUBJECT FLOODWAY RECTANGULAR CHANNEL

S.F. AGAINST OTM = $8625/5616 = 1.53 > 1.5$ O.K

SOIL PRESSURE : f_b $e' = \frac{8625-5616}{1750} = 1.72'$

$e = \frac{7.5}{2} - 1.72 = 2.03' > \frac{7.5}{6}$

$L = 1.72 \times 3 = 5.16$

$f_b = 1750 / \frac{1}{2} \times 5.16 \times 1. = 678\ \#/ft^2$

[WITHOUT SURCHARGE LOAD OTM = 2805 '#/'

$e' = \frac{8625-2805}{1750} = 3.32'$

$e = \frac{7.5}{2} - 3.32 = 0.43$ (middle 3)

$f_b = \frac{1750}{7.5} \pm \frac{6 \times 1750 \times 0.43}{7.5^2} = 233 \pm 80 = 313\ \#/ft^2$ OR $153\ \#/ft^2$]

MOMENT AT FACE OF WALL :

$M = 1750 \times (7.5 - \frac{10}{12} - \frac{5.16}{3}) - \frac{1}{2} \times 150 \times (7.5 - \frac{10}{12})^2$

$= 8565'\# - 3333 = 5232'\#/' = 5.23'K/'$

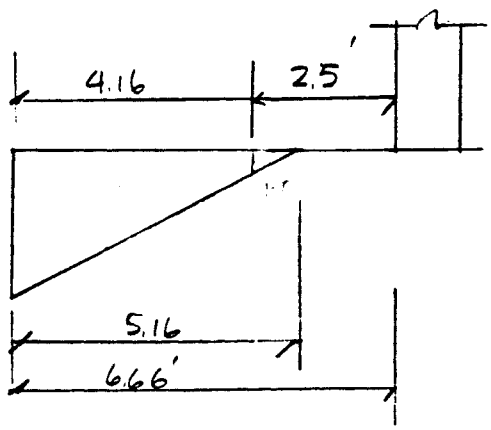
$Mu = 1.8M = 1.8 \times 5.23 = 9.4'K/'$

$F = 12 \times 8.5^2/12000 = .07225$ $Ku = M/F = 9.4/.07225 = 130$

$\rho = .005 \times 12 \times 8.5 = 0.51\ ^{\square"}/'$ #6 @ 10" o/c

OR #6 @ 12" o/c + #4 @ 16" o/c

MOMENT AT 2'-6 FROM FACE OF WALL.



$M = 1750 \times (4.16 - \frac{5.16}{3}) - (\frac{692}{5.16}) \times \frac{1}{6} \times 1^3$

$- \frac{1}{2} \times 150 \times 4.16^2$

$= 4270 - 22 - 1298 = 2950'^* = 3.0'K/'$

$Mu = 1.8 \times 3.0 = 5.4'K/'$

$Ku = 5.4/.07225 = 74$ $\rho = .002$

$As = .002 \times 1.33 \times 12 \times 8.5 = 0.27\ ^{\square"}/'$ #5 @ 12" o/c

EBASCO SERVICES INCORPORATED

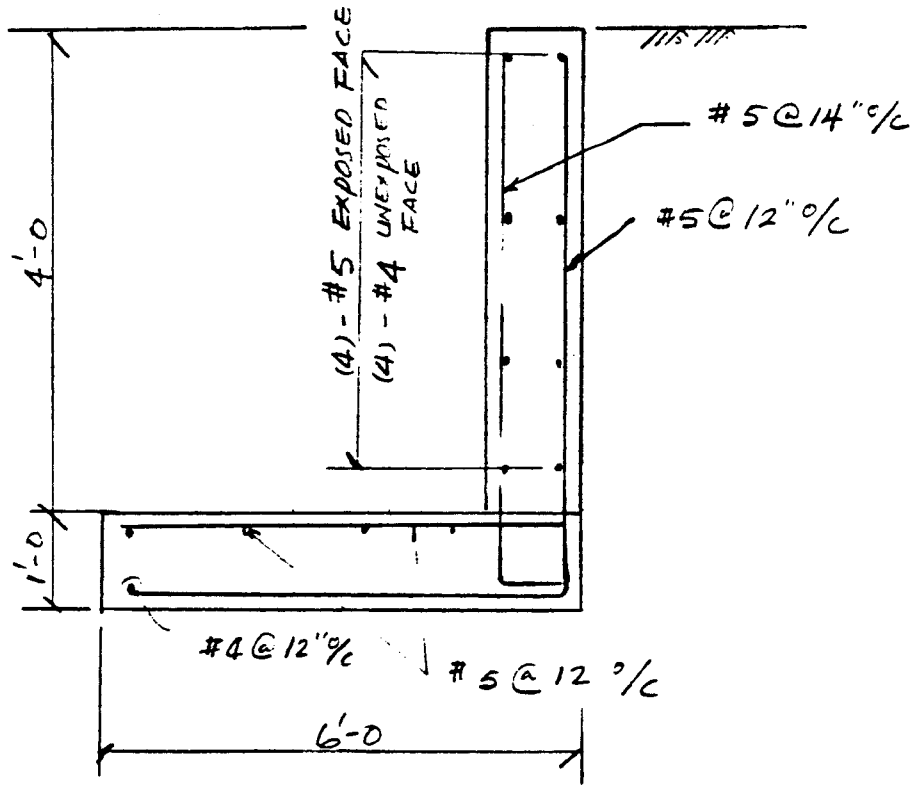
BY N. Hung DATE 12/14/82 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT ~~USDA SOIL CONSERVATION SERVICE~~

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT BULLDOG FLOODWAY RECTANGULAR CHANNEL



EBASCO SERVICES INCORPORATED

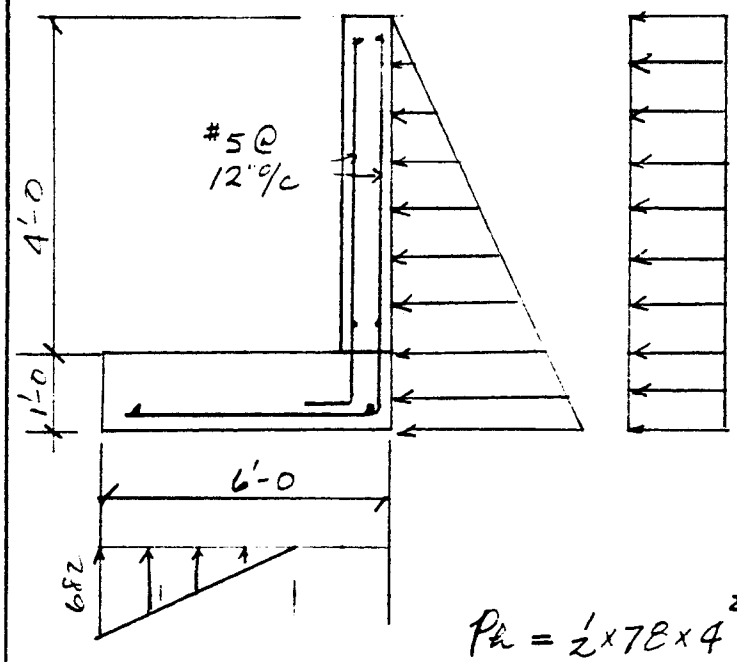
BY N. Hung DATE 10/15/85 SHEET ____ OF ____

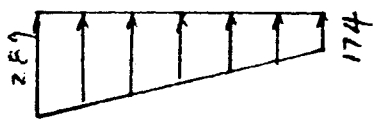
CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT BULLDOG FLOODWAY RECTANGULAR CHANNEL





EQUIVALENT FLUID PRESSURE = 78 PCF

ADDITIONAL SURCHARGE LOAD = 78 x 2 = 156 P.F

A): WALL DESIGN: (t = 10")

$M = \frac{1}{6} \times 78 \times 4^3 + 156 \times \frac{4^2}{2}$

$= 832^{\#'} + 1248 = 2080^{\#'}$

$= 2.1^{K'}$

$P_a = \frac{1}{2} \times 78 \times 4^2 + 156 \times 4 = 624 + 624 = 1248^{\#'}$

$M_u = 1.8M = 1.8 \times 2.1 = 3.75^{K'}$

$V_u = 1.8\, P_a = 1.8 \times 1248 = 2246^{\#'}$

$F = .049 \quad K_u = M_u/F = 3.78/.049 = 77$

$\rho = .0022 \quad A_s = .0022 \times 1.33 \times 12 \times 7 = .25^{\square''}$

USE #5 @ 14"o/c

EXPOSED FACE: $\rho_{min} = .002$

$A_s = .002 \times 12 \times 10 = .24^{\square''}$ #5 @ 14"o/c OR #4 @ 10"o/c

HORIZ. BARS: UNEXPOSED FACE #4 @ 14"o/c

EXPOSED FACE #5 @ 14"o/c

SHEAR O.K BY INSPECTION

FOOTING DESIGN: O.T. $M = \frac{1}{6} \times 78 \times 5 + 156 \times \frac{5^2}{2} = 1625 + 1950 = 3575^{'}$

$P_a = \frac{1}{2} \times 78 \times 5^2 + 156 \times 5 = 975 + 780 = 1755^{\#'}$

RESISTING MOMENT:

STEM 10"	$150 \times \frac{10}{12} \times 4$	= 500	x 5.58	= 2790
FOOTING	150 x 1 x 6 = 900	x 3		= 2700
	1400			5490

S.F. AGAINST OTM $= \frac{5490}{3575} = 1.54 > 1.50$

SOIL PRESSURE f_b: $e' = \frac{5490 - 3575}{1400} = 1.3678'$

$L = 1.3678 \times 3 = 4.10'$

$f_b = \frac{1400}{\frac{1}{2} \times 4.10 \times 1} = 682\ \#/ft$

[WITHOUT SURCHARGE LOAD: O.T.M = 1625 ft#

$e' = \frac{5490 - 1620}{1400} = 2.76$ (middle $\frac{1}{3}$)

$e = \frac{6}{2} - 2.76 = 0.24'$

$f_b = \frac{1400}{6} \pm \frac{6 \times 1400 \times .24}{6^2} = 233 \pm 56 = 289$ or 177]

$M = 1400\left(6' - 1.4' - \frac{1.0'}{12}\right) - \frac{1}{2} \times 150 \times \left(6 - \frac{1.0}{12}\right)$

$= 5273\ ft\# - 1008 = 3270\ ft\#/' = 3.27\ k/'$

$M_u = 1.6\ M_u = 5.9\ ft\text{-}k/'$ $d = 12 - 3.5 - 0.5''$

$F = .01722$ $K_u = M_u/F = 4.37/.01722 = 81.6$

$1.33 K_u = 109$, $\rho = .0031$

$A_s = .0031 \times 12 \times 8.5 = .316\ in^2/'$ USE #5 @ 12 o/c

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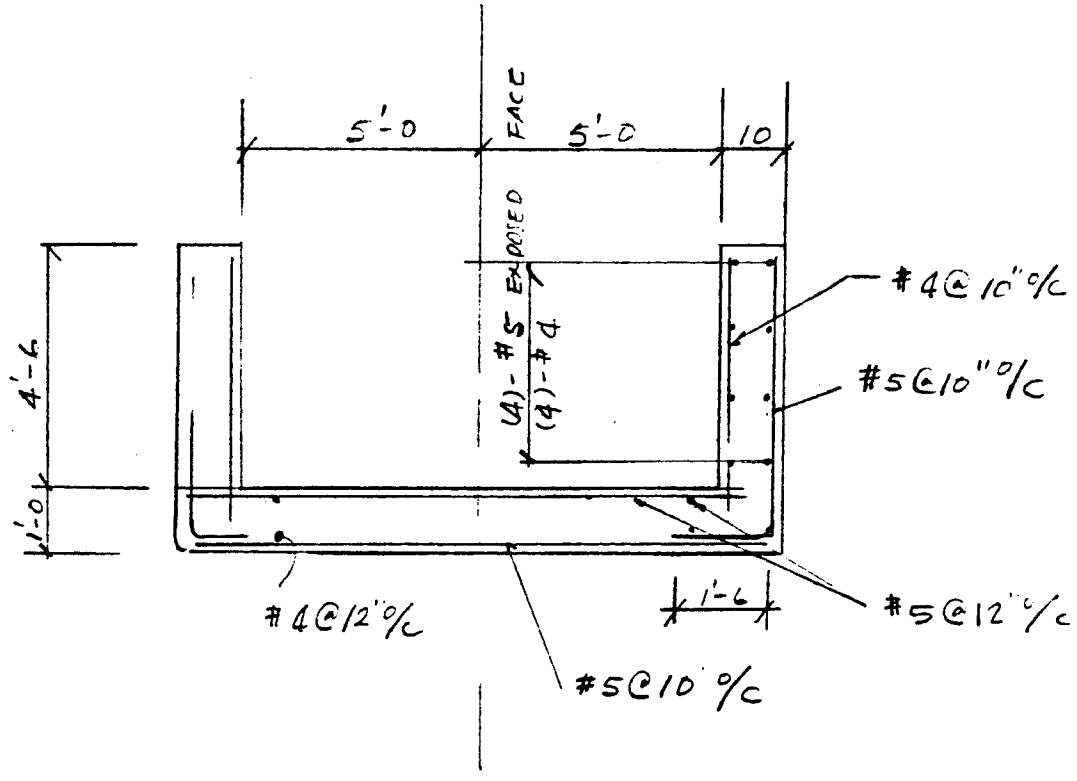
BY N. Hung DATE 10/14/81 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT ~~USDA SOIL CONSERVATION SERVICE~~

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT BULLDOG FLOODWAY - RECTANGULAR CHANNEL



BY N. H. DATE 10/14/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT ____

A): WALL DESIGN.

UNEXPOSED FACE

$M = \frac{1}{6} \times 78 \times 4.5^3 + 156 \times \frac{4.5}{2}^2 = 1185 + 1580 = 2765^{1\#}$

$Mu = 1.8M = 1.8 \times 2765 = 5000'\#/' = 5.0'^K/'$

$F = 0.49 \quad Ku = 5.0/.649 = 103$

$1.33K = 137. \quad p = .0039$

$As = .0039 \times 12 \times 7 = 0.33^{D''}/' \quad \#5 @ 10\frac{1}{2}''$ o/c

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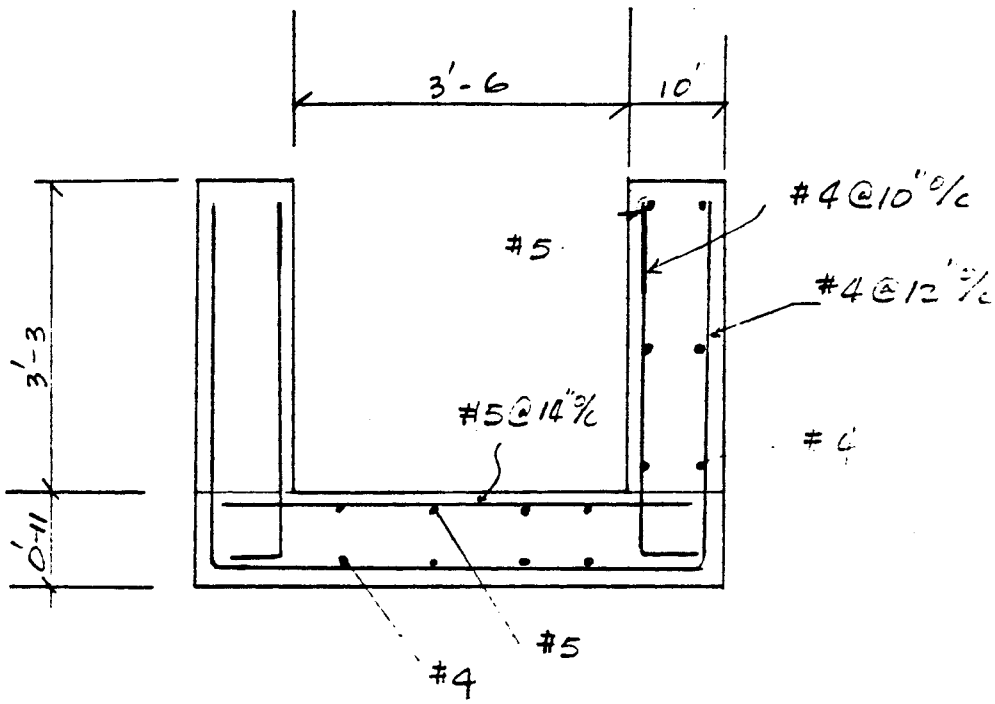
BY N. Hung DATE 10/14/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-303 DEPT. NO. 243

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT



EBASCO SERVICES INCORPORATED

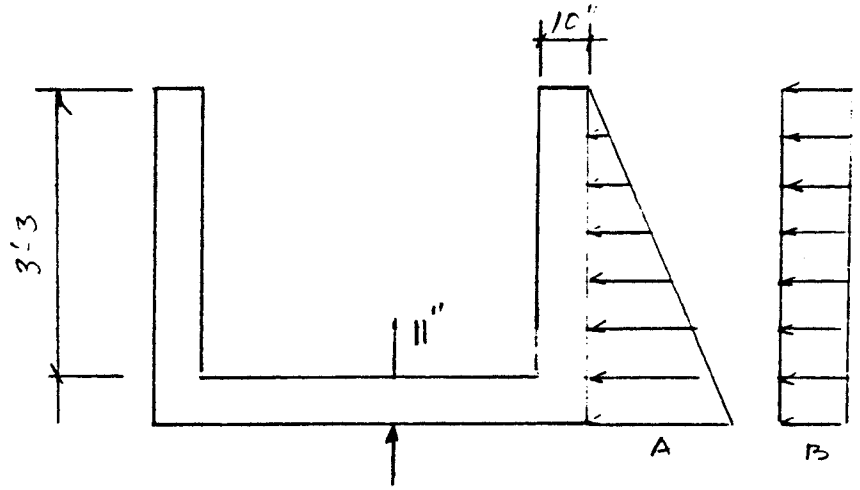
BY N Hung DATE 10/14/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-302 DEPT. NO. 243

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT BULLDOG FLOODWAY RECTANGULAR CHANNEL



A: EQUIVALENT FLUID PRESSURE = 78 PCF

B: ADDITIONAL SURCHARGE LOAD = 156 PSF

H = 3.25'

WALL DESIGN: t = 10"

UNEXPOSED FACE: $M = \frac{1}{6} \times 78 \times 3.25^3 + 156 \times \frac{3.25^2}{2} = 446'^{\#}/' + 823 = 1269'^{\#}/'$

$P_u = \frac{1}{2} \times 78 \times 3.25^2 + 156 \times 3.25 = 411 + 507 = 918'^{\#}$

$M_u = 1.8 \times 1.27 = 2.3'^{K}/'$ $P_u = 1.8 P_u = 1652^{\#}/'$

$F = .049$ $K_u = 2.3/.049 = 47$ $1.33 K_u = 62$ $f = .002$

$A_s = .002 \times 12 \times 7 = 0.16^{\square'}/'$ # 4 @ 12"/c

EXPOSED FACE: $.002 \times 12 \times 10 = .24^{\square'}/'$ # 5 @ 15½"/c

FOOTING: MIN REINFORCEING REQ'D BY INSPECTION

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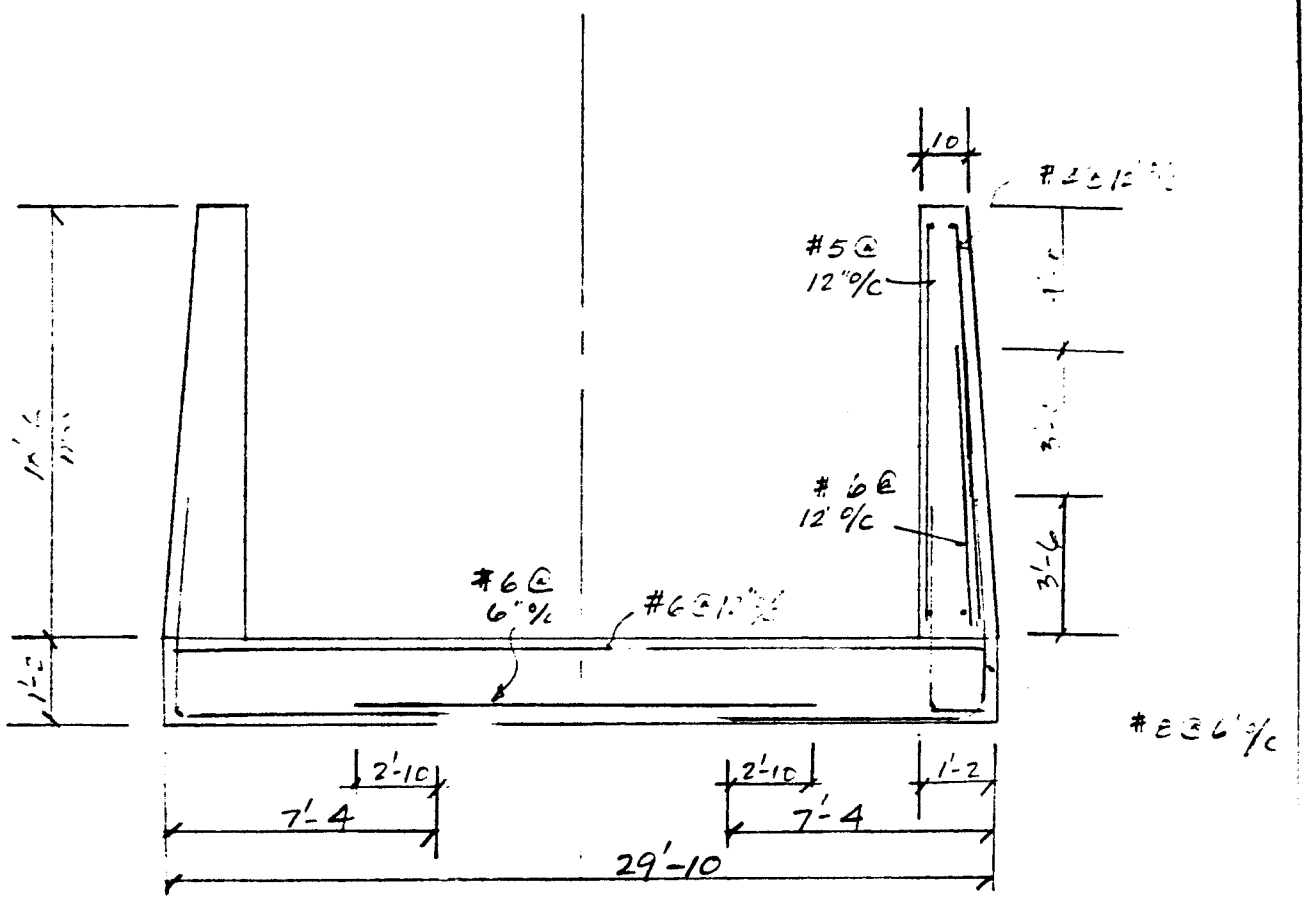
BY N. Hung DATE 11/11/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT ~~USDA-SOIL CONSERVATION SERVICE~~

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT BULLDOG FLOODWAY OUTLET CHANNEL



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BY N Hung DATE 11/11/35 SHEET ____ OF ____

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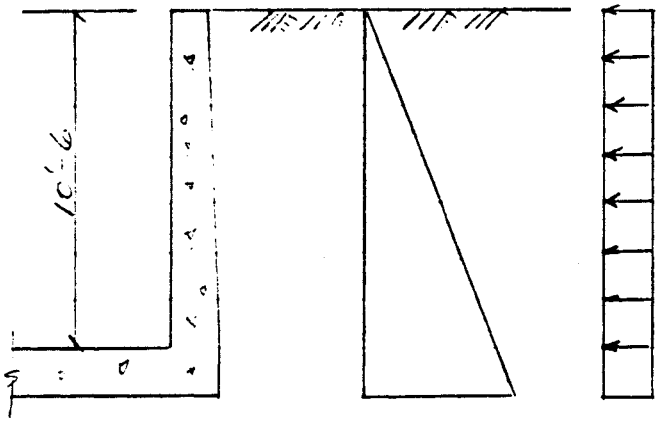
CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT BULLDOG FLOODWAY RECTANGULAR CHANNEL



EQUIVALENT FLUID PRESSURE
= 78 PCF
ADDITIONAL SURCHARGE LOAD
= 156 PSF

A): WALL DESIGN

(I): UNEXPOSED FACE: $H = 10.5'$

$M = \frac{1}{6} \times 78 \times 10.5^3 + \frac{1}{2} \times 156 \times 10.5^2$

$= 15053 + 6600 = 23650$ '#/'

$P_a = \frac{1}{2} \times 78 \times 10.5^2 + 156 \times 10.5 = 4300 + 1638 = 5938$ #/'

$M_u = 1.8 M = 1.8 \times 23.7$ 'K/' $= 42.7$ 'K/' $V_u = 1.8 P_a = 4.26$ K/'

$d = 14" - 3 = 11"$ $F = .121$

$K_u = M_u / F = 42.7 / .121 = 353$ $\rho = .0105$

$A_s = .0105 \times 12 \times 11 = 1.386$ □"/' #6 @ 6½" □/c

$v_u = V_u / \phi d = 4.26 / (12 \times 11) = .032$ K/□" $= 32.3$ #/□" $< 2\phi\sqrt{f'_c} = 107$ ±□

$h = 7'-0$ PER 11'-3 HEIGHT WALL
#6 @ 12" □/c + #4 @ 12" □/c

FOR INFORMATION NOT SHOWN
SEE 11'-3" HT. WALL CALCULATION

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BY N. Hung DATE 11/11/85 SHEET ____ OF ____

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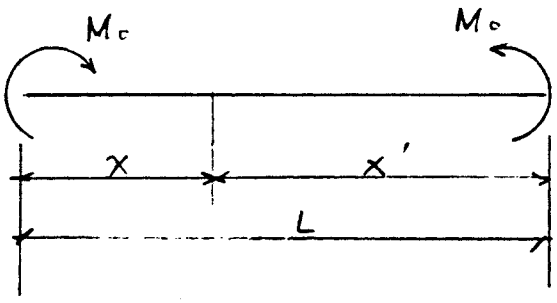
CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT FLOODWAY RECTANGULAR CHANNEL

BEAM ON ELASTIC FOUNDATION

REFERENCE : BEAM ON ELASTIC FOUNDATION BY M. HETENYI P. 51



$$M = M_o \frac{1}{\sin\lambda L + \sinh\lambda L}(\sinh\lambda x \cdot \cos\lambda x' + \cosh\lambda x \sin\lambda x' + \sinh\lambda x' \cos\lambda x + \cosh\lambda x' \sin\lambda x$$

BENDING MOMENT AT THE MIDDLE

$$M_c = 2M_o \frac{\sinh\frac{\lambda L}{2}\cos\frac{\lambda L}{2} + \cosh\frac{\lambda L}{2}\sin\frac{\lambda L}{2}}{\sinh\lambda L + \sin\lambda L}$$

(1) $K = 120\ ^{kips}/_{ft^3}$

$K_s' = 1 \times 120 = 120\ ^{K}/_{ft}$

$E_c = 3.62 \times 10^6\ psi = 5.213 \times 10^5\ ksf$

$I = bh^3/12 = 1 \times 1^3/12 = .0833$

$$\lambda = (K_s'/4EI)^{1/4} = \left(\frac{120}{4 \times 5.213 \times 10^5 \times .0833}\right)^{1/4} = 0.162$$

(2) For $h = 1'\text{-}2$

$I = \frac{1}{12} \times 1 \times 1.166^3 = 0.1323$

$$\lambda = (K_s'/4EI)^{1/4} = \left(\frac{120}{4 \times 5.213 \times 10^5 \times 0.1323}\right)^{1/4} = 0.1444$$

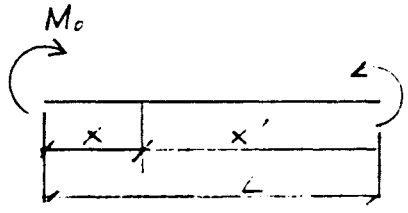
FOUNDATION DESIGN

FOR $d = 1'-2$ $\lambda = .1444$

$\lambda L = .1444 \times 29.8 = 4.30 > \pi$

$$M = \frac{M_c}{\sin\lambda L + \sinh\lambda L}(\sinh\lambda x \cos\lambda x' + \cosh\lambda x \sin\lambda x' + \sinh\lambda x \cos\lambda x + \cosh\lambda x' \sin\lambda x)$$

$$= \frac{M_c}{-.9162 + 36.8431} A = .02784\, M_o A$$



1. $X' = 1'-2$

$M = M_o$

2. $X = 6'.0$ $\quad x' = 23.8'$

$\lambda x = .864$ $\quad \lambda x' = 3.44$

$A = (\sinh\lambda x \cos\lambda x' + \cosh\lambda x \sin\lambda x' + \sinh\lambda x' \cos\lambda x + \cosh\lambda x' \sin\lambda x)$

$= .977 \times (-.9555) + 1.395 \times (-.2940) + 15.5774 \times .6486 + 15.6195 \times .7610)$

$= -.9339 - .411 + 10.10 + 11.88 = 20.635$

$M = .02784 M_o A = .02784 M_o (20.635) = 0.575\, M_o$

3. $x = L/2$

$$M = 2M_o \frac{\sinh\frac{\lambda L}{2}\cos\frac{\lambda L}{2} + \cosh\frac{\lambda L}{2}\sin\frac{\lambda L}{2}}{\sinh\lambda L + \sin\lambda L}$$

$$= 2M_o \frac{4.2342(-.5474) + 4.3507 \times .8369}{36.8431 - .9162} = .074 M_o$$

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BY N. Hung DATE 11/11/85 SHEET ____ OF ____

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CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT BULLDOG FLOODWAY; RECTANGULAR CHANNEL

AT $X = 6'$

$M_u = .575 M_o = .575 \times 42.7 = 24.56$ 'K/'

$d = 14" - 3 - 1 = 10"$ $\quad F = .01$

$K_u = M_u / F = 24.56 / .01 = 246$

$\rho = .0071$ $\quad A_s = .0071 \times 10 \times 12 = 0.86$ "/' $\quad$ — #6 @ 6" o/c

$A_s = 0.88$ "/'

AT FACE OF WALL

$M_u = 42.7$

$K_u = 42.7 / .01 = 427$ $\quad \rho = .0129$

$A_s = .0129 \times 12 \times 10 = 1.55$ "/' $\quad$ #8 @ 6" o/c

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BY N.A. DATE 12/3/85 SHEET ____ OF ____

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CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT BULLDOG FLOODWAY QUANTITY TAKE OFF

G) GROUTED ROCK RIPRAP (DROP #2)

$\left[150 \times \frac{120+50}{2}\right] \times 4.0 = 51,000$

$19 \times 120 \times 4.0 = 9,120$

$37 \times 120 \times 3.25 = 14,430$

$50 \times 56 \times 3.0 = 8,400$

$\frac{50}{2} \times 150 \times 3.0 = 11,250$

$32 \times 56 \times 3.0 = 5376$

$\frac{32}{2} \times 150 \times 3.0 = 7200$

106,776 cu.ft

3955 cu.yd ←

H): DRAINFILL: 1. DROP #2

$\left[150 \times \frac{120+50}{2}\right] \times 1.0 = 12,750$ cu.ft

$120 \times 56 \times 1.0 = 6720$

50×56 " $= 2800$

32×56 " $= 1792$

$\frac{32}{2} \times 150$ " $= 2400$

$\frac{50}{2} \times 150$ " $= 3750$

30,212 cu.ft = 1120 cu.yd

2. FLOODWAY

$(2' \times 1') \times 2 \times (20350 - 10146) = 40816$ cu.ft = 1511 cu.yd

TOTAL 1120 + 1511 = 2631 cu.yd

561/8-81

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BY N.K. DATE 12/4/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT BULLDOG FLOODWAY QUANTITY TAKE OFF

I) LOOSE ROCK RIPRAP

$4' \times 25 \times (100' + 10') = 11000$ cu ft

$\frac{11000 \times 100}{2000} = 550$ TONS

J) BEDDING

$2 \times 25 \times 120 = 6000$ cu ft

$6000 \times 110/2000 = 330$ TONS ←

K) CLEARING & GRUBBING: $1040{,}000/43560 = 23.9$ ACRES ←

37 $(3.5 + \frac{20}{12} + 14 \times 2 + 3) \times (11510 - 10146) = 50468$

52 $(10 + \frac{20}{12} + 14 \times 2 + 12) \times (12163 - 11510) = 34{,}000$

" $\times (13272 - 12163) = 57{,}668$

60 $(18 + \frac{20}{12} + 14 \times 2 + 12) \times (14026 - 13272) = 45{,}240$

$(22 + \frac{20}{12} + 14 \times 2 + 12) \times (15481 - 14026) = 93{,}120$

76 $(28 +$ " " $+ 18) \times (17050 - 15481) = 119{,}240$

77 $(35 + \frac{20}{12} + 14 \times 2 + 12) \times (18385 - 17050) = 102{,}800$

94 $(50 + \frac{20}{12} + 14 \times 2 + 14) \times (20300 - 18385) = 180{,}000$

$(130 + 54) \times (21977 - 20300) = 308{,}568$

45 $(9 + \frac{20}{12} + 14 \times 2 + 6) \times 148 = 6{,}660$

$(27.5 +$ " $+ 6) \times 600 = 38{,}400$

$(7 +$ " $+ 6) \times 80 = 3440$

$1039{,}600$ SQ. FT

581/8-81

Bulldog

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BY N. Hung DATE 9/19/85 SHEET ____ OF ____

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CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE BULLDOG FLOOD CONTROL PROJECT

SUBJECT

REFERENCES:

(1) DESIGN OF RECTANGULAR STRUCTURAL CHANNEL (USDA TR-50)

(2) DESIGN OF SMALL CANAL STRUCTURES (USDI, BUREAU OF RECLAMATION)

(3) ENGINEERING HANDBOOK. SECT. 14 CHUTE SPILLWAYS (USDA, UCS)

(4) SAMPLE CALCULATIONS OF DETERMINING THICKNESS OF GROUTED ROCK DROP STRUCTURES, LETTER BY JACK STEVENSON DATED JUNE 27, 1983.

(5) DESIGN OF OPEN CHANNELS (USDA. UCS TR 25)

(6) BEAM ON ELASTIC FOUNDATION (BY M. HETENYI)

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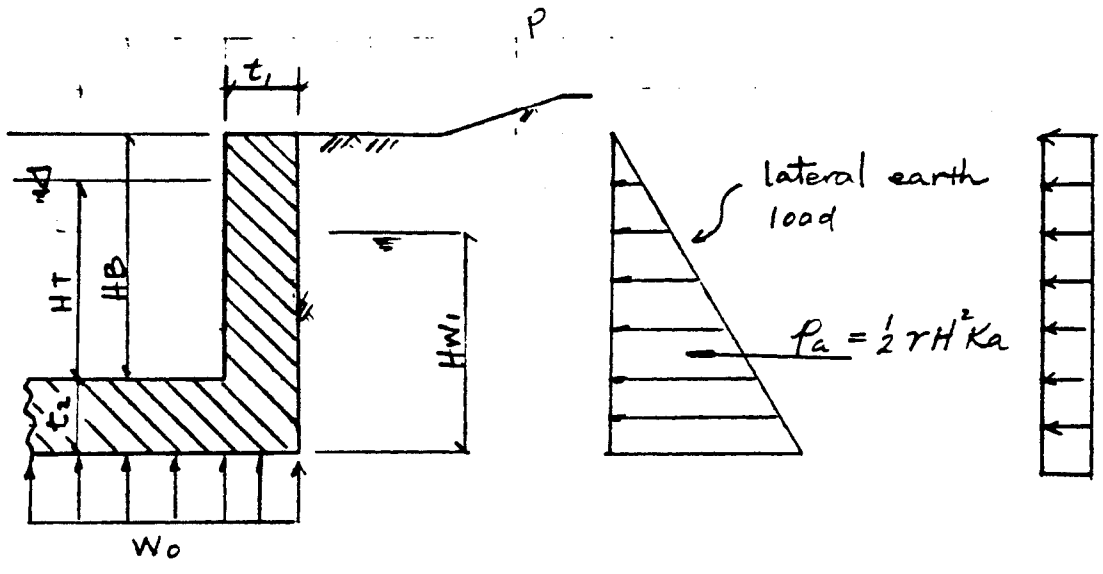
CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT Assumptions for rectangular channel design

D: Cond. I: External load with floodway empty



(1): wt. of backfill $\gamma = 130$ pcf

(2) lateral earth pressure coefficient $k_a = 0.6$

Equivalent fluid pressure

* $\gamma K_a = 130 \times 0.6 = 78$ psf/ft (CONSERVATIVE)

(3) $H_{W_1} = 0$ $W_o = 0$.

(4) ADDITIONAL LATERAL LOAD EQUIVALENT TO 2' OF EARTH SURCHARGE: $78\#/' \times 2 = 156\#/'$

(5) $t_1 \geq 10$, $t_2 \geq 12"$.

Allow. soil bearing pressure 2500 psf

Coefficient of friction. soil to concrete .35

" soil to soil .55 } (TR 50 P.7)

(6) $f_s = 40$ KSI. $f_c = 4$ KSI

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CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT ____

PAVEMENT SLAB DESIGN

VELOCITY OF FLOW = 15 fps

CHANNEL CLASS : "C", PER ENGINEERING DESIGN STANDARDS BY OSC FAR WEST STATES (FIGURE 1.7) & 6-23

$t = 6"$

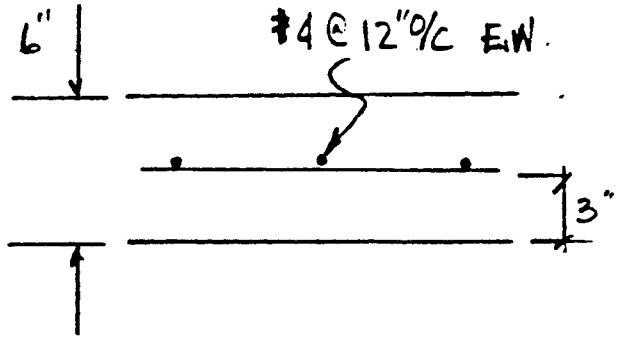
* $A_s = .003 \times 12 \times 6 = 0.216^{\square"}/'$

OR $P_1 = 62.4\left(7.5' + \frac{6}{24}'\right) \times \frac{6}{12}$

$= 241.8^{\#}/'$

$A_s = \frac{242 \times 1.8}{40{,}000} = .011^{\square"}/' < .216^{\square"}/'$

USE #4 @ 12" o/c E.W



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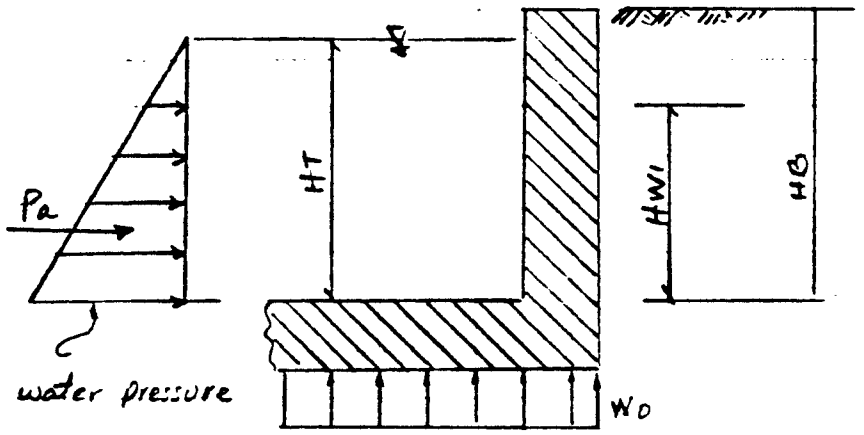
CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT Assumption for rectangular channel design

II): Cond. II : Internal load : water level max. with no backfill in place



(1) fluid pressure: 62.4 psf/ft

$P_a = \frac{1}{2}(62.4) H_T^2$ (H_T = DESIGN WATER HT.)

(2) $HW_1 = 0$. $W_O = 0$

(3) No surcharge Load

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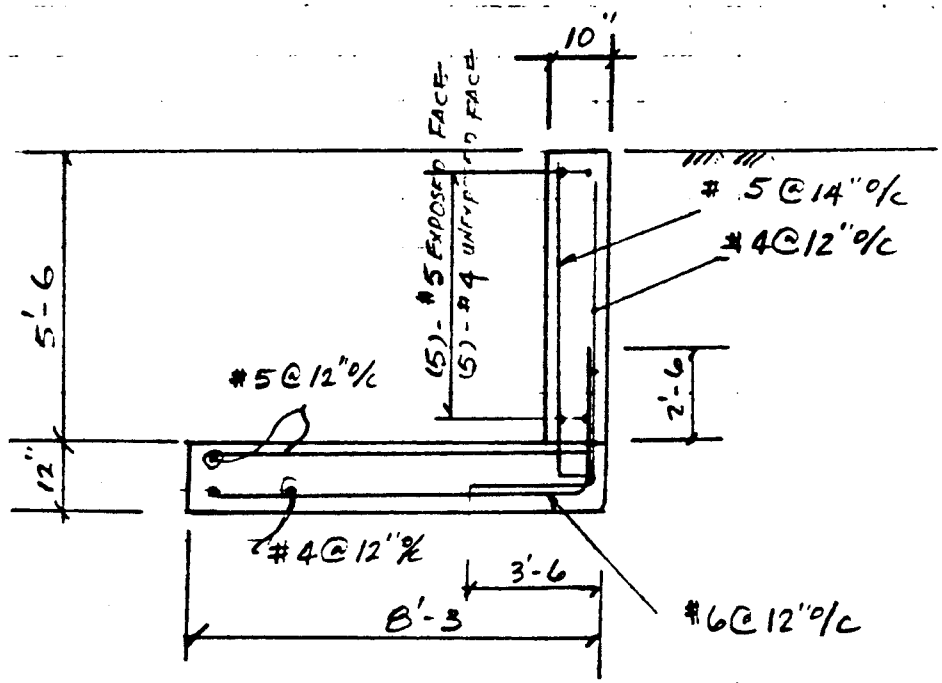
BY N. Hung DATE 10/15/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT USDA SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT FLOODWAY RECTANGULAR CHANNEL



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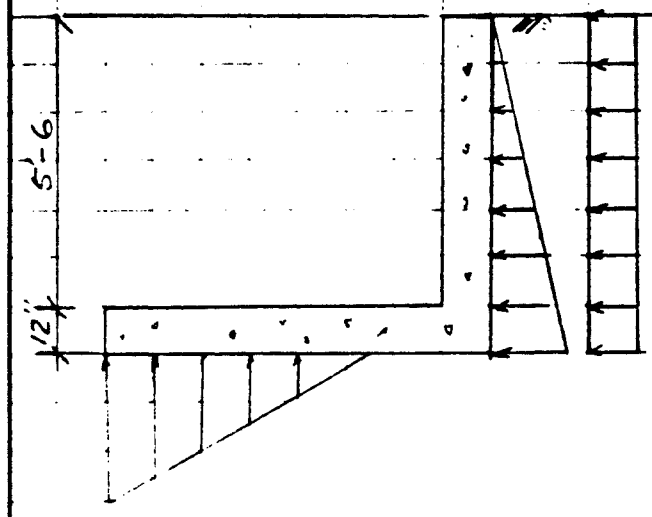
BY N. Hung DATE 10/15/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT FLOODWAY RECTANGULAR CHANNEL



A): WALL DESIGN $t = 10"$

1) UNEXPOSED FACE

$H = 5'-6"$

$M = \frac{1}{6} \times 78 \times 5.5^3 + \frac{1}{2} \times 156 \times 5.5^2$

$= 2163 + 2360 = 4522$ '#/'

$P_e = \frac{1}{2} \times 78 \times 5.5^2 + 156 \times 5.5$

$= 1180 + 853 = 2033$ '#/'

$M_u = 1.8\,M = 8140$ '#/' $= 8.14$ 'K/'

$F = .049$, $K_u = \frac{M_u}{F} = 8.14/.049 = 167$

$\rho = .005$

$A_s = .005 \times 12 \times 7. = 0.42$ □"/'

EXPOSED FACE : MIN REINF. #5 @ 12" o/c

HORIZ REINF. BAR : #5 @ 15" o/c MIN. FOR EXPOSED FACE

#4 @ 15" o/c " FOR UNEXPOSED FACE.

B): FOOTING DESIGN ($t = 12"$) RESISTING MOMENT.

(1) $150 \times \frac{10}{12} \times 5.5 = 687 \times 7.83 = 5379$ '#

(2) $150 \times 1 \times 8.25 = 1237 \times \frac{8.25}{2} = 5103$

1924 #/' 10482 '#/'

OTM $= \frac{1}{6} \times 78 \times 6.5^3 + \frac{1}{2} \times 156 \times 6.5^2 = 3570 + 3296 = 6865$ '#/'

S.F. AGAINST OTM $= 10482/6865 = 1.53 > 1.50$

SOIL BEARING PRESSURE f_b:

$e' = (10482 - 6865)/1924 = 1.88$

$e = \frac{8.25}{2} - 1.88 = 2.24 > 8.25/6$ $\quad l = 1.88 \times 3 = 5.64$

EBASCO SERVICES INCORPORATED

BY N. Hung DATE 10/15/85 SHEET ____ OF ____

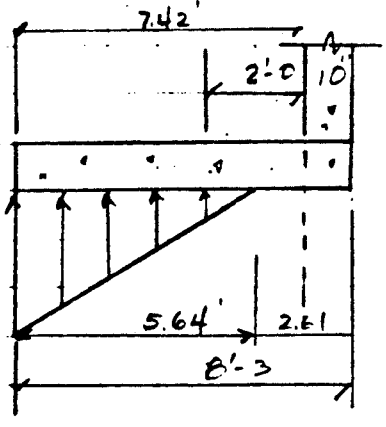
CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT RECTANGULAR CHANNEL

$f_b = \frac{1924}{\frac{1}{2}\times 5.64\times 1.} = 682.0\ ^{\#}/_{ft}$



MAX. MOMENT AT FACE OF WALL.

$M = 1924\left(8.25 - \frac{10}{12} - \frac{5.64}{3}\right) - \frac{1}{2}\times 150\times\left(8.25-\frac{10}{12}\right)^2$

$= 10659 - 4125 = 6534\ '^{\#}/_{'}$

$M_u = 1.8\times 6.53 = 11.8\ '^{K}/_{'}$

$F = .07225 \qquad K_u = M_u/F = 11.8/.07225 = 164$

$\rho = .005 \qquad A_s = .005\times 12\times 8.5 = 0.51\ ^{D"}/_{'}$

$\#6@12"/c + \#4@12"/c$

MOMENT AT 2' FROM FACE OF WALL

$M = 1924(7.42 - 2 - 1.86) - \frac{1}{2}\times 150\times(7.42-2)^2$

$= 6810 - 2203 = 4607\ '^{\#}/_{'}$

$M_u = 1.8M = 1.8\times 4.6 = 8.3\ '^{K}/_{'}$

$K_u = 8.3/.07225 = 115 \qquad 1.33K_u = 153$

$\rho = .0044 \qquad A_s = .0044\times 12\times 8.5 = 0.44\ ^{D"}/_{'}$

$\#6@12"/c$

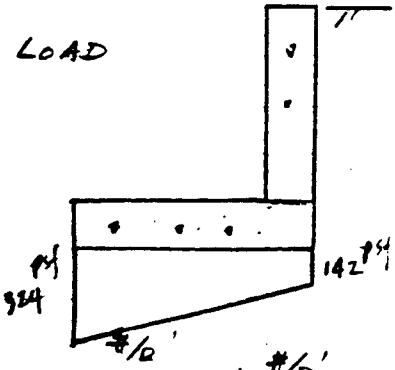
CHECK SOIL PRESSURE WITHOUT 2' SURCHARGE LOAD

RESISTING MOMENT = $10482\ '^{\#}/_{'}$

ACTING " = $3570\ '^{\#}/_{'}$

$e' = \frac{10482-3570}{1924} = 3.59'$

$e = \frac{8.25}{2} - 3.59 = .535' < 8.25/6$



$f_b = \frac{1924}{8.25}\left(1 \pm \frac{6\times .535}{8.25}\right) = 233(1 \pm .39) = 324 \text{ OR } 142\ ^{\#}/_{ft}$

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CLIENT _____

PROJECT _____

SUBJECT FLOODWAY RECTANGULAR CHANNEL

FOR $H = 3'-6$

$M = \frac{1}{6} \times 78 \times 3.5^3 + \frac{1}{2} \times 156 \times 3.5^2 = 558 + 955 = 1513^{1\#} = 1.5^{1K/'}$

$M_u = 1.8 \times 1.5^{1K/'} = 2.7^{1K/'}$

$K_u = M_u/F = 2.7/.049 = 55$

$1.33 K_u = 73 \qquad \rho = .0021$

$A_s = .0021 \times 12 \times 7 = 0.18^{\square''/'} \qquad \#4 @ 12''\text{o/c}$

$A_s = 0.2^{\square''/'}$

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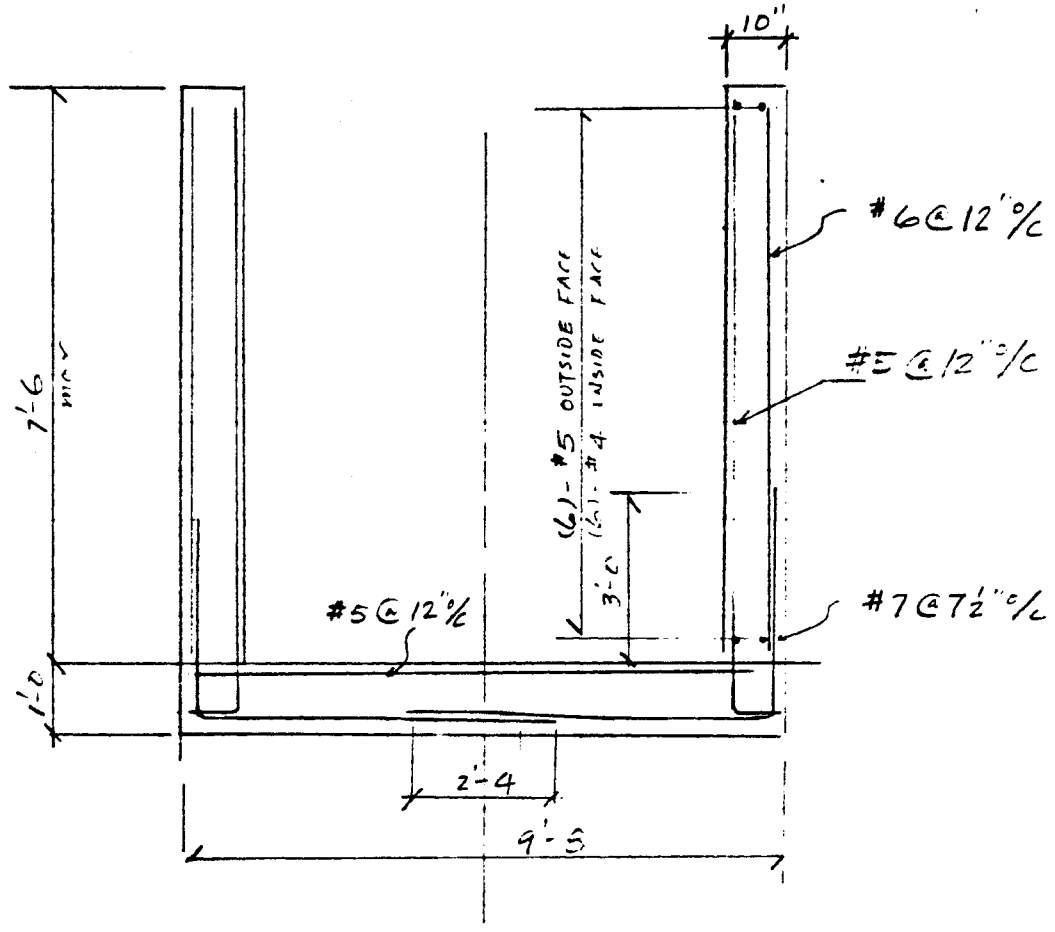
CLIENT USDA-SOIL CONSERVATION SERVICE

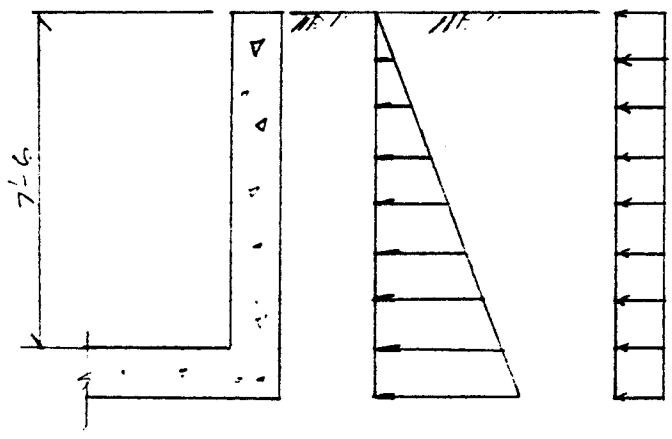
PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT BULLDOG FLOODWAY RECTANGULAR CHANNEL



581/8-81

SUBJECT BULLDOG FLOODWAY RECTANGULAR CHANNEL



WALL DESIGN: $t = 10''$

UNEXPOSED FACE

$H = 7'-6$:

$M = \frac{1}{6} \times 78 \times 7.5^3 + \frac{1}{2} \times 156 \times 7.5^2$

$= 5484 + 4387 = 9871$ '#/'

$M_u = 1.8M = 17.76$ 'K/'

$d = 10 - 3 = 7''$

$F = 12 \times 7^2 / 1200 = .049$

$K_u = \frac{M_u}{F} = \frac{17.76}{.049} = 363$

$\rho = .0108$

$A_s = .0108 \times 12 \times 7 = .91$ "/'

#7 @ 7½" o/c

$H = 5'-0$ $M = \frac{1}{6} \times 78 \times 5.0^3 + \frac{1}{2} \times 156 \times 5^2$

$= 1625 + 1950 = 3575$ '#/'

$M_u = 1.8M = 6435$ '#/' $= 6.5$ 'K/'

$K_u = M_u/F = 6.5/.049 = 133$

$\rho = .0050$ $A_s = .0050 \times 12 \times 7 = .42$ "/' - #6 @ 12"/c

SHEAR O.K BY INSPECTION

EXPOSED FACE: HT. OF WT $= 6.25$

$M = \frac{1}{6} \times 62.4 \times 6.25^3 = 2540$ '#/'

$M_u = 1.8 \times 2.54 = 4.57$ 'K/'

$K_u = M_u/F = 4.57/.049 = 94$ $1.33K_u = 125$

$\rho = .0035$ $A_s = .0035 \times 12 \times 7 = 0.294$ "/' #5 @ 12"/c

$A_{s\,min} = .002 \times 12 \times 10 = .24$ "/'

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CLIENT USDA-SOIL CONSERVATION SERVICE

PROJECT APACHE-BULLDOG FLOOD CONTROL PROJECT

SUBJECT BULLDOG FLOODWAY SIDE INLET AA

HORIZ. BARS .002 x 12 x 10 = .24"/' EXPOSED FACE

.24 x 7.5/.31 = 5.8 (6) - #5

UNEXPOSED FACE :

.001 x 12 x 10 = .12"

.12 x 7.5/.20 = 45 (6) - #4

FOUNDATION

EXPOSED FACE : .002 x 12 x 12 = 0.29"/' #5 @ 12" o/c E.F

UNEXPOSED FACE : #7 @ 12" o/c TRANSVERSE DIRECTION

#4 @ 12" o/c LONGITUDINAL DIRECTION

581/8-81

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BY M Hung DATE 10/4/85 SHEET ____ OF ____

CHKD. BY ____ DATE ____ OFS NO. 3767-300 DEPT. NO. 243

CLIENT [illegible] SERVICE

PROJECT APACHE [illegible] FLOOD CONTROL PROJECT

SUBJECT FLOODWAY RECTANGULAR CHANNEL