Greiner Engineering

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COMPARATIVE DESIGN STUDY FOR SCS RWCD FLOODWAY REACH 6

CONTRACT NO. 53-9457-00469
JOB NO. E 101012

FEBRUARY, 1986

VOLUME I

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Steps Taken for Comparative Studies

-- After topographic maps have been completed, a detailed site investigation will be done. This will identify proposed inlet location, existing underground drainage features, and verify mapping.

-- Proposed and existing bridges and culverts will be plotted in plan and profile on topographic base maps (at street crossings).

-- A preliminary grade will then be established for the entire project from structure to structure at street crossings adhering to the work plan as close as possible.

-- A prehydrology meeting will be held to finalize the hydrology done by SCS.

-- A final hydrology meeting will be held to establish peak flow for the 10, 25, and 100-year, 24-hour storm event for all inlets and for the main channel.

-- Preliminary layout for the main channel will be done based on the final hydrology and the work plan (i.e., channel sections and transition areas). For this, we will use channel sections from the work plan if the peak flows in the main channel are the same as from the work plan. If not, sections will be established preliminarily using a straight Manning's Equation.

-- Existing underground utilities will be plotted in plan view on topographic maps.

-- The soils mechanics report will be evaluated to establish the need for erosion protection and slope stability within the main channel.

-- A preliminary backwater analysis will be done for the 100-year, 50% 100-year, and the 10-year storm event using our preliminary grade, horizontal alignment, cross section, n values, and erosion protection based on the soils mechanics report. WSP II will be used for backwater analysis. Hydraulic control grade elevation will be based on PRC Toup HEC-2 analysis for Leisure World. At this time, all existing structures (i.e., bridge culverts) and proposed structures will be checked for their adequacy. Revisions to alignment, cross sections, and linings will be made as necessary.

-- Channel transitions (i.e., rip rap, soil, cement, or other alternates) will also be evaluated at this time along with different lining in the main channel.

-- Cost estimates, feasibility of construction, and operation and maintenance of each of our modifications and alternates will be evaluated.

Greiner Engineering

SCS RWCD REACH 6, JOB NO. E-101-012

DETAILED SCHEDULE FOR
COMPARATIVE DESIGN STUDIES AND APPROACH

Scope of Services per Specifications

- Develop the general features of the structural installation.
  - Selection of the most suitable type of structures.
  - Optimum layout and arrangement of the elements of the structural system.
  - Compare different alternates for these structures.
  - Prepare cost estimates for all alternates.
  - Consider foundation and other site conditions.
  - Consider feasibility of construction, operation, and maintenance.
- Project features and alternatives are:
  - Earth channel.
  - Earth maintenance ramps.
  - Lined channel for all reaches not meeting criteria for earth channel.
    - Consider:
      - Recompacted earth.
      - Soil cement.
      - Other alternates.
  - Side inlets.
    - Consider:
      - Pipe.
      - Grouted rock.
      - Other alternates.
  - Channel transitions.
    - Consider:
      - Rip rap.
      - Soil cement.
      - Other alternates.
- Prepare a feasibility study report showing recommendations and rankings of the project feature alternatives along with full supporting data.

-- Preliminary earthwork computations will be done using the RDS computer program to analyze cuts and fills for the main channel, maintenance, roadways, and side cut ditches for each alternate. These results will be included in our cost estimates along with the feasibility and ease of construction. At this point, all existing structures and underground utilities will be looked at for conflicts for each alternate.

-- Inlet locations and types will be established depending on peak flows from the final hydrology and topography base maps.

-- Side ditches will also be established based on the above. Use straight Manning's Equation to size ditches.

-- Existing underground drainage facilities outletting into the floodway will be studied for their acceptance into side inlets or the main channel.

-- Different type of inlet (i.e., pipe, grouted rock, and other alternates) will be evaluated based on cost, feasibility of construction, and operation and maintenance. Water surface profiles, velocities, and erosion analysis will be performed for each alternate to establish their size and performance.

-- Earth maintenance ramps will be laid out and located based on information given to us by the Flood Control District.

-- A detailed log will be kept establishing a chronologic order of the procedures used, rational for different alternates chosen, calculations, cost estimates, concepts, and final conclusions and recommendations. This will then be turned into a feasibility study report showing recommendations and rankings of the project feature alternatives.

COMPARATIVE DESIGN STUDIES SCHEDULE
SCS R.W.C.D. REACH 6

	September				October				November					December		
Tasks	6	13	20	27	4	11	18	25	1	8	15	22	29	6	13	20
Site Investigation	X															
Plot Existing Structures	X															
Set Preliminary Grades		XX														
Pre-hydrology Meeting	X															
Final Hydrology Meeting		X														
Prelim. Layout for Main Channel		XXXX														
Plot Existing Utilities	XXXXX															
Evaluate Soils Mech. Report				X												
Prelim. Backwater Analysis				XXXXXXX												
Evaluate Channel Transitions				XXXXXX												
Prelim. Earthwork Computations			XXXXX			XXX										
Locate Inlets			XXXX													
Determine Inlet Types			XXXXX													
Establish Geom. for Side Ditches					XXXXX											
Evaluate Exist. Underground Drainage Facilities						XXXXX										
Layout Maintenance Ramps							XXXX									
Cost Estimates					XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX											
Feasibility Study Report										XXXXXXXXXXX						
Review												XXXXXXXXXX				

Greiner

February 10, 1986

Re: SCS RWCD Reach 6
Comparative Design Study
Contract No. 53-9457-00469
Job No. E-101-012
Summary of Conclusions and Recommendations

Greiner Engineering Sciences, Inc., is pleased to submit the findings from the Comparative Design Study for the SCS RWCD Reach 6 Floodway Protection Project. Enclosed are the following: Six (6) copies of the report (Volumes I and II); six (6) sets of bluelines showing grade, alignment, water surface elevations and the layout and arrangement of the project features for Alt. No. 1, 2 and 3; one (1) set of tractive power calculations; and one (1) set of computer printouts for "WSPG" water surface profile calculations for all hydraulic features (floodway, major inlets, and collector channels); TR-20 for all off-site subdivisions adjacent to the floodway, "STORM"; storm drain analysis for all storm drains entering the floodway; "CIRCO1TI" normal depth calculations for pipes entering the floodway channel; and "TRAPO1I" used to analyze existing trapezoidal channels entering the floodway channel.

Greiner has adhered to the approach as outlined in this section. We have developed a ranking system for all alternates and features within the floodway based on cost, maintenance, availability, ease of construction, aesthetics and hydraulic performance and/or general performance. A point system of one (1) through ten (10), with ten being the highest possible score, was used based on the above. Different multipliers were used for each item as follows:

Items	Multiplier	Possible No. of Points
Cost	2	20
Maintenance	1	10
Availability	1	10
Ease of Construction	0.5	5
Aesthetics	0.5	5
Hydraulic Performance	1	10
Total Available Points	---	60

The alternate that scored the highest number of points was the one recommended.

The report is set up in two (2) volumes, with twenty-six (26) sections, as shown in the index. Each section is composed of a write-up of recommendations, concepts, criteria, techniques and results. Following each write-up are summary tables, cost estimates, detailed sketches, telephone conversations, design procedures used, details of proposed recommendations, calculations and ranking tables.

In summary, Greiner has looked at three (3) alternates for grade and alignment of the floodway. Alt. No. 1 was based on the original work plan by SCS dated 10-74. Alt. No. 2 is a modified Alt. No. 1 with the amendment due to Modification No. 3 of Greiner's contract. Alt. No. 3 is a modified Alt. No. 2 with a concept based on a serpentine layout. Greiner recommends utilizing Alt. No. 2 for the grade and alignment of the floodway.

Recommendations for structures at roadway crossings were made for Apache/Higley, Adobe Road and Brown Road. It is recommended that a five (5) barrel, 10' x 7' box concrete culvert approximately 352 feet in length be installed at Apache/Higley. Due to problems in time delays associated with this intersection (See Section 25), Greiner has not been able to do a full investigation of this structure during this phase of their contract. A further investigation will be performed during the preliminary design phase. This investigation will consist of finalizing the two (2) major inlet structures, one on the northwest corner and one on the southwest corner, and the connection of two (2) major storm drains entering into the floodway, one from the north on Higley Road and one from the east on Apache Boulevard. Greiner Engineering will also be investigating the shortening of wingwalls on the eastside of the upstream and downstream end of this structure. A possible use of a standard A.D.O.T. tapered wingwall on both east sides of the structure, using a 3:1 side slope on both east sides of the structure transitions, shortening the length of side slope protection and extending bottom protection upstream and downstream of the structure will be investigated. Preliminary investigations and calculations within this report and

its attachments indicate that the above is very feasible and deserves a further look.

It is recommended that a five (5) barrel, 8' x 8' concrete box culvert with tapered wingwalls be installed at Adobe Road. The approximate length of the concrete box culvert is 100 lineal feet. Inlet and outlet aprons are not necessary for this structure. See Section 25 for the proposed grade and alignment for the proposed Adobe Road and detailed recommendations.

It is recommented that a two (2) barrel, 8' x 8' concrete box culvert with tapered wingwalls be installed at Brown Road. The approximate length of the structure is 124 lineal feet. Inlet and outlet aprons are not necessary for this structure.

Proposed and existing drainage reports were evaluated in conjuction with field visits, aerial mapping, and routing techniques used by the SCS's TR-20 runs to establish peak flows for subdivisions adjacent to the floodway. Results from Greiner's TR-20 program showed that it was necessary to design a major inlet structure discharging from the existing retention facilities for Stoneybrook between stations 77+00 - 79+00, Sunlife North between stations 92+00 - 95+00, and from street drainage at Mesa Shadows East at stations 143+66 and 150+98. (See Sections 5 and 6 for details).

Eleven (11) major inlet structures with their associated collection systems are recommended for the RWCD Reach 6 project along the east side of the floodway. Side inlet structures are designed to collect off-site flows from major east-west streets (surface drainage) with provisions made for existing storm drain systems and discharge from existing retention facilities from adjacent subdivisions. Surface drainage from these off-site areas are very wide and large and it was necessary to pick these up in a wide collection area to assure adequacy. After off-site flows are picked up, they are funneled and concentrated into the spillway system and delivered into the main floodway channel. It is recommended that the upstream banks of the collection systems and the spillways for all major inlet structures be constructed with the same technique and material. Greiner Engineering recom-

mends the use of soil cement for this material. (See Sections 5, 8, and 24 and the bluelines for Alt. No. 2 for locations, write-ups, and details for all the major inlet structures).

It is Greiner's recommendation that the operation and maintenance roadways on both sides of the main floodway channel be graded and drain away from the main channel at a slope of 1.75 percent. This recommendation is made to cut down on the amount of ruts which form on the main floodway channel banks during storm events due to the runoff from the roadways. These ruts change the "n" value of the channel banks and cause extensive maintenance due to weeds and constant grading. Greiner Engineering did a major investigation to see if this roadway could be treated to cut down on maintenance vehicle slippage. The investigation showed that this is feasible but is an additional expense. Although a treatment is an additional expense, Greiner recommends that 7" of soil cement be used for the maintenance roadways. It is recommended that an agreement with the RWCD be made to allow an encroachment of the maintenance roadway at ramp locations at certain locations on the west side of the floodway. These locations are as follows: north of Adobe Road, north of Apache Boulevard, south of Higley Road, and north of Brown Road. The same situation exists and a precedent was set during Reaches 2 and 3. It is possible, if an agreement cannot be reached, to eliminate the maintenance ramps in these locations.

Since the operation and maintenance roadways drain away from the main floodway, it is necessary to collect and discharge this runoff plus the runoff within the right-of-way of the floodway and discharge it at a point into the major floodway channel. Many alternates based on grade, alignment, placement of inlets, materials, ease of construction, maintenance, cost and hydraulic performance were evaluated for both east and west collection systems. The following are our recommendations: On the east side of the floodway, the availability of area was not a problem due to the horizontal alignment of the floodway. Spacing of the discharge inlet is such that the collector channel does not become a major earthwork item to facilitate good hydraulic performance and low maintenance. Therefore, it is recommended that inlets be spaced approximately every 500 feet with the drainage coming

from the north and south, thus limiting earthwork. On the westside of the floodway, limited space is available (sometimes only 7.5 feet of room), therefore, the collector channel invert parallels the grade on the maintenance roadway. It is recommended that inlets be spaced approximately every 600 feet with discharge coming from the north. Both of the collection systems have a side slope adjacent to the maintenance road of 4:1, so that if slippage should occur off the maintenance road, a vehicle could recover. The side slope graded back to existing ground will be at a 3:1. On the west side of the floodway right-of-way, it will be necessary to procure a temporary grading easement so that the top of the 3:1 slope of the channel bank will match the existing RWCD canal maintenance road and to assure positive drainage into the collector channel. The materials for both collector channels will have an earthen lining.

Both collector channels will have the same discharge inlet system composed of a 24 inch C.M.P. drop shaft with a pre-fabricated trash rack, and 2-4 inch P.V.C. perforated pipes embedded in pea gravel, wrapped in a filter blanket connecting into the 24 inch drop shaft. Welded to the bottom of the drop shaft will be an 18 inch C.M.P. discharging into the floodway invert.

A complete material investigation was performed for all alternates and features for the floodway. The results from our ranking system for the remainder of the floodway features are as follows: Soil cement is recommended for all erosion protection including; the main floodway channel, collector outlets, the 42 inch pipe at station 143+66 discharging into the collection system across the maintenance roadway in that area, and the 36 inch pipe south of University Drive. The only area that soil cement is not recommended is for the banks under the Broadway Road bridge constructed at a 1:1 side slopes and within the transition areas. It is recommended that a concrete lining be used, due to the fact that concrete can be pumped and there is not enough room under the bridge for any construction equipment. Soil cement is also recommended for the maintenance roadways and ramps. The ramps will be constructed with a cutoff wall on the upstream side of the floodway and at the bottom. Weep holes are recommended on the ramps to prohibit uplift due to hydrostatic pressures. All maintenance ramps will be

graded so that they enter into the floodway in the same direction of flow of stormwater, limiting erosion and maintenance. A plunge basin is recommended versus a drywell for the 54 inch pipe south of Brown Road. This plunge basin will be constructed out of soil cement with weep holes for drainage.

Headwalls with trash racks are recommended for the outlet of the 54 inch pipe south of Brown Road, the 36 inch pipe south of University Drive, and the 42 inch pipe located in the collection system of the major inlet structure at station 143+66.

It is recommended that the inlet channel to the north terminus of the floodway be protected using soil cement on the bottom, the sides of both banks and 10 feet to the east on natural ground. On the most easterly edge of the soil cement, a cutoff wall is also recommended.

It is recommended that wherever erosion protection is recommended in the main floodway channel, a three (3) foot cutoff wall be constructed on the upstream and downstream edge of the material. In addition, it is recommended that for the first ten (10) feet on the upstream edge of this erosion material, weep holes be placed every twenty (20) feet to prevent hydrostatic uplift.

It is recommended that a 3 foot high concrete retaining wall, approximately 50 feet in length, be constructed between the eastern bank of the main floodway channel and the most western bank of the collection system to the major inlet south of Brown Road. This needs to be installed because the grade differential is approximately 2 feet in this area. See detail in Section 5.

A temporary grading permit needs to be obtained in two additional areas. One to tie the inlet channel at the north terminus into the existing channel located at the most northern right-of-way for this project, and one at station 143+66. It is necessary to remove the existing headwall and trash rack and two (2) sections of 42 inch pipe beyond the right-of-way of the RWCD floodway and rebuild the headwall and trash rack. This must be done to give

enough room to swing the maintenance road around the inlet spillway structure (See the detail in Section 5).

The selection of one major material for all the features within the floodway should provide the Contractor and the Soil Conservation Service with many advantages. It is recommended that plated soil cement be used as the major material. A batch process is not recommended for the following reasons: There is only a limited amount of this material being used. The floodway being approximately 2.5 miles in length and the major inlet structures, collection facilities, inlet channels, outlet protection, and bank and bottom protection being spaced so far apart would take a tremendous amount of haul distance. Therefore, it is recommended that soil cement be mixed directly into the soil at each feature location including the maintenance roadways. Since the same equipment can be used for rough grading, finish grading, and the application of soil cement, the Contractor should only have to mobilize one time on the site, saving a tremendous amount of time and cost and in return passing the savings on to the Soil Conservation Service.

Chronological Log of Concepts and Rational

Steps Taken for Comparative Studies

✓ 1. Site Investigation (9/3/85)

2. Plot Existing Structures (9/19, 9/20 & 9/23)

✓ Plot structure elevations (proposed and existing bridges and culverts) at street crossings.

✓ Check the high water elevations and inverts at the above structures.

3. Establish a preliminary grade

✓ By the work plan.

✓ By maps of the proposed and existing structures.

✓ Adhere to the work plan as close as possible.

4. Preliminary layout for the main channel (9/25 -

✓ Plot the main channel in plan based on the work plan.

- Plot transtion areas at street crossings.

✓ Call out the inlets and discharges (Alt. #3) recommanded by SCS.

- Plot the exististing maintenance road & E. of R.O.W. in profile.

✓ Side slopes under Broadway are 2:1. (Because of bridge fundations)

✓ Side slopes under University are 2:1. (Bridge Abutments)

✓ Plot inlet cross sections (9/30 & 10/1 - 10/2)

5. Establish Floodway centerline south of Broadway Road

✓ Set project limit at 161+30 on survey baseline. (9/26)

✓ Run COGO to get alignment. (9/26 ~ 9/27)

✓ Plot information on the topo maps. (10/3)

6. Plot Existing Utilities

✓ Plot existing underground utilities on the base map.

✓ Check the existing utilities from As-Builts. (9/28 & 9/30)

✓ Vertify the existing utilities in field (10/1)

— Send survey crew out & get the missing data.

7. Evaluate Existing Subdivision Drainage Reports

✓ Sundance Groves Drainage Report (Ref. Sect 21) (10/2)

✓ Drainage Study of Mini Park Area Plus Drainage Area North of E. Main Street. (Ref. Sect. 21) (10/3 - 10/4)

8. Preliminary Earthwork Computations:

- Use "Cross Section Earthwork Program (DIRT)" computer program.
- Hydraulic calculations and cost estimate for proposed box culvert at Brown Road. (10/3)
- Set up "TEMPLATE FILE" for DIRT (10/5)
- Set up "COMMAND FILE" for DIRT (10/5)
- Add last 500 feet station terrain data into "TERRAIN FILE" (10/5)
- Running and Debugging

9. Preliminary Backwater Analysis:

- Compare WSPG and HEC-2 with WSP2
- Backwater analysis alternate No. 1 using WSPG.
- Test run to compare WSPG and HEC-2 (10/16)

10. Investigation of chemical treatment of soil for maintenance Road

Greiner Engineering

Greiner Engineering Sciences, Inc.

Tucson 602 327-3413
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Job: RWCD Flooding Reach 6, E101012
Description: Comparative Design Studies

Calculated by: Garf Sun Date: _____ Sheet No. 1
Checked by: M.S.S. Date: _____ of _____

9/3/85 Site Investigation

- Crew : Michael Shapiro, Mustafa Chudnoff and Garf Sun
- Photos taken
- New headwall for 42" R.D. at Mesa Shadows East
- Apache / Higley Intersection Existing Drainage.
- Evaluate the potential locations for the major inlet structures.

9/15 ~ 9/18 & 9/23 ~ 9/25

Plot Existing Utilities:

- Existing underground utilities on Brown Road.
- Existing underground sewer line between Adobe Road and transmission easement.
- Existing underground utilities on University Drive.
- Existing underground sewer line crossing floodway at approx. Sta. 117+00.
- Existing underground utilities on Apache Blvd. and Higley Road.
- Existing underground power lines at Sta. 140+00 and Sta. 142+70.
- Existing underground power line at Sta. 148+20.
- Existing underground sewer line on Broadway Road.

9/19

Plot Existing Structures:

- Structure elevations and inverts at Broadway Road Bridge. (by RGA for Flood Control District of Maricopa County) (Ref. Sect 10)
- Structure elevations and inverts at University Drive Bridge. (Flood Control District of Maricopa County) (Ref. Sect. 10)

9/20

Plot Existing Structures:

- Box Culvert elevations and inverts at Apache Blvd. and Higley Road. (by MKA Preliminary Design for Flood Control District of Maricopa County) (Ref. Sect 10)
- Check the high water elevations and inverts at street crossings.

9/23 - 9/24

Establish a preliminary grade:

- Plot proposed grade from the work plan on base map.
- Check the proposed and existing structure inverts.
- Adhere to the work plan as close as possible
- Call out the inlets and discharges (Alt #3) recommanded by SCS.

9/25

Preliminary Layout for the Main Channel:

- Plot bottom of the main channel in plan base on the work plan.
- Plot the existing maintenance road (west side of floodway) in profile.
- Check cross sections at street crossings with the work plan's.

(1) Side slopes under Broadway and University are 2 to 1. (Because of bridge abutments)

(2) Apache and Higley: 5 barrel 8'x10' box culvert

9/26 - 9/27

Establish Floodway Centerline 530 feet south of Broadway Road:

- Set project limit at Sta. 161+30 on survey baseline.
- Set floodway centerline 39.705 ft. west of baseline at Sta. 161+30.
- Run COGO to get alignment and plot lines and points using the same scale as the base map.

9/28 and 9/30

Plot Existing Utilities:

- Check the existing underground utilities. (Ref. Sect. 22)

Plot Inlet Cross Sections. (Ref. Sect. 5)

10/1

Plot Inlet Cross Sections (Ref. Sect. 5)

Plot Existing Utilities:

- A detailed site investigation to identify existing underground utilities. (Ref. Sect. 22)
- Check with Keith (City of Mesa)

Evaluate Existing Subdivision Drainage Reports:

- Review "Sundance Groves Drainage Report" (Ref. Sect. 21)

10/2

Plot Inlet Cross Sections (Ref. Sect. 5)

Establish Centerline profiles:

- For 530 feet south of Broadway Bridge.

Evaluate Existing Subdivision Drainage Reports:

- Review "Sundance Groves Drainage Report" (Ref. Sect. 21)

10/3

Evaluate Existing Subdivision Drainage Reports:

- Review "Drainage Study of Mini Park Area Plus Drainage Area North of E. Main Street. (Ref. Sect. 21)

Establish Centerline profiles:

- On the topo maps for 530 ft south of Broadway Bridge.

10/3 (Cont'd)

Plot Existing Utilities:

- Revise some locations of existing utilities on topo maps as per findings.
- Revision of Geologic data on topo maps

Preliminary Earthwork Computations:

- Use "Cross Section Earthwork Program (DIRT)" computer program
- Need the proposed box culvert at Brown Road with capacity of 900 cfs.
- Three alternates (single 12'x8', single 10'x8' and Double 6'x7') have been calculated and compared. Recommand using 2-6'x7' after cost estimate for three alternates. (Ref. Sect. 11)

10/4

Evaluate Drainage Reports: (Ref. Sect. 21)

- Review "Drainage Study of Mini Park Area Drainage Area North of E. Main Street.
- Review "Hydrology Report for Northpointe"

Drafting Revisions

10/5

Preliminary Earthwork Computations:

- Set up "TEMPLATE FILE" for DIRT
- Set up "COMMAND FILE" for DIRT
- Input last 530 feet (Sta. 156+00 ~ Sta. 161+30) terrain data into "TERRAIN FILE"
- Running and Debugging

10/7

Preliminary Earthwork Computations:

- Running and Debugging

Send Hydraulic computations for University & Broadway to Kenny to have soil stability & errosion analyses for > to 1 slopes.

Plot E. of R.O.W in profile

10/8

Preliminary Earthwork Computations:

- Running and Debugging
- Send "PLOTFILE" to plotter

Plot information on work sheets into sepias.

Evalue Drainage Reports.

10/9

Preliminary Earthwork Computations:

- Check cross section plots

Plot information on work sheets into sepias for comparative design alternate #1

10/10

Reviews and Meetings:

1. Need Backwater analysis

Review Existing Operation and Maintenance Manuals:

- What steps can be taken during design to limit maintenance?

Plot information on work sheets into sepia for alternate #1

10/11

Preliminary Backwater Analysis:

- Use TR-61 WSP2 computer program

Plot R.O.W on cross section plots.

10/12

Preliminary Backwater Analysis:

- Test WSP2 computer program

Plot R.O.W. on cross section plots.

10/14

Preliminary Backwater Analysis:

- Test WSP2 computer program
- Make comparison between HEC-2, WSPG and WSP2.

Location of Maintenance Ramps:

- At University Bridge, two maintenance ramps should locate at downstream side to minimize deterioration.

Revision on cross section plots.

10/15

Preliminary Backwater Analysis:

- Make comparison between HEC-2, WSPG and WSP2.
- Meet Don Paulus at SCS office (1:15PM)
- Run test program to compare WSPG with HEC-2.

Location of Maintenance Ramps:

- Should consider maintenance ramps for Adobe Road.

10/16

Preliminary Backwater Analysis:

- Decide to adopt WSPG after comparison between HEC-2 and WSPG test run.
- Backwater analysis alternate No. 1 trial #1. (Ref. Sect. 23)

10/17

Preliminary Backwater Analysis:

- Revise Apache Blvd. and Higley Rd. Box Culvert as per new plan.
- Input data for WSPG run.
- Question on the WSP2 run for Leisure World about the location of the station 153+12.

Plot channel bottom in plan as per first DIRT run templates.

10/18

Preliminary Backwater Analysis:

- Apply the datum correction of +0.05 foot for SCS elevation data.
- Input data for WSPG run. (Ref. Sect. 23)

Plot channel bottom in plan as per first DIRT run templates.

10/19

Preliminary Backwater Analysis:

- First trial of WSPG run
- Check the results and input data.

10/21

Preliminary Backwater Analysis:

- Revise the first trial run.
- Have SCS rerun WSPG using 2400 cfs for stations 150+32, 151+82 and 153+12 instead of using 3100 cfs. Get new control downstream elevation of 1340.05 (SCS 1340.10) from Don.
- Freeboard requirement for concrete lined channels is 1 foot. (Don)

10/22

Preliminary Backwater Analysis:

- Modify input data for Alternate No. Trial #2
- WSPG program kicks out from computations. (Call Rich Peterson at Irvine)

10/23

Hydraulics for side inlets

- Computer water depth for Q_{100} at Brown Rd. earth channel, Adobe Rd., Electric Easement Channel. (Ref. Sect. 5)

Preliminary Backwater Analysis:

- WSPG cannot have negative invert slope. Use irregular channels to avoide the negative invert slope.

10/24

Preliminary Backwater Analysis:

- Alternate No. 1 Trial #2: Use irregular channels to avoide the negative invert slope.

Redesign Box Culvert at Brown Road to have at least 1 foot freeboard inside the Box. (Ref. Sect. 11) 2 barrel 12'x8' box culvert

10/25 - 10/26

Preliminary Backwater Analysis:

- Alternate No. 1 Trials #3 & #4 cross section modifications for proposed 2 barrel 12'x8' box culvert at Brown Road.

10/27

Preliminary Backwater Analysis:

- WSPG results for Alternate No. 1 Trials #3 & #4 (Ref. Sect. 23)

10/28

Preliminary Backwater Analysis:

- Review WSPG runs for Alternate No. 1 Trials #2 ~ #4 (Ref. Sect. 23)

Hydraulic & Hydrologic Design of Collector Channels (Refer Sect. 7)

10/29

Hydraulic & Hydrologic Design of Collector Channels (Refer Sect. 7)

Preliminary Backwater Analysis:

- Adopt 2 barrel 8'x8' box culvert at Brown Road.
- Cross section modifications for Alt. No. 1 Trial #5-1 & #5-2

10/31/85

Hydraulic and Hydrologic Design of Collector Channels:

- East Collector Channels

11/1/85

Hydraulics of Collector Channels:

- West Collector Channels with triangular sections.

11/2/85

Hydraulics for Collector Channels:

- "WSPG" run for West Collector Channel and inlet at Sta. 158+90.67

11/4/85

Hydraulics for Main Channel:

- Set Up Alt. No. 1 Trial #6 for Q_{100} with $n = 0.025$.
- Set Up Alt. No. 1 Trial #6-1 for 50% of Q_{100} with $n = 0.023$.

11/5/85

Hydraulics for Side Inlets:

- Powerline Easement: Three alternates. (Ref. Sect. 24)
- "Storm" run for as-built 36" S.D. at University Drive

11/6/85

Hydrology for Adjacent Subdivisions and inlets:

- Field Trip

① Sunlife Parcel Subdivision

② Mesa Shadows East

③ East Adobe Road - Water will drain from the north side of the roadway to the Floodway.

④ University Drive - Water will drain from the north side of the roadway to the Floodway.

⑤ Remarks - (i) Reconstruction the inlet channel which was located at downstream of Broadway Road (Design by PRC).

(ii) RWCD Canal is under construction along the Sedimation Basin and a new inlet pipe is installed.

- Powerline Easement Channel:

① Design of Box Culvert.

② Set Up Alt. No. 1 Trial #1 run.

11/7/85 - 11/20/85

Evaluation of Proposed Channel at Powerline Easement: (Ref. Sect. 24)

- Alt. No. 1, 2 and 3.

11/7/85 - 11/8/85

Evaluation of revising the retention basins within the powerline easement and constructing detention facilities with control structures to reduce the peak flow.

10/30

Preliminary Backwater Analysis:

- Review the revised WSPG run for Leisure World by SCS (10/21/85).

  At Sta. 163+10 (SCS Section 15312)

  Q = 2400 cfs W.S.E. = 40.05 (SCS 40.00)

  Q = 1200 cfs W.S.E. = 37.95 (SCS 37.90)

- Send WSPG run Alt. No. 1 Trial #5-2 with assumptions, typical sections and plans views of structures to SCS.

Receive Exhibit of Transmission Line Easement S. of Adobe Rd. from SCS.

- Can not plot this easement on base maps because of lack of accuracy on distance. (roundoff)

Hydraulic & Hydrologic Design of Collector Channels (Refer to Sect. 7)

- Ask City of Mesa for 100 scale aerial photos Sect. 23. T-1-N, R-6-E, NE 1/4 Sect. 22, T-1-N, R-6-E

- Storm Drain Plans on University Drive just east of the RWCD Floodway.

11/20/85

Water Surface Profile Calculations for Main Channel:

- Run Alt. No. 1 Trial #10 which is informed by SCS at 8 AM on Nov. 20, 1985. (Ref. Sect. 4)

Water Surface Profile Calculations for Side Inlets:

- Powerline Easement Channel (Ref. Sect. 5)
  - ① Alt. No. 1 Trial #3
  - ② Alt. No. 2 Trial #3

11/21/85

Water Surface Profile Calculations for Side Inlets:

- Powerline Easement Channel on hold. Wait for the superelevation calculations in trapezoidal supercritical channel resolved by SCS.
- Side inlet at S.E. of Higley Road Q=500 cfs. (Ref. Sect. 5)
- Side inlet at S. of University Drive Q=133 cfs (Ref. Sect. 5)

11/21/85

Water Surface Profile Calculations for Side Inlets:

- Powerline Easement Channel on hold. Wait for the superelevation calculations in trapezoidal supercritical channel resolved by SCS.
- Side inlet at S.E. of Higley Road Q= 500 cfs. (Ref. Sect. 5)
- Side inlet at S. of University Drive Q= 133 cfs. (Ref. Sect. 5)

11/22/85

Hydraulics of Side Inlets: (Ref. Sect. 5)

- Side Inlet at S.E. of Higley Road Q= 500 cfs
- Side Inlet at S. of University Drive Q=133 cfs.

11/23

Hydraulics for Side Inlets:

- Side Inlet at S.E. of Higley Road. (Ref. Trial #1 Sect. 5) Spillway width=30'

11/25

Hydraulics for Side Inlets:

- Side Inlet at S. of University Drive. (Ref. Sect. 5)
- Side Inlet at E. Brown Road. (Ref. Sect. 5)
- Side Inlet at S.E. of Higley Road. (Ref. Sect. 5) Trial #2

11/26

Hydraulics for Side Inlets:

- Side Inlet at S. of University Drive. (Ref. Sect. 5)
- Side Inlet at E. Brown Road. (Ref. Sect. 5)
- West Collector Channel Inlets. (Ref. Sect. 7)
- Side Inlet at S.E. of Higley Road. (Ref. Sect. 5)

11/27

Hydraulics for Side Inlets:

- West Collector Channel Inlets. (Ref. Sect. 7)

12/2

Hydraulics for Side Inlets:

- Side Inlet at Sta. 143+66 (42" S.D.) (Ref. Sect. 5)
- Side Inlet at S.E. of Higley Road. (Ref. Sect. 5)

12/3

Hydraulics for Side Inlets:

- Side Inlet at Sta. 143+66 (42" S.D.) (Ref. Sect. 5)
- Side Inlet at S.E. of Higley Road. (Ref. Sect. 5)

12/4

Hydraulics for Side Inlets:

- Side Inlet at Sta. 143+66 (42" S.D.) (Ref. Sect. 5)

12/16

Write Chronologic Log.

Hydraulics for Side Inlets: (Ref. Sect. 5)

- Side Inlet at MESA SHADOWS EAST SPILLWAY. (Q=17 cfs)

12/17

Hydraulics for Side Inlets: (Ref. Sect. 5)

- Side Inlet at MESA SHADOW EAST SPILLWAY. (Q=17cfs)
- Side Inlet at North of University Drive. (Q=600 cfs)
- Side Inlet at S.E. of Higley Road (Q=500cfs). under-design

12/18

Hydraulics for Side Inlets: (Ref. Sect. 5)

- Side Inlet at MESA SHADOW EAST SPILLWAY.
- Side Inlet at North of University Drive.
- Side Inlet at North of Apache Trail.

12/19/85

Meeting and Review at Flood Control District

Hydraulics of Side Inlets = (Ref. Sect. 5)

- 36" S.D. at South of University Drive "STORM" run.

Hydraulics of Collector Channels = (Ref. Sect. 7)

- West Collector Channel Design

12/20/85

Hydraulics of Collector Channels = (Ref. Sect. 7)

- West Collector Channel Design (at Sta. 39+67.99)

12/23/85

Hydraulics of Side Inlets = (Ref. Sect. 5)

- Side Inlet at Sta. 150+98 (MESA SHADOWS EAST) Q=17cfs.

Hydraulics of Collector Channels = (Ref. Sect. 7)

- East & West Collector Channels normal depth calculations

12/24/85

Hydraulics of Side Inlets = (Ref. Sect. 5)

- Side Inlet at MESA SHADOWS EAST Sta. 150+98. (Q=17cfs)

12/26/85

Hydraulics of Side Inlets = Side Inlet at Sta. 150+98

12/27/85

Modification No. 3 : (Ref. Sect. 25)

— "COGO" run for sewer calculations at Broadway Road

Hydraulics of Side Inlets : (Ref. Sect. 5)

— North of Adobe Road at Sta. 60+60.

Hydraulics of Collector Channels : West and East

12/28/85

Modification No. 3 : (Ref. Sect 25)

— Sewer calculations for Broadway Road

— Trial #11

Hydraulics of Side Inlets (Ref. Sect. 5)

— North of Adobe Road at Sta. 60+60

12/30/85

Modification No. 3 : (Ref. Sect. 25)

— Trials #11 and #12

12/31/85

Modification No. 3: (Ref. Sect. 25)

- Trials #13 and #14

1/2/86

Hydraulics of Side Inlets: (Ref. Sect. 5)

- South of Adobe Road at Sta. 64+03. (Q=116 cfs)
- South of Brown Road at Sta. 35+18. Trial #2 (Q=201 cfs)

1/3/86

Modification No. 3: (Ref. Sect. 25)

- Box culvert design for East Adobe Road.

Hydraulics of Side Inlets: (Ref. Sect. 5)

- South of Adobe Road at Sta. 64+03. (Q= 116 cfs)
- South of Brown Road at Sta. 35+18. Trial #2 (Q=201cfs)

1/4/86

Modification No. 3: (Ref. Sect. 25)

- Trial #15 (50% of Q_{100})
- Cross Section Taken at the Centerline of East Adobe Road.

1/6/86

Modification No. 3 : (Ref. Sect. >5)

- Trial #15 (50% of Q100).
- Cross Section at the Centerline of East Adobe Road.

Hydraulics of Side Inlets : (Ref. Sect. 5)

- North of University Drive at Sta. 89+11. (Q = 600 cfs)

1/7/86

Modification No. 3 : (Ref. Sect. >5)

- Cross Section at the Centerline of East Adobe Road
- Vertical Curves Design for East Adobe Road.

1/8/86

Modification No. 3 : (Ref. Sect. >5)

- Trials #16 and #17
- Cost Estimate for five barrel 8'x8', five barrel 10'x8' and six barrel 8'x8' box culvert at East Adobe Road.

1/9/86

Modification No. 3 : (Ref. Sect. >5)

- Trials #16 and #17 cross sections.

1/10/86

Modification No. 3: (Ref. Sect. 25)

- Trials #16 and #17 cross sections.
- Trial #16 and Trial #17 "WSPG" runs.

1/13/86

Hydraulics of Side Inlets: (Ref. Sect. 5)

- Side Inlet at Terminus of Project North of Brown Road. (Q=196 cfs)

Modification No. 3: (Ref. Sect. 25)

- Roadway Design (Vertical Curves Design) for East Adobe Road.
- Trials #16 and #17 runs

1/14/86

Hydraulics of Side Inlets: (Ref. Sect. 5)

- Side Inlet at Terminus of Project North of Brown Road. (Q=196 cfs)

Modification No. 3: (Ref. Sect. 25)

- Cost Estimate for 7 foot high box culvert on Apache/Higley.
- Plot five barrel 8'x8' box culvert at E. Adobe in plan & in profile

1/15/86

Modification No. 3: (Ref. Sect. 25)

- Cost Estimate for 7 foot high box culvert on Apache/Higley.

1/16/86

Modification No. 3 : (Ref. Sect. 25)

— Cost Estimate for 7 foot high box culvert on Apache / Higley.

1/17/86

Write Up on Overall Analysis and Recommendations.

1/20/86

Write Up on Overall Analysis and Recommendations.

1/21/86

Meeting and Review with Don Paulus at Greiner Engineering's Office

Write Up on Overall Analysis and Recommendations.

1/22/86

Write Up on Overall Analysis and Recommendations.

1/23/86

Write Up on Overall Analysis and Recommendations.

Modification No. 3 : (Ref. Sect. 25)

— Finalizing the "WSPG" run for Mod. No. 3

1/24/86

Modification No. 3 : (Ref. Sect. 25)

- Finalizing the "WSPG" run for Mod. No. 3.
- Plot the channel geometry in plan and the channel grade in profile.

1/25/86

Modification No. 3 : (Ref. Sect. 25)

- Finalizing the "WSPG" run for Mod. No. 3 and making Trials #18 (Q_{100}) and #19 (50% of Q_{100}) "WSPG" runs.

1/27/86

Modification No. 3 : (Ref. Sect. 25)

- Finalizing the "WSPG" run for Mod. No. 3

Hydraulics of Side Inlets : (Ref. Sect. 5)

- South of Brown Road for 54" S.D. tying into the Floodway.

1/28/86

Modification No. 3 : (Ref. Sect. 25)

- Make Trial #20 "WSPG" run for erosion calculations.
- Plot the channel geometry in plan and the channel grade in profile.

1/28/86 (Cont'd)

- Cost Estimate for a four barrel 10'x8' box culvert at E. Adobe.

1/29/86

Modification No. 3: (Ref. Sect. 25)

- Make Alt. No. 2 Trial #21 "WSPG" run (50% of Q_{100})
- Plot the channel grade and Q_{100} water surface elevations.

Write-Ups for Overall Analysis for Hydraulics of Side Inlets.

1/30/86

Plot the channel grade and Q_{100} water surface elevations.

Summary of Overall Analysis for Hydraulics of Side Inlets.

1/31/86

Plot water surface profiles and channel invert grade.

Summary of Overall Analysis for Hydraulics of Side Inlets.

Hydraulics for Side Inlets: (Ref. Sect. 5)

- North of University Drive at Sta. 89+11 (Q_{100} = 600 cfs).

2/1/86

Hydraulics for Side Inlets: (Ref. Sect. 5)

- North of University Drive at Sta. 89+11 (Q_{100} = 600 cfs).

Summary of Overall Analysis of Hydraulics for Main Channel Mod. No. 3.

2/3/86

Drafting:

- Additions & rivision for Alternate No. 1 plans.
- Drafting on major structures for Modification No. 3.
- Show design Q's for main channel and inlets.

Hydraulics for Side Inlets: (Ref. Sect. 5)

- North of University Drive at Sta. 89+11 (Q_{100} = 600 cfs).

Summary of Overall Analysis of Hydraulics for Main Channel Mod. No. 3.

2/3/86 (A Check List is attached)

Location of Maintenance Ramps:

- North of Brown & S. of Broadway

Modification No. 3:

- Write ups

Erosion Protection

2/4/86

Erosion Protection: Tractive Power Calculations

Location of Maintenance Ramps and Inlets: N. of Brown & S. of Broadway

Modification No. 3: Write ups

Hydraulics for Side Inlets

2/5/86

Erosion Protection: Tractive Power Calculations

Hydrologic & Hydraulic Design for Collector Channels: Summary

Evaluation of Soil Mechanics Report: Summary

Earthwork: Summary and Concepts

Complete Drafting on Modification No. 3 (Water Surface Profiles)

2/6/86

Erosion Protection: Tractive Power Calculations

Plunge Basin Design for Side Inlet at S. of Brown Road

Prepare a list of questions for the meeting with survey and construction staff.

Ranking System Concept is used to evaluate different alternates and to make a good recommendation.

Evaluation and Types of Side Inlets: Summary

Existing Operation and Maintenance Manuals for Former Reaches

Grade and Alignment for Main Channel.

Modification No. 3: Summary of Channel Grade, Lining & Geometry.

Complete Drafting Water Surface Profiles on Modification No. 3.

Backwater Analysis: Summary

2/7/86

Meeting with Survey Manager (Jim Cristia) and Construction Management Manager (Phil Turner) at 11AM at Greiner:

1. Grade and Alignment for Main Channel Alternate No. 3 Serpentine Concept: (Ref. to Sect. 17)
   - Staking requirements.
   - Degree of difficulty in constructing 2,500 lineal feet of curves due to serpentine concept.
2. Construction Concepts for Main Channel, Major Inlet Structures, Collector Channels and Maintenance Roadway:
   - Erosion Protections through the project.
   - Spillway details for major inlets.
   - Construction materials, construction methods, construction cost, maintenance requirements and feasibility of construction.

Complete Drafting on Modification No. 3

Review Drafting

Write ups:

- Grade and Alignment for Main Channel
- Hydraulics for Main Channel

2/7/86 (Cont'd)

- Hydraulics for Side Inlets
- Erosion Protection & Cost Estimate

2/8/86

Complete Drafting on Modification No. 3 and Review Drafting

Write ups:

- Hydraulics for Main Channel
- Hydraulics for Side Inlets (Typical Spillway Inlet)
- Summary for Proposed Structure at Brown Road
- Location of Maintenance Ramps
- Cost Estimate for Different Alternates

2/10

Revision to Alternate No. 1, 2 & 3 Drafting and Reviewing

Write ups:

- Erosion Protection
- Summary of Cost Estimate for Different Alternates
- Summary of Conclusions and Recommendations
- Hydraulics for Side Inlets (computer printouts)

Randall Beck:

1- Finish evaluation of east and west side collector systems including: Finished west side col. chan.

- cost estimates
- write up on overall analysis and recommendations

2- Erosion protection calculations and analysis for:

A. Major inlet structures @ the following locations:
- ✓ south of Brown Rd.
- ✓ north & south of Adobe Rd.
- ✗ powerline easement
- ✗ north & south of University Dr.
- ✗ north & south of Apache/Higley Culvert
- ✓ between Higley and ~~University Dr.~~ Broadway Rd.
- ✓ just north of Broadway Rd.

B. Inlet pipes as follows:

- from east and west collectors
- existing 36" pipe on the south side of University Drive. (We should probably construct @ headwall) MAG Spec.

C. Within the floodway at the upstream end of project above Brown Rd. (Including tractive power)

D. - need material evaluation, cost evaluations, ease of operation, construction and maintenance evaluation for all alternative.
- write up overall analysis and recommendations.

3- Revise east [illegible] collection system based on inlet structure locations. Maintenance Ramps

Gary Sun

1- Finish hydraulic analysis for the following:

A. Major inlet structures @ the following locations:

- ✓ just south of Brown Rd.
- ✓ powerline easm't
- ✓ north & south of Adobe Rd.
- ✗ - north of University Dr.
- ✗ - north of Apache Trail.

B. East & West collector system

- ✓ redo model for west side for no flow condition based on setting HGL using straight manning equation to get actual depth of flow.
- ✓ do least side system.

✓ C. Capacity of 36" pipe south of University Drive outletting into floodway to establish maximum velocity under no flow conditions.

✓ ✗ D. Backwater analysis north of Brown Rd. for Q_{100} & 50% Q_{100} based on revised sketch. (possibility of another inlet structure)

2- Write up on overall analysis for all hydraulic analysis including but not limited to:

- Brown Rd. Structure
- ✗ powerline easement

- south of Brown Rd. inlet
- concept for remainder of other major inlet structures
- east and west collector systems.

Michael Shapiro

1- Finish sketches for major inlet structure @:

- south of Brown Rd.
- north and south of Adobe Rd.

2- Finish sketch for main floodway channel above Brown Rd. (possibly an additional inlet structure)

3- Sketch (Redline) concept for a serpentine floodway to allow more room for the west side collection system and get w/ Jim Cristea and Phil Turner to evaluate to additional costs based on the new concept.

4- Design maintenance ramps into the floodway channel and maintenace road south of Broadway Road on the east side of floodway.

5- Write up overall concepts for the following:

- all major inlets
- maintenance ramps and roadways
- termination of floodway above Brown Rd.

Greiner Engineering

Greiner Engineering Sciences, Inc.

Tucson 602 327-3413
Phoenix 602 275-5400

Job RWCD Reach 6 E101012
Description Tasks for completing the Compact Design Study Per Orig Contract
Calculated by M Shapiro Date 12/14/95 Sheet No. 4
Checked by _____ Date _____ of 4

Deborah Rush-Gerber

1- Final drafting for Alt. No. 1 including:

50%- all major inlet structures from 50 scale sketches

50%- revisions to maintenance roadways around major inlet structures from 50 scale sketches.

✓ future alignment for Adobe Rd. from 50 scale sketches

- maintenance ramps to bottom of floodway channel
- revision to floodway channel for terminus above Brown Rd.
- revisions to east collector system based on modifications due to major inlet structures

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Job E101012 RWCD Reach 6
Description List of Task for the week 1/13 - 1/19
Calculated by M. Shapiro Date 1/8/86 Sheet No 1
Checked by _____ Date _____ of _____

- (See Tasks for completing the comparative design study per original contract 12/14/85)
- Modification No. 3

Gary Sun

- ✓ Do cost estimate for 7 foot high box on Apache/Higley including wingwalls
- ✓ Finish WSPG runs for 5 & 6 barrel 8'x8' culverts on Adobe Rd. & compare runs to latest run from Mod. No. 3. for Q 100. If box culvert does not work on Brown Rd. revise culvert as necessary.

Randall Beck

Adobe Rd.
- Revise maintenance ramps on Adobe Rd. based on culvert and transition design
- Revise east & west collection system based on maintenance ramp designs.

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Job RWCD Rach 6 E101 012
Description In-house status meeting for finalizing the Comparitive Design
Calculated by M. Shapiro Date 2/3/86 Sheet No 1
Checked by _____ Date _____ of 2

Michael Shapiro

- ✓ review all writeup & drafting
- serpentine concept
- summary write up & recommendation (See Gary)
- Review
- ✓ Contact Don

Randall Beck

- ✓ Maintenance ramp on west side
- ✓ inlet locations "
- ✓ plunge basin for south of Brown Rd.

?M.C. - maintenance road comp. for slippage & stability
- erosion protection north of Univ.
- List for P. Turner for cost comp & feasibility of construction

M.C. ✓ Comp. design for erosion protection for main floodway & inlet channel @ North terminus.
- ✓ Erosion protection for 42" RGRCP sta 143 +66
- ✓ Finalized maintenance road, maintenance ramps and collector channel.

Mustafa Chudnoff

- erosion protection for inlet collection system (see Gary) Tractive power
- ✓ Finish tractive power w/in main floodway & terminus (inlet channel)

Gary Sun

- ✓ North of Univ. Pt. Inlet Design
- ✓ Write ups for east & west collector channel
- " " for main channel

Greiner Engineering

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Job RWCD Randle #101012
Description In-house status meeting for finalizing the Comp Des Study
Calculated by M. Shapiro Date 2/3/85 Sheet No 2
Checked by _____ Date _____ of 2

- supervise Deborah
- powerline easement w/ Michael's help.

Deborah Rush-Gerber

- Additions & revision for Alt. #1
  North terminus of Brown & Adobe Rd.
- Ramps revision & collector inlet from Randall Mod. #3
- Complete drafting on major inlet structure on Mod. #3
- show design Q's for mainchannel & inlets.
- make sure bridge & structure are drafted
- finish drafting 3/11/86 or sooner

Greiner Engineering

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Phoenix 602 275-5400

Job RWCD Reading EIA02
Description Review comments & check list for writeups for Comp. Des Study
Calculated by M. Shapiro Date 2/3/86 Sheet No 1 of 6
Checked by _____ Date _____

Volume I

Section No. 1

- need summary of conclusions and recommendations. (Michael) 2/10/86

Section No. 2 - O.K.

R.S. Section No. 3

2/5/86 - need a write up on the evaluation of the Soils Mechanics Report, include copies of excerpts from the report.

B. Section No. 4

2/7/86 - 2/8/86 - need general writeup for trial #8 w/ Q_{100} & 50% Q_{100}, stating why we revised for Mod. No. 3 (inadequacies), also describe in general the velocities & reference to Section 8 for erosion protection.

B. Section No. 5

2/4/86 but Powerline ✓ Summary of peak flows (spillway width) revise where necessary (refer to Mod. No. 3, Section 25)

2/4/86 ✓ Design concept - talk about why a large collection system was necessary to convey storm water into the spillway area.

- Design details - finish N. of Quin ✓ 2/4/86 & Powerline count N/A 2/4/86

2/4/86 ✓ need typical detail of spillway. ✓ mayflex

2/4/86 ✓ fill out all calc. sht's w/ Job #, name, date

M.S. / R.

Section No. 6

Sec. 17

2/5/86 - Need a summary table for all hydrologic calculations for offsite discharges and a write up stating we used the TR-20 program along w/ existing drainage reports. (Refer to TR-20 printouts) & why it was done.

Name of Subdivision	Approx. Sta. @ Floodway	Peak flow 100 yr. 24hr storm (cfs)	depth of discharge (feet)	velocity of discharge
Eg Sundance Groves	60+00-63+00	7.3 cfs	0	0
Stoneybrook	77+00-79+00	596.5 cfs	0.90	3.3

M.S. / R.

Section No. 7

2/5/86

- need write up stating that we used the rational method per A.D.O.T. design criteria for the 100yr. 24hr. design storm. A value of 3.40 inches of runoff was used for this storm.

this should be in front.

- need write up stating the maintenance road & the R.O.W. area drain to these collector channels. Side slopes were established as follows: a 4:1 slope was used adjacent to the maintenance road (give rationale) & a 3:1 slope was used to get back to existing ground.

- need summary on inlet for collector ditches, pipe etc.

M.C. / R.B.

Section No. 8

2/10/86 - No erosion protection has bee written up. Write up of techiques to determine if protection is needed and techniques used for design. Need summary table for tractive power etc.

Section 9 - O.K.

Section 10 - O.K.

M.S. Section 11 -

2/8/86 - Need summary for Brown Rd. Structure giving criteria, including: design flow, freeboard etc., proposed size and associated costs, length of structure & appurtenances, freeboard available and erosion protection. Need design procedures including: Bureau of public road charts, using standard A.D.O.T. boxes and wingwalls, tapered wingwalls and water surface profile calc's. 6:1 slope. the reason for that

M.S. Section 12 -

2/5/86 - Need write up on what program was used, procedures used & why it was done. Also talk about digitized x-sections, plots & future use for the earthwork program. Fit in the existing ground & Maintenance road & Collector Channels.

Section 13 -

M.S. 2/6/86 - Discuss the rationale for our selection of side inlet (geometrics) & Mat'ls including - problems in reach 2 & 3, recommendation from SCS to use spillway per Signal Butte Floodway etc.

R. Section 14 -

2/8/86 - Discuss rationale for ramps upstream & downstream of Broadways. (not enough height for maintenance vehicles) Specify where ramps have encroachment problems on the west R.O.W. & the precedent set under Reaches 2 & 3 and the reason for this. (Need room on east side of floodway for collection

system for major inlet structures)

~~S.~~ Section 15.

M.S. 2/6/86 - make a statement that these were reviewed and a meeting was held w/ SCS & FCD to go over concepts for Reach 6 & were incorporated into the comparison design.

Volume 2-

- need index on first tab

R. Section 16

2/10/86 - need a summary (table) for all alternative features.

Eg.

West collector channel

Mat'l.	Quantity	Unit Cost	Cost
½ galvanized ½ pipe			
½ 36" Conc pipe			
shotcrete			
soil cement			
earthen channel			

M.S. Section 17-

2/7/86 - need write up of the concept used to establish the grades and alignments! Eg. (establishing % of flooding, inverts established, talk about original work plan, future storm drain connections, existing & proposed plans etc.)

Section 18 - O.K.

Section 19 - O.K.

Section 20 - O.K.

Section 21 - O.K.

Section 22 - O.K.

8. Section 23 -

2/6/86 - write up on comparison between HEC-2, WSP2 & WSPG with recommendation. Write up on how WSPG works.

on hold.
8. Section 24 -

- when powerline easm't is comple need a summary of steps taken & concept & recommendations.

2/6/86
8. Section 25 -

Wait for Mustafa's erosion analysis.

A - we need to make recommendations @ Apache/Higley structure on limiting slope paving and addition to bottom protection

B - add that velocities at the south terminus due to the modification did not warrant an outlet structure. Also add the limits of channel lining under Broadway Road were less prior to the modification.

161+00 ~ 157+00.00 10630 ~ 10000 ~~10555.02~~ — 10630 ~ 10581.34 155+00 ~ 155+48.66

C - state that the box culvert @ Adobe Road is 100 L.F. in length and is a standard A.D.O.T. box w/ tapered wingwalls.

2/6/86

✓ make a statement that as agreed upon w/ SCS the collection system and spillway upstream and downstream of the structure as Apache/Higley and the routing of proposed storm drain facilities from Higley Road and Apache Boulevard have been eliminated from the comparative design study due to time delays. These issues will be handled in the preliminary design phase.

✓ Reference WSPG run to the computer printouts

Section 26

R.

- need complete write up on materials investigated and what use they have. Also include the recommendation of which materials should be used for which project feature including stationing and description.

In General:

✓ Need general writeup on computer programs "WSPG", normal depth kalculations for pipes & "STORM" (I have type written writeups for "WSPG" & STORM")

Requirements for final submittal on Feb. 18th (morning)

- 6 reports
- 6 sets of blueline (edge bound) w/ reference in report to blueline (in summary writeup)
- 1 complete set of computer printouts

List of Contents with program filenames on

Erosion analysis: See Section 8

Slope stability analysis: Banks steeper then a 2:1 slopes must be stabilized. (Per Modification No 3 at the Broadway Road bridge and transition areas upstream and downstream of Apache/Higley structure) Based on the analysis by Western Technologies no other areas require any stabalization.

Dispersion: Although some test results show moderate to high dispersion, these areas occur randomly throughout the entire length of the floodway. Due to the random nature of the dispersion characteristic, it does not appear that treatment of dispersive soils are feasible during construction and is not recommended.

In General: All items were evaluated but only the above mentioned were utilized during the Comparative Design Phase. Other items such as site clearing, excavation, embankment fill area preparation, placement and compaction and ground compaction and shrinkage will be utilized during the preliminary design phase.

Reference: See Soil Mechanics Report (Final)
RWCD Floodway - Reach 6
Contract No. E101012 76000
for
Greiner Engineering Sciences
Job. No. 2125 N108

A list of contents for this section is provided as follows:

1. Summary of Conclusions
2. Design Procedure
3. Description of Computer Programs used
4. Description for all trial runs (Trials 1 ~ 9)

Summary of Hydraulics for Alternate No. 1

After nine water surface profile calculations were performed, the following conclusions are made:

1. The constriction at the Broadway Road Bridge gave less than one foot of freeboard inside at the proposed five barrel 10'X8' box culvert at Apache/Higley under design by the Flood Control District (FCD). As requested by SCS, a run (Trial #9) has been made by eliminating the Broadway Road Bridge, modeling it as a continuous channel and raking in elevations between the downstream of Apache/Higley culvert and the terminus of the floodway at south of Broadway Road. Results from this run showed that there was approximately 2.5 feet of freeboard at the proposed box culvert. (See memorandum dated 11/18/85) Also the proposed 8 foot high box will create a puddling problem on the north side of the Apache/Higley Intersection. Then Modification No. 3 to the floodway study is neccessary for the Comparative Design Study. This will also include the design of the Adobe Road Culvert. (See letter from City of Mesa dated 11/11/85)

Summary of Hydraulics for Alternate No. 1 (Cont'd)

2. Four concrete box culverts were analyzed for hydraulics except one (2-Bbl 8'x7') due to inadequacies. Greiner recommended an ADOT Std. CB-2 double barrel 8'x8' concrete box culvert with a length of 124 feet. The cost is estimated approximately $61,400. This includes concrete box, ADOT Std. CW2-6 tapered wingwalls and ADOT Std. CWA-1 aprons.

3. The downstream and upstream transitions at Broadway Road Bridge should be provided erosion protections due to supercritical velocities under the bridge.

4. Low velocities for As-Built condition (50% of Q_{100}), were noted within the floodway.

Sta. 31+48.00 – Sta. 31+73.15	Velocity 0.71 fps
Sta. 36+79.83 – Sta. 78+43.91	Velocities 1.07 ~ 1.43 fps
Sta. 90+52.99 – Sta. 118+75.72	Velocities 1.79 ~ 1.91 fps
Sta. 159+74.63 – Sta. 161+30.00	Velocities 1.96 ~ 1.62 fps

Same attention should focus on this area for the Modification No. 3 in the Comparative Design Study.

Design Procedure for Alternate No. 1

The following steps and criteria were followed for Alternate No. 1 in Comparative Design Study:

1. The preliminary channel grade was established for the entire project adhering to the original vertical alignment as per the BCS work plan. Alignment of the proposed Apache/Higley culvert was incorporated in the preliminary grade.

2. The preliminary channel geometry for the main floodway was based on the BCS work plan and existing bridge plans at street crossings (University Drive and Broadway Road). Also channel geometry was included for the proposed Apache/Higley culvert by Mathew, Kessler & Associates.

3. A structure was designed for street crossing at Brown Road. The ADOT standard box culvert was utilized with a carrying capacity of 900 cfs. (See Memorandum of conversation with Don Paulus at 11:00 on 9/25/85). Cost estimate was also done including wingwalls & aprons.

4. Potential utility conflicts were checked for the entire project with field data and City of Mesa as-built utility maps.

Design Procedure for Alternate No. 1 (Cont'd)

5. The bottom width of the channel, side slopes for banks, height of banks and transition lengths were sketched and modelled. (See Section 19 for typical cross sections for main channel)

6. Water surface profile calculations were made by using the "WSPG" program. The design peak flows utilized were from final hydrology meeting with SCS used Alternate No. 3 conditions (Memorandum dated 9/18/85 and summary sheets dated 9/11/85). For the Manning's "n" values, 0.023 was used for As-built condition while 0.025 was used for Aged condition (Table 5.4-1 in SCS Engineering Handbook Section 5 "Hydraulics"). The design peak flow is a 100-year, 24-hour storm event. Aged condition was utilized for the design discharge and As-built condition was applied to 50 percent of design discharge (See attached paper by SCS and also see memorandum of meeting with Don Paulus at 1:15 PM on 10/15/85 at SCS).

7. Tailwater control elevations for two conditions (Aged & As-built) were provided by the SCS "WSP2" run. This elevation was located at approximate 180 feet south of the south terminus of the floodway.

Design Procedure for Alternate No. 1 (Cont'd)

7. (Cont'd) Adjustment of plus 0.05 foot in elevations has been made to correspond to Greiner's datum.

8. A preliminary earthwork run was accomplished during the Comparative Design Study using the "DIRT" program. (See Section 12) Computer Plots for cross sections along the entire floodway was produced. These plots have been used intensely for designs of proposed structures, transitions, major side inlets, east/west collector channels and maintenance roadway.

9. Channel geometry and channel lining were adjusted if necessary to satisfy the freeboard requirements from the "WSPG" runs and the feasibility to the floodway on the computer plots. Freeboard for the entire floodway should be provided as follows:

   one foot freeboard for a lined channel

   two foot freeboard for an unlined channel

   one foot freeboard inside a concrete box culvert

10. Superelevations have been checked for all curve reaches using the SCS criteria in title of "Engineering Design Standards for Far West States".

Design Procedure for Alternate No. 1 (Cont'd)

10. (Cont'd) For trapezoidal channels:

Subcritical velocity — $SE = \frac{V^2(b+2Zd)}{2(gR-2ZV^2)}$

Supercritical velocity — $SE = \frac{V^2(b+2Zd)}{gR-2ZV^2}$

11. If any of the above criteria has not been met, repeat the previous ten steps and check the new design.

12. After determining that all systems are functioned adequately, tractive power calculations are performed for erosion analysis.

Details of description of the computer programs using in this project are attached at the end of this sub-section.

Open Channel (ft)

Definition

Constructing or improving a channel, either natural or artificial, in which water flows with a free surface.

Scope

This standard applies to construction of open channels or modification of existing streams or ditches. Design criteria for channel stability and maintenance of floodwater diversions (400), floodways (404), or surface drainage, main or lateral (608), having a drainage area in excess of 1 mi^2 (1.6 km^2) shall be in accord with this standard for open channels. It does not apply to diversions (362), grassed waterways or outlets (412), irrigation field ditches (388), surface drainage, field ditches (607), or irrigation canals or laterals (320).

Purpose

To provide discharge capacity required for flood prevention, drainage, other authorized water management purposes, or any combination of these purposes.

Conditions where practice applies

This standard applies to all earth channel construction or modification except as noted under "Scope."

It also applies where stability requirements can be met, where the impact of the proposed construction on water quality, fish and wildlife habitat, forest resources, and quality of the landscape is evaluated and the techniques and measures necessary to overcome the undesirable effects are made part of any planned work, where an adequate outlet for the modified channel reach is available for discharge by gravity flow or pumping, and where excavation or other channel work does not cause significant erosion, flooding, or sedimentation.

Design criteria

Plan. Channel construction or modification shall be according to an approved plan prepared for the site. TR-25 shall be used in surveys, planning, and site investigations for channel work. Design criteria in TR-25 shall be followed, using the procedure best adapted to site conditions.

In selecting the location and design of channels, careful consideration shall be given to minimizing water pollution, damage to fish and wildlife habitat, and to protecting forest resources and the quality of the landscape. In considering requirements for construction and operation and maintenance, selected woody plants must be preserved. The overall landscape character, prominent views, and fish and wildlife habitat requirements must be considered.

Planned measures necessary to mitigate unavoidable losses to fish or wildlife habitat shall be included in the project. The quality of the landscape shall be maintained by both the location of channel works and plantings, as appropriate.

The alinement of channels undergoing modification shall not be changed to the extent that the stability of the channel or laterals thereto is endangered.

Capacity. The capacity for open channels shall be determined according to procedures applicable to the purposes to be served and according to related engineering standards and guidelines in handbooks. The water surface profile or hydraulic gradeline for design flow shall be determined according to guidelines for hydraulic design in TR-25. The *n* value for aged channels shall be based on the expected vegetation, along with other retardance factors, considering the level of maintenance prescribed in the operation and maintenance plan prepared with the owners or sponsors. The required capacity may be established by considering volume-duration removal rates, peak flow, or a combination of the two, as determined by the topography, purpose of the channel, desired level of protection, and economic feasibility.

Cross section. The required channel cross section and grade shall be determined by the plan objectives, the design capacity, the materials in which the channel is to be constructed, the vegetative establishment program, and the requirements for operation and maintenance. A minimum depth may be required to provide adequate outlets for subsur-

face drains, tributary ditches, or streams. Urban and other high-value developments through which the channel is to be constructed must be considered in the design of the channel section.

Channel stability. Characteristics of a stable channel are:

1. The channel neither aggrades nor degrades beyond tolerable limits.
2. The channel banks do not erode to the extent that the channel cross section is changed appreciably.
3. Excessive sediment bars do not develop.
4. Gullies do not form or enlarge because of the entry of uncontrolled surface flow to the channel.

All channel construction and modification (including clearing and snagging) shall be according to a design that can be expected to result in a stable channel that can be maintained at reasonable cost. Vegetation, riprap, revetments, linings, structures, or other measures shall be used if necessary to insure stability.

The method applicable to site conditions in TR-25 shall be used in determining the stability of proposed channel improvements.

Bankfull flow is the flow in a channel that creates a water surface at or near the normal ground elevation, or the tops of dikes or continuous spoil banks that confine the flow for a significant length of a channel reach.

Channels must be stable under conditions existing immediately after construction (as-built condition) and under conditions existing during effective design life (aged condition). Channel stability shall be determined for discharges under these conditions as follows:

1. As-built condition—Bankfull flow, design discharge, or 10-year-frequency flow, whichever is smallest, but not more than 150 percent nor less than 50 percent of design discharge.

The allowable as-built velocity (regardless of type of stability analysis) in the newly constructed channel may be increased by a maximum of 20 percent if:

a.) The soil and site in which the channel is to be constructed are suitable for rapid establishment and support of erosion-controlling vegetation,
b.) Species of erosion-controlling vegetation adapted to the area and proven methods of establishment are known, and
c.) The channel design includes detailed plans for establishing vegetation on the channel side slopes.

2. Aged condition—Bankfull flow or design discharge, whichever is larger, except that it is not necessary to check stability for discharge greater than the 100-year frequency.

Stability checks that are flow related are not required if the velocity is 2 ft/s (0.6 m/s) or less.

For newly constructed channels in fine-grained soils and sands, the *n* values shall be determined according to procedures in chapter 6 of TR-25, and shall not exceed 0.025. The *n* value for channels to be modified by clearing and snagging only shall be determined by reaches according to the expected channel condition upon completion of the work.

Appurtenant structures. The channel design shall include all structures required for proper functioning of the channel and its laterals, as well as travelways for operation and maintenance. Inlets and structures needed for entry of surface and subsurface flow into channels without significant erosion or degradation shall be included in the channel design. The design also shall provide for necessary flood gates, water-level-control devices, bays used in connection with pumping plants, and any other appurtenances essential to the functioning of channels and contributing to attainment of the purposes for which they are built. If needed, protective structures or treatment shall be used at junctions between channels to insure stability at these critical locations.

The effect of channel work on existing culverts, bridges, buried cables, pipelines, irrigation flumes, and inlet structures for surface and subsurface drainage on the channel and laterals thereto shall be evaluated to determine the need for modification or replacement.

Culverts and bridges that are modified or added as part of channel projects shall meet reasonable standards for the type of structure and shall have a minimum capacity equal to the design discharge or state agency design requirements, whichever is greater. Capacity of some culverts and bridges may need to be increased above the design discharge.

Disposition of spoil. Spoil material from clearing, grubbing, and channel excavation shall be disposed of in a manner that will:

1. Not confine or direct flows so as to cause instability when the discharge is greater than the bankfull flow.
2. Provide for the free flow of water between the channel and flood plain unless the valley routing and water surface profile are based on continuous dikes being installed.

3. Not hinder the development of travelways for maintenance.
4. Leave the right-of-way in the best condition feasible, consistent with the project purposes and adjacent land uses.
5. Direct water accumulating on or behind spoil areas to protected outlets.
6. Maintain or improve the visual quality of the site to the extent feasible.

Vegetation of channel. Vegetation shall be established on all channel slopes, berms, spoil, and other disturbed areas according to the SCS standard for channel vegetation (322).

Operation and maintenance

Plan. An operation and maintenance plan must be prepared for each channel system. Minimum requirements for operation, maintenance, and replacement shall be consistent with the design objectives. This includes consideration of fish and wildlife habitat, quality of the landscape, water quality, mitigation features, methods, equipment, costs, stability, function for design life, frequency, and time of year for accomplishing the work. Detailed provisions for operation and maintenance must be made if complex features, such as water-level-control structures and pumping plants, are required.

Maintenance access. Travelways for maintenance generally shall be provided as part of all channel work. This requirement may be met by providing ready access points to sections of the channel if this will permit adequate maintenance in conformance with the operation and maintenance plan.

A travelway shall be provided on each side of large channels if necessary for use of maintenance equipment. Travelways must be adequate for movement and operation of equipment required for maintenance of the channel. The travelway may be located adjacent to the channel on a berm or on the spread spoil. In some places the channel itself may be used as the travelway. The travelway, including access points, must blend into the topography, the landscape, and adjacent land uses.

Safety. Open channels can create a safety hazard. Appropriate safety features and devices should be installed to protect people and animals from accidents such as falling or drowning.

Plans and specifications

Plans and specifications for constructing open channels shall be in keeping with this standard and shall describe the requirements for properly installing the practice to achieve its intended purpose.

Description of Computer Programs

1. Storm Drain Analysis Program Description

Storm drain analyses were performed using the "STORM" program. "STORM" is a computer program written and used by the Los Angeles County Road Department, and is considered applicable to this study. The "STORM" program was used specifically to calculate the hydraulic grade line.

The storm drain analysis program "STORM" used the average of the hydraulic grade line elevations of the main sewers at the ends of each junction and assumes this elevation as the control elevation for the lateral or the lateral system.

For partial and seal flow, seal indicates flow changes from part to full or vice versa, the analysis is performed initially upstream through the system until it reaches the highest upstream inlet. Then a downstream analysis is performed by computing drawdown curves and applying the pressure-plus-momentum equation at each junction. This analysis is terminated as soon as a hydraulic control or a segment of the sewer is identified as flowing full. The upstream analysis proceeds by computing the backwater curves and checks for those points which should be overridden, then the pressure-plus-momentum equation is applied to compute the final flow depths.

For pressure flow, the analysis proceeds upstream assuming that the hydraulic grade line passed through points identified by adding the

friction losses and the minor losses to the hydraulic grade line elevation at the downstream end of the line. The pressure-plus-momentum equation is applied at each junction to compute the hydraulic grade line at the upstream side of the junction. The analysis then proceeds to the next upstream line, in succession.

Basic Equation Used in Storm Drain Analysis Program

Manning's Equation:

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

where V = velocity of flow (feet/sec)

S = slope of the conduit (feet/foot)

R = hydraulic radius (feet)

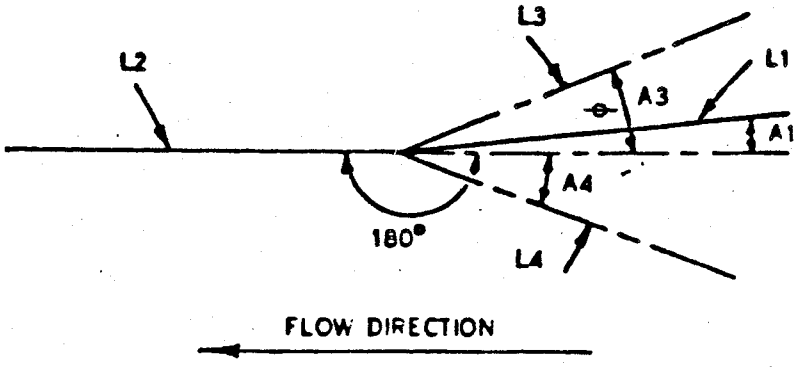
n = Manning's coefficient of roughness

Various forms of this general equation are incorporated in the "STORM" program including tables from King's Handbook of Hydraulics.

Junction Losses

The change in hydraulic grade line across a junction is calculated by:

$$Y = \frac{Q_2V_2 - Q_1V_1 \cos \theta_1 - Q_3V_3 \cos \theta_3 - Q_4V_4 \cos \theta_4}{\frac{g\,(A_1 + A_2)}{2}}$$



where: A = area of flow at a given section (square feet)

Q = quantity of flow (cfs)

V = velocity (feet/second)

g = gravitational acceleration (32.2 ft/sec^2)

θ = angle of convergence between the centerline of the downstream main sewer and the centerline of the sewer carrying the incoming flow [upstream main sewer and laterals (degrees)].

Backwater and Drawdown Equation

This equation is used for determining backwater curves and drawdown curves (see King's Handbook).

$$L = \frac{V_2^{\,2}/2g + D_2 - V_1^{\,2}/2g - D_1}{S_o - S_{avg}}$$

where: L = length of reach between sections (ft)

V = velocity of flow (ft/sec)

D = depth of flow (ft)

g = gravitational acceleration (32.2 ft/sec^2)

S_o = slope of the invert of the channel (feet/foot)

S_{ave} = average slope computed by Manning's Equation (feet/foot)

NOTE: A backwater curve is defined as a hydraulic grade line when the depth of flow increases in the downstream direction. A drawdown curve is defined as a condition when the depth of flow decreases in the downstream direction.

<u>Force Equation for Hydraulic Jump Analysis</u>

$$F = \frac{Q_1^{\,2}}{g\,A_1} + A_1\,\overline{Y}$$

This equation is used to determine if a hydraulic jump occurs in a certain segment of the sewer.

where: Q = quantity of flow (cfs)

A = area of flow at a given section (sq. ft.)

g = gravitational acceleration (32.2 ft/sec^2)

$\overline{Y}$ = the vertical distance (ft) below the hydraulic grade line (for pressure flow) or the water surface (for partial flow) to the center of gravity of the flow cross section.

2. Water Surface Profile Computation Program Description

"WSPG" (Water Surface Profile Computation) computer program was used to analyze ~~the~~ floodway design. "WSPG" is a hydraulic analysis system composed of an input edit program and a program which produces the water surface profile gradient data. The program was developed by the Design Systems and Standards Group of the Design Division and the Data Processing Section of the Business and Fiscal Division of the Los Angeles County Flood Control District.

Each set of calculations has two sets of computer printouts. The first set is the "Water Surface Profile Edit Program". The edit program gives a detailed explanation of all the input used to analyze the channel design. It informs us of the shape of the channel; for instance, the section number, number of piers, average pier width, height of channel, base width and the side slopes left and right. It also tells you the system outlet including station, section number, invert elevation and water surface elevation. It then gives you a complete reach description including station, invert elevation, section number, Manning's "n" value, radius if around a curve or deflection angle point, and manhole. It also gives you information regarding transitions from one reach to another, bridge exits and entrances, junctions including station, invert elevation, section number, Manning's "n" value, radius if around a curve or deflection angle point and manhole. At a junction it gives you additional information including the lateral numbers coming in, the Manning's "n" value for that lateral, the flow entering the laterals, the lateral invert elevations and the angle from the lateral to the main channel.

The other set is the actual calculations showing the station, length along channel it evaluated, slope of channel invert, depth of flow, water surface elevation, flow, velocity, velocity head, average friction slope, energy gradient elevation, head loss due to friction, super elevation, critical and normal depth, height of channel, base width, side slope of channel, left and right, number of piers and average width of piers. The output also lets you know where a hydraulic jump, transition structure, bridge entrance and exit and a junction occurs. There is also a plot showing stationing, invert elevations, critical depth, water surface elevation, height of channel, energy grade line, curves crossing over, bridge entrance or exit, wall entrance or exit, and lets you know if it's a reach, transition structure or junction. Wherever a change occurs, new data is printed out.

Description of Computer Programs (Cont'd)

3. Normal Depth Calculations for Pipes Program Description:

Normal depth calculations for pipes were performed using the "CIRCØ1I" program. This computer program is written and used by Greiner, and is used to compute normal depth as a tailwater control for "WSPG" run. For given Q (discharge in cfs), Manning's "n" value, S_o (pipe slope in ft/ft) and D (diameter in ft), "CIRCØ1I" program will compute the normal depth, the critical depth and some hydraulic information (A, R, V etc.). The documentation of the theory and equations using in this program is attached and the Newton's method is used to slove these nonlinear equations.

4. Normal Depth and Critical Depth Calculations for Channels Program Description:

Normal depth and critical depth calculations for a given type of channel were performed using the "TRAPØ1I" program. This program is written in FORTRAN and used by Greiner. It is an interactive program and it can calculate normal, critical depth for a rectangular, or a trapezoidal or a triangular channel. For given Q, n, S_o and channel parameters for a given type of channel, "TRAPØ1I" program

Description of Computer Programs (Cont'd)

4. (Cont'd) will compute the normal depth, the critical depth and hydraulic data. The theory and equations using in this program are attached. The Newton's method is also used to slove these equations. (Note: "MANNING" program was the previous name for "TRAPØ1I")

No description were provided for computer programs "TR-20" and "COGO". Description regarding the "DIRT" program should refer to Section 12.

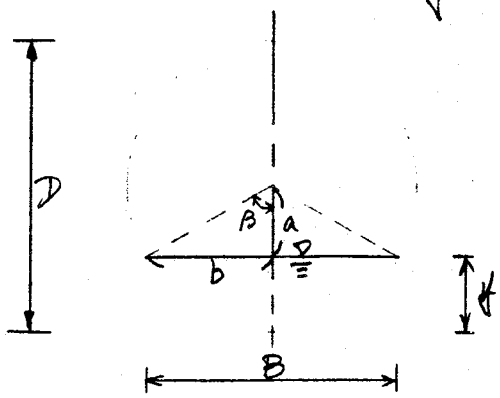
Greiner Engineering

Greiner Engineering Sciences, Inc.

Tucson 602 327-3413
Phoenix 602 275-5400

Normal Depth Calculations for a circular pipe

1. Geometric Analysis



For $0 \le \beta \le \pi/2$

$$a = \frac{D}{2} - y, \quad b = \sqrt{\left(\frac{D}{2}\right)^2 - \left(\frac{D}{2} - y\right)^2} = \sqrt{y(D-y)}$$

$$\sin\beta = \frac{b}{D/2} = \frac{2\sqrt{y(D-y)}}{D}, \quad \cos\beta = \frac{a}{D/2} = 1 - \frac{2y}{D}$$

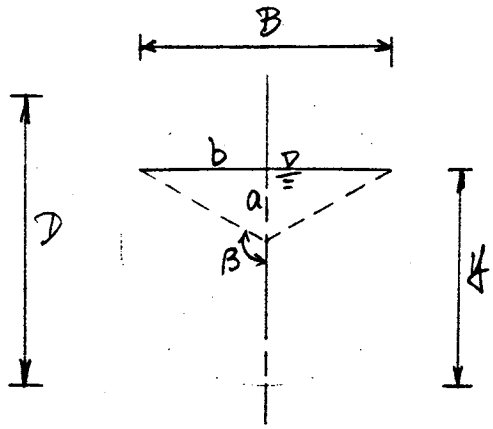
$$\because y = \frac{D}{2} \Rightarrow \beta = \frac{\pi}{2} \quad \Rightarrow \quad y = \frac{D}{2}(1-\cos\beta)$$

$$A = \frac{\pi D^2}{4}\frac{2\beta}{2\pi} - ab = \frac{\beta D^2}{4} - \left(\frac{D}{2}\cos\beta\right)\frac{D}{2}\sin\beta$$

$$= \frac{D^2}{4}(\beta - \sin\beta\cos\beta)$$

$$P = D\pi\left(\frac{2\beta}{2\pi}\right) = D\beta, \quad R = A/P$$

$$B = 2b = 2\sqrt{y(D-y)} = D\sin\beta$$



For $\frac{\pi}{2} \le \beta \le \pi$

$$a = y - \frac{D}{2}, \quad b = \sqrt{\left(\frac{D}{2}\right)^2 - \left(y - \frac{D}{2}\right)^2} = \sqrt{y(D-y)}$$

$$\sin\beta = \sin(\pi-\beta) = \frac{b}{D/2} = \frac{2\sqrt{y(D-y)}}{D}$$

$$\cos\beta = -\cos(\pi-\beta) = -\frac{a}{D/2} = 1 - \frac{2y}{D}$$

$$\because y = \frac{D}{2} \Rightarrow \beta = \frac{\pi}{2} \quad \therefore y = \frac{D}{2}(1-\cos\beta)$$

$$A = \frac{\pi D^2}{4}\frac{2\beta}{2\pi} + ab = \frac{D^2}{4}(\beta - \sin\beta\cos\beta)$$

$$P = D\beta, \quad R = A/P, \quad B = 2b = 2\sqrt{y(D-y)} = D\sin\beta$$

2. Normal Depth Computations:

$$Q = \frac{1.486}{n} A R^{2/3} S_o^{1/2}$$

$$\Rightarrow \frac{Qn}{1.486 S_o^{1/2}} = A R^{2/3} \quad \text{where} \quad A = \frac{D^2}{4}(\beta - \sin\beta\cos\beta), \quad P = D\beta$$

$$R = A/P$$

Solve for β then $Y_n = \frac{D}{2}(1-\cos\beta)$

Apply Newton's Method

$$F = \frac{Qn}{1.486 S_o^{1/2}} - A R^{2/3} = \frac{Qn}{1.486 S_o^{1/2}} - \frac{A^{5/3}}{P^{2/3}} \quad \text{where} \quad A = \frac{D^2}{4}(\beta - \sin\beta\cos\beta)$$

$$= \frac{Qn}{1.486 S_o^{1/2}} - \frac{\left[\frac{D^2}{4}(\beta - \sin\beta\cos\beta)\right]^{5/3}}{(D\beta)^{2/3}} \qquad P = D\beta$$

$$\frac{dF}{d\beta} = -\frac{\frac{5}{3}\left[\frac{D^2}{4}(\beta - \sin\beta\cos\beta)\right]^{2/3}\frac{D^2}{4}(1-\cos 2\beta)(D\beta)^{2/3} - \left[\frac{D^2}{4}(\beta - \sin\beta\cos\beta)\right]^{5/3}\frac{2}{3}(D\beta)^{-\frac{1}{3}}D}{(D\beta)^{4/3}}$$

$$= \frac{-\frac{5}{3}\left[\frac{D^2}{4}(\beta - \sin\beta\cos\beta)\right]^{2/3}\left(\frac{D}{4}\right)^2(2\sin^2\beta)(D\beta)^{2/3} + \frac{D^{10/3}}{4^{5/3}}(\beta - \sin\beta\cos\beta)^{5/3}\frac{2}{3}(D\beta)^{-\frac{1}{3}}D}{(D\beta)^{4/3}}$$

$$= -\frac{5}{3}\left\{\frac{\left[\frac{D^2}{4}(\beta - \sin\beta\cos\beta)\right]}{D\beta}\right\}^{2/3}\frac{D^2}{2}\sin^2\beta + \left\{\frac{\left[\frac{D^2}{4}(\beta - \sin\beta\cos\beta)\right]}{D\beta}\right\}^{5/3}\frac{2}{3}D$$

$$= -\frac{5}{6}R^{2/3}D^2\sin^2\beta + \frac{2}{3}R^{5/3}D$$

3. Critical Depth Computation:

Apply Newton's Method

$$F_r^2 = \frac{Q^2 B}{g A^3} = 1 \qquad Q^2(D\sin\beta) = g\left[\frac{D^2}{4}(\beta - \sin\beta\cos\beta)\right]^3$$

$$\therefore Q^2/gD^5 = (\beta - \sin\beta\cos\beta)^3 / 64\sin\beta$$

$$F = \frac{Q^2}{gD^5} - \frac{(\beta - \sin\beta\cos\beta)^3}{64\sin\beta}$$

$$\frac{dF}{d\beta} = F' = \frac{-3(\beta-\sin\beta\cos\beta)^2(1-\cos 2\beta)\,64\sin\beta + (\beta-\sin\beta\cos\beta)^3\,64\cos\beta}{4096\sin^2\beta}$$

$$= \frac{-3(\beta-\sin\beta\cos\beta)^2(2\sin^2\beta)\,64\sin\beta + (\beta-\sin\beta\cos\beta)^3\,64\cos\beta}{4096\sin^2\beta}$$

$$= \frac{-3(\beta-\sin\beta\cos\beta)^2\sin\beta}{32} + \frac{(\beta-\sin\beta\cos\beta)^3\cos\beta}{64\sin^2\beta}$$

if let $BSC = \beta - \sin\beta\cos\beta$

$$F = \frac{Q^2}{gD^5} - \frac{(BSC)^3}{64\sin\beta}$$

$$F' = \frac{-3(BSC)^2\sin\beta}{32} + \frac{(BSC)^3\cos\beta}{64\sin^2\beta}$$

$A = \frac{D^2}{4}(\beta - \sin\beta\cos\beta)$

$Y_c = \frac{D}{2}(1-\cos\beta)$

$B = D\sin\beta$

Check results:

1. Given $Q = 20$ cfs, $D = 3$ ft, $S_0 = 0.0085$ ft/ft, $n = 0.013$

then $Y_n = 1.1771$ ft ($\beta = 1.35382$) $\Rightarrow A = 2.57308$, $P = 4.06146$, $R = 0.63354$

$Q = \frac{1.486}{n}(S_0)^{1/2} A R^{2/3} = 20.0025$ cfs # O.K.

$Y_c = 1.434955$ ($\beta = 1.527419$) $\Rightarrow A = 3.339218$, $B = 2.997178$

$Q^2 = gA^3/B = 400.01625 \Rightarrow Q = 20.000406$ cfs # O.K.

2. Given $Q = 60$ cfs, $D = 3.5$ ft, $S_0 = 0.004$ ft/ft, $n = 0.013$

then $Y_n = 2.7043$ ft ($\beta = 2.14756$) $\Rightarrow A = 7.97677$, $P = 7.51646$, $R = 1.06124$
$\Rightarrow Q = 59.9986$ cfs # O.K.

then $Y_c = 2.429976$ ($\beta = 1.969862$) $\Rightarrow A = 7.129159$, $B = 3.224985$
$Q^2 = 3617.7873 \Rightarrow Q \approx 60.148$ cfs # O.K.

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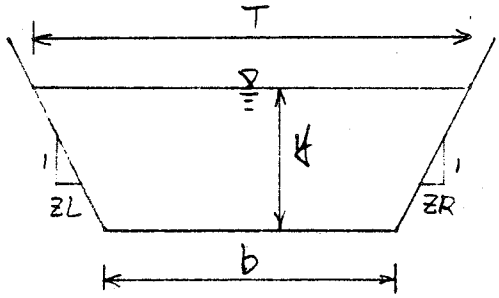
Job TRAPOI.FOR

Description

Calculated by B. Gerd Sun Date 12/27/85 Sheet No. 1

Checked by M.S.S. Date of 2

Normal Depth Calculations for a rectangular or trapezoidal, or triangular section



For a rectangular section: $ZL = ZR = 0.0$

For a triangular section: $b = 0.0$

$$T = b + (ZL + ZR)y \quad , \quad P = b + (\sqrt{1+ZL^2} + \sqrt{1+ZR^2})y$$

$$A = \left(b + \frac{ZL+ZR}{2}y\right)y \quad , \quad R = A/P$$

$$Q = \frac{1.486}{n} S_0^{1/2} A R^{2/3}$$

Apply Newton's Method:

$$F = \frac{Qn}{1.486\, S_0^{1/2}} - A R^{2/3} = \frac{Qn}{1.486\, S_0^{1/2}} - \frac{A^{5/3}}{P^{2/3}}$$

$$\frac{dF}{dy} = F' = -\frac{\frac{5}{3} A^{2/3}\left(\frac{dA}{dy}\right)P^{2/3} - A^{5/3}\left(\frac{2}{3}P^{-1/3}\right)\left(\frac{dP}{dy}\right)}{P^{4/3}}$$

$$= \frac{-\frac{5}{3}A^{2/3}T}{P^{2/3}} + \frac{\frac{2}{3}A^{5/3}(\sqrt{1+ZL^2} + \sqrt{1+ZR^2})}{P^{5/3}} \quad \because \frac{dA}{dy} = T \ \& \ \frac{dP}{dy} = \sqrt{1+ZL^2} + \sqrt{1+ZR^2}$$

$$= -\frac{5}{3}R^{2/3}T + \frac{2}{3}(\sqrt{1+ZL^2} + \sqrt{1+ZR^2})R^{5/3} \quad \#$$

If $\left|\left(\frac{F}{F'}\right)/Y_n\right| > \text{Error} \Rightarrow Y_n = Y_n - \frac{F}{F'}$

Critical Depth Calculations for a rectangular, or trapezoidal, or triangular section

Critical Flow $Fr^2 = \frac{Q^2 T}{g A^3} = 1$

$$\because E = y + \frac{v^2}{2g} = y + \frac{Q^2}{2gA^2}$$

$$\frac{dE}{dy} = 1 + \frac{Q^2}{2g}(-2A^{-3})\frac{dA}{dy}$$

$$= 1 - \frac{Q^2 T}{g A^3} = 0$$

$$\therefore \frac{Q^2 T}{g A^3} = 1 \text{ for critical}$$

Apply Newton's Method:

$$F = \frac{Q^2}{g} - \frac{A^3}{T}$$

$$\frac{dF}{dy} = F' = -\frac{3A^2 \frac{dA}{dy}(T)}{T^2} + \frac{A^3 \frac{dT}{dy}}{T^2}$$

$$\frac{dA}{dy} = T \quad \& \quad \frac{dT}{dy} = \frac{d[b + (ZL+ZR)y]}{dy} = ZL + ZR$$

$$\therefore F' = \frac{(ZL+ZR)A^3}{T^2} - 3A^2 \quad \#$$

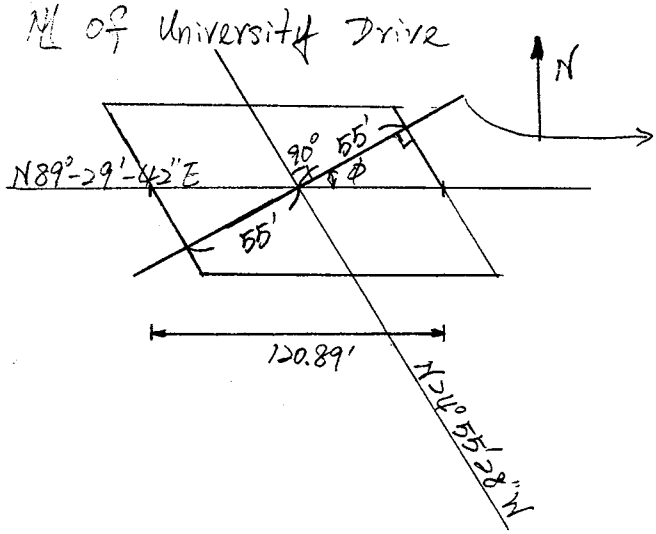
IF $\left|\left(\frac{F}{F'}\right)/Y_c\right| >$ Error $\Rightarrow Y_c = Y_c - \frac{F}{F'}$

First trial for Alternate 1

1. Check with TR-25 to see what the minimum allowable velocity is for an unlined channel.

2. The downstream control water surface elevation of 1340.10 (for Q=3100 cfs) per SCB Don Paulus WSP2 results at sedimentation basin (south of Broadway Bridge) is applied and G.E.S will use elevation of 1340.15. (Applying the datum correction of +0.05 foot)
SCB will rerun WSP2 with Q = 2400 cfs.

3. University Bridge (As per "University Drive Crossing at the R.W.C.D. Floodway" by E.M. Plummer Consulting Engineers, Inc.)
Bottom width = 120.89 ft with invert 1336.89 along the ℄ of University Drive



N 65°04'32" E

$\phi = (N89°29'42"E) - (N65°04'32"E)$

$= 24°25'10"$

$x = \frac{120.89}{2} \cos(24°25'10")$

$= 55.038$ ft

Total channel width = 110 ft. O.K.

Pier Diameter is 1'-4" (Sheet 10 of 13)

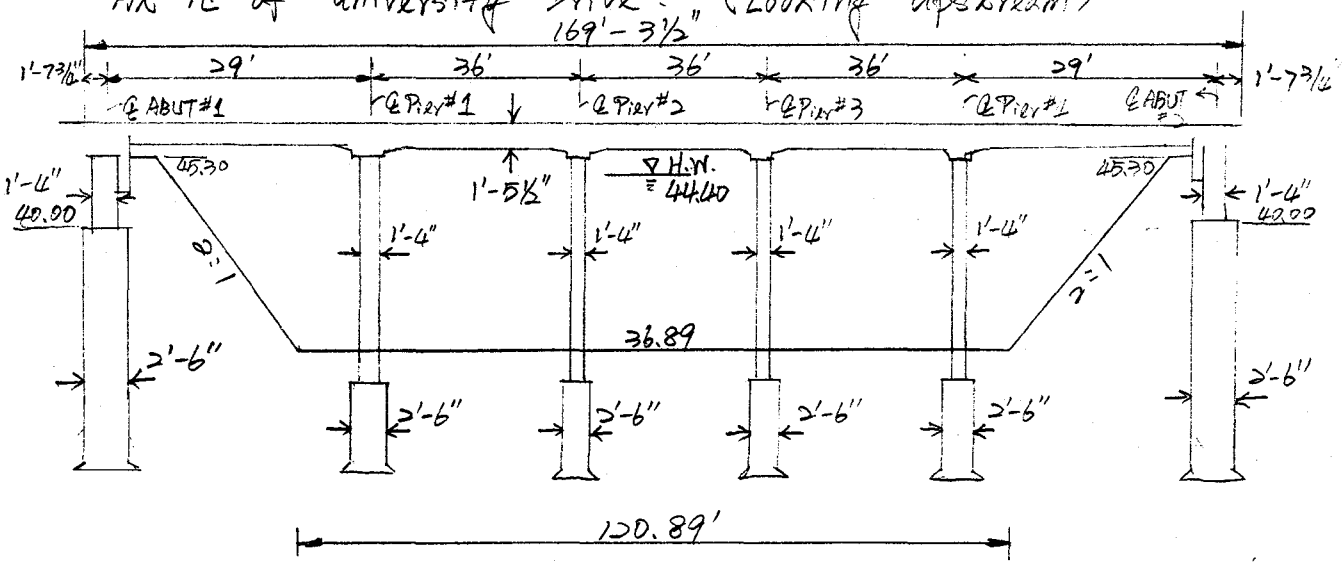
3. (Cont'd)

Sheet 12 of 13:

Bottom of the Bridge at the center of pier

= Top Bridge Elevation − (2'-1.5")

At ℄ of University Drive: (Looking upstream)



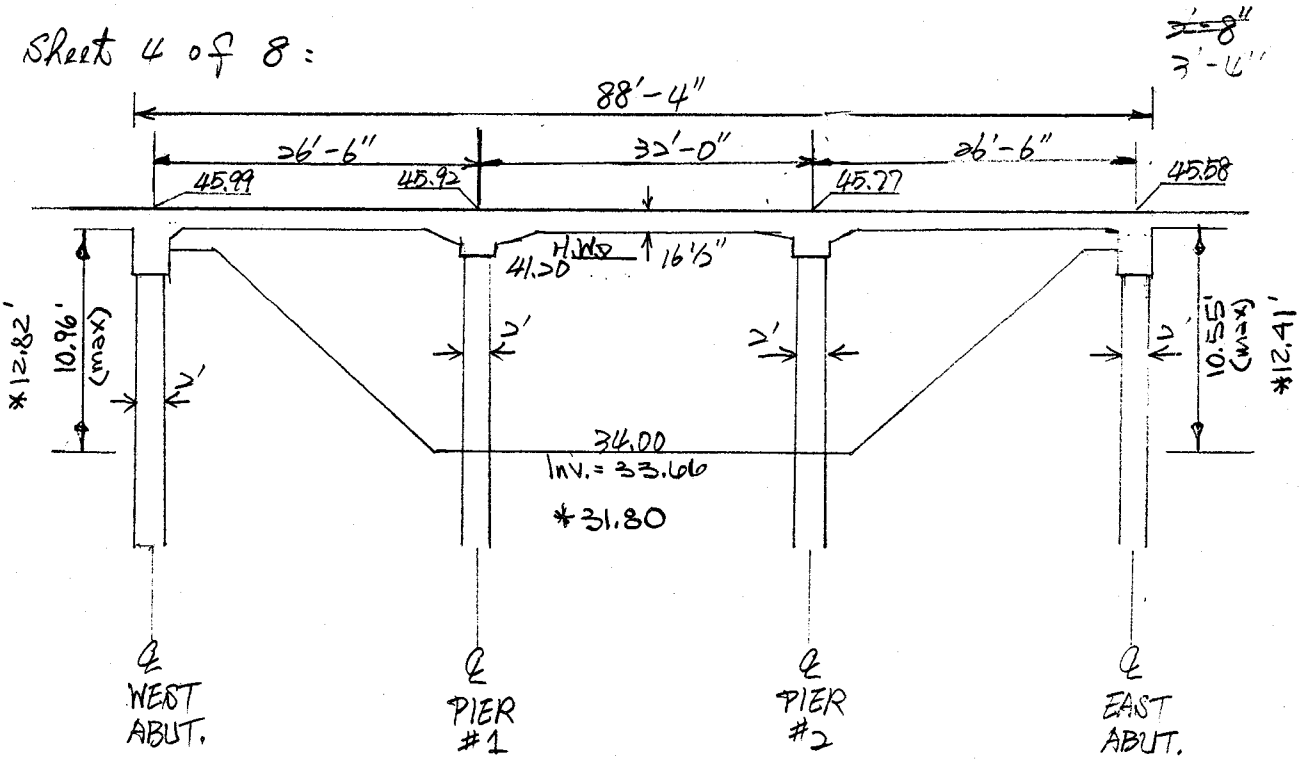
Top of column − 3" = Bottom of Bridge

	Top of Bridge	Bottom of Bridge	Top of column	Bottom of Bridge
ABUT #1	47.83		45.081	
PIER #1	48.06	45.935	46.188	45.938
PIER #2	48.21	46.085	46.339	46.089
PIER #3	48.21	46.085	46.338	46.088
PIER #4	48.06	45.935	46.184	45.934
ABUT #2	47.82		45.074	

Sta. 91+13.87 Elev. 48.23 Bottom of Bridge = $48.23 - \frac{17.5}{12} = 46.77$

4. Broadway Bridge (As per "Construction Plans for Broadway Road Bridge over RWCD Floodway" by rga consulting engineers)

Sheet 4 of 8:



Sta. 125+31.54 Top of Bridge Elev. 1345.86

Bottom of Bridge $= 45.86 - \frac{16.5}{12} = 44.49$

Use lower value $= 45.58 - \frac{16.5}{12} = 44.20$

T= ~~82'~~ 81'-8" on skew
T= 65.22' perpendicular to floodway

need 80.46' for 2:1 side slopes

5. Assumptions for First Trial

① Use downstream control water surface elevation of 1340.15 for Q = 3100 cfs. (SCS = 1340.10)

② Not to consider the skew of the structures and curve reaches.

③ An angle of 45 degrees is used where there is lateral inflow into the system.

④ Side channels at Higley, Electric Easement, S. Brown used a trapezoidal channel with bottom width of 10 feet and side slopes of 3 to 1.

⑤ Side inlets at Apache and N. Brown used a 48" Concrete circular pipe.

⑥ Proposed 2 barrel 6'x7' 30° skew box culvert 6:1 slopes.

⑦ SCS recommended the following freeboard requirements:

1 foot freeboard for concrete lined channels.

2 foot freeboard for earth channel sections.

(For Box Culvert = 1 foot freeboard inside the Box)

6. Assumptions for Trial #2

① Use downstream control water surface elevation of 1340.05 for Q= 2400 cfs. (SCS)

② Not to consider the skew of the structures.

③ Only apply curve reaches to curve No. 610, 608, 603 & 600.

④ Side channels at Higley, Electic Easement & S. Brown used a trapezoidal channel with bottom width of 10 feet and side slopes of 3 to 1.

⑤ Side inlets at Apache and N. Brown used a 48" Concrete pipe.

⑥ An angle of 90 degrees is used where there is a lateral inflow into the system.

⑦ Proposed 2 barrel 6'x7' 30° skew box culvert with 6:1 slopes at Brown.

⑧ Transition segments at Brown Road crossing are used 3:1 side slopes, while at Apache & Higley are used 3:1 to 1:1.

⑨ Use irregular channels to avoid the negative invert slopes except at entrance of Brown Rd. box culvert (Sta. 32+50.99).

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Job: NCB RWCD Floodway Reach 6 - 810012

Description: Comparative Design Studies
ALT. No. 1 Trial 2-1

Calculated by: B. Gary Sur Date: 10/28/85 Sheet No. 6

Checked by: W.S.S. Date: _____ of 17

RWCD6.A121 (Results were identical to RWCD6.A12)

At 10478.66 (Sta. 156+51.34 depth = 4.227' supercritical)

Sta.	Elev.
156+91	1200.03

$S_0 = -0.00643$ ft/ft

Sta.	Elev.
158+90.67	32.78

$S_0 = -0.002826$ ft/ft

Sta.	Elev.
155+48.66	33.75
156+51.34	33.46

Sta.	Elev.
152+91	34.52
	88.74

7. For Trial #3:

Redesign box culvert at Brown Road. Proposed 2 barrel 12'x8' box culvert, 30° skew & 6:1 slopes.

Results:

① Supercritical flow at Broadway Road Bridge.

② Freeboard requirements:

(i) All street crossings are adequate.

(ii) Sta. 161+30 ~ 159+32.92 & sta. 152+74.98 ~ 128+79.37 are not met 2 foot freeboard requirement.

③ Critical depth at system headwork.

8. For Trial #4:

Change Manning's n values at Broadway & University.

Use $n = 0.017$ at transition segments.

$n = 0.013$ at bridges.

Results: Same problems as Trial #3.

9. Assumptions for Trial #5:

① Use downstream control water surface elevation of 1340.05 for Q= 2400 cfs.

② Not to consider the skew of the structures.

③ Only apply curve reaches in the run to curve numbers 610, 608, 603 & 600.

④ Side channels at Higley, Eletric Easement & S. Brown used a trapezoidal channel with bottom width of 10 feet and side slopes of 3 to 1.

⑤ Side inlets at Apache and N. Brown used a 48" concrete pipe.

⑥ An angle of 90 degrees is used where there is lateral inflow into the system.

⑦ Proposed 2 barrel 8'x8' box culvert, 30° skew (ADOT Highway Structure Section) & 6:1 slope.

⑧ Transition sections at Brown Road crossing are used 3 to 1 side slopes, while transition sections at Apache & Higley are used 3:1 to 1:1.

⑨ Use irregular channels to avoid the negative or zero invert slope except at box entrance of Brown Road box culvert. (Sta. 32+50.99)

9. (Cont'd)

(10) Use extra protection (n = 0.013) at downstream side of transition section of Apache & Higley box culvert.

Alternate No. 1 Trial #6

Problem Set Up:

1. The downstream control water surface elevations of 40.05 for Q=2400 cfs and 37.95 for Q=1200 cfs as per SCS WSP2 results at Sedimentation Basin. (Applying the datum correction of +0.05')
2. Use n=0.025 for Aged condition (Q_{100}) and n=0.023 for As-Built condition. At Sta. 163+10.00 (9820.00) & 161+87.00 (9943.00) use n=0.035 as per SCS WSP2 run.
3. Apply same cross section as SCS WSP2 run section 15312 at Sta. 163+10.00 (9820.00). (Applying the datum correction of +0.05 ft.)
4. An angle of 90 degrees is used where there is a lateral inflow into the system.
5. Side channels at Higley, Powerline Easement & S. Brown used a trapezoidal channel with bottom width of 10 feet and side slopes of 3 to 1.
6. Consider proposed Apache & Higley 5 barrel 10'x 8' box culvert angle points: 9.00° at Box Culvert Exit Sta. 125+76.45 (13552.54)
   10.50° at Box Culvert Entrance Sta. 122+05.22 (13924.78)

Alternate No. 1 Trial #6 (Cont'd)

7. Only apply curve reaches to Curve Numbers 610, 609, 608, 603 & 600.

Curve No.	R	P.T.	P.T.
610	1452.53'	161+30.00 (10000.00)	158+90.67 (10239.33)
609	1452.53'	158+90.67 (10239.33)	156+51.34 (10478.66)
608	2456.83'	102+48.39 (15881.61)	97+08.37 (16421.63)
603	1994.99'	95+97.84 (16532.16)	93+97.84 (16732.16)
600	1134.04'	88+47.84 (17282.16)	86+47.84 (17482.16)

Note: For Curve No. 609 only apply curve reach between 158+90.67 (10239.33) and 157+00.00 (10430.00).

8. Proposed 2 barrel 8'x8' 30° skew box culvert w/ 6:1 slope and wingwalls at Brown Road.

9. Transition sections at Brown Road crossing are used 3 to 1 side slopes, while transition sections at Apache & Higley are used 3:1 to 1:1.

10. Use irregular channels to avoid the negative or zero invert slope except at Brown Road box entrance (Sta. 32+50.99).

11. Use extra protection (n=0.013) at downstream side of transition section of Apache & Higley Box Culvert (Sta. 128+79.37 ~ 126+71.23)

12. Manning's n values at Broadway Road

Use $n = 0.017$ at transition sections.

Use $n = 0.013$ under the bridge

13. At University Drive Bridge: There is no need extra protection for earth channel (use $n = 0.025$ for Q_{100} & $n = 0.023$ for 50% of Q_{100}).

Results for Trial #6 w/ Q100

1. At Sta. 157+00.00 ~ 155+48.66 (Broadway Road Bridge) flowing supercritical flow. At Broadway Road Bridge min. 4.87' freeboard.
2. At Apache & Higley box culvert only 0.906' freeboard.
3. At University Drive Bridge 1.60' freeboard.
4. At Brown Road box culvert min. 1.69' freeboard.
5. Critical depth at system headwall (Sta. 30+50.00)

Results for Trial #6 with 50% of Q100

1. Supercritical flow at Sta. 157+00.00 ~ 155+48.66 (Broadway Road). Min. 6.54' freeboard under the bridge.
2. Critical depth at system headwall (Sta. 30+50.00)

Problem Set Up for Trial #7

1. Without considering the existing Broadway Road Bridge.

2. Consider Curve No. 610, 609, 607, 606, 608, 603 & 600

Curve No.	R	P.T.	P.T.
610	1452.53'	161+30.00 (10000.00)	158+90.67 (10239.33)
609	1452.53'	158+90.67 (10239.33)	156+51.34 (10478.66)
607	1374.96'	155+50.00 (10580.00)	153+50.00 (10780.00)
606	1346.63'	153+50.00 (10780.00)	151+50.00 (10980.00)
608	2456.83'	102+48.39 (15881.61)	97+08.37 (16421.63)
603	1994.99'	95+97.84 (16532.16)	93+97.84 (16732.16)
600	1134.04'	88+47.84 (17282.16)	86+47.84 (17482.16)

Note: For Curve No. 609 only apply curve reach between 158+90.67 (10239.33) and 157+00.00 (10430.00).

Results for Trial #7 w/ Q100

1. At least 2.79' freeboard at proposed Apache & Higley box culvert.

2. 2.53' freeboard at University Drive Bridge.

3. Min. 2.20' freeboard at proposed Brown Road box culvert.

4. Critical depth at system headwall (Sta. 30+50.00).

Recommended Peak Discharge (Sep. 11, 1985 by SCS):

Brown Road:			
Reach 6 EXT.	300 cfs		
Under Road Crossing	900 cfs		
Inlet (from S. of Brown proposed 54" S.D. & Gunite Channel)	360 cfs		
		RWCD	1200 cfs
Adobe Road:			
Inlet (from N. of Adobe)	310 cfs		
		RWCD	1200 cfs
Powerline Easement:			
Inlet:	1600 cfs		
		RWCD	1800 cfs
University Drive:			
Inlet (N. of University 600 cfs)	620 cfs		
		RWCD	1840 cfs
Fun Life Swimming Pool (1/4-Mile S. of Univ.)	110 cfs		
		RWCD	1840 cfs
Apache Trail			
Inlet (N. of Apache)	1000 cfs		
		RWCD	1900 cfs
S.E. of Higley Road			
Inlet (From Apache Trail)	500 cfs		
		RWCD	2400 cfs
Broadway Road			
Inlet (From Mesa Shadows East)	220 cfs		
		RWCD	2400 cfs

Alternate No. 1 Trial #8

Problem Set Up:

1. The same as Trial #6 except the following:

   1. Design Peak Flows:

Station – Station	Q_{100}	50% of Q_{100}	Q_{10}
30+50.00 – 31+73.15 N. Brown	300 cfs	150 cfs	154 cfs
31+73.15 – 36+84.83 Brown Box	900 cfs	450 cfs	154 cfs
36+84.83 – 78+43.91 Adobe Rd.	1,200 cfs	600 cfs	193 cfs
78+43.91 – 88+89.51 Powerline	1,800 cfs	900 cfs	296 cfs
88+89.51 – : University Dr.	1,840 cfs	920 cfs	460 cfs
– 121+15.05 1/4 mi. S. Univ.	1,840 cfs	920 cfs	453 cfs
121+15.05 – 128+84.37 Apache Trail	1,900 cfs	950 cfs	721 cfs
128+84.37 – S.E. of Higley	2,400 cfs	1,200 cfs	1,029 cfs
– 161+30.00 S. Broadway	2,400 cfs	1,200 cfs	1,014 cfs

Results: (Q_{100} flow)

1. Supercritical velocities up to 17 fps occurred under Broadway Road Bridge.
2. Inadequacy of freeboard at Apach/Higley 8 foot high box culvert. (Only 0.906 foot of freeboard inside the box).

Alternate No. 1 Trial #9

Problem Set Up:

1. Same alignment as Trial #8 except without considering Broadway Road Bridge.
2. One "WSPG" run has been made with Q_{100} flows.

Results:

1. Minimum 2.792 feet of freeboard was shown at Apache/Higley 8 foot high box culvert.
2. Alternate No. 2 or Modification No. 3 was to be started for different channel grade and alignment.

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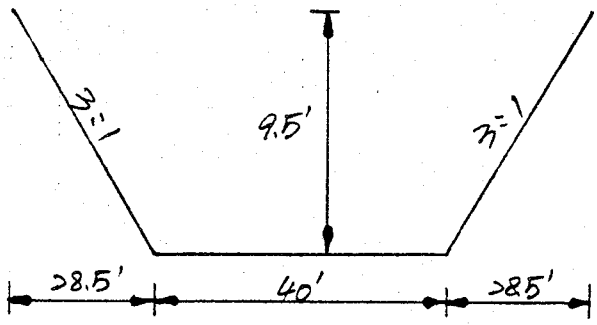
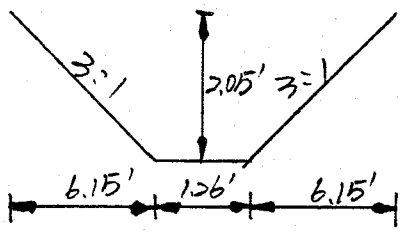
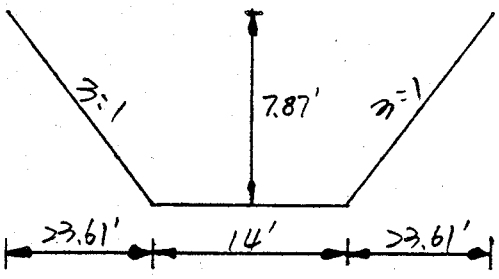
Cross Sections (Cont'd)



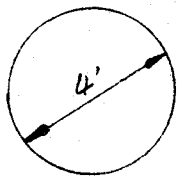
Sec. 7 Sta. 31+48.00 & 30+70.00
(37.51) (37.52)



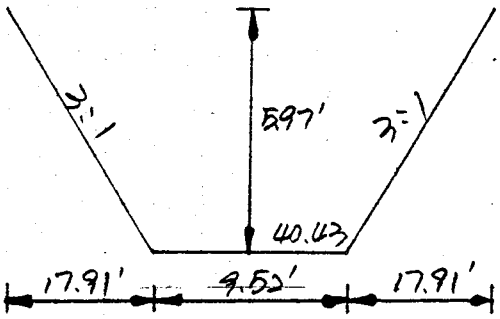
Sec. 10 Sta. 28+85



Sec. 8 Sta. 30+69.99 & 30+43.36



Sec. 11 Junction Structure



Sec. 9 Sta. 29+93

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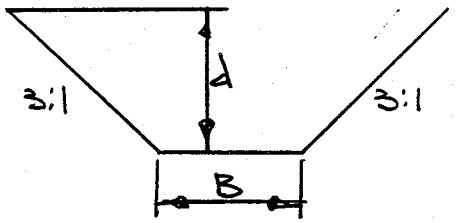
Job E101012 RWCD Reach 6

Description Design of Small Channel Into Terminus of Floodway

Calculated by M. Shapiro Date 11/01/86 Sheet No. 1

Checked by B.G.S. Date _____ of 1

(See 50' scale sketch)



Q = 196 cfs
S = 0.0381%

	B (ft)	d (ft.)
Section A	14	7.87
" B	9.52	5.97
" C	1.26	2.05

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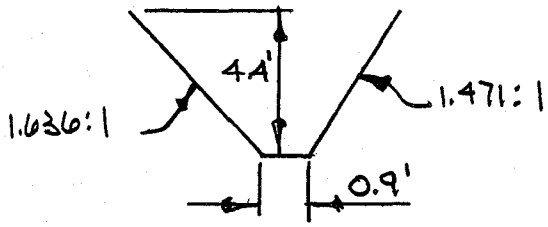
Job E101012 RWCD Reach 6

Description Capacity of existing channel north of Brown Rd. (Westside)

Calculated by M. Shapiro Date 1/10/86 Sheet No. 1

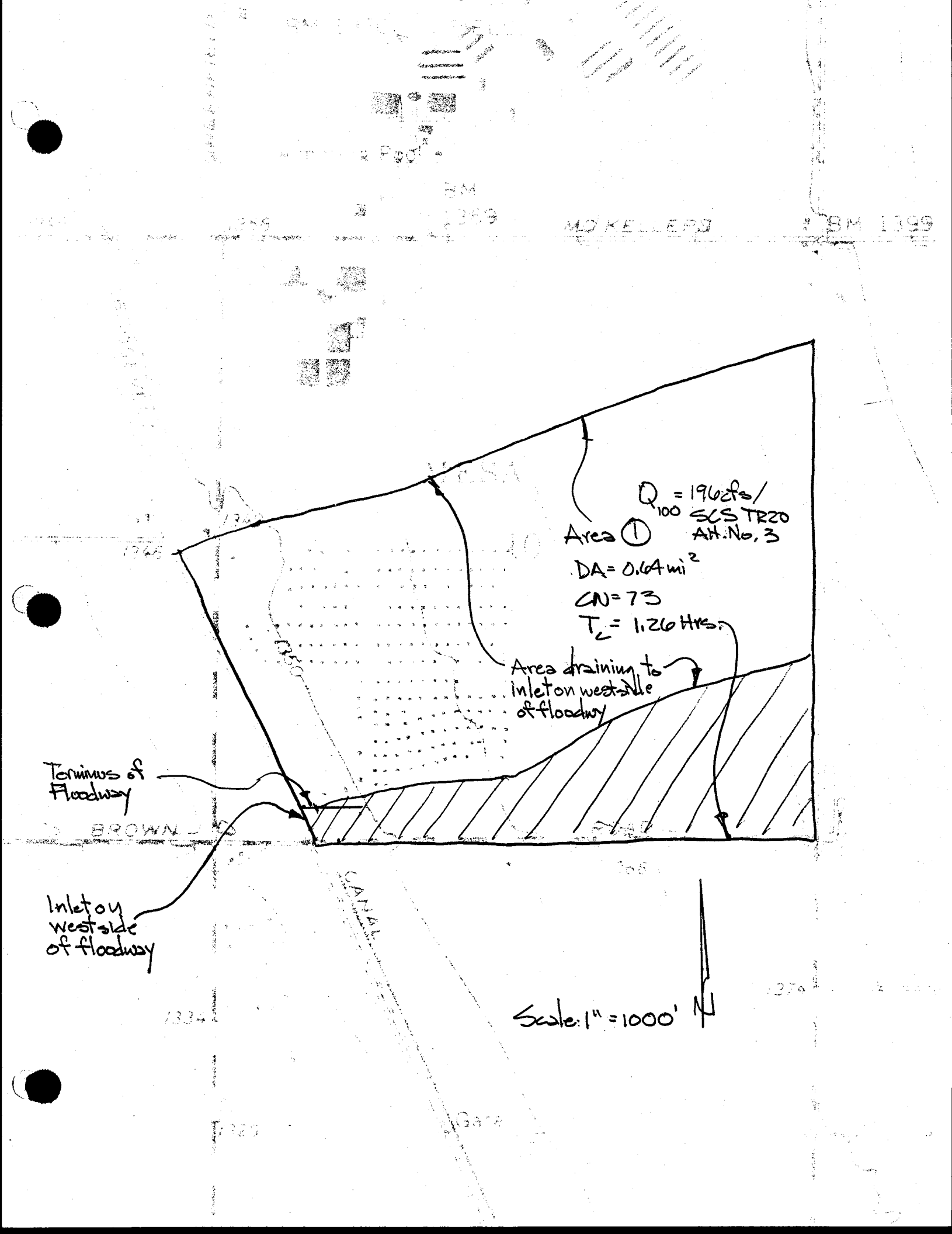
Checked by B.G.R. Date _____ of 1

Sta. 31+00



S = 0.001 ft/ft
n = 0.025

1.636	L BK
1.471	R BK
0.9	BASE
0.001	FPF
0.025	N
4.4	DP
34.03576	AREA
17.16300729	WP
1.983088362	R
2.973705697	FPS
101.2123334	CFS


Q100 = 196 cfs/
SCS TR20
Alt. No. 3
Area 1
DA = 0.64 mi²
CN = 73
Tc = 1.26 Hrs.
Area draining to inlet on west side of floodway
Terminus of Floodway
Inlet on west side of floodway
Scale: 1" = 1000'
N

N 887220
Sta.30+70.00
Inv.=37.52
Sta.31+48.00
Inv.=37.51
End Trans.
Erosion Protection Extends 10' Beyond top of bank.
Sta29+93
Inv.=40.43
SectionB
Sta.30+43.36
Inv 38.53
Section A
Sta28+85
Inv.=44.55
Section C
Meet Existing Ground
O&M Road
O&M Road
Sta.11+64
Gunite Channel
T.B.=48.74
Future
TW=50.60
T.B.=46.98
Small Retaining Wall
ROAD
R/W
R/W
1350
55'
Q=196cfs
360 CFS

Summary

1. One "STORM" run has been performed to find the capacity of the approved 54 inch pipe. This was found to be 159 cfs. (See computer printout files BROWN.DAT and BROWN.OUT)

2. Two trials were calculated for water surface profile analysis. Trial No. 1 was based on the approved gunite channel connecting to the floodway with an earth channel. The results showed that overflow occurred in the gunite channel due to inadequacy of channel capacity. A collector system with the spillway was designed to replacing the gunite and earth channel as the Trial No. 2. This system functioned adequately for a capacity of >01 cfs. Then, Trial No. 2 is recommended. A retaining wall (See computer printouts SBROWN2.DAT, SBROWN2.OUT, QSBROWN2.OUT, SBROWN21.DAT, SBROWN21.OUT & QSBROWN21.DAT) will design between the maintenance roadway and the floodway due to elevation difference. The length of retaining wall is approximate 50 feet. This is recommended instead of lining the channel bank.

3. Two different alternates were designed for connecting the 54 inch concrete pipe into the floodway. Alternate No. 1 is a manhole with a bleed-off pipe connecting to a drywell. Alternate No. 2 is a manhole with a plunge basin in the floodway.

Trial #1

1. Run "STORM" for proposed 54" storm drain (BROWN.DAT)

Problem Set Up:

① Downstream control tailwater elevation = 44.47 (WSPG Alt. No. 1 Trial #8 Sta. 36+80).

② Upstream maximum allowable top of water elevation = 51.86 (Set it to the rim elevation of manhole).

③ n = 0.013 for concrete pipe.

Results:

① 54" concrete pipe capacity = 159 cfs.

② Max. velocity = 10 fps.

2. Run "WSPG" for proposed gunite channel (EBROWN.DAT & QEBROWN.DAT)

Problem Set Up:

① Q = 201 cfs.

② Use n = 0.014 for gunite channel.

③ Use H.W. = 44.47 at Sta. 12+00 (As per Alt. No. 1 Trial #8)

④ Curve reach between Sta. 12+23.61 and Sta. 13+10. (R = 55')

⑤ Transition reach starts from Sta. 12+70 to Sta. 13+10.

Results:

① Flow over the bank at Sta. 12+00 ~ 12+34.82 & Sta. 13+10.

② Hydraulic jump at Sta. 12+34.82. V= 21.40 fps &

superelevation = 4.87 ft.

③ Redesign the gunite channel.

Trial # 1
O/M ROAD
Sta. 12+70
Start Transition
FE = 44.60
BROWN ROAD
R/W
Inv. = 38.00
Gunite Channel
S = .0020 ft/ft
S = .0051 ft/ft
pipe
1:1
1.94'
11.62'
L = 179'
Inv. = 37.09
Inv. = 36.83
Channel w/ 2:1 slopes
3' deep
54" PIPE
Q = 200 CFS
Topo to Headwall = 42.50
Q = 200 CFS
CHANNEL
Channel w/ 3:1' bottom & 2:1 slopes
4' deep
Sta. 8+00
Inv. 34.60
Sta. 36+80
H.W. 40.47
Inv. = 37.46
FLOW
O/M ROAD

SCE

XEQ W D1027

BROWN.DAT

Page ___ of ___

STORM INPUT FORM

Code	Project Description	53 Designer	72 Not Used
1	RWCD REACH 6 PROPOSED 54" STORM DRAIN AT E. BROWN	B. GARY SUN	0

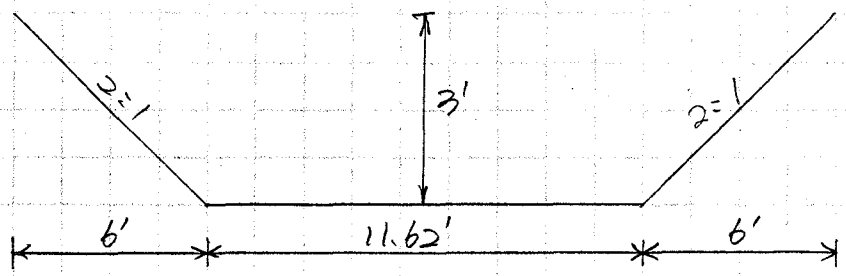
Data Code	Line No. L3	Maximum Q (cfs)	Adjusted Q (cfs)	Line Length (ft)	Elevation Downstream (F.L. 1)	Elevation Upstream (F.L. 2)	Hydraulic Grade Line Elevation (Control or T.W.) 31	D (in.)	W (in.)	Start Trk	K1	K2	KM	Control Line No.	L1	L3	L4	A1 (deg)	A3 (deg)	A4 (deg)	J (ft)	75 N
8	1						44.47															
2	2	1.59		450.0	36.60	36.83		54		3		0.10			1	3		45				0.13
2	3	1.59		510.0	36.83	37.09		54		3		0.10				4		45				0.13
2	4	1.59		1790.0	37.09	38.00		54		3		0.10				5		45				0.13
2	5	1.59		1050.0	38.00	38.54	51.86	54		1		0.10										0.13

Greiner Engineering

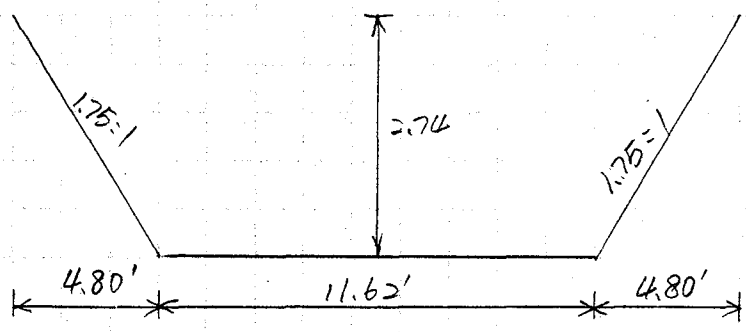
Greiner Engineering Sciences, Inc.

Tucson 602 327-3413
Phoenix 602 275-5400

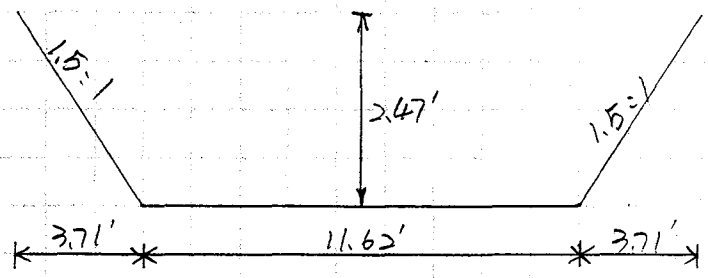
Job SCS RWCD Floodway Reach 6 - E101012
Description Comparative Design Studies
Side Inlet at E. Brown Trial #1
Calculated by B. Bard Sr Date 11/25/85 Sheet No. 3
Checked by M.S.S. Date _____ of 4



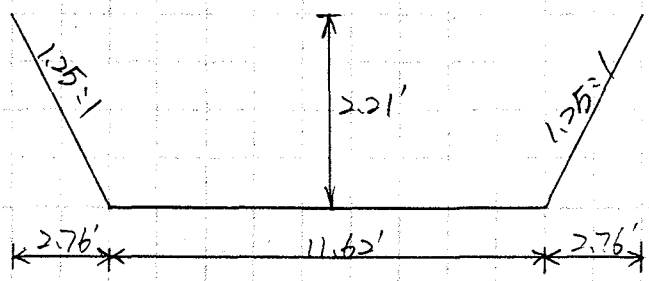
Sec. 1 Sta. 12+00, 12+23.61 & 12+70



Sec. 2 Sta. 12+80 45.74



Sec. 3 Sta. 12+90 46.88



Sec. 4 Sta. 13+00 48.03

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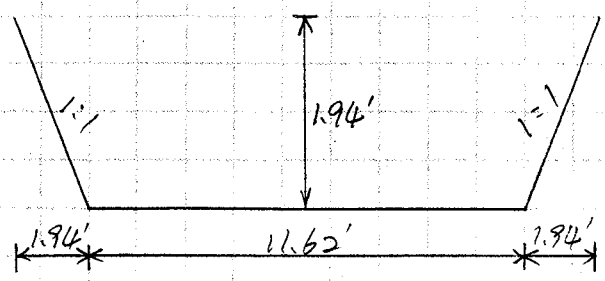
Job SCS RWCD Floodway Reach 6 - E101012

Description Comparative Design Studies
Side Inlet at E. Brown Trial #1

Calculated by B. Gary Sun Date 11/25/85 Sheet No. 4

Checked by M.S.S. Date _____ of 4



Sec. 5 Sta. 13+10 & 17+90

Side Inlet at South of Brown Road (Sta. 35+18) Trial #2

1. Problem Set Up:

① New design includes:

(i) Remove gunite channel to R/W and concrete apron and rip-rap channel.

(ii) Install 108 L.F. of 54" R.C.P. to Floodway.

(iii) Install Headwall at Sta. 35+92 for 54" R.C.P.

(iv) Construct new M.H. and remove existing headwall. Also install 60 L.F. of 18" PVC for bleed off.

(v) Design a new side inlet structure with capacity of 201 cfs (50' wide spillway).

2. Results:

(1) Full-Flow Condition: (SBROWN2.DAT, SBROWN2.OUT & QSBROWN2.OUT)

① Work hydraulically.

② Erosion analysis will perform for Sta. 10+88 ~ Sta. 11+14.

(2) No-Flow Condition: (SBROWN21.DAT, SBROWN21.OUT & QSBROWN21.OUT)

① Same as Full-Flow Condition.

② Apron will be designed by using the velocity of 4.91 cfs.

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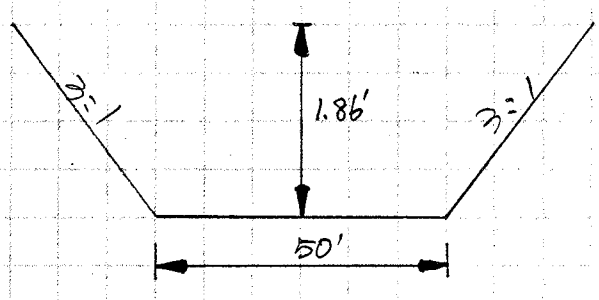
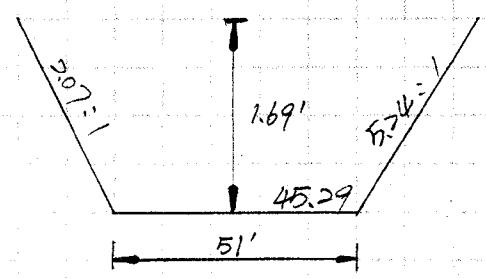
Job: SCS RWCD Floodway Reach 6 - E101012
Description: Comparative Design Studies
Side Inlet at South of Brown Road
Calculated by: B. Gary Sun Date: 1/2/86 Sheet No. 2
Checked by: M.S.S. Date: of 2

SBROWN2.DAT, QSBROWN2.DAT Trial #2

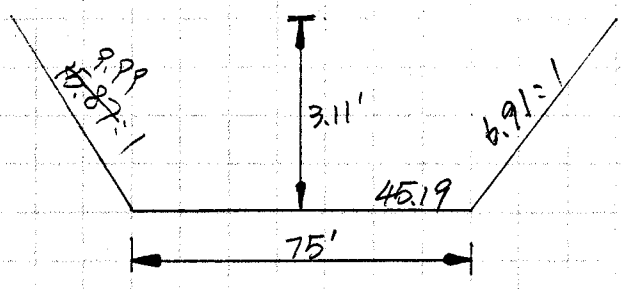
Side Inlet at South of Brown Road (Sta. 35+18)



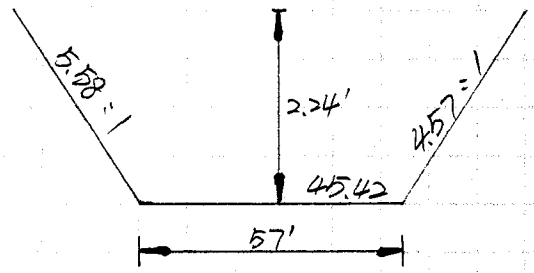
Sec. 1 Sta. 10+00, 10+26.5 & 10+55



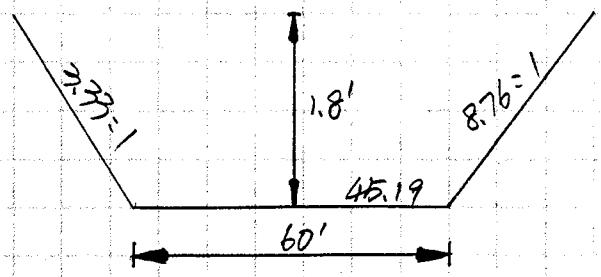
Sec. 4 Sta. 10+88



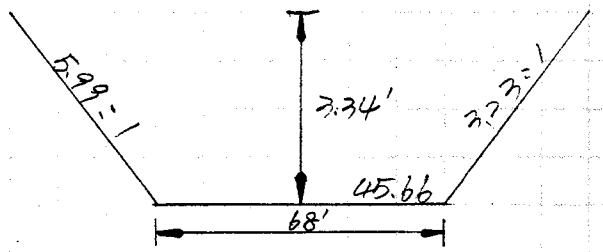
Sec. 2 Sta. 10+69



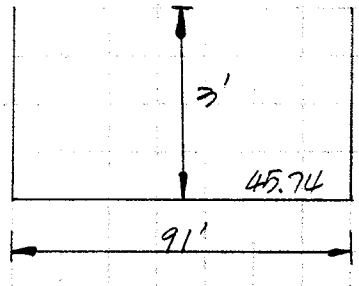
Sec. 5 Sta. 11+14



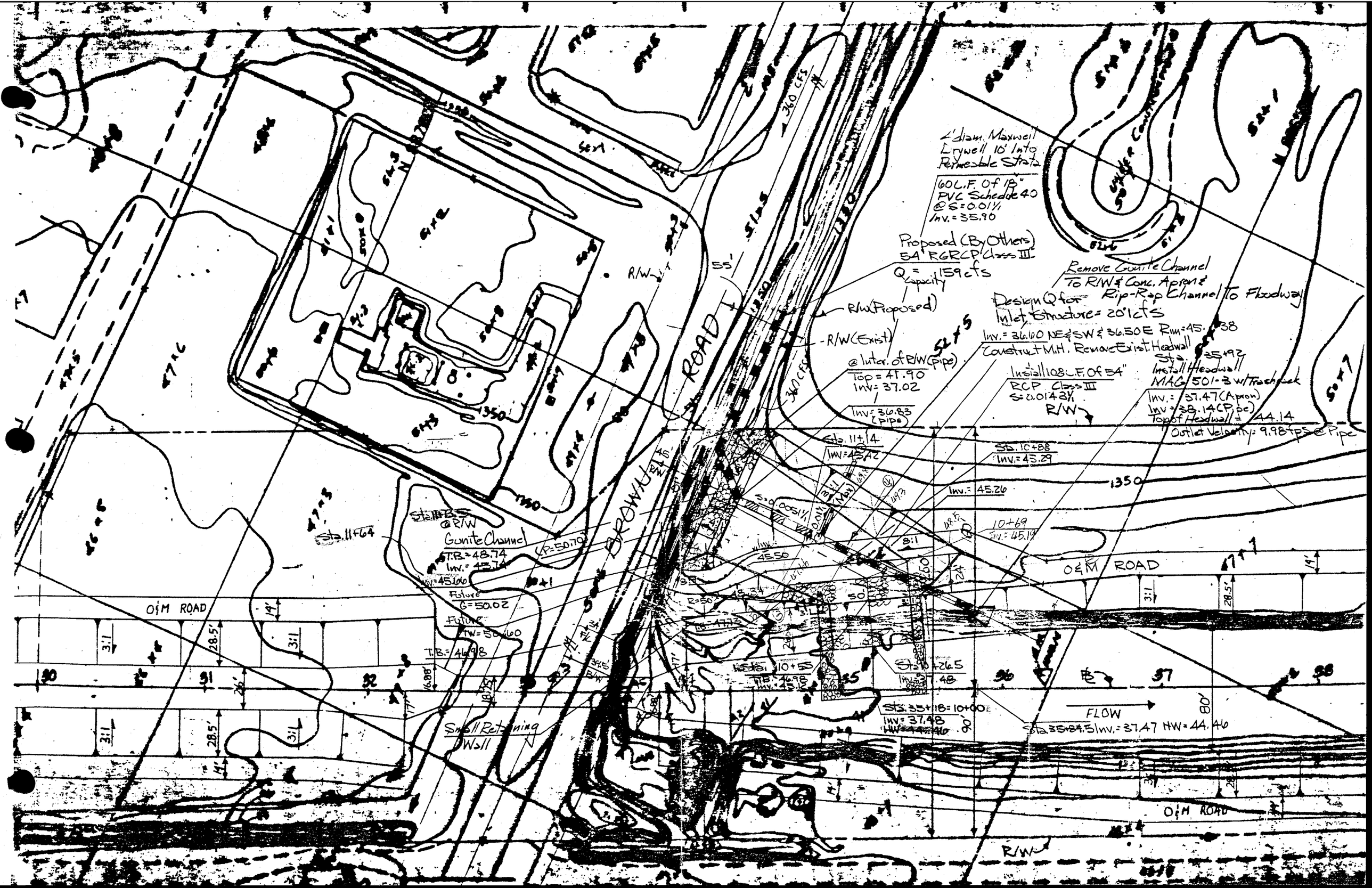
Sec. 3 Sta. 10+69.01



Sec. 6 Sta. 11+64



Sec. 7 Sta. 11+73.5


4' diam. Maxwell
Drywell 10' into
Permeable Strata
60 L.F. Of 18"
PVC Schedule 40
@ S=0.01%
Inv.=35.90
Proposed (By Others)
54" RGRCP Class III
Q capacity 159 cfs
Remove Gunite Channel
To R/W & Conc. Apron &
Rip-Rap Channel To Floodway
Design Q for
Inlet Structure = 201 cfs
R/W (Proposed)
R/W (Exist)
Inv.= 36.60 NE & SW & 36.50 E
Construct M.H., Remove Exist. Headwall
@ Inter. of R/W (Pipe)
Top = 41.90
Inv = 37.02
Install 108 L.F. Of 54"
RCP Class III
S=0.0143%
Install Headwall
MAG 501-3 w/Trashrack
Inv.= 37.47 (Apron)
Inv.= 38.14 (Pipe)
Top of Headwall = 44.14
Outlet Velocity = 9.98 fps @ Pipe
Inv.= 36.83 (Pipe)
Sta. 11+14
Inv.= 45.42
Sta. 10+88
Inv.= 45.29
Inv.= 45.26
10+69
Inv.= 45.19
Sta. 11+64
Gunite Channel
T.B.= 48.74
Inv.= 45.74
Future
G=50.02
Future
TW=50.60
T.B.= 46.98
Small Retaining Wall
O&M ROAD
BROADWAY
ROAD
FLOW
Sta. 35+84.5 Inv.= 37.47 HW=44.46
Sta. 35+18 = 10+00
Inv.= 37.48
R/W

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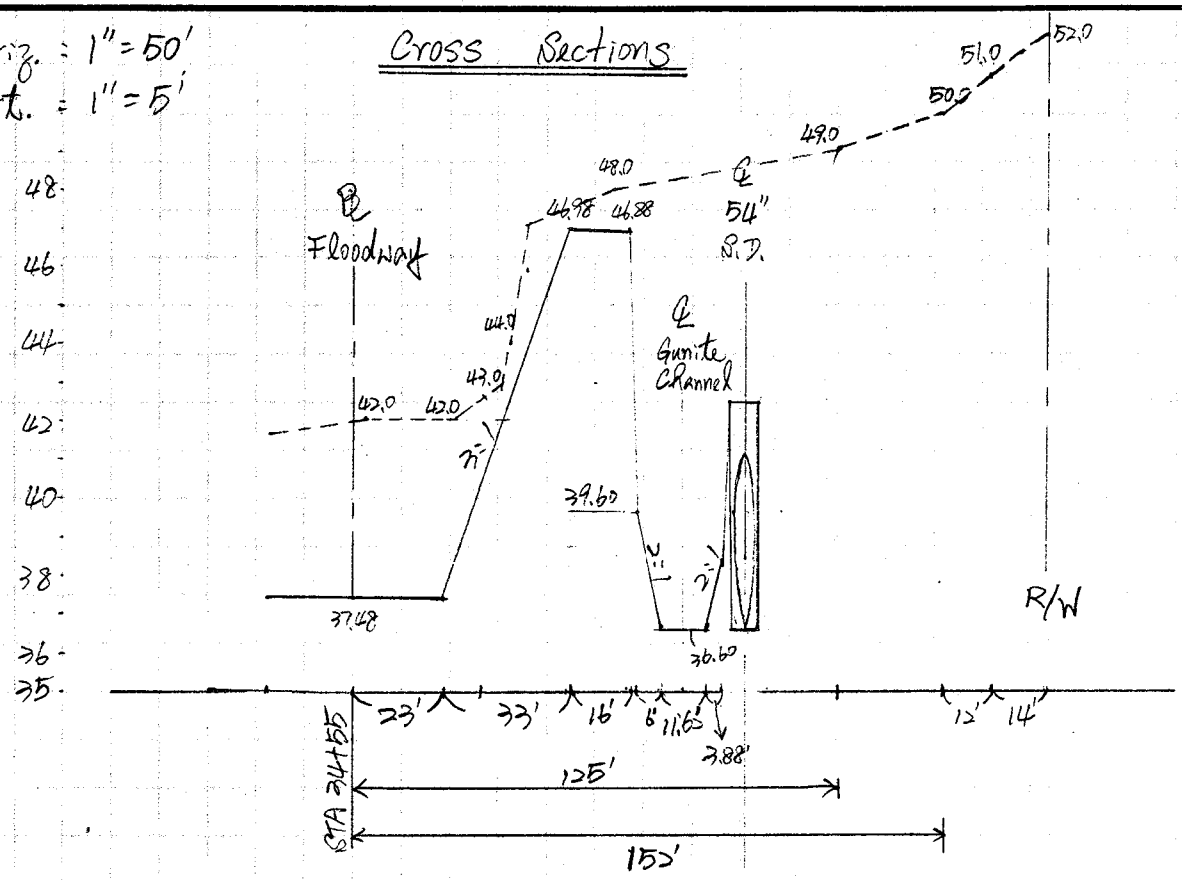
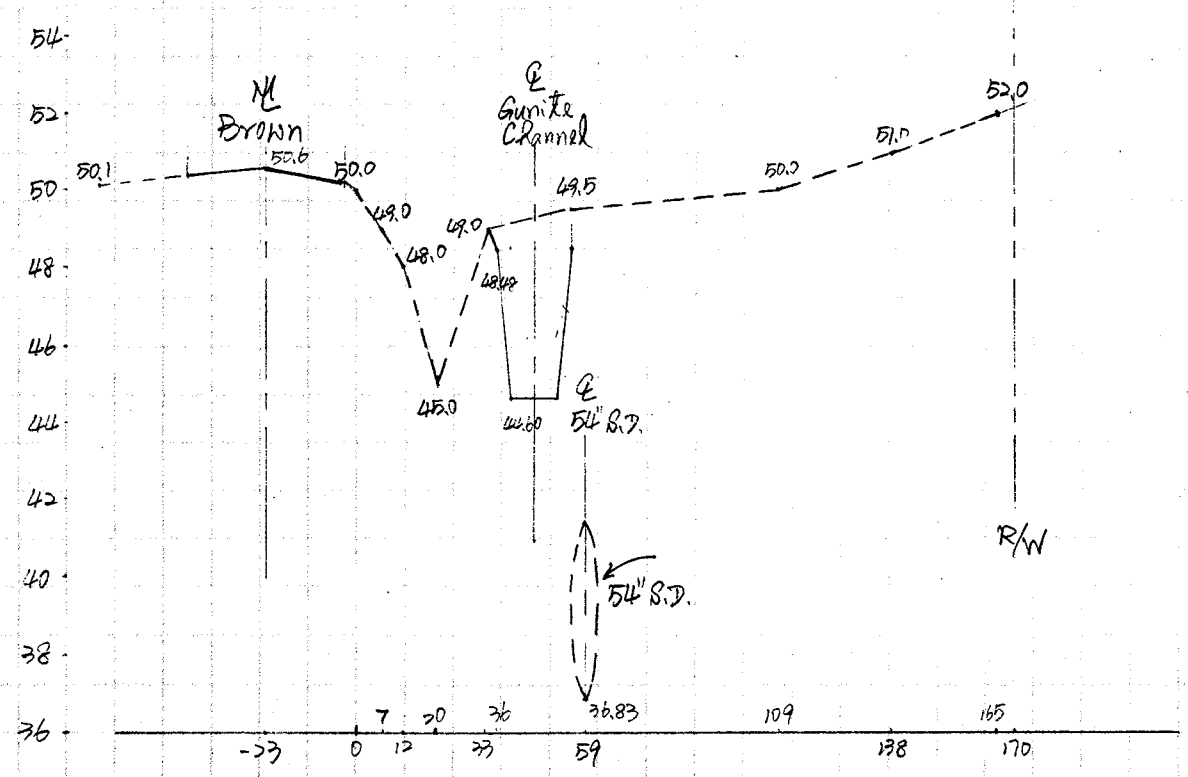
Job: RCB RWCD Floodway Reach 6 - E101012
Description: Comparative Design Studies
Inlet Structure at E. Brown Road
Calculated by: B. Gary Sun Date: 12/26/85 Sheet No. 1
Checked by: M.S.S Date: _____ of 1

Horiz. = 1" = 50'
Vert. = 1" = 5'

Cross Sections

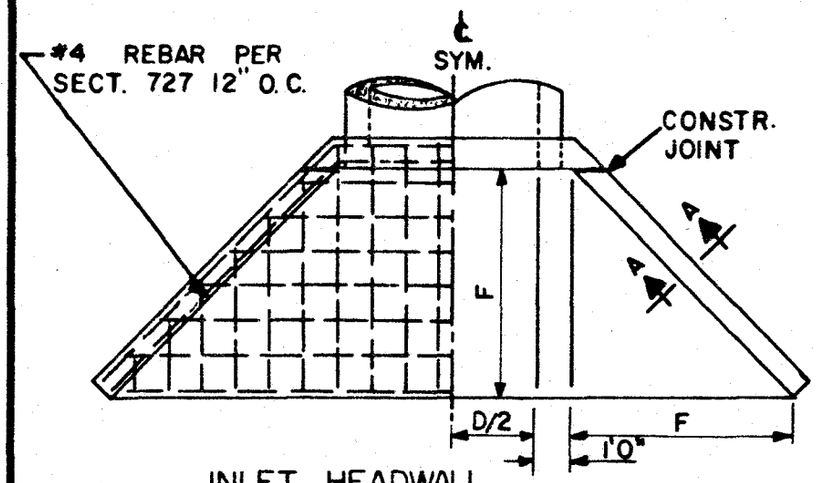


Sec. 1 At 54" S.D. Headwall Outlet (Facing North)

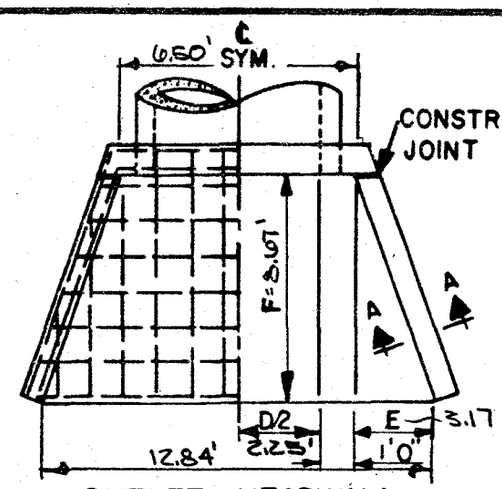


Sec. 2 At the Skew of 54" S.D. (Facing North)

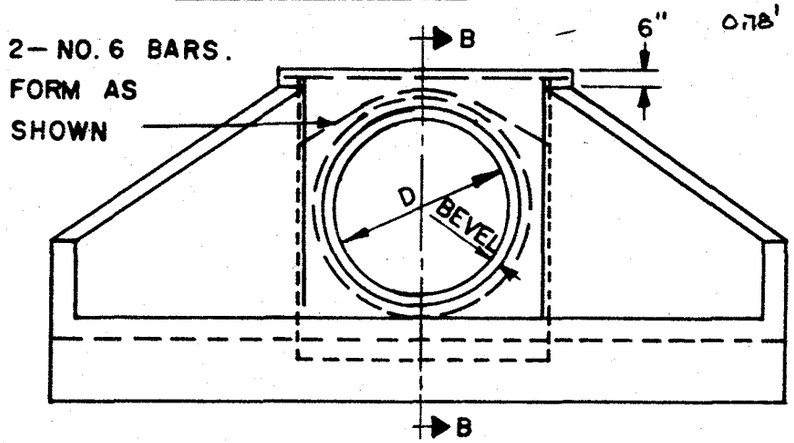
Inlet South of Brown Rd.



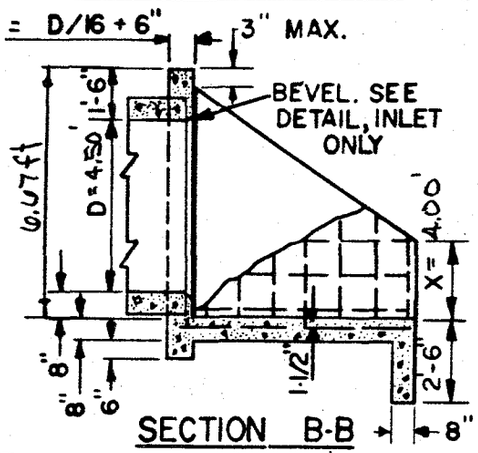
INLET HEADWALL



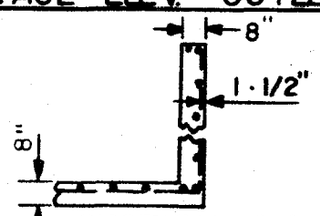
OUTLET HEADWALL



INLET HEADWALL FACE ELEV- OUTLET SIMILAR

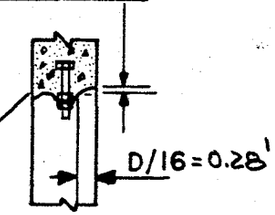


SECTION B-B



SECTION A-A

3/4" X 6" HEX HEAD BOLTS, 1'-6" C TO C FOR C.M.P.



BEVEL - DETAIL

CONCRETE SHALL BE CLASS A, PER SECT. 725

		1 1/2 : 1 EMBANKMENT SLOPE					
		DIMENSIONS			CONC. (C.Y.)		REINF. STEEL
D	TYPE	F	E	X	C.M.P.	R.C.P.	(LBS.)
42"	1(INLET)	5'-2"	5'-2"	1'-9"	4.55	4.45	275
	2(OUTLET)	5'-2"	1'-11"	1'-9"	3.53	3.45	213
48"	3(INLET)	5'-8"	5'-8"	1'-11"	5.32	5.20	321
	4(OUTLET)	5'-8"	2'-1"	1'-11"	4.12	4.03	249
54"	5(INLET)	6'-2"	6'-2"	2'-1"	6.14	6.01	370
	6(OUTLET)	6'-2"	2'-3"	2'-1"	4.75	4.65	287
60"	7(INLET)	6'-8"	6'-8"	2'-3"	7.03	6.88	424
	8(OUTLET)	6'-8"	2'-5"	2'-3"	5.43	5.31	328
66"	9(INLET)	7'-2"	7'-2"	2'-5"	7.98	7.81	481
	10(OUTLET)	7'-2"	2'-7"	2'-5"	6.16	6.02	372
72"	11(INLET)	7'-8"	7'-8"	2'-7"	8.99	8.80	542
	12(OUTLET)	7'-8"	2'-9"	2'-7"	6.94	6.78	419
78"	13(INLET)	8'-2"	8'-2"	2'-9"	10.07	9.85	608
	14(OUTLET)	8'-2"	3'-0"	2'-9"	7.78	7.61	461
84"	15(INLET)	8'-8"	8'-8"	2'-11"	11.20	10.96	676
	16(OUTLET)	8'-8"	3'-2"	2'-11"	8.66	8.47	522
		1 1 EMBANKMENT SLOPE					
42"	17(INLET)	8'-8"	8'-8"	3'-0"	7.88	7.70	475
	18(OUTLET)	8'-8"	3'-2"	3'-0"	5.59	5.46	337
48"	19(INLET)	8'-8"	8'-8"	3'-6"	8.47	8.28	511
	20(OUTLET)	8'-8"	3'-2"	3'-6"	6.10	5.97	368
54"	21(INLET)	8'-8"	8'-8"	4'-0"	9.07	8.87	548
	22(OUTLET)	8'-8"	3'-2"	4'-0"	6.83	6.48	400
60"	23(INLET)	9'-4"	9'-4"	4'-4"	10.39	10.16	627
	24(OUTLET)	9'-4"	3'-5"	4'-4"	7.60	7.43	458
66"	25(INLET)	9'-8"	9'-8"	4'-9"	11.42	11.17	689
	26(OUTLET)	9'-8"	3'-6"	4'-9"	8.39	8.20	506
72"	27(INLET)	9'-8"	9'-8"	5'-3"	12.11	11.84	731
	28(OUTLET)	9'-8"	3'-6"	5'-3"	8.99	8.80	542
78"	29(INLET)	10'-0"	10'-0"	5'-8"	13.22	12.93	798
	30(OUTLET)	10'-0"	3'-8"	5'-8"	9.88	9.66	596
84"	31(INLET)	10'-8"	10'-8"	6'-0"	14.81	14.48	893
	32(OUTLET)	10'-8"	3'-11"	6'-0"	11.00	10.76	664

DETAIL NO.			
[redacted]01-3	STANDARD DETAIL	H[redacted]DWALL 42" TO 84" PIPE	[redacted]

Description.

A proposed 54 inch pipe from the approved subdivision plans for "Sundance Groves" is to be installed within the floodway right-of-way with an invert elevation approximately 0.9 feet lower than the proposed floodway invert. Two alternative designs are proposed and are summarized as follows:

<u>Alternate 1.</u> At the end of the 54 inch pipe it is proposed to install a manhole and to install an additional 108 lineal feet of pipe with a positive slope discharging into the floodway channel. The outlet of the 54 inch pipe is to be constructed with a headwall and a concrete apron having the same invert of the floodway channel. From the manhole, 60 lineal feet of 18 inch PVC pipe will be connected to the east and discharge into a 4 foot diameter drywell. This would allow the storm water in the 54 inch pipe to percolate into the ground instead of

standing in the 54 inch pipe, possibly causing water to stagnate.

<u>Alternate 2.</u> This alternate consists of connecting an additional 108 lineal feet of 54 inch pipe to the existing pipe and have it drain into the floodway with a negative slope. The outlet of the 54 inch pipe will be equipped with a plunge basin which will allow the water to drain into the basin and be subjected to percolation and evaporation thus eliminating the problem of stagnant water.

Alt 1.

Material	Quantity	Unit Cost	Cost
Riprap	140 yd^3	20/yd^3	2800.
Bedding	40 yd^3	8/yd^3	320.
Conc Pipe 54"	108 l.f.	120 / L.F.	12960.
Headwall	1	1000 ea.	1000.
			$17,080.

Greiner Engineering

Greiner Engineering Sciences, Inc.

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Phoenix 602 275-5400

Job: SCS RWCD Reach 6

Description: Write up of alternatives for 54" pipe outlet S. of Brown Rd.

Calculated by: RBeck Date: 2-11-96 Sheet No. 3

Checked by: M.S.S. Date: _____ of 7

Alt-2

Material	Quantity	Unit Cost	Cost.
Drywell	1	3000	3000
54" conc. pipe	108 l.f.	120/L.F.	12960
18" PVC pipe	60 l.f.	30/L.F.	1800.
Headwall & Apron	1	2,000	2000
Manhole	1	2,000	2000
			$21760.

Plunge Basin Design.

Design Procedure taken from HEC 14 Hydraulic Design of Energy Dissipators for Culverts and Channels

Given: $Q = 159$ cfs
$S = .0051$
$D = 54''$
$V = 9.98$ fps
$TW = 1.0'$

$Q/D^{2.5} = 159/(4.5)^{2.5} = 3.70$

$TW/D = 1/4.5 = 0.22$

From figure III-10, $y_o/D = 0.63$

$y_o = 0.63(4.5) = 2.84'$

$TW/y_o = 1/2.84 = .35$

Brink area for $y_o/D = 0.63$ from Table III-2

$\frac{d}{D} = \frac{2.84}{4.5} = 0.63 \Rightarrow A/D^2 = .5212$

$A = (4.5)^2(.5212) = 10.55 ft^2$

$Y_e = (A/2)^{1/2} = (10.55/2)^{1/2} = 2.3'$

$Fr = V_o/(32.2 \times Y_e)^{1/2} = 15.07/(32.2 \times 2.3)^{1/2} = 1.75$

Try $d_{50}/y_c = 0.35 \Rightarrow d_{50} = 0.35(2.30) = 0.81'$

$d_{max} = 1.5 d_{50} = 1.22'$

From figure XI-2 $h_s/y_c = 1.3 \Rightarrow h_s = 1.3(2.3) = 3.0'$

Check $h_s/d_{50} = 3/.81 = 3.7$ ok.

$L_s = 10 h_s = 10(3) = 30'$

$L_s = 3 W_o = 3(4.5) = 13.5'$

Use $L_s = 30'$

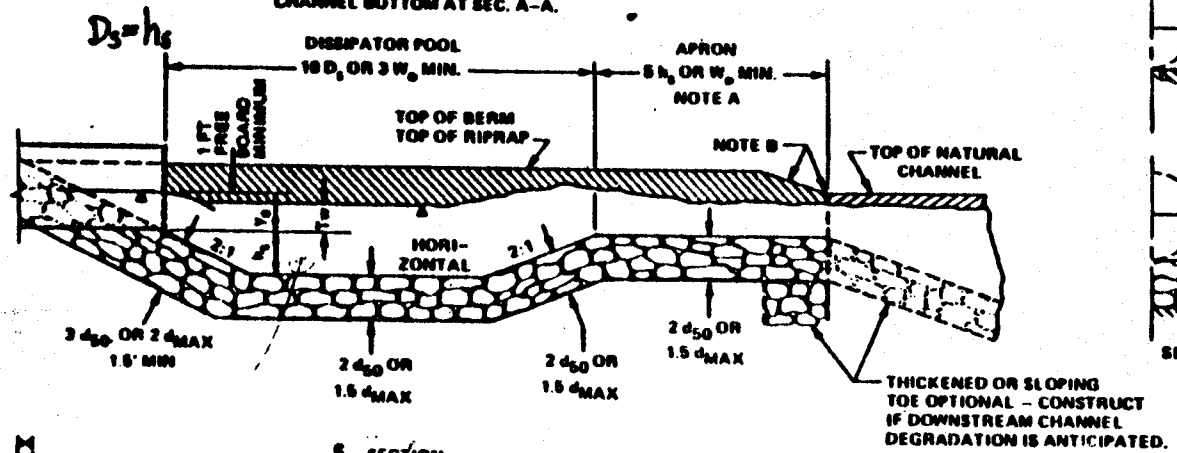
$L_B = 15 h_s = 15(3) = 45'$

$L_B = 4 W_o = 4(4.5) = 18'$

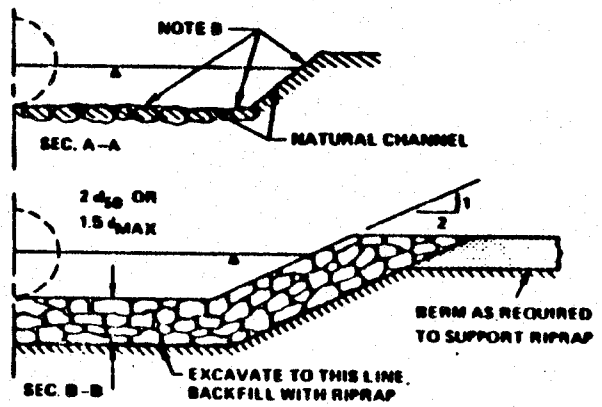
Use $L_B = 45'$

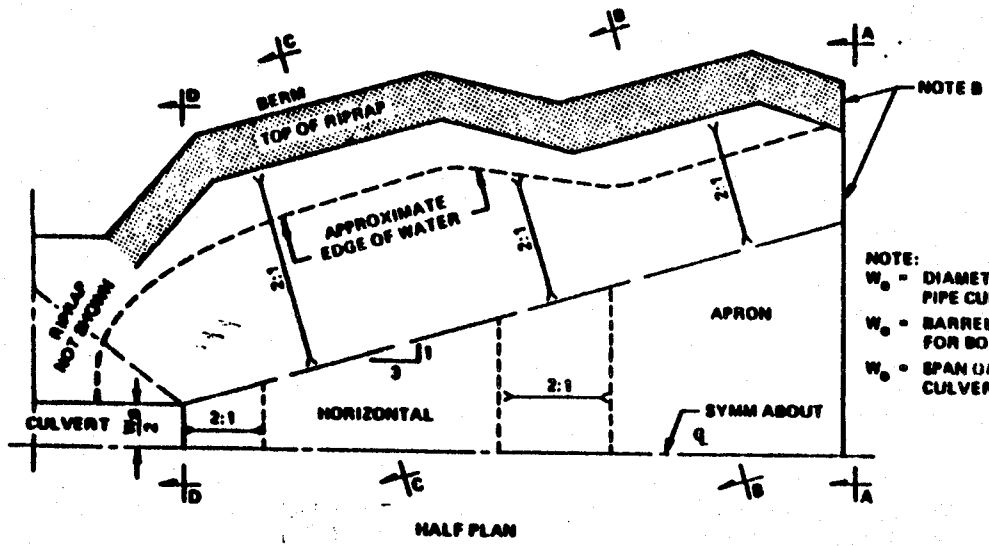
NOTE A – IF EXIT VELOCITY OF BASIN IS SPECIFIED, EXTEND BASIN AS REQUIRED TO OBTAIN SUFFICIENT CROSS-SECTIONAL AREA AT SECTION A–A SUCH THAT Q_{des}/(CROSS SECTION AREA AT SEC. A–A) = SPECIFIED EXIT VELOCITY.

NOTE B – WARP BASIN TO CONFORM TO NATURAL STREAM CHANNEL. TOP OF RIPRAP IN FLOOR OF BASIN SHOULD BE AT THE SAME ELEVATION OR LOWER THAN NATURAL CHANNEL BOTTOM AT SEC. A–A.

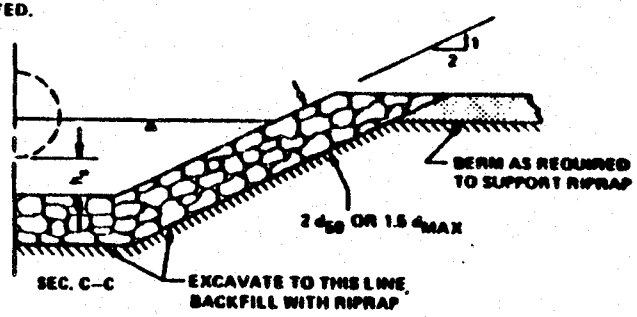


℄ SECTION





NOTE:
W_o = DIAMETER FOR PIPE CULVERT
W_o = BARREL WIDTH FOR BOX CULVERT
W_o = SPAN OF PIPE-ARCH CULVERT



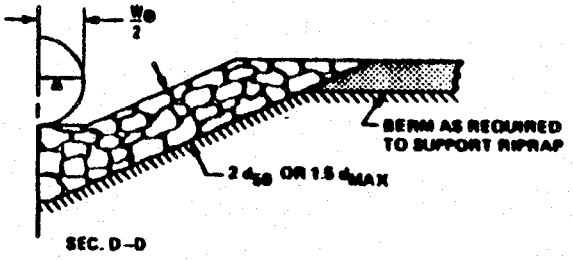


FIGURE X1–1. DETAILS OF RIPRAPPED CULVERT ENERGY BASIN

Greiner Engineering

Greiner Engineering Sciences, Inc.

Tucson 602 327-3413
Phoenix 602 275-5400

Job: SCS RWCD Floodway Reach 6
Description: Quantities of riprap for plunge basin S. of Brown Rd.
Calculated by: R. Beck Date: 2-6-86 Sheet No. 7
Checked by: M.S.S. Date: of 7

Floor Area = 877.6 ft^2

Side Area = 1269 ft^2

Toe down = 373.5 ft^2

Assume 18" thickness

Floor	48.76 yd^3
Sides	70.50 yd^3
Toe down	20.75 yd^3
	Total 140 yd^3

Bedding Floor + Sides

$$[877.6 + 1269] \times \frac{0.5}{27} = 39.75\ yd^3$$

Unit Cost		
20/yd^3	Quantity of riprap = 140 yd^3	= 2800
8/yd^3	Quantity of bedding 40 yd^3	320
	d_{50} = 10"	$3120
	d_{max} = 15"	

Greiner Engineering

Greiner Engineering Sciences, Inc.

Tucson 602 327-3413
Phoenix 602 275-5400

Job RWCD Reach 6 E101012
Description Project Feature Ranking

Calculated by M. Shapiro Date 2/9/86 Sheet No 1
Checked by B.G.S. Date _____ of 1

Ranking System 1-10 points (pts.)

Based On:

Items	Multiplier
Cost (C)	2
Maintenance (M)	1
Availability (A)	1
Ease of Construction (E)	0.5
Aesthetics (AE)	0.5
Hydraulic Performance (H)	1
Total available points	60

Project Feature: Plunge Basin Vs. Drywell for 54" Pipe South Of Brown Road

Item	Type of Material					
	Plunge Basin	Drywell				
C	8	6				
M	9	7				
A	9	9				
E	8	6				
AE	8	8				
H	7	7				
Total # of pts.	49	42				

Recommended Material for Project Feature: Plunge Basin

Side Inlet at North of Adobe Road (at Sta. 60+60)

1. Problem Approach: (Trial #1)

① First, run the main spillway with Q = 194 cfs (Also put a junction structure at Sta. 11+34.5 with Q = 110 cfs.

② Second, with Water Surface Elevation at Sta. 11+34.5 for the previous run as control water elevation, run the rest of inlet structure with Q = 110 cfs.

2. Results:

① Floodway running full:

(i) PART 1:

(1) Works hydraulically.

(2) Provide protection at the toe of spillway.

(ii) PART 2:

(1) Works hydraulically.

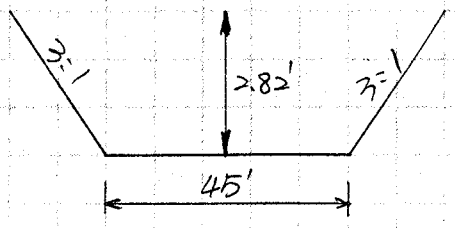
(2) Tractive power calculation will done at the junction.

② No-Flow Condition:

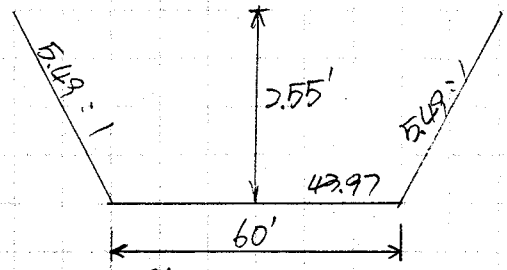
(1) Velocity of 5 fps will use for apron design.

NAPIT1.DAT & QNAPIT1.DAT

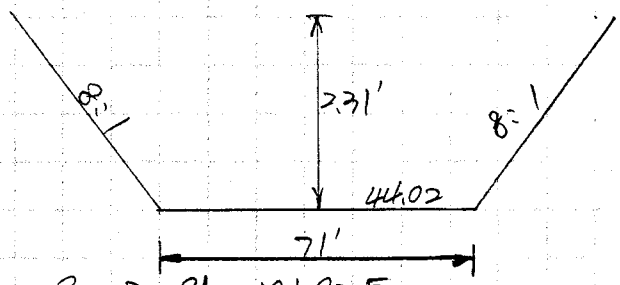
Cross Sections (Part 1, Trial #1)



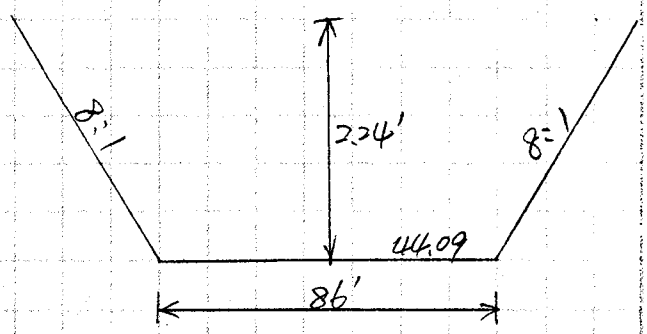
Sec. 1 Sta. 10+00, 10+40 & 10+68.5
10+60



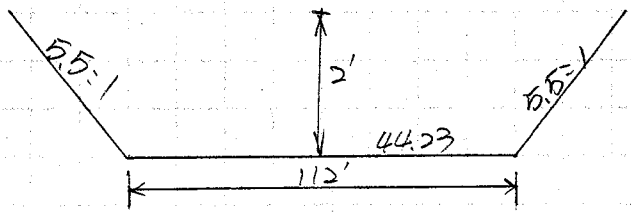
Sec. 2 Sta. 10+82.5



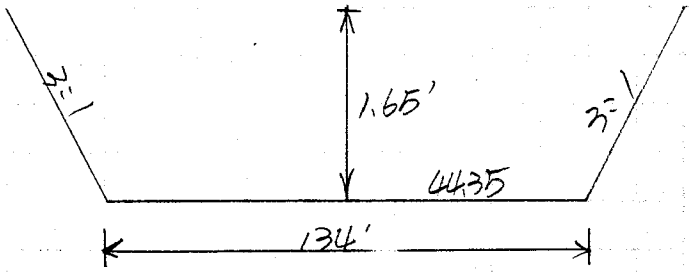
Sec. 3 Sta. 10+92.5



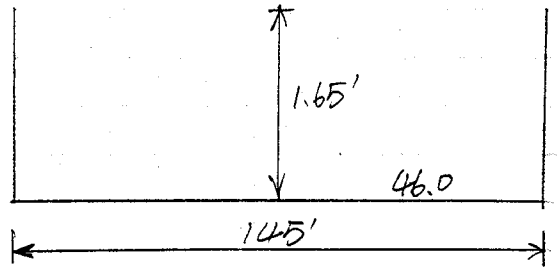
Sec. 4 Sta. 11+06.5



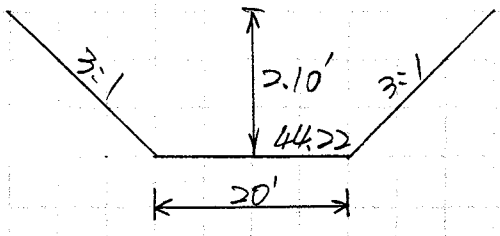
Sec. 5 Sta. 11+34.5



Sec. 6 Sta. 11+57.5



Sec. 7 Sta. 11+68



Sec. 8 Junction structure at Sta. 11+34.5

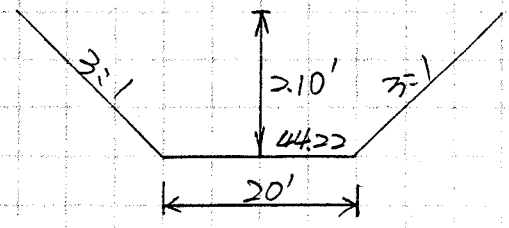
Greiner Engineering

Greiner Engineering Sciences, Inc.

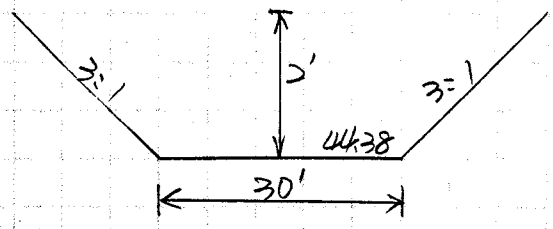
Tucson 602 327-3413
Phoenix 602 275-5400

Job: SCR RWCD Floodway Reach 6 - E101012
Description: Comparative Design Studies
Side Inlet at N. of Adobe Road
Calculated by: B. Gary Run Date: 12/27/85 Sheet No. 3
Checked by: M.S.S. Date: _____ of 3

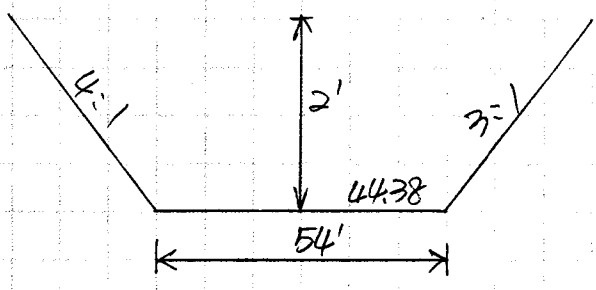
Cross Sections (Part 2, Trial #1)



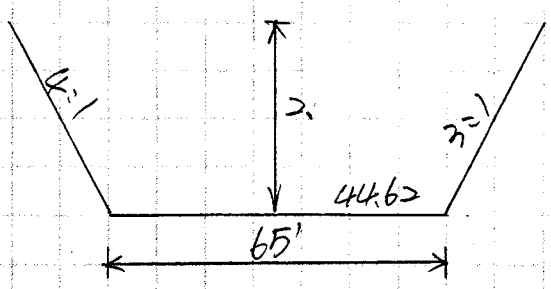
Sec. 1 Sta. 10+00



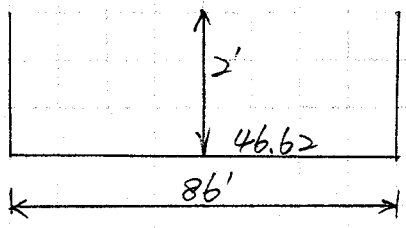
Sec. 2 Sta. 10+32



Sec. 3 Sta. 10+32



Sec. 4 Sta 10+79



Sec. 5 Sta. 10+87

N 48th St.
Center of Section
HW El = 46.9'
5.3 ft deep
(from Qootyan subdivision only)
Sta. 11+34.5
Inv = 44.23
Junction Cont.
Sta. 11+68
T.B. 46.0
47.16
82.4'
(T.C. 49.09)
(G = 48.51)
(T.C. 48.42)
(G = 47.92)
(T.C. 48.55)
(G = 48.05)
(49.0)
(49.8)
(49.2)
P.C.
P.R.C.
P.T.
R = 3400.00'
Δ = 3°34'57"
L = 212.59'
T = 106.33
310 CFS
S = 0.00289
Sta. 11+57.5
Inv = 44.35
Sta. 11+02.5
Inv = 44.09
Sta. 10+92.5
Inv = 44.02
Sta. 10+00
Inv = 44.22
Sta. 11+02
Inv = 44.13
Sta. 10+68.5
T.B. 46.72
Inv = 43.90
T.B. = 46.33
T.B. = 46.32
T.B. = 46.10
Inv = 44.0
Sta. 10+00
Sta. 60+60
Inv = 37.22 HW = 44.24
Sta. 10+00
Sta. 64+03
Inv = 37.19 HW = 44.
R = 3,400±
N 89°23'40" E
S 24°55'28" E
FLOW
O&M ROAD
R/W
3:1
28.5'
14'
250'
160'
80'
90'
134'
145'
103'
20ft

Greiner Engineering

Greiner Engineering Sciences, Inc.

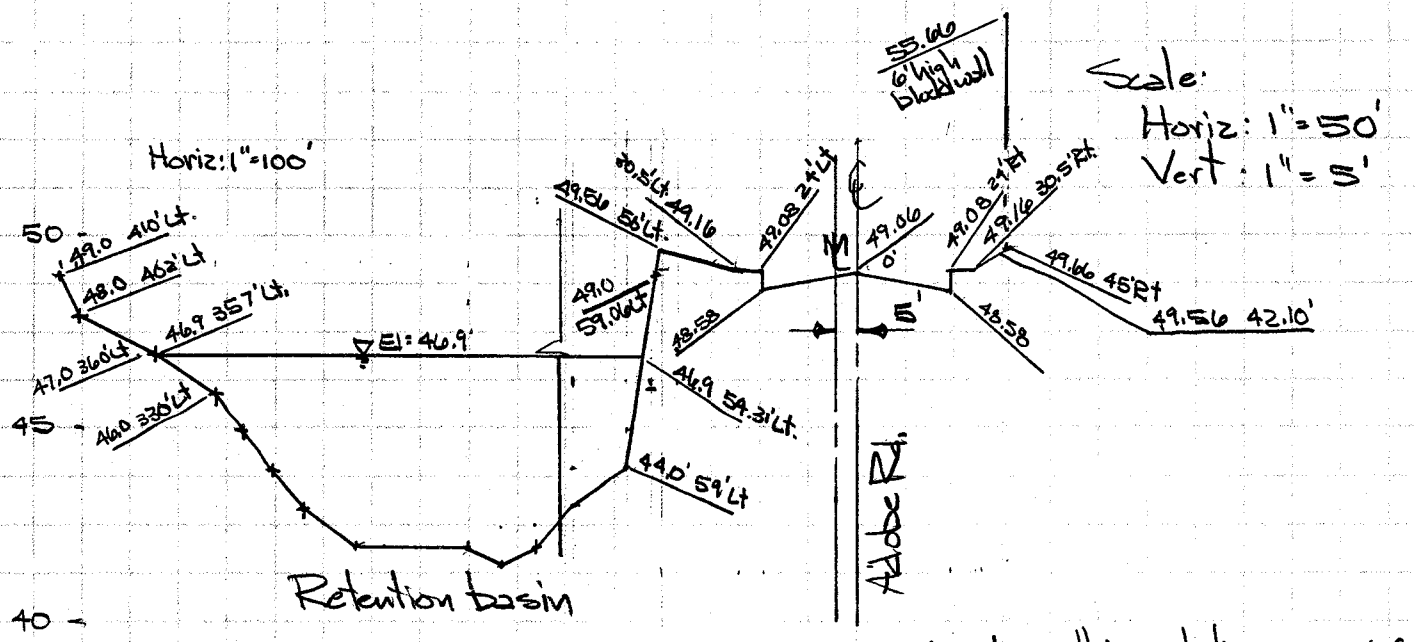
Tucson 602 327-3413
Phoenix 602 275-5400

Job RWCD Reach 6 E101012

Description Depth Calculation for Adobe Rd.

Calculated by M. Shapiro Date 12/17/85 Sheet No. 1

Checked by B.G.S. Date _____ of 3



S = 0.0082%

Total Flow in Street

HW elev within subdivision = 46.9

Left side of street

```
ENTER X AND Y VALUES
      49.56
        50.
      49.16
       30.5
      49.08
        24.
      48.58
        24.
      49.06
         0.
      48.58
       -24.
      49.08
       -24.
      49.16
      -30.5
      49.56
      -42.1

      47.46          =A
93.12158025          =WP
     0.0082          =SF
      0.018          =N

       226.          =Q
30.27483309
30.23118762
```

```
ENTER X AND Y VALUES
      49.56
        50.
      49.16
       30.5
      49.08
        24.
      48.58
        24.
      49.06
         0.
      49.56
         0.

      24.52          =A
51.00939394          =WP
     0.0082          =SF
      0.019          =N

       106.          =Q
15.04277492
14.96696457
```

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Rightside of street

```
ENTER X AND Y VALUES
        49.56
           0.
        49.06
           0.
        48.58
         -24.
        49.08
         -24.
        49.16
        -30.5
        49.56
        -42.1

        22.94          =A
 43.11218631          =WP
       0.0082          =SF
        0.018          =N
        112.           =Q
 15.06020865
 14.98182749
```

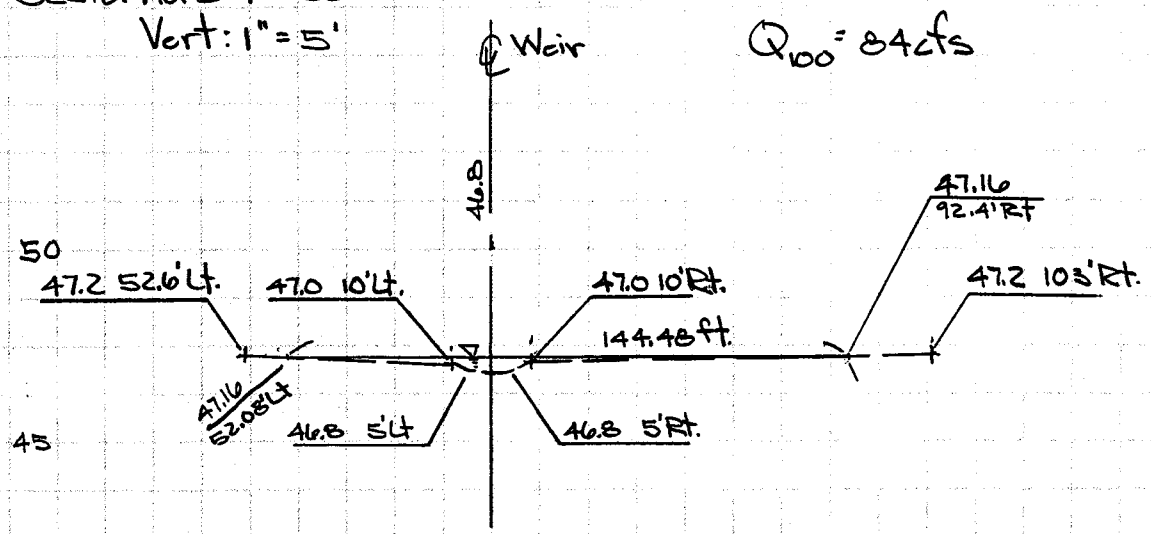
Total flow in street = 226 cfs

		adj	
Lt	106 cfs	→	110 cfs
Rt.	112 cfs	→	116 cfs

Discharge from Sundance Groves Retention Facility

Scale: Horiz: 1" = 50'
Vert: 1" = 5'

Q_{100} = 84 cfs



SECTION 'A-A'

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Discharge over broad crested weir $Q = CLH^{3/2}$ Eq. 5-10 Kings P5-23

Trapezoidal shape upsteam face ave 18:1 downstream face ave 6:1 width of crest ave. 17.5 ft

From Kings P5-43 Table 5-9,10 line 7 & 8

'C' value = 2.78 H = 0.36 ft L = 144.48 ft

$Q = CLH^{3/2}$
$= 2.78(144.48)\,0.36^{3/2}$
$= 91.43$ cfs ≥ 84 cfs ∴ O.K.

```
ENTER X AND Y VALUES
        47.16
        52.08
          47.
          10.
        46.8
          5.
        46.8
         -5.
         47.
        -10.
       47.16
       -92.4

     16.1584          =A
144.4884563          =WP
```

$V = \frac{Q}{A}$

$= \frac{84}{16.158} = 5.20$ fps

Greiner Engineering

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Phoenix 602 275-5400

Side Inlet at South of Adobe Road (Sta. 64+03)

1. Problem Set Up:

① H.W. surface elevation = 4421 for full flow condition.

② 40' wide spillway with Q = 116 cfs.

2. Results:

① Works hydraulically except doesn't meet the freeboard requirement inside the spillway for full flow condition.

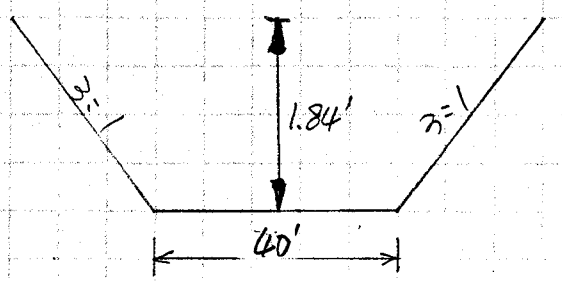
Greiner Engineering

Greiner Engineering Sciences, Inc.
Tucson 602 327-3413
Phoenix 602 275-5400

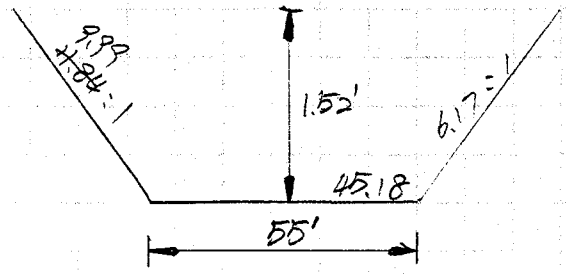
Job SCS RWCD Floodway Reach 6 - E101012
Description Comparative Design Studies
Side Inlet at S. of Adobe Road
Calculated by B. Gary Sun Date 1/2/86 Sheet No. 2
Checked by M.S.S. Date of 2

SADO1.DAT QSADO1.DAT

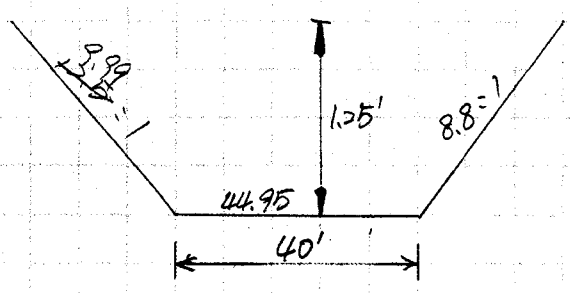
Cross sections for side inlet at South of Adobe Road (Sta. 64+03)



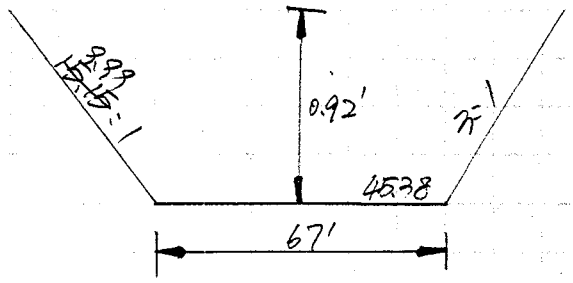
Sec. 1 Sta. 10+00, 10+40 & 10+68.5
10+82.5



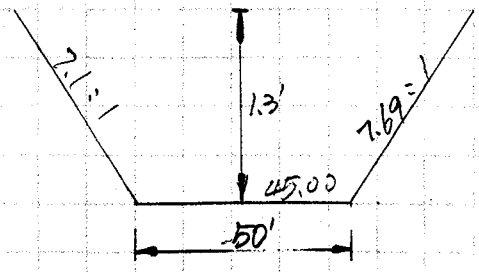
Sec. 4 Sta. 11+37.5



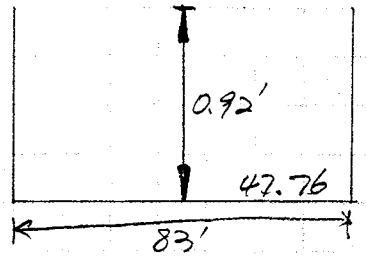
Sec. 2 Sta. 10+88.5



Sec. 5 Sta. 11+81

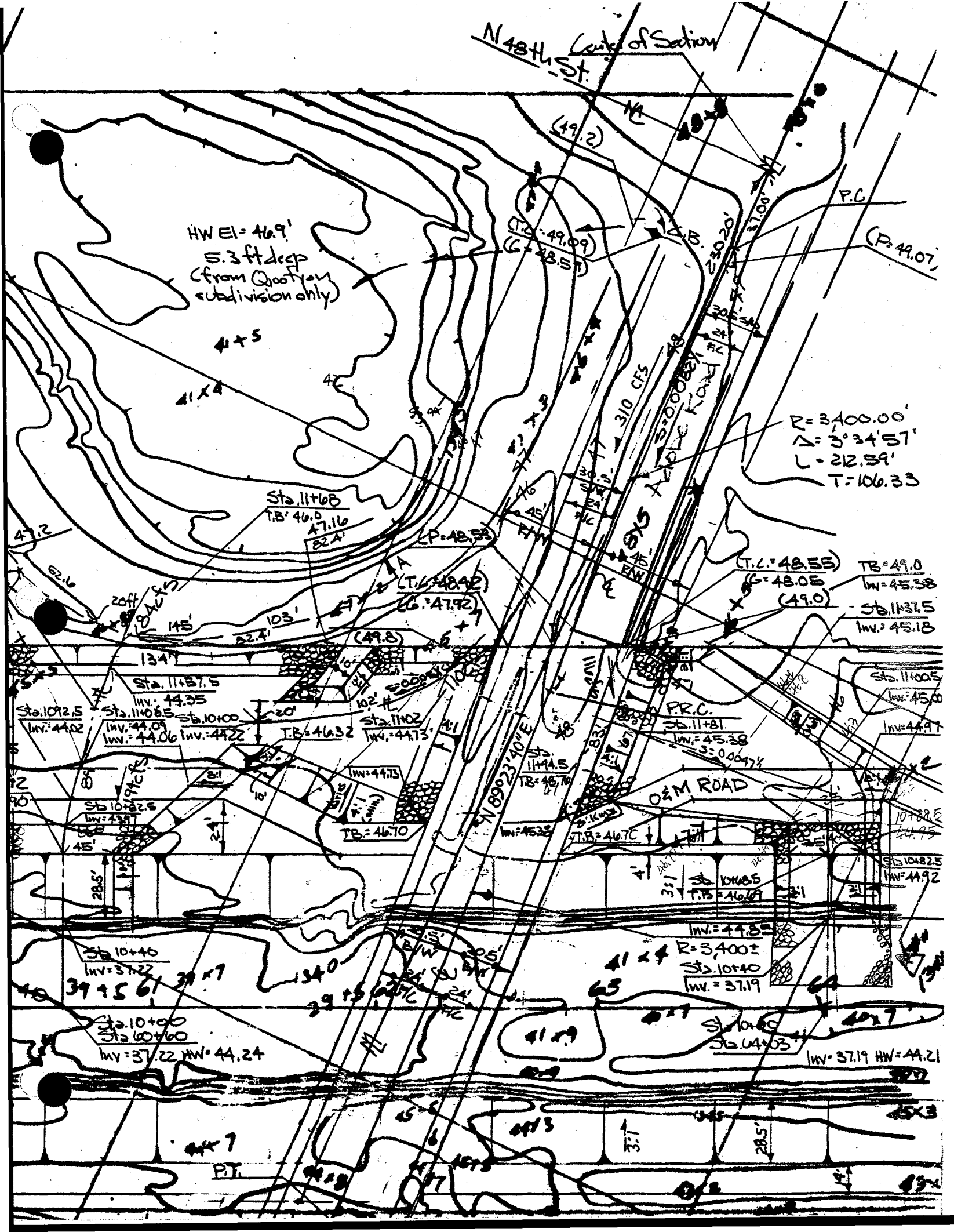


Sec. 3 Sta. 11+00.5



Sec. 6 Sta. 11+94.5

40 ft wide spillway needed


N 48th St.
Center of Section
HW El = 46.9'
5.3 ft deep
(from Qoofyan subdivision only)
P.C.
(P = 49.07)
(T.C. = 49.09)
(G = 48.57)
R = 3,400.00'
Δ = 3°34'57"
L = 212.59'
T = 106.33
310 CFS
Sta. 11+68
T.B. = 46.0
47.16
82.4'
(P = 48.55)
(T.C. = 48.42)
(G = 47.92)
(T.C. = 48.55)
(G = 48.05)
(49.0)
TB = 49.0
Inv = 45.38
Sta. 11+37.5
Inv. = 45.18
(49.8)
Sta. 11+57.5
Inv. = 44.35
Sta. 10+92.5
Inv. = 44.02
Sta. 11+06.5
Inv. = 44.09
Inv. = 44.06
Sta. 10+00
Inv. = 44.22
T.B. = 46.32
Sta. 11+02
Inv. = 44.73
Sta. 11+05
Inv. = 45.00
Inv = 44.97
P.R.C.
Sta. 11+81
Inv. = 45.38
S = 0.0047%
Sta. 11+44.5
T.B. = 46.70
N 89°23'40" E
O&M ROAD
Inv. = 44.73
T.B. = 46.70
Inv. = 45.30
T.B. = 46.70
Sta. 10+82.5
Inv = 43.97
Sta. 10+82.5
Inv = 44.92
Sta. 10+65
T.B. = 46.69
Inv. = 44.85
R = 3,400±
Sta. 10+40
Inv. = 37.19
Sta. 10+40
Inv = 37.22
Sta. 10+00
Sta. 10+60
Inv = 37.22 HW = 44.24
Sta. 10+60
Sta. 10+03
Inv = 37.19 HW = 44.21
P.T.

Summary

Three trials have been made. Based on the water surface profile calculations, Trial No. 3 has the capacity of 600 cfs with a 80 foot spillway width and with an invert slope of 0.015 ft/ft for the inclined channel. (See computer printouts NUNIV3.DAT, NUNIV3.OUT, QNUNIV3.OUT, NUNIV31.DAT, NUNIV31.OUT & QNUNIV31.OUT in the separate cover)

Side Inlet at N. of University Drive (at Sta. 89+11)

Trial #1

Problem Set Up: (Floodway running full)

1. Control T.W. Elev. = 43.77 at Sta. 89+11.
2. No apron between Sta. 10+00 and Sta. 10+42.
3. Grouted riprap at Sta. 10+42 ~ Sta. 10+82.
4. Dump riprap at Sta. 11+29.00 ~ Sta. 11+35.00
5. Spillway width = 60 ft.
6. Q = 600 cfs

Results: (Full Flow Condition) NUNIV1.DAT, QNUNIV1.DAT

1. At inlet velocity = 4.18 at Sta. 11+35 with dump riprap.
2. Over bank flow at Sta. 10+90.5 ~ 11+29.

Results: (No Flow Condition) NUNIV2.DAT, QNUNIV2.DAT

1. Velocity = 15.77 fps at the toe of spillway (Sta. 10+42).
2. Over bank flow at Sta. 10+90.5 ~ 11+29.
3. Re-design the inlet structure.

Greiner Engineering

Greiner Engineering Sciences, Inc.

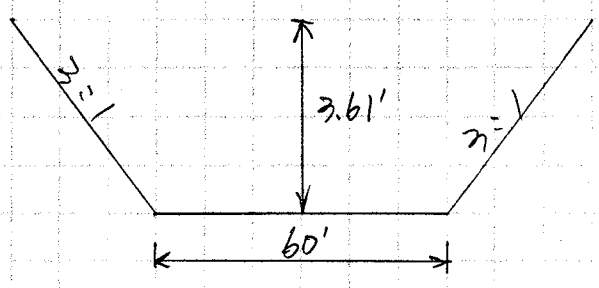
Tucson 602 327-3413
Phoenix 602 275-5400

Job: SCS RWCD Floodway Reach 6-E10/012
Description: Comparative Design Studies
Side Inlet at North of University Drive
Calculated by: B. Gary Barr Date: 12/17/85 Sheet No. 2
Checked by: M.S.S. Date: _____ of 2

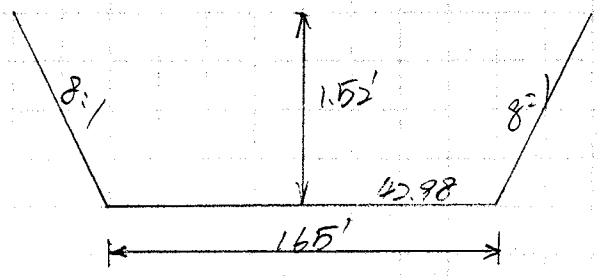
Trial #1

Side Inlet at north of University Drive (at Sta. 89+11)

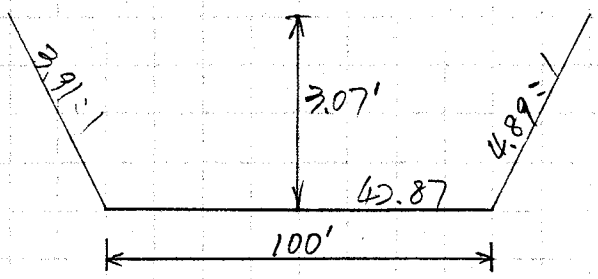
Cross Sections



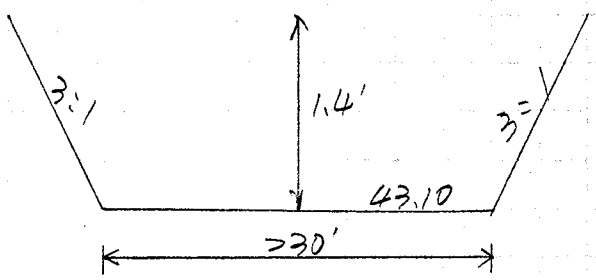
Sec. 1 Sta. 10+00, 10+42, 10+68
10+27



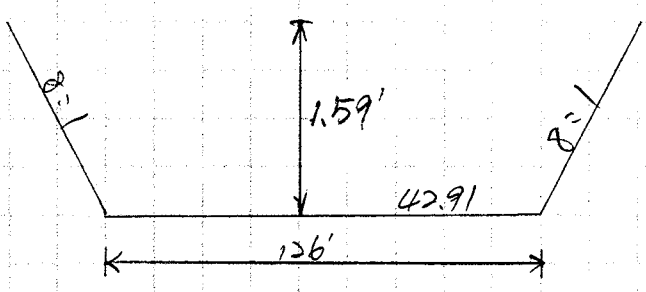
Sec. 4 Sta. 11+04.5



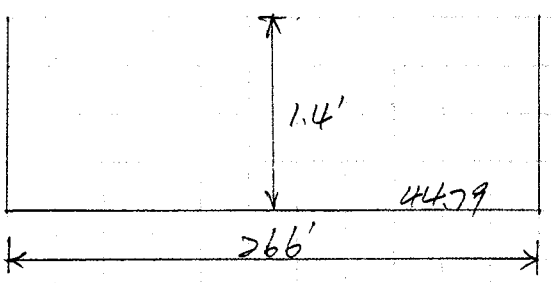
Sec. 2 Sta. 10+82



Sec. 5 Sta. 11+29



Sec. 3 Sta. 10+90.5



Sec. 6 Sta. 11+35

Side Inlet at North of University Drive (Sta. 89+11) Trial #2

Problem Set Up:

① Floodway running full:

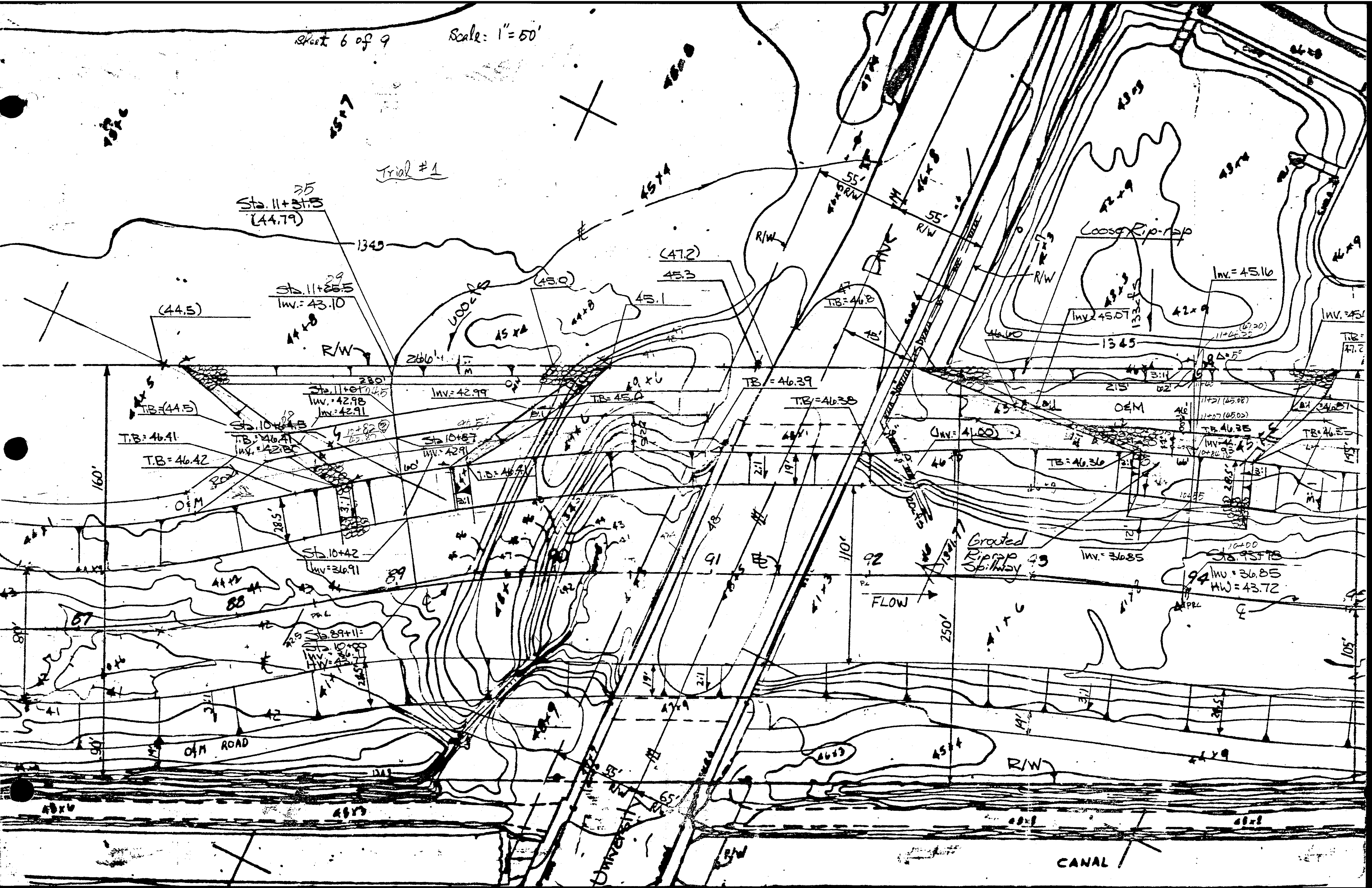
(i) Use 80' wide spillway with Q = 600 cfs.

(ii) Change base width at Sta. 10+82 to 115' wide, at Sta. 10+90.5 to 143' wide and at Sta. 11+04.5 to 172' wide.

Results:

① Over bank flow occurs at Sta. 10+90.50 ~ Sta. 11+29.00

② Provide a steeper slope for the inclined channel. i.e, this will be done by lowing the crest of the spillway.



Sheet 6 of 9
Scale: 1" = 50'
Trial #1
Sta. 11+31.5
(44.79)
Sta. 11+26.5
Inv. = 43.10
(44.5)
R/W
(47.2)
45.3
(45.0)
45.1
55'
55'
R/W
Loose Rip-rap
Inv. = 45.16
Inv. = 45.07
1345
TB = 46.8
TB = 46.39
TB = 46.38
T.B. = 45.4
Sta. 11+01
Inv. = 42.98
Inv. = 42.91
Inv. = 42.99
T.B. = (44.5)
T.B. = 46.41
T.B. = 46.42
Sta. 10+87
Inv. = 42.9
O&M
Inv. = 41.00
TB = 46.36
TB = 46.35
TB = 46.35
Sta. 10+42
Inv. = 36.91
Grouted Riprap Spillway
Inv. = 36.85
Sta. 93+98
Inv. = 36.85
HW = 43.72
FLOW
160'
110'
250'
80'
105'
O&M ROAD
R/W
CANAL

Side Inlet at N. of University Drive Sta. 89+11

Trial #3

Problem Set Up:

1. Tailwater Control Elevation = 43.01 at Sta. 89+11 from Trial #20 Mod. No. 3 run (Full Flow Condition)
2. Spillway width = 80 feet with Q_{100} = 600 cfs.
3. An invert slope of 0.015 ft/ft for the inclined channel.

Results:

I. Full Flow Condition:

1. Supercritical velocity up to 9.56 fps occurred at the toe of the drop inlet (Sta. 11+29).
2. Erosion analysis should be done to protect the inclined channel floor at the drop inlet (Sta. 11+29) and at Sta. 10+82.

II. No Flow Condition:

1. Supercritical velocity of 9.56 fps occurred at the toe of the drop inlet (Sta. 11+29).
2. Erosion analysis should be done at Sta. 11+29 and Sta. 10+82.
3. Velocity of 6.05 at the outlet spillway should be used for apron design.

Greiner Engineering

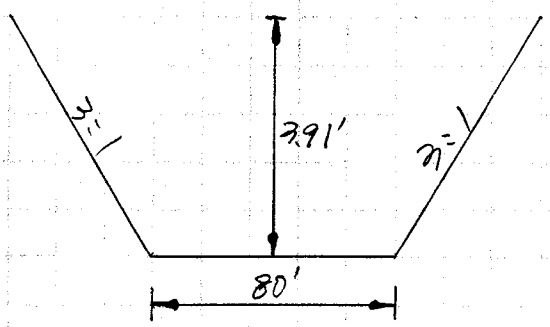
Greiner Engineering Sciences, Inc.

Tucson 602 327-3413
Phoenix 602 275-5400

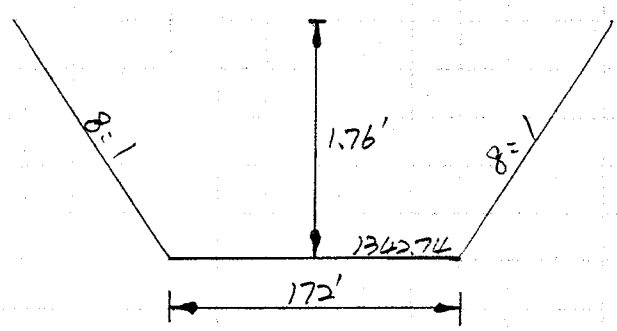
Job SCS RWCD Floodway Reach 6 - E101012
Description Comparative Design Studies
Side Inlet at North of University Drive
Calculated by B. Gary Sun Date 2/4/86 Sheet No. 2
Checked by M.S.S. Date of 2

Trial #3 Side Inlet at North of University Drive (at Sta. 89+11)

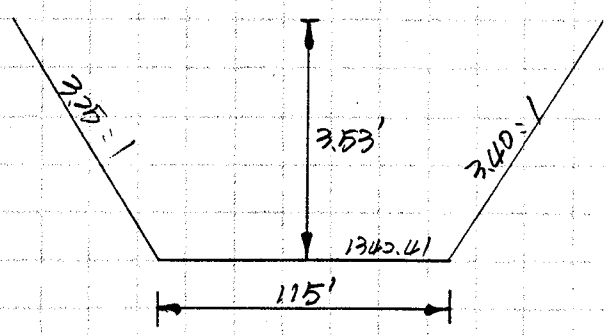
Cross Sections



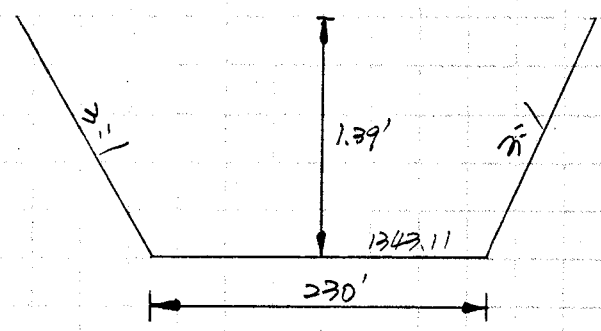
Sec. 1 Sta. 10+00, 10+42, 10+49.5, 10+57, 10+62 & 10+68



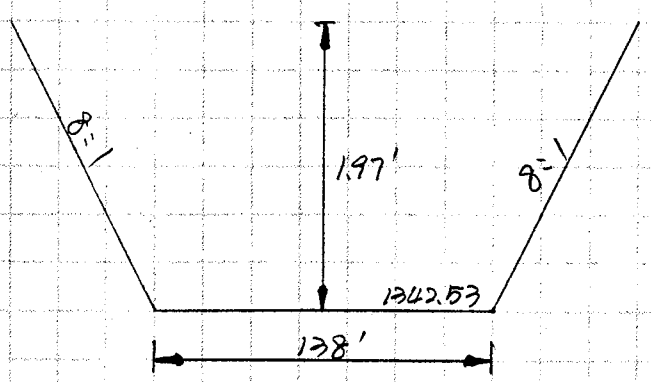
Sec. 4 Sta. 11+04.50



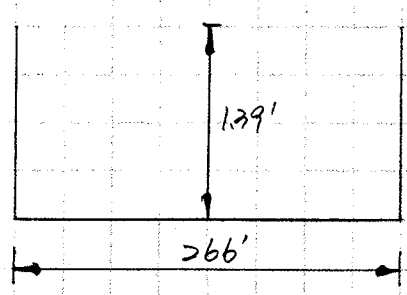
Sec. 2 Sta. 10+82



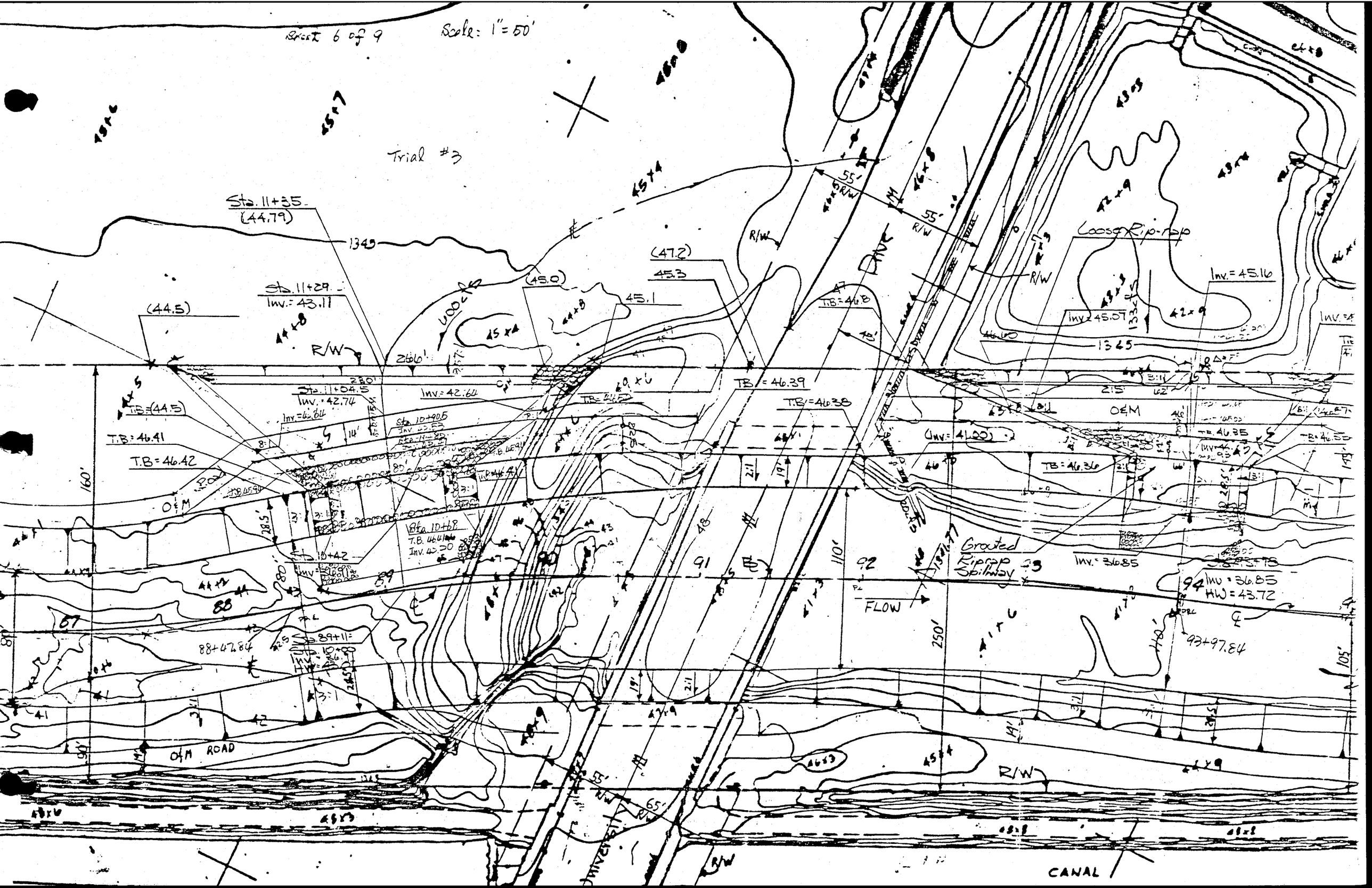
Sec. 5 Sta. 11+29



Sec. 3 Sta. 10+90.50



Sec. 6 Sta. 11+35


Sheet 6 of 9
Scale: 1" = 50'
Trial #3
Sta. 11+35
(44.79)
Sta. 11+29
Inv. = 43.11
(44.5)
R/W
1349
(45.0)
(47.2)
45.3
45.1
55'
R/W
Loose Rip-rap
Inv. = 45.16
Inv. = 45.07
1345
T.B. = 46.8
T.B. = 46.39
T.B. = 46.38
Inv. = 42.64
Sta. 11+04.5
Inv. = 42.74
T.B. = (44.5)
T.B. = 46.41
T.B. = 46.42
O&M Road
Sta. 10+90.5
Sta. 10+68
T.B. 46.41
Inv. 40.30
10+42
Inv. = 40.91
88+47.84
Sta. 89+11
Inv. = 40.10
HW = 42.57
O&M ROAD
(Inv. = 41.00)
T.B. = 46.35
T.B. = 46.36
Grouted Riprap Spillway
Inv. = 36.85
Inv. = 36.85
HW = 43.72
93+97.84
FLOW
R/W
CANAL

Greiner Engineering

Greiner Engineering Sciences, Inc.

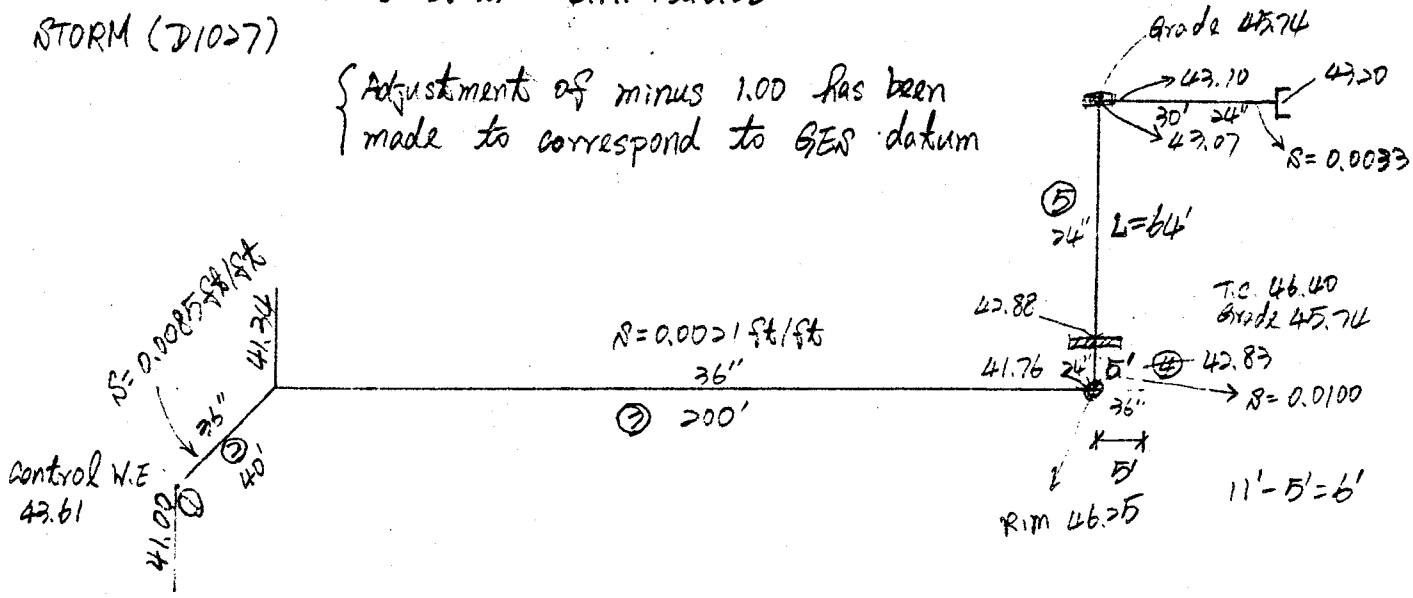
Tucson 602 327-3413
Phoenix 602 275-5400

Job: SCR RWCD Floodway Reach 6 - E101012
Description: University Drive Existing B.D. "STORM" run At Sta. 92+70
Calculated by: B. Gayle Sun Date: 11/5/85 Sheet No. ____
Checked by: M.S.S. Date ____ of ____

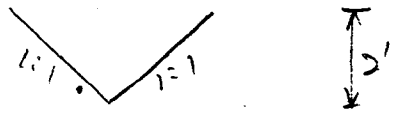
* As-Built B.M. 1346.55

STORM (D1027)

{ Adjustment of minus 1.00 has been made to correspond to GES datum



1.	L BK
1.	R BK
0.	BASE
0.0074	FPF
0.025	N
2.	DP
4.	AREA
5.656854249	WP
.7071067812	R
4.053681399	FPS
16.21472559	CFS



S= 0.0074 ft/ft
n= 0.025

Max. Q= 16.21 cfs

UDSD.DAT UDSD.OUT 11/5 9:15 AM

1. For Full-Flow Condition:

∴ UDSD.DAT
Results:

1. Capacity = 20 cfs 2. Outlet Velocity = 3.1 fps

Greiner Engineering

Greiner Engineering Sciences, Inc.

Tucson 602 327-3413
Phoenix 602 275-5400

Job BCB RWCD Floodway Reach 6 - E101012

Description University Drive Existing S.D. "STORM" run for No Flow Cond.

Calculated by B. Gary Sun Date 12/18/85 Sheet No. ____

Checked by M.S.S. Date ____ of ____

2. E. University Drive Existing S.D. system "STORM" run for No-Flow Condition.

Assumptions:

1. Set Control T.W at 44.00 (Top of 36" pipe)

Results:

1. Capacity = >0 cfs.
2. Outlet velocity = 2.8 fps
3. Rerun with the normal depth at outlet as control T.W.

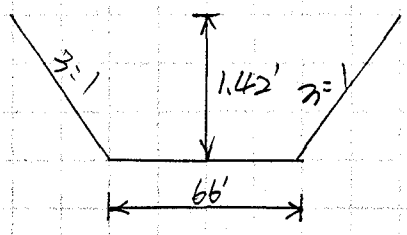
Note: From the result from "CIRCØ1I" program, the normal depth is 1.177 feet for the existing 36" S.D. at outlet. (See computer printout CIRCØ1I.OUT)

A Maricopa Association of Governments (MAG) Std. Detail 501-3 Headwall with trash rack should be constructed at the outlet.

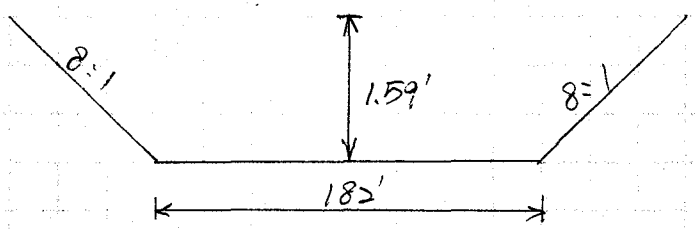
Sta. 43+48

Problem Set Up:

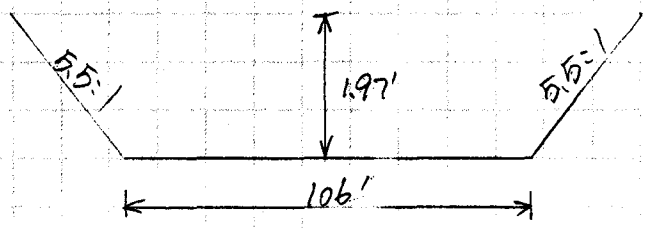
1. Q = 133 cfs per TR-20 run for N. of Sunlife retention basin.
2. Use n = 0.030 for grouted riprap reaches at Sta. 10+43.00 ~ 10+98.14 and Sta. 11+40 ~ 11+46.20.
3. H.W. = 43.72 at Sta. 10+00. for Floodway running full.
4. Cross sections:



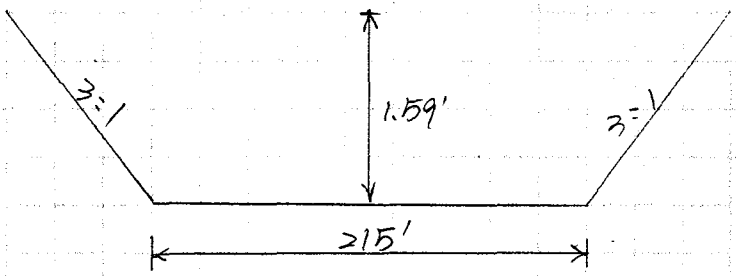
Sec. 1 & 2
Sta. 10+00, 10+43, 10+55



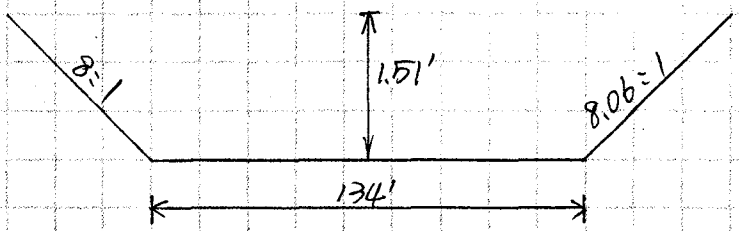
Sec. 4 Sta. 11+21.00



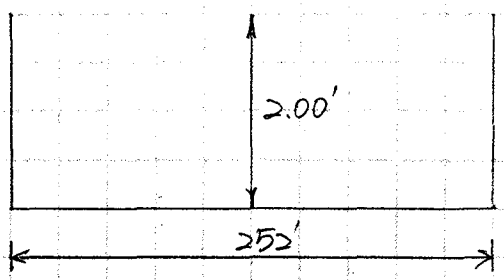
Sec. 7 Sta. 10+98.14



Sec. 5 Sta. 11+40.00



Sec. 3 Sta. 11+07.00



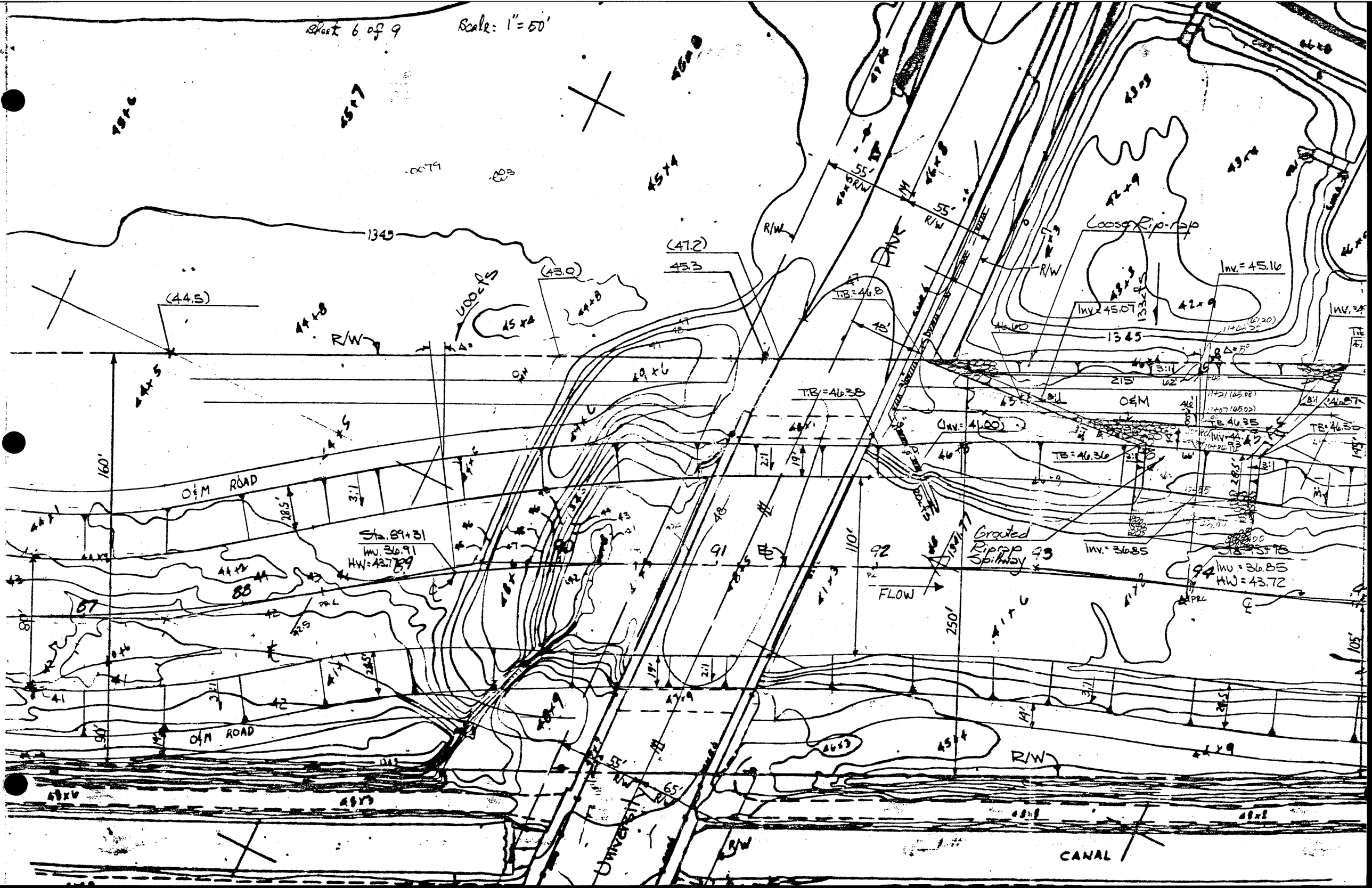
Sec. 6 Sta. 11+46.20

Results:

① Enough protection for both floodway full and empty runs.

② Meet freeboard requirements inside the collection system.

(See computer printouts SUNIV1.DAT, SUNIV1.OUT, QSUNIV1.OUT, SUNIV2.DAT SUNIV2.OUT & QSUNIV2.OUT in the separate cover)


Sheet 6 of 9
Scale: 1" = 50'
Loose Rip-rap
Inv. = 45.16
Inv. = 45.07
Grouted Riprap Spillway
Inv. = 36.85
HW = 43.72
Sta. 89+31
Inv. 36.91
HW = 43.79
O&M ROAD
O&M
FLOW
CANAL
R/W
TB = 46.8
TB = 46.38
TB = 46.36
TB = 46.35
(Inv. = 41.00)
(47.2)
45.3
(44.5)
(43.0)
1345
215'
160'
250'
110'
55'
65'
45'
19'
14'
285'
105'
91
92
93
94
88
87
89

Greiner Engineering

Greiner Engineering Sciences, Inc.

Tucson 602 327-3413
Phoenix 602 275-5400

Job: SCS RWCD Floodway Reach 6-E101012
Description: Comparative Design Studies
Side Inlet at Sta. 143+66 (42" S.D.)
Calculated by: B. Gary Sun Date: 2/10/86 Sheet No. 1
Checked by: M.S.S. Date: _____ of 1

Summary

1. A "STORM" run has been performed to find the capacity for the existing 42" S.D. The maximum capacity was 118 cfs. (MED18.DAT)
2. Design a major inlet structure to handle >>0 cfs of stormwater. A spillway width of 30 feet was functioned adequately for the design flow. (See *1.DAT, *1.OUT, Q*1.OUT & *2.DAT, *2.OUT, Q*2.OUT & *3.DAT, *3.OUT, Q*3.OUT files, where * = MEAD)
3. Reconstruction of the MAG. Std. Detail 501-3 headwall with trash rack is required.

Greiner Engineering

Greiner Engineering Sciences, Inc.

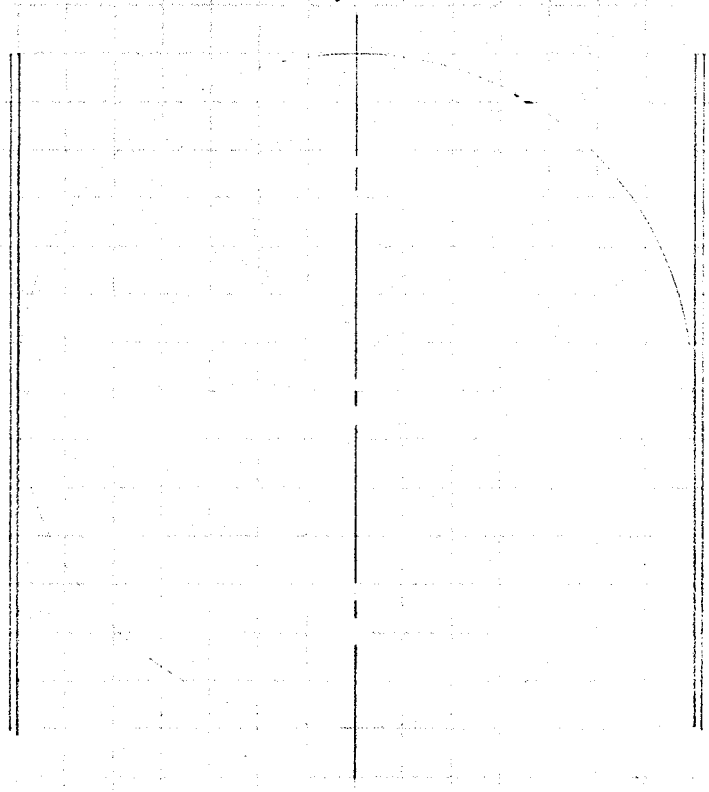
Tucson 602 327-3413
Phoenix 602 275-5400

Job SCS RWCD Floodway Reach 6 - E101012
Description Comparative Design Studies
Side Inlet at Sta. 143+66 (42" S.D.)
Calculated by B. Gary Sun Date 12/2/85 Sheet No. 1
Checked by M.S.S. Date _____ of _____

1. Outlet headwall w/ trash rack w/ 42" pipe

Pipe size No. of Bars

42" 12



* No need to consider the entrance loss for outlet trash rack.

2. Run "STORM" program for 34 foot 42" pipe

① Problem Set Up:

(i) Control of Tail Water = 42.96 (at the top of the pipe).

(ii) $K_e = 0.10$ & $n = 0.013$

(iii) $Q = 118$ cfs

(iv) Hydraulic Grade Line = 46.00 (Rim Elevation)

2. (Cont'd)

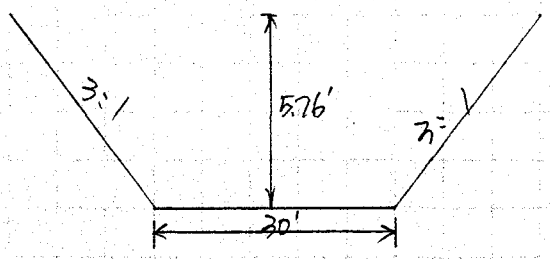
② Results:

(i) Max. Velocity = 12.3 fps

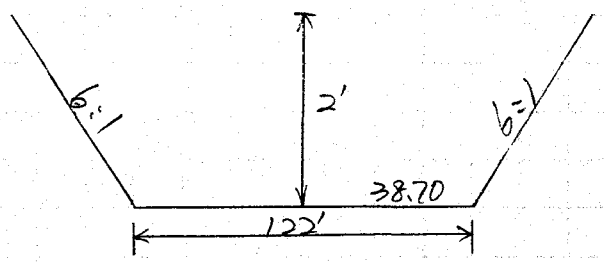
(ii) Outlet W.S. = 42.96

3. "WSPG" run for the Inlet (MEAD1.DAT & QMEAD1.DAT)
No Flow : MEAD3.DAT & QMEAD3.DAT

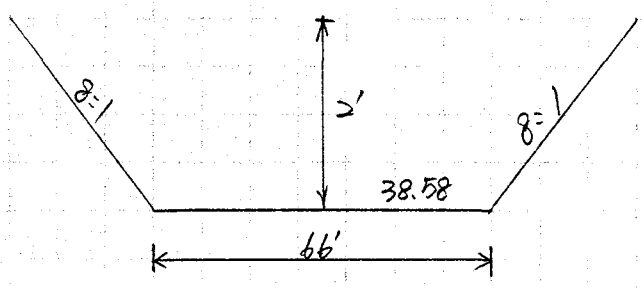
Cross Sections



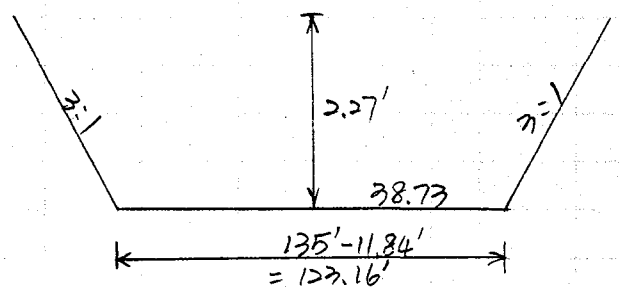
Sec. 1 Sta. 10+00, 10+45 & 10+73.5



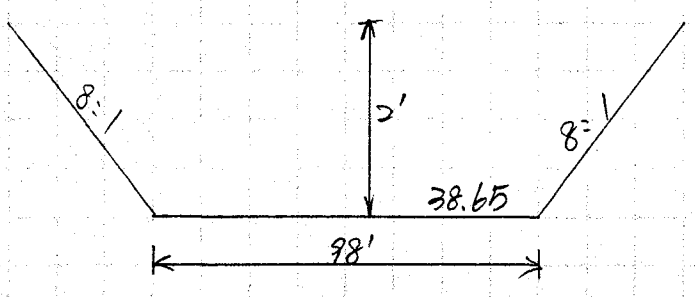
Sec. 4 Sta. 11+10.5



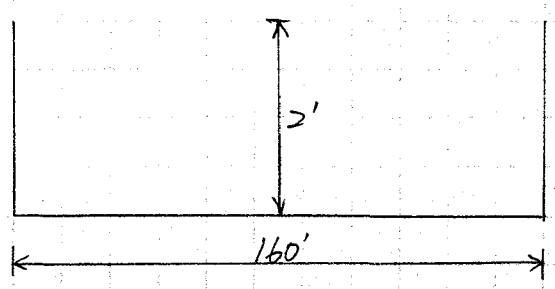
Sec. 2 Sta. 10+87.25



Sec. 5 Sta. 11+15.5



Sec. 3 Sta. 11+01.25



Sec. 6 Sta. 11+33.26

3. (Cont'd)

(1) With Floodway running full

① Problem Set Up for Inlet Structure: (MEAD1.DAT & QMEAD1.DAT)

(i) Control W.S.E. = 40.21 from "WSPG" run Alt 1. Trial #8

(ii) No protection at the bottom of the Floodway.

(iii) Run through the designed inlet up to 1344 contour line.

(iv) Provide 13.75' of grouted riprap at the top of spillway.

(v) Rebuild headwall as per MAG DTL. 501-3 for 42" S.D.

(vi) Q = 220 cfs for Sta. 10+00 ~ Sta. 11+15.5

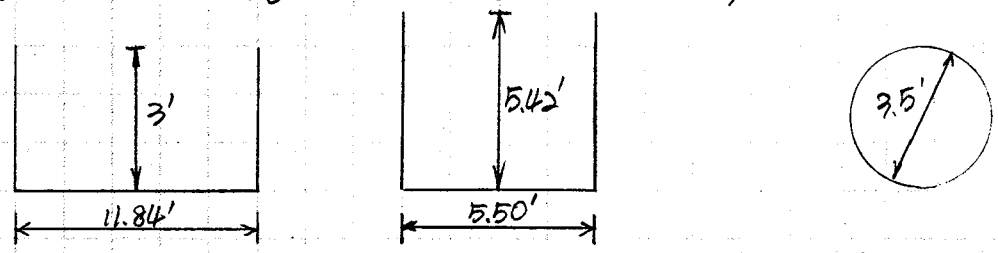
Q = 102 cfs for Sta. 11+15.5 ~ Sta. 11+77.26

② Results:

(i) Works.

③ Problem Set Up for Outlet headwalls: (MEAD2.DAT & QMEAD2.DAT)

(i) Cross Sections: n = 0.013 (concrete)



Sta. 11+15.5 Sta. 11+24.17 Sta. 11+24.18 & 11+58.17

④ Results:

(i) Max. Velocity = 18.39 fps at Outlet (Sta. 11+15.5)

3. (Cont'd)

(2) No Flow condition:

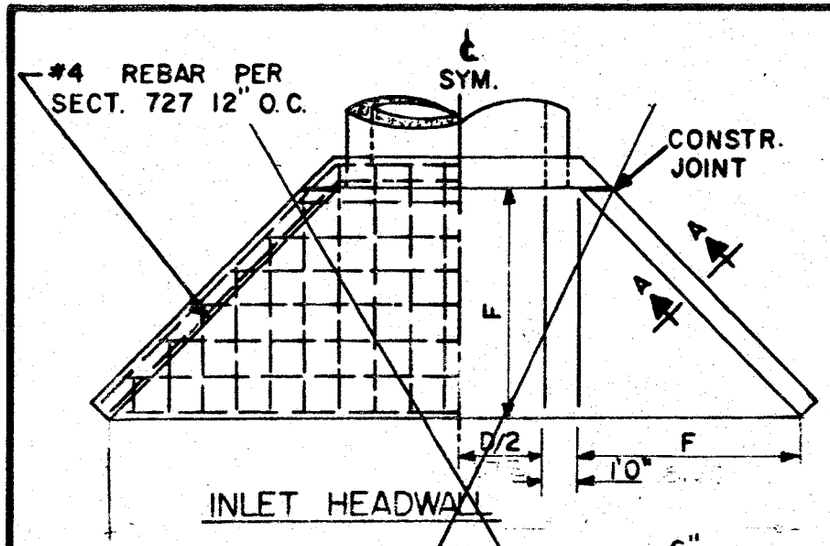
① Problem Set Up for Inlet Structure: (MEAD3.DAT & QMEAD3.DAT)

same as MEAD1.DAT but no control W.S.E.

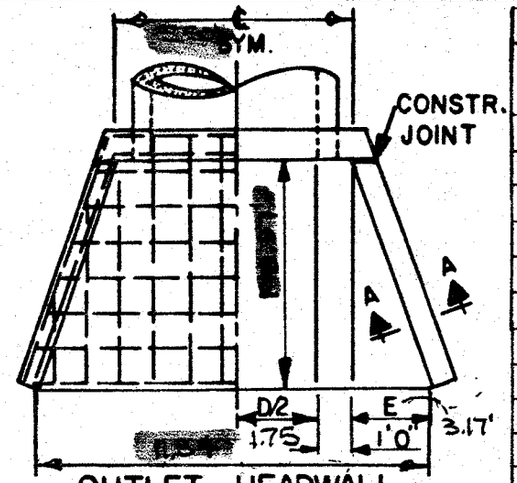
② Results:

(i) Design apron at the bottom of Floodway.

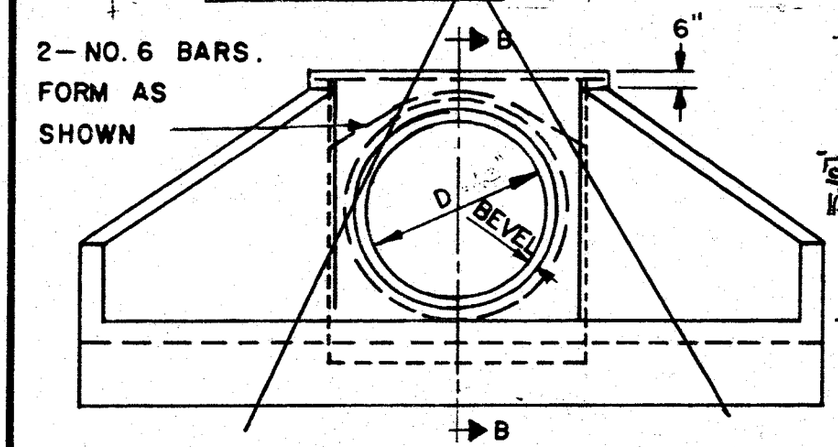
Sta. 143+66 Outlet headwall w/42" w/ Trash Rack



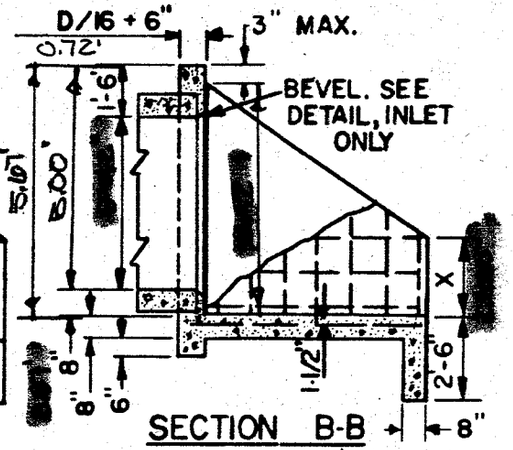
INLET HEADWALL



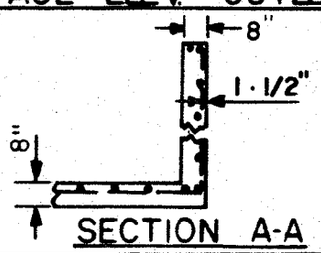
OUTLET HEADWALL



INLET HEADWALL FACE ELEV.- OUTLET SIMILAR



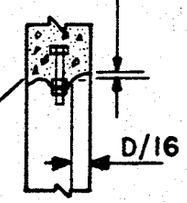
SECTION B-B



SECTION A-A

CONCRETE SHALL BE CLASS A, PER SECT. 725

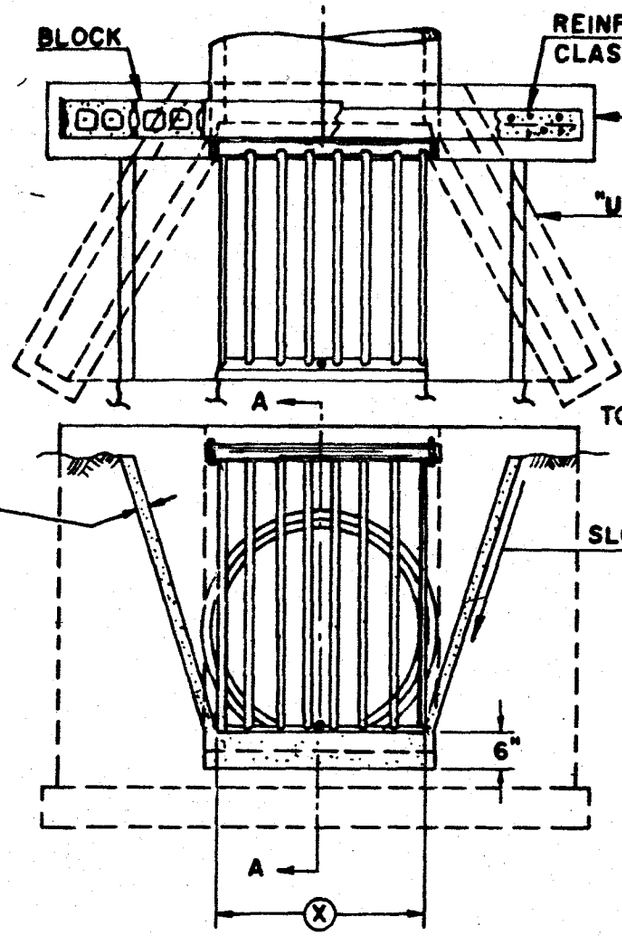
3/4" X 6" HEX HEAD BOLTS, 1'-6" C TO C FOR C.M.P.

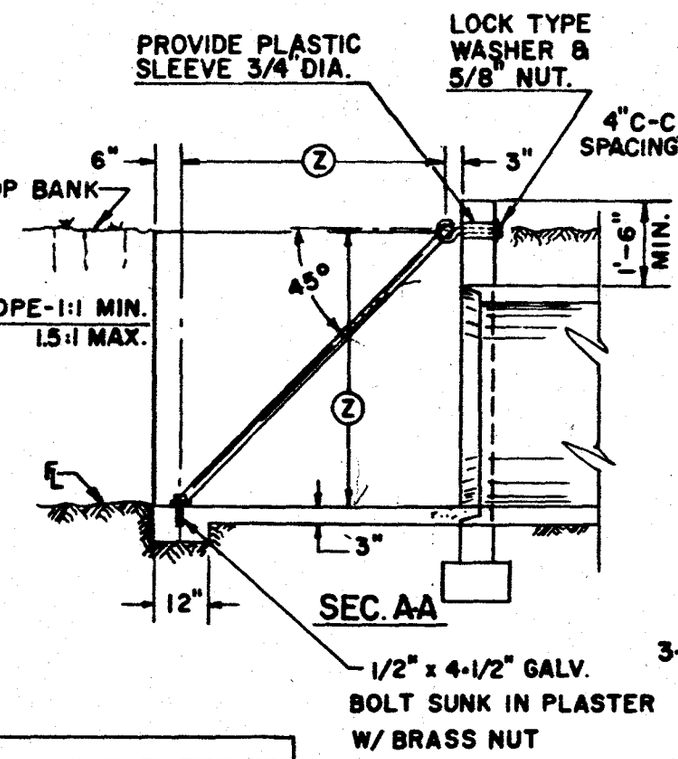


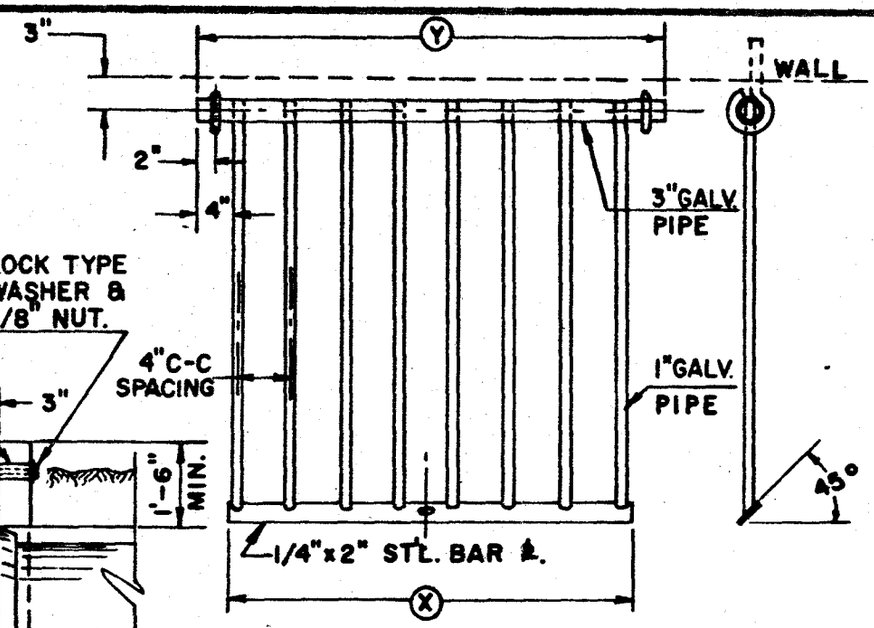
BEVEL DETAIL

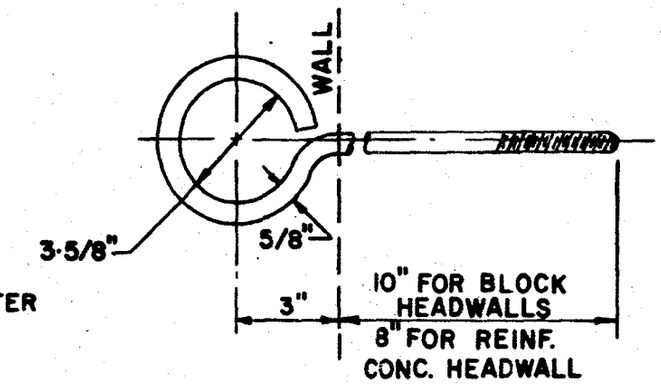
D	TYPE	DIMENSIONS F	DIMENSIONS E	DIMENSIONS X	CONC. (C.Y.) C.M.P.	CONC. (C.Y.) R.C.P.	REINF. STEEL (LBS.)
	1 1/2 : 1 EMBANKMENT SLOPE						
42"	1(INLET)	5'-2"	5'-2"	1'-9"	4.55	4.45	275
	2(OUTLET)	5'-2"	1'-11"	1'-9"	3.53	3.45	213
48"	3(INLET)	5'-8"	5'-8"	1'-11"	5.32	5.20	321
	4(OUTLET)	5'-8"	2'-1"	1'-11"	4.12	4.03	249
54"	5(INLET)	6'-2"	6'-2"	2'-1"	6.14	6.01	370
	6(OUTLET)	6'-2"	2'-3"	2'-1"	4.75	4.65	287
60"	7(INLET)	6'-8"	6'-8"	2'-3"	7.03	6.88	424
	8(OUTLET)	6'-8"	2'-5"	2'-3"	5.43	5.31	328
66"	9(INLET)	7'-2"	7'-2"	2'-5"	7.98	7.81	481
	10(OUTLET)	7'-2"	2'-7"	2'-5"	6.16	6.02	372
72"	11(INLET)	7'-8"	7'-8"	2'-7"	8.99	8.80	542
	12(OUTLET)	7'-8"	2'-9"	2'-7"	6.94	6.78	419
78"	13(INLET)	8'-2"	8'-2"	2'-9"	10.07	9.85	608
	14(OUTLET)	8'-2"	3'-0"	2'-9"	7.78	7.61	461
84"	15(INLET)	8'-8"	8'-8"	2'-11"	11.20	10.96	676
	16(OUTLET)	8'-8"	3'-2"	2'-11"	8.66	8.47	522
	1 : 1 EMBANKMENT SLOPE						
42"	17(INLET)	8'-8"	8'-8"	3'-0"	7.88	7.70	475
	18(OUTLET)	8'-8"	3'-2"	3'-0"	5.59	5.46	337
48"	19(INLET)	8'-8"	8'-8"	3'-6"	8.47	8.28	511
	20(OUTLET)	8'-8"	3'-2"	3'-6"	6.10	5.97	368
54"	21(INLET)	8'-8"	8'-8"	4'-0"	9.07	8.87	548
	22(OUTLET)	8'-8"	3'-2"	4'-0"	6.63	6.48	400
60"	23(INLET)	9'-4"	9'-4"	4'-4"	10.39	10.16	627
	24(OUTLET)	9'-4"	3'-5"	4'-4"	7.60	7.43	458
66"	25(INLET)	9'-8"	9'-8"	4'-9"	11.42	11.17	689
	26(OUTLET)	9'-8"	3'-6"	4'-9"	8.39	8.20	506
72"	27(INLET)	9'-8"	9'-8"	5'-3"	12.11	11.84	731
	28(OUTLET)	9'-8"	3'-6"	5'-3"	8.99	8.80	542
78"	29(INLET)	10'-0"	10'-0"	5'-8"	13.22	12.93	798
	30(OUTLET)	10'-0"	3'-8"	5'-8"	9.88	9.66	596
84"	31(INLET)	10'-8"	10'-8"	6'-0"	14.81	14.48	893
	32(OUTLET)	10'-8"	3'-11"	6'-0"	11.00	10.76	664

DETAIL NO. 501-3 | STANDARD DETAIL | HEADWALL 42" TO 84" PIPE | DETAIL NO. 501-3





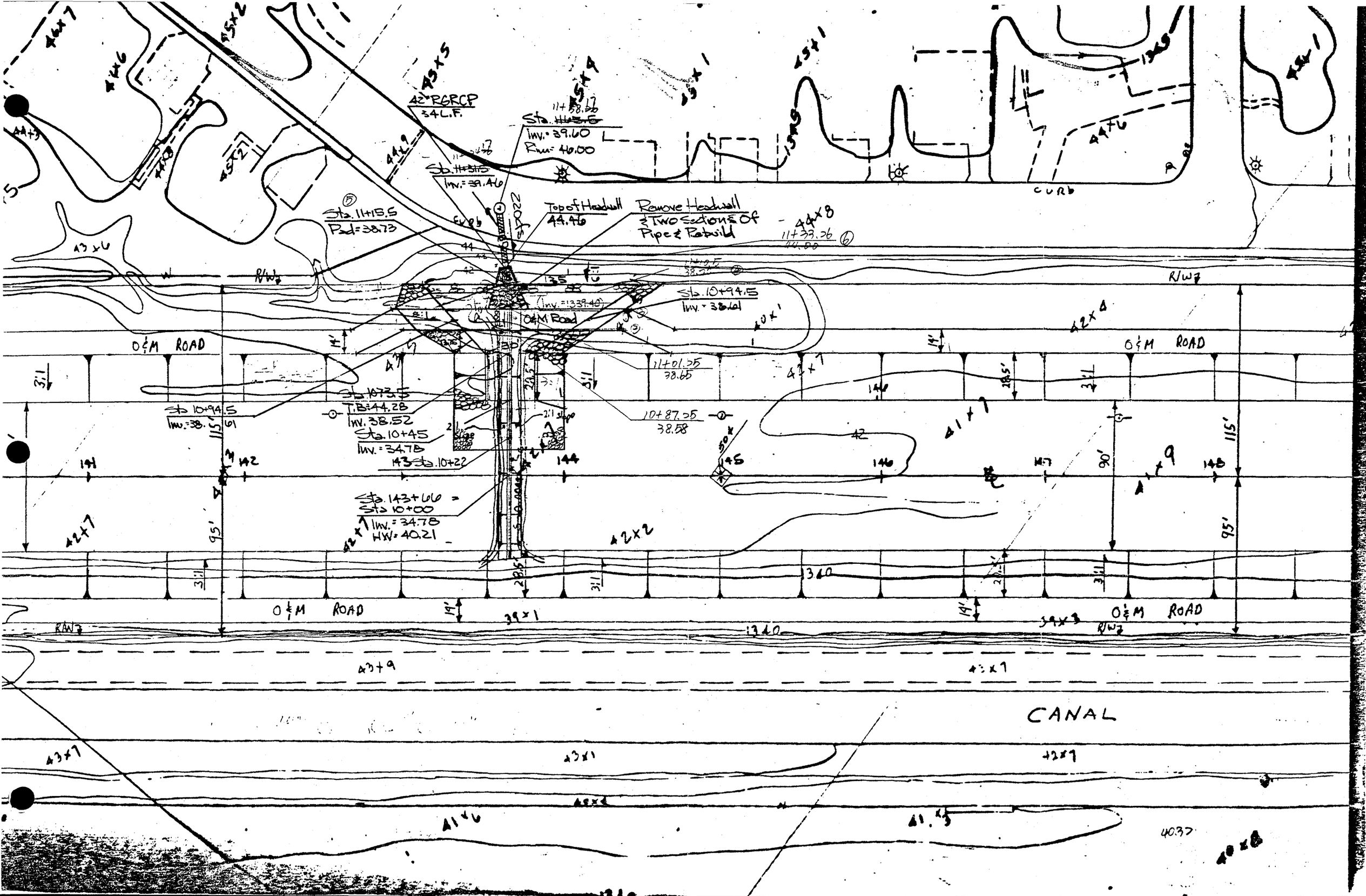




EYE BOLT

TYPE BASED ON PIPE SIZE						
TYPE	PIPE SIZE	NO. OF BARS	LENGTH OF BARS	DIMENSIONS X	Y	Z
A	18"	6	3'-7"	1'-9"	2'-5"	2'-5"
	24"	8	3'-7"	2'-5"	3'-1"	2'-5"
B	30"	10	4'-4-1/4"	3'-1"	3'-9"	2'-11-1/2"
C	36"	10	5'-1-1/2"	3'-1"	3'-9"	3'-6"
D	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
E	48"	14	6'-7-3/4"	4'-5"	5'-1"	4'-7"

DETAIL NO.				DETAIL NO.
502-2	STANDARD DETAIL	TRASH RACK		502-2


42" RCPCP
34 L.F.
Sta. 11+38.5
Inv. = 39.60
Rim = 46.00
Sta. 11+31.5
Inv. = 39.46
Sta. 11+15.5
Pad = 38.73
Top of Headwall
44.46
Remove Headwall
& Two Sections Of
Pipe & Rebuild
11+39.26
Sta. 10+94.5
Inv. = 38.61
O&M Road
11+01.25
38.65
Sta. 10+73.5
T.B. = 44.28
Inv. 38.52
Sta. 10+45
Inv. = 34.78
Sta. 10+22
10+87.25
38.58
Sta. 143+66 =
Sta. 10+00
Inv. = 34.78
HW = 40.21
O&M ROAD
O&M ROAD
O&M ROAD
R/W
R/W
R/W
CURB
CANAL
141
142
143
144
145
146
147
148
95'
115'
90'
28.5'
14'
3:1
2:1 slope
40.37

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
3335 West Durango Street, Phoenix, Arizona 85009 (602) 262-1501

FCD 85-178

LICENSE TO USE FLOOD CONTROL DISTRICT RIGHT-OF-WAY

Filing Fee	Waived	Rec'd	By
Inspection Fee	Waived	Rec'd	By
Bond	Waived	Rec'd	By
Certificate of Insurance Rec'd By	Waived		

License No. 85-178
Effective Date 2-1-85
Expiration Date 7-30-85

This Agreement made by and between the Flood Control District of Maricopa County, hereinafter referred to as DISTRICT, and City of Mesa, Post Office Box 1466, Mesa, Arizona, Arizona 85201

hereinafter referred to as LICENSEE. The DISTRICT hereby grants, pursuant to the terms and conditions appearing below and upon the reverse side hereof, a revocable license to enter upon, occupy and use, at LICENSEE's sole expense, right-of-way of the DISTRICT described as follows:

RWCD Floodway, North of Broadway at approximately 54th Street and Arcadia as shown on the attached sketch.

The right-of-way is to be used for the sole and express purpose of:

Cutting a shallow ditch from the existing Mesa retention basin west to the RWCD Floodway channel to drain stormwater into the Floodway area.

All work is to be done in a safe, hazard-free manner leaving no debris. The work is to be done to the satisfaction of the Flood Control District Inspector.

Licensee is to notify the Flood Control District three days before beginning work in the District's right-of-way.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

By: Edward D. Opstein
Title: Chief, Land Management Division
Date: 2-1-85

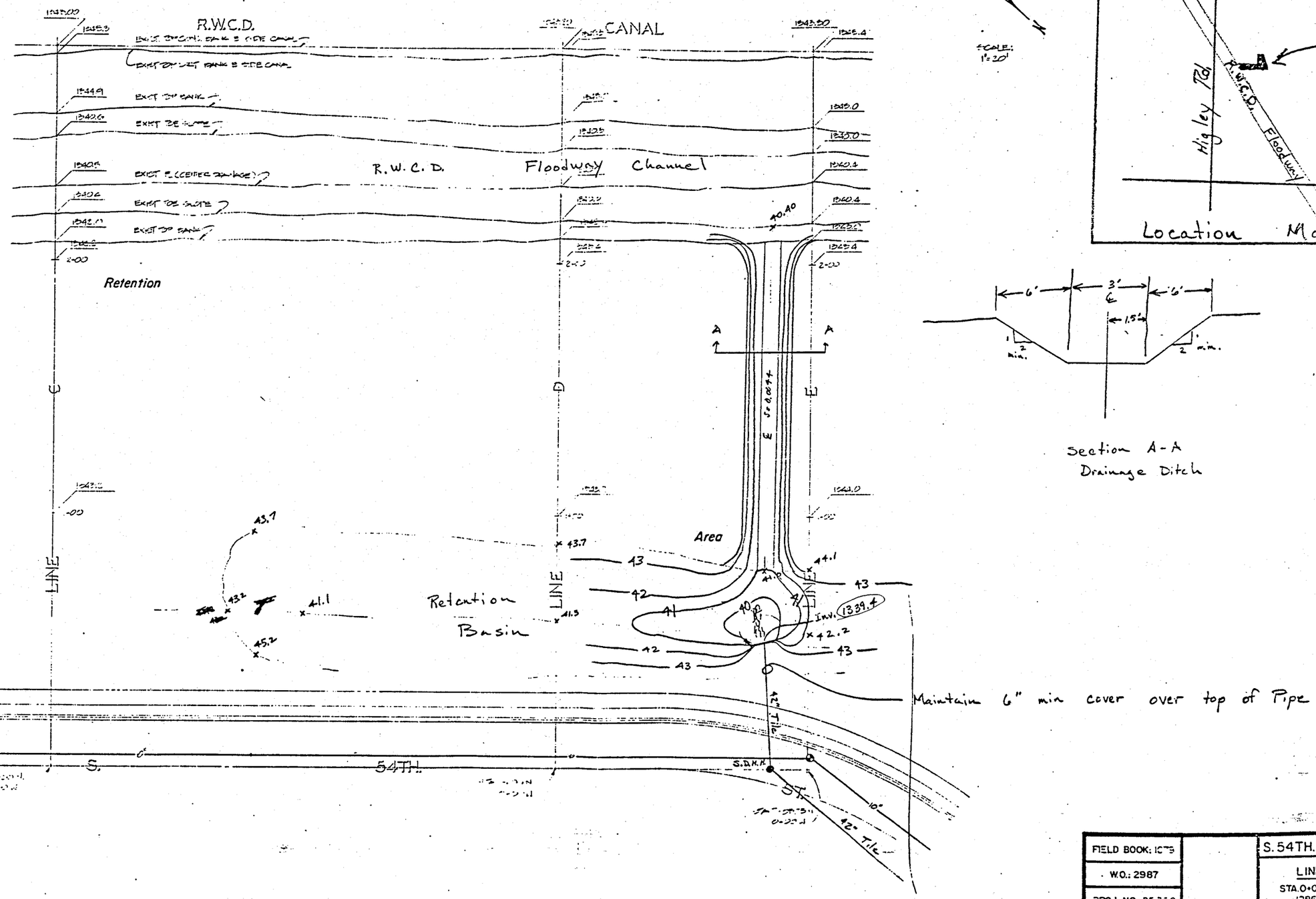
FINAL INSPECTION:

By:
Title:
Date:

LICENSEE:

Name: City of Mesa
Address: Post Office Box 1466
Mesa, Arizona 85201
Phone: 834-2558
By: John Roberts
Title: Senior Civil Engineer
Date: 12-10-84

CITY OF MESA ENGINEERING DEPARTM



FIELD BOOK: 1073		S. 54TH. STORM DRAIN IM
W.O.: 2987		LINE C, D & E
PROJ. NO.: 85 369		STA. 0+00 TO STA. 2+86 (286'W OF 54TH)
DATE:	DRAWN BY / ENGINEER / APPROVED BY	SHEET OF / CATALOG NUMBER

Greiner Engineering

Greiner Engineering Sciences, Inc.

Tucson 602 327-3413
Phoenix 602 275-5400

Job: SCS RWCD Floodway Reach 6 - E101012
Description: Comparative Design Studies
Side Inlet at Sta. 150+98 (MESA SHADOW E.
Calculated by: B. Gary Sun Date: 12/16/85 Sheet No. 1
Checked by: MSS. Date _____ of _____

Side Inlet at MESA SHADOW East existing spillway (Sta. 150+98)

1. Problem Set Up: (Trial #1)

(i) H.W. Elev. = 42.47.

(ii) Q = 17 cfs.

(iii) Spillway width = 8 ft. with side slopes of 3:1

2. Results:

① Computation Error Message #5 - Over 50 Records Written in Reach, Element = 4 Station = 1068.08 12/17/85

② Rerun on 12/24/85. add two stations 10+65 and 10+70.

③ Full Flow Condition: (MBE1.DAT & QMBE1.DAT)

(i) Velocities at (Sta. 10+00 ~ Sta. 10+71.31, Sta. 10+87.5 ~ Sta. 11+42.5) are smaller than 2 fps.

④ No Flow Condition: (MBE2.DAT & QMBE2.DAT)

(i) Velocities at Sta. 10+87.5 ~ Sta. 11+42.5 are smaller than 2 fps.

Greiner Engineering

Greiner Engineering Sciences, Inc.

Tucson 602 327-3413
Phoenix 602 275-5400

Job: BCS RWCD Floodway Reach 6 - E101012

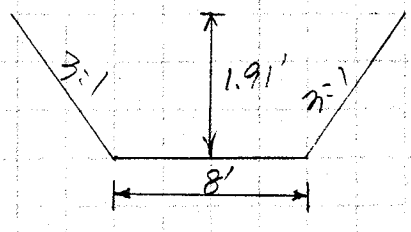
Description: Comparative Design Studies
Side Inlet at MESA SHADOW East spillway

Calculated by: B. Gary Sun Date: 12/16/85 Sheet No. 2

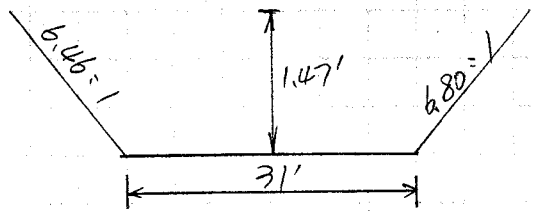
Checked by: M.S.S. Date: _____ of _____

~~ME~~ MSE1.DAT, QMSE1.DAT

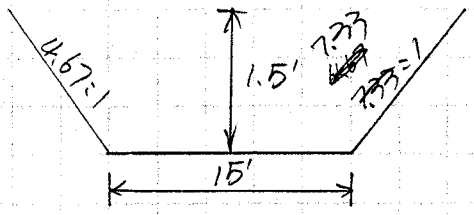
Cross Sections



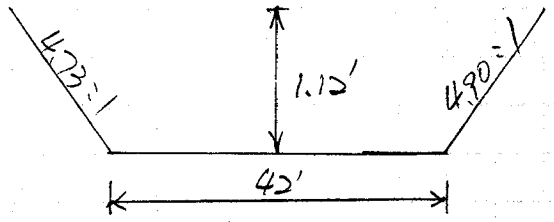
Sec. 1 Sta. 10+00, 10+35, 10+45 & 10+73.5



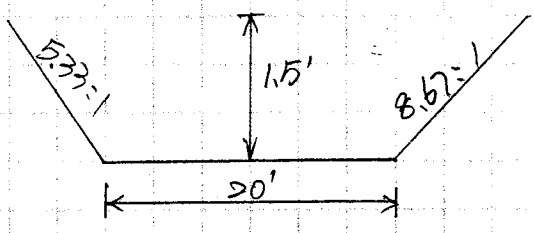
Sec. 4 Sta. 11+18.5 (42.39)



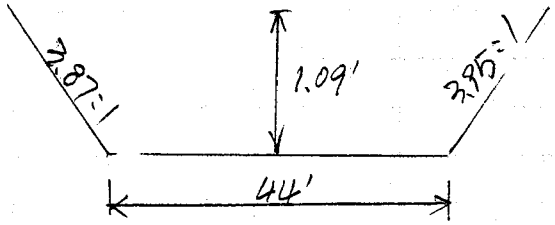
Sec. 2 Sta. 10+87.5 (42.33)



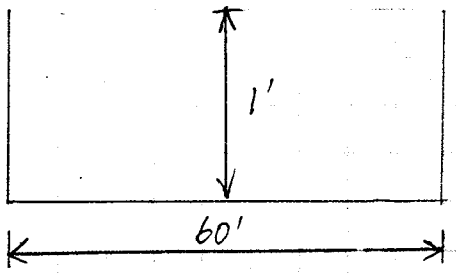
Sec. 5 Sta. 11+36.5 (42.48)



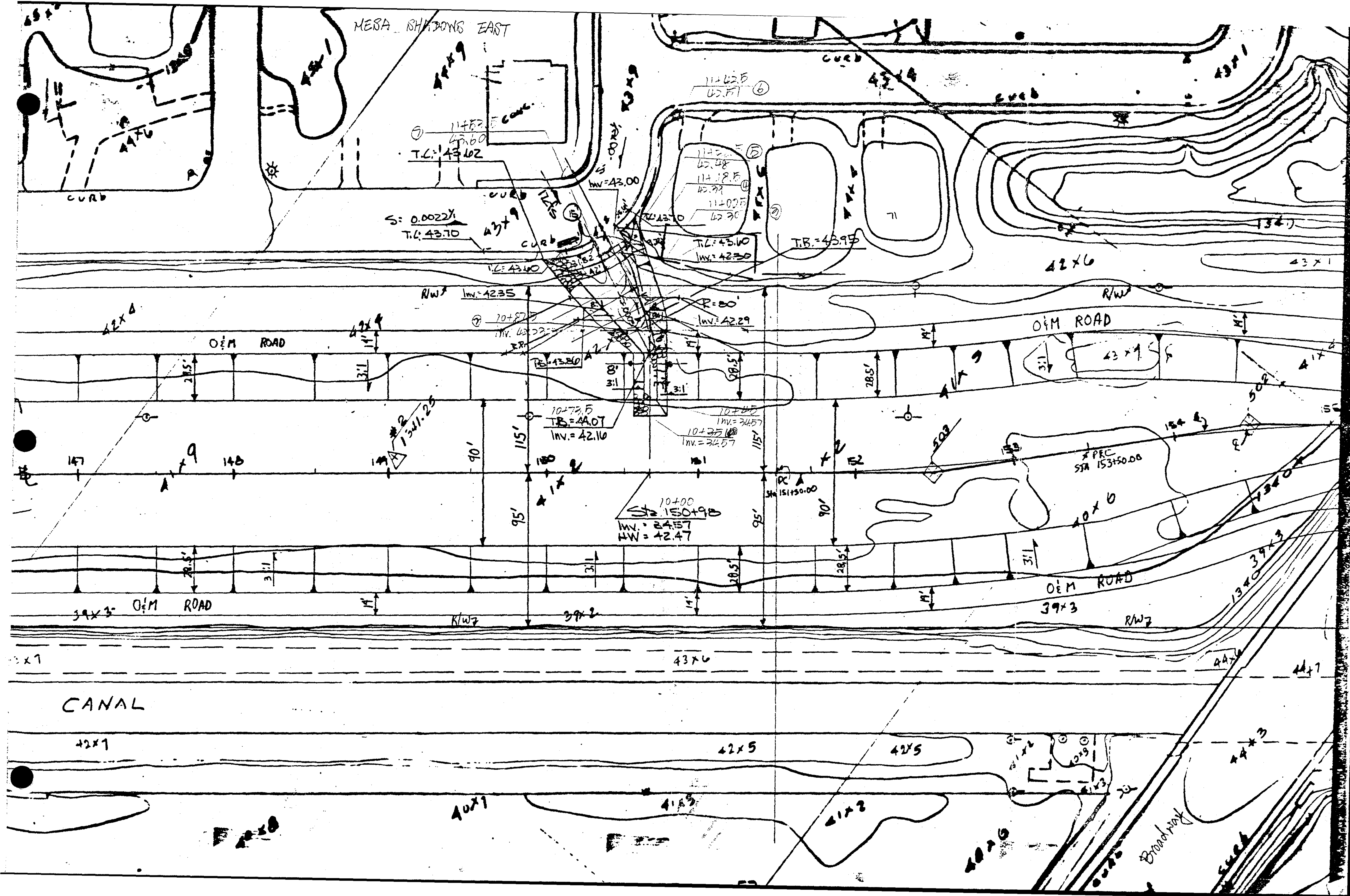
Sec. 3 Sta. 11+00.5 (42.30)



Sec. 6 Sta. 11+42.5 (42.51)



Sec. 7 Sta. 11+53.5 (42.60)


MESA SHADOWS EAST
CURB
T.C. = 43.62
S: 0.0022%
T.C. 43.70
T.C. 43.40
Inv. = 43.00
T.C. = 43.60
Inv. = 42.30
T.B. = 43.95
R/W
Inv. = 42.35
R = 80'
Inv. = 42.29
O&M ROAD
TB = 43.86
10+73.5
TB = 44.07
Inv. = 42.16
10+00
Sta 150+98
HW = 42.47
PC
Sta 151+50.00
PRC
STA 153+50.00
147
148
149
150
151
152
115'
95'
90'
28.5'
14'
3:1
CANAL
Broadway

As per a meeting held at SCS on September 4, 1985 at 8:00 A.M. with Mr. Paulus, Mr. Milsap and Mr. Shapiro it was decided that because the SCS's TR-20 program did not address intermediate points, as far as storm water runoff between the major inlet structures, Greiner Engineering would assess the peak discharge flows for all existing and/or proposed subdivisions outletting into the floodway.

Proposed and existing drainage reports for these subdivisions were evaluated (See section 21) in conjunction with field visits, aerial mapping and routing techiques used by the SCS's TR-20 runs. These were all incorporated into the analysis. The TR-20 program version 3.82 was used to perform the calculations. The 100 year 24 hour storm event with a rainfall depth of 3.60 inches was used.

Per TR-20 computer printout (See under seperate cover)

STRUCT 1 - Sundance Groves
STRUCT 2 - Stoneybrook + SCS offsite
STRUCT 3 - Apache Trails
STRUCT 4 - Sunlife (North
STRUCT 5 - Sunlife (South)
STRUCT 6 - Mesa Shadows East

See the summary table on the following page for results of the TR-20 output and the calculations on the following pages.

Greiner Engineering

Greiner Engineering Sciences, Inc.

Tucson 602 327-3413
Phoenix 602 275-5400

Job RWCD Reach 6 E101012
Description Analysis of adjacent subdivision
Calculated by M. Shapiro Date 2/5/86 Sheet No. 2
Checked by B. G. S. Date _____ of 2

Name of Subdivision	Approx. Sta. of Outlet @ Floodway	Peak flow 100yr. 24hr. Storm (cfs)	Depth of Discharge (feet)	Velocity of Discharge (fps)
Sundance Groves	60+00 - 63+00	7.3	0	0
Stoneybrook	77+00 - 79+00	596.5	0.90	3.3
Apache Trail	137+50 - 138+00	2.2	0.01	0.3
Sunlife (North)	92+00 - 95+00	133	0.46	2.1
Sunlife (South)	117+00 - 119+00	0.0	0.0	0.0
Mesa Shadows East	153+00 - 156+00	0.08	0.0	0.0

Also for addition information see Section 5.

HYDRAULIC & HYDROLOGIC ANALYSIS FOR OFFSITE DISCHARGERS AND APPURTENANCE STRUCTURES FOR ADJACENT SUBDIVISIONS TO THE EAST OF THE FLOODWAY

Greiner Engineering

Greiner Engineering Sciences, Inc.
Tucson 602 327-3413
Phoenix 602 275-5400

Job: SCS RWCD Floodway Rch 6
Description: Collector Channel design
Calculated by: JAA Date: 10-28-85 Sheet No. 2
Checked by: MSS Date: _____ of _____

I. HYDROLOGIC ANALYSIS OF SUNDANCE GROVES
LOCATED WITHIN SUBBASIN 5 OF RWCD REACH 6
POINT OF DISCHARGE IS STA. 60+00± TO 63+00± ℄ FLOODWAY.

(1) TOTAL DRAINAGE AREA = 12.151 ac. to CB #1
FROM SUBBASINS 1-5 + 10.856 ac. to CB #2
+ 6.171 ac. to CB #3
+ 2.906 ac. to CB #4
+ 1.782 ac. to CB #5
33.866 ac.* = 0.0529 sq. mi.

* Subbasin 2A has separate retention

(2) TIME OF CONCENTRATION = 25 MIN = 0.42 HR
(See "Storm Sewer Design Chart")

(3) RUNOFF CURVE NUMBER

SUBBASIN	AREA (AC)	SOIL GROUP	RCN	PRODUCT	
1	12.151	B	81*	984.2	54% imp.
2	10.856	B	81*	879.3	54% imp.
3	6.171	B	81*	499.9	54% imp.
4	2.906	B	88*	255.7	72% imp.
5	1.782	B	85*	152.2	66% imp.
TOTAL	33.866			2771.3	

WEIGHTED RCN = $\frac{\text{PRODUCT}}{\text{TOTAL AREA}}$ = 82

* Based on RCN = 98 for pavement and RCN = 61 for landscaping

SUNDANCE GROVES (CONT'D)

(4) STAGE-STORAGE (REF "SUNDANCE GROVES RETENTION BASIN PLANS, SHT. 26 OF 32" & "DRAINAGE REPORT, SHT 2")

ELEV. (NGVD)	Δh (FT)	AREA (SF)	AVG AREA (SF)	INC. VOLUME (CF)	TOTAL VOLUME (CF)	TOTAL VOLUME (AF)
44.5		0			0	0
	1.0		22060	22060		
45.50		44120			22,060	0.5
	0.5		50840	25420		
46.0		57560			47,480	1.1
	1.0		60580	60580		
47.0		63600			108,060	2.5
	1.0		67140	67140		
48.0		70680			175,200	4.0
	1.0		70680	70680		
49.0		70680			245,880	5.6
	1.0		70680	70680		
50.0		70680			316,560	7.3

SEE STAGE-STORAGE CURVE ON NEXT PAGE

Greiner Engineering

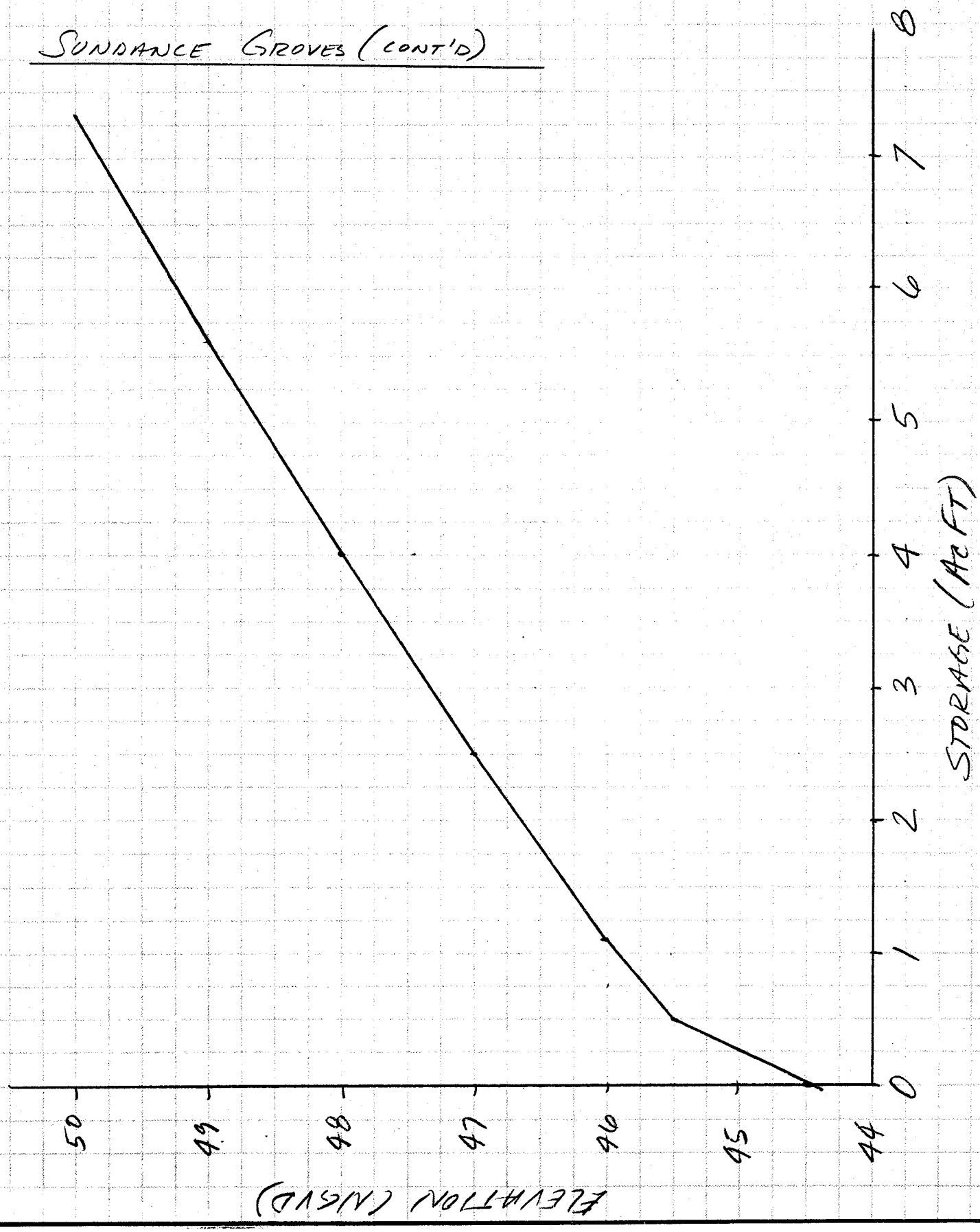
Greiner Engineering Sciences, Inc.

Tucson 602 327-3413
Phoenix 602 275-5400

Job SCS RWCD Floodway Rch 6
Description Collector channel design

Calculated by JAA Date 10-29-85 Sheet No. 4
Checked by M.S.S. Date _____ of _____

SUNDANCE GROVES (CONT'D)



Greiner Engineering

Greiner Engineering Sciences, Inc.

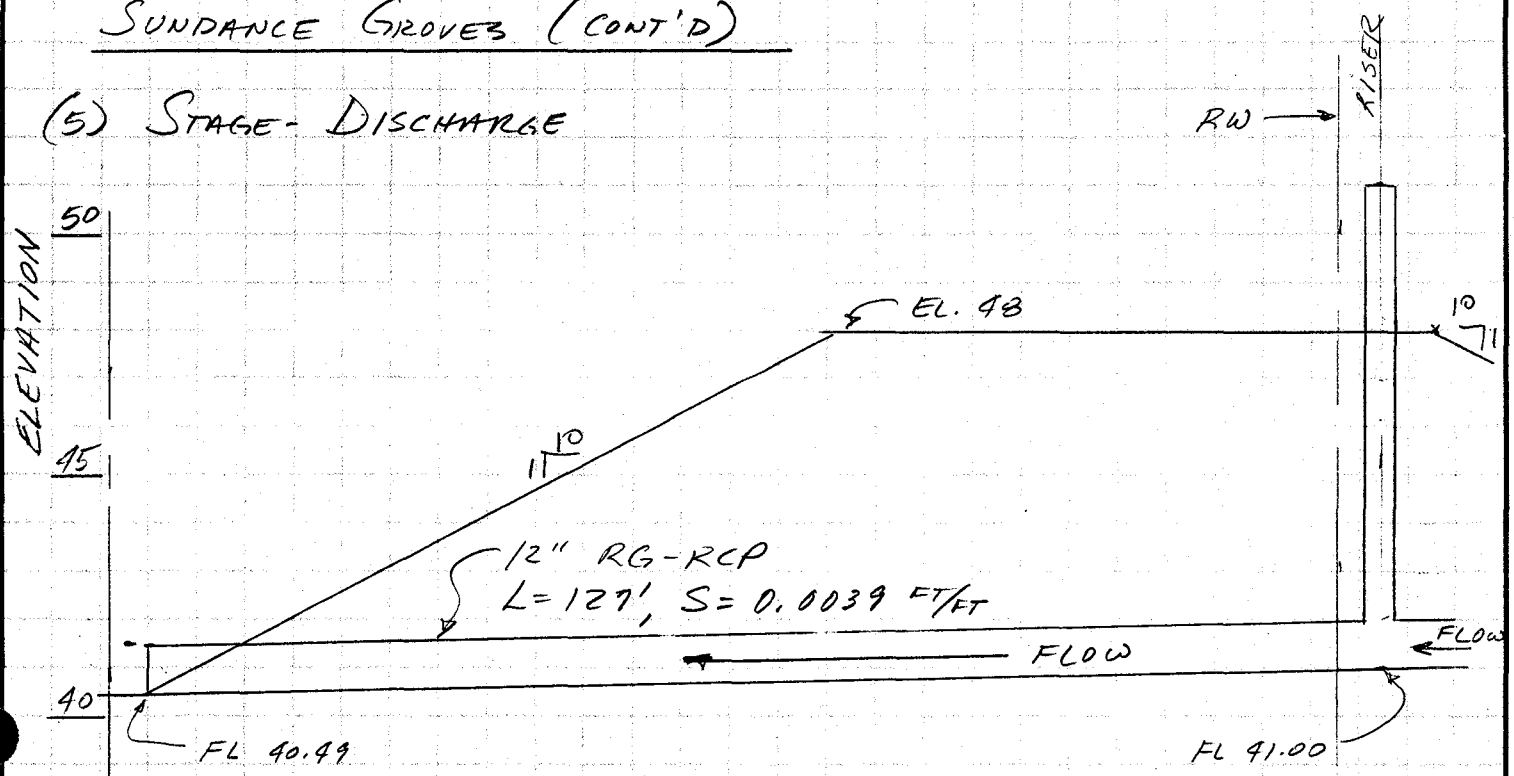
Tucson 602 327-3413
Phoenix 602 275-5400

Job: SCS KWCD Floodway Ch 6
Description: Collector channel design

Calculated by: JAA Date: 10-29-85 Sheet No. 5
Checked by: MSS Date: _____ of _____

SUNDANCE GROVES (CONT'D)

(5) STAGE- DISCHARGE



PROFILE OF OUTLET PIPE
HOR. 1"=20'
VERT. 1"=4'

Greiner Engineering

Greiner Engineering Sciences, Inc.
Tucson 602 327-3413
Phoenix 602 275-5400

Job SCS RWCD Floodway Rch 6
Description Collector channel design
Calculated by JAH Date 10-29-85 Sheet No. 6 of
Checked by MSS Date

SUNDANCE GROVES (CONT'D)

STAGE - DISCHARGE

PIPE FLOW 41 ≤ W.S.E.

$d = 12''$ Downstream Flowline = 40.49
$n = 0.013$ Upstream Flowline = 41.00
$L = 127'$ Use mannings eqn. *

WEIR FLOW 48 ≤ WSE

$Q = CLh^{3/2}$
$C = 3.3$, $L = 180'$
$Q = 594\,h^{3/2}$

WSE or HW (NGVD)	TW** (NGVD)	h = HW-TW (FT)	S = h/127' (FT/FT)	Q (cfs)	h (ft)	Q (cfs)	TOTAL DISCHARGE (cfs)
41.0	–	0	0	0	–	–	0
42.0	41.49	0.51	0.0040	2.2	–	–	2.2
43.0	41.49	1.51	0.012	3.9	–	–	3.9
44.0	41.49	2.51	0.020	5.0	–	–	5.0
45.0	41.49	3.51	0.028	6.0	–	–	6.0
46.0	41.49	4.51	0.036	6.8	–	–	6.8
47.0	41.49	5.51	0.043	7.4	–	–	7.4
48.0	41.49	6.51	0.051	8.0	0	0	8.0
49.0	41.49	7.51	0.059	8.6	1	594	603
50.0	41.49	8.51	0.067	9.2	2	1680	1684

* "Hydraulics, Section 5, ES-54, pg 2"
** Assume crown of pipe for flowing full.

SUNDANCE GROVES (CONT'D)

(6) TR-20 FLOODROUTING, SEE STRUCTURE 01 OUTPUT

Q_{100} = 7.3 cfs
DHW_{100} = 46.9'
Depth of flow over embankment = 0'

(7) SUMMARY & CONCLUSION

No spillway is required for flow over embankment. Must provide drainage connection for 12" RCP.

II HYDROLOGIC ANALYSIS OF STONEYBROOK

LOCATED WITHIN SUBBASIN 10 RWCD REACH 6.
POINT OF DISCHARGE IS STA. 77+00± TO 79+00± ℄ FLOODWAY.

(1) TOTAL DRAINAGE AREA

AREA EAST OF HIGLEY ROAD DOES NOT CONTRIBUTE BASED ON "DRAINAGE STUDY FOR THE SOUTH PORTION OF HIGLEY ROAD FROM 2800 FEET NORTH OF MC KELLIPS ROAD TO MAIN STREET."

SUBBASINS 1-28	= 72.9 ac.	
RETENTION BASIN I	= 39.1 ac.	
RETENTION BASIN II	= 46.9 ac.	
TOTAL	158.9 ac.	= 0.2483 sq. mi.

ONSITE + OFFSITE = 1.555 sq. mi. (input as READHD)

(2) TIME OF CONCENTRATION = 29 MIN = 0.48 HR
(See "Storm Sewer Design Chart)

(3) RUNOFF CURVE NUMBER

SUBBASIN	AREA (Ac)	SOIL GROUP	RCN	PRODUCT	
1-28	72.9	B	76 *	5540.4	40% imp.
BASIN I	39.1	B	82 **	3206.2	0% imp.
BASIN II	46.9	B	82 **	3845.8	0% imp.
TOTAL	158.9			12,592.4	

WEIGHTED RCN = $\frac{\text{PRODUCT}}{\text{TOTAL AREA}}$ = 79

* Based on RCN = 98 for pavement & RCN = 61 for grass
** Based on RCN = 82 for dirt

STONEY BROOK (CONT'D)

(4) STAGE - STORAGE

REFERENCES: "STONEYBROOK GRADING & DRAINAGE PLAN, SHT. 43, 44"
"HYDROLOGY AND HYDRAULICS REPORT, SHT. 14"

ELEV (NGVD)	Δh (FT)	AREA (Ac)	AVG. AREA (Ac)	INC. VOLUME (AF)	TOTAL VOLUME (AF)
42.0		0			0
	1.5		0.33	0.5	
43.5		0.66			0.5
	0.5		0.99	0.5	
44.0		1.32			1.0
	1.0		1.53	1.53	
45.0		1.73			2.53
	1.0		1.88	1.88	
46.0		2.02			5.41
	1.0		2.18	2.18	
47.0		2.34			7.59
	1.0		2.34	2.34	
48.0		2.34			9.93

SEE STAGE-STORAGE CURVE ON NEXT PAGE.

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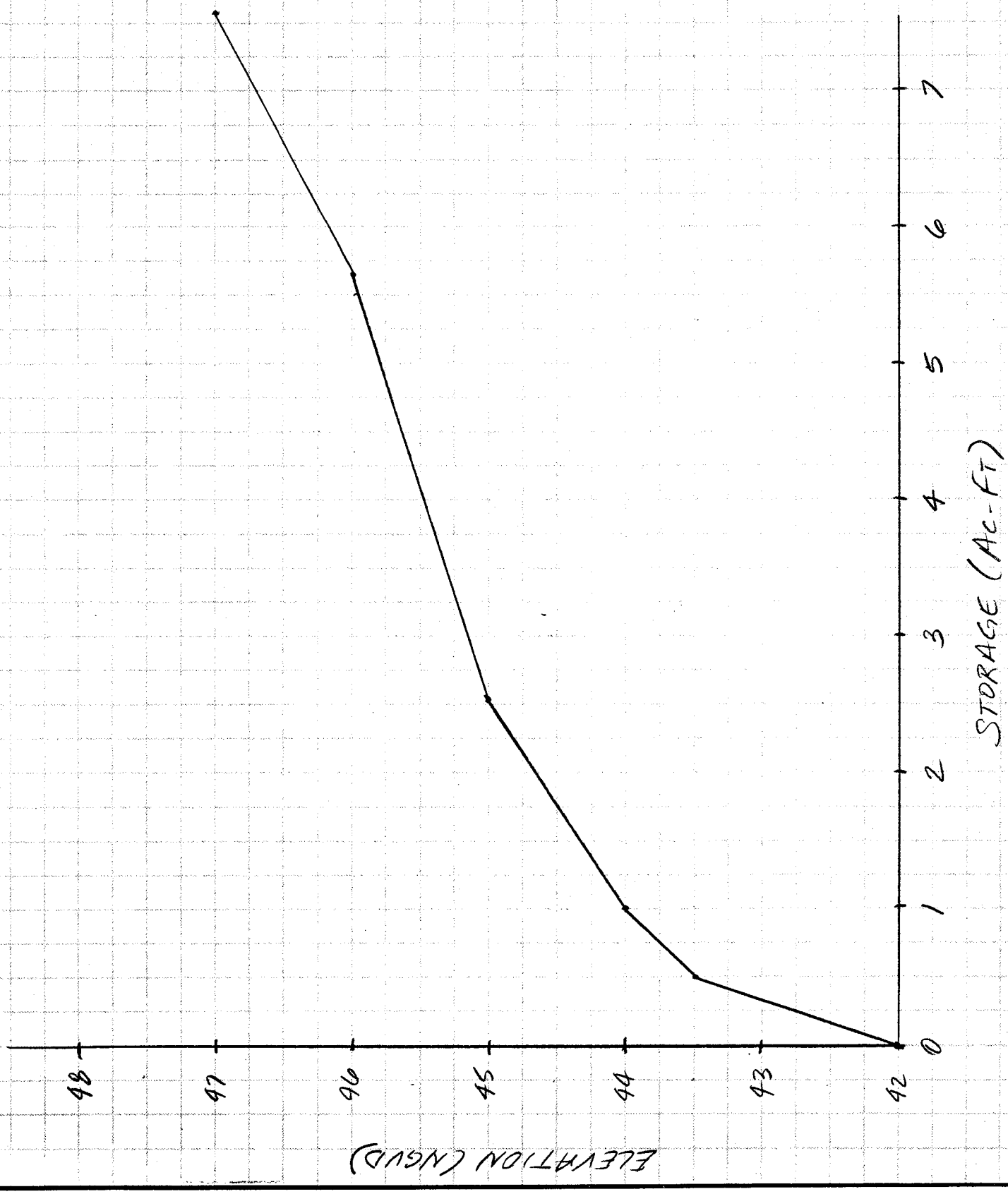
Phoenix 602 275-5400

Job SCS RWCD Floodway Rch 6
Description Collector channel design

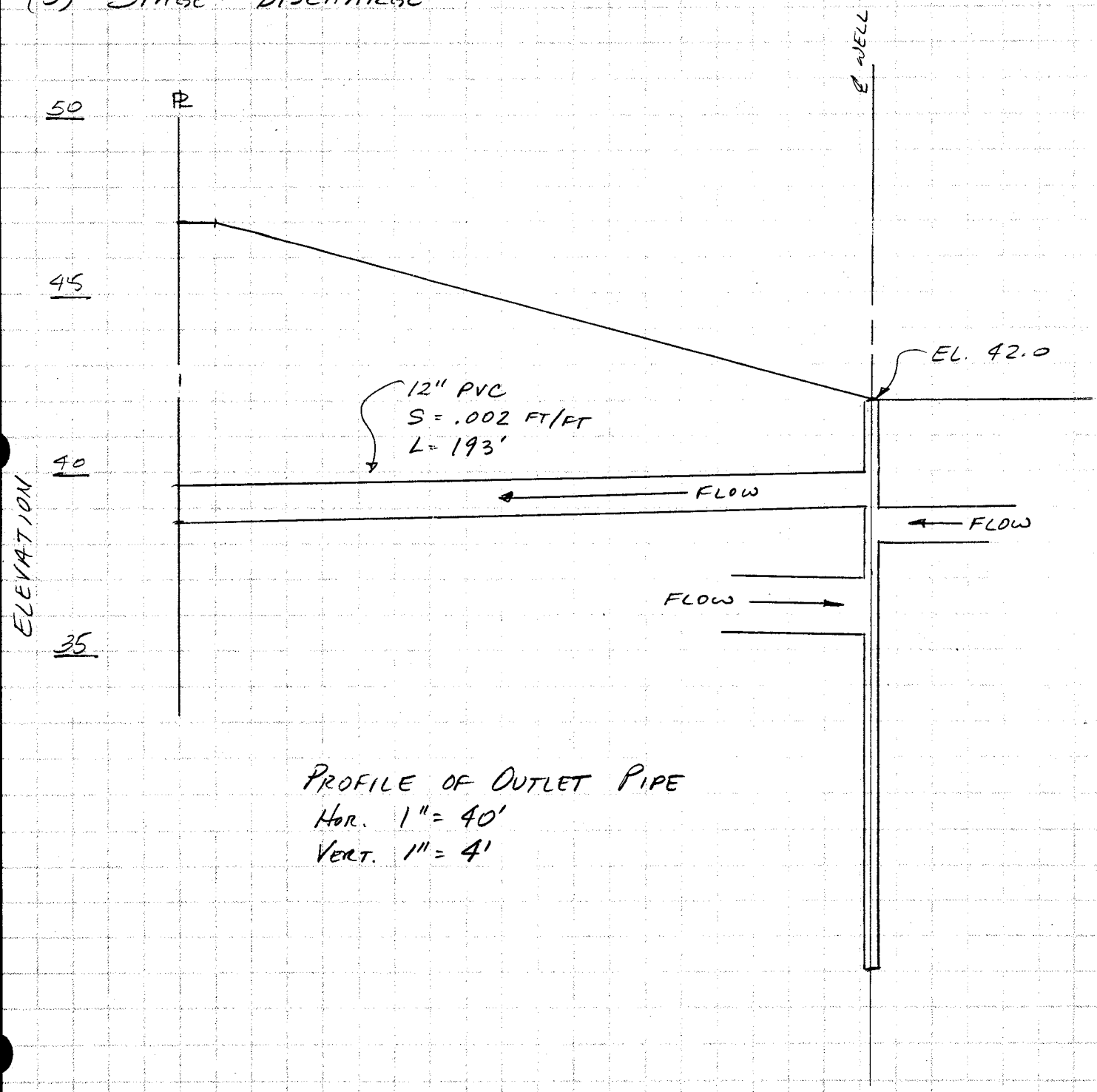
Calculated by JAA Date 10-29-85 Sheet No. 10
Checked by M.S.S. Date _____ of _____

STONEYBROOK (CONT'D)



STONEYBROOK (CONT'D)

(5) STAGE - DISCHARGE



PROFILE OF OUTLET PIPE
HOR. 1" = 40'
VERT. 1" = 4'

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Job: SCS RWCD Floodway Rch 6
Description: Collector channel design
Calculated by: JAA Date: 10-29-85 Sheet No. 12 of
Checked by: MSS Date:

STONEYBROOK (CONT'D)

PIPE FLOW 42 ≤ WSE					WEIR FLOW 47 ≤ WSE		
d = 12"	Downstream Flowline = 38.61				$Q = CLh^{3/2}$		
n = 0.013	Upstream Flowline =				C = 3.3, L = 200'		
L = 193'	Use Manning's Eqn. *				$Q = 660h^{3/2}$		
WSE or HW (NGVD)	TW** (NGVD)	h = HW-TW (FT)	S = h/193' (FT/FT)	Q (cfs)	h (FT)	Q (cfs)	TOTAL DISCHARGE (cfs)
42	39.61	2.39	0.0124	3.7	-	-	3.7
43	39.61	3.39	0.0176	4.4	-	-	4.4
44	39.61	4.39	0.0227	5.2	-	-	5.2
45	39.61	5.39	0.0279	5.9	-	-	5.9
46	39.61	6.39	0.0331	6.4	-	-	6.4
47	39.61	7.39	0.0383	7.0	0	0	7.0
48	39.61	8.39	0.0435	7.4	1	660	667

* Reference "Hydraulics, Section 5, ES-54"
** Assume crown of pipe for flowing full

STONEYBROOK (CONT'D)

(6) TR-20 FLOODROUTING, SEE STRUCTURE 02 OUTPUT

Q_{100} = ~~126.4~~ cfs 603.9 cfs
DHW_{100} = ~~47.18'~~ 47.9
Depth of flow over embankment = ~~0.18'~~ 0.90
Determine Q_{100} over embankment by interpolation,
Q_{100} = ~~118.8~~ cfs 596.5 cfs

(7) SUMMARY & CONCLUSION

Spillway is required for flow over embankment to collector channel. Must provide drainage connection for 12" RCP. See details next page.

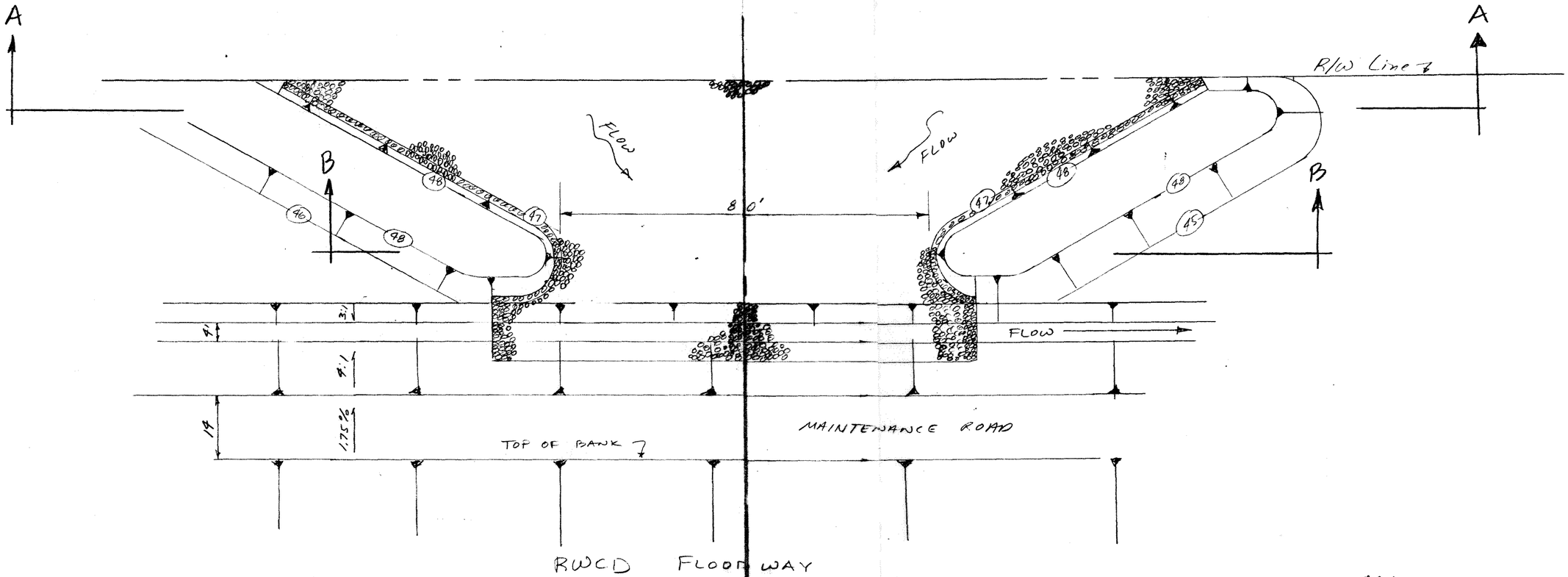
(8) DETERMINE EROSION PROTECTION REQUIREMENT

- AT R/W LINE (SECTION A-A)

d = DEPTH OF FLOW = ~~0.18~~ 0.9 ft
A = AREA = (~~0.18'~~ 0.9 X 200') + (3(~~0.18~~ 0.9)²) = ~~36.1~~ 182.4 ft²
Q = DISCHARGE = ~~118.8~~ 596.5 cfs
V = AVERAGE VELOCITY = $\frac{Q}{A}$ = $\frac{\cancel{118.8}\ 596.5 \text{ cfs}}{\cancel{36.1}\ 182.4 \text{ ft}^2}$ = ~~3.3~~ 3.3 fps
∴ PROTECTION REQUIRED

- AT COLLECTOR CHANNEL (SECTION B-B)

d = DEPTH OF FLOW = ~~0.18~~ 0.9 FT
A = AREA = (~~0.18'~~ 0.9 X 60') + (3(~~0.18~~ 0.9)²) = ~~10.9~~ 56.4 ft²
Q = DISCHARGE = ~~118.8~~ 596.5 CFS
V = AVERAGE VELOCITY = $\frac{Q}{A}$ = $\frac{\cancel{118.8}\ 596.5 \text{ cfs}}{\cancel{10.9}\ 56.4 \text{ ft}^2}$ = ~~10.9~~ 10.6 fps ∴ PROTECTION REQUIRED



EMERGENCY SPILLWAY FOR STONEYBROOK
PLAN VIEW
HOR. 1" = 20'

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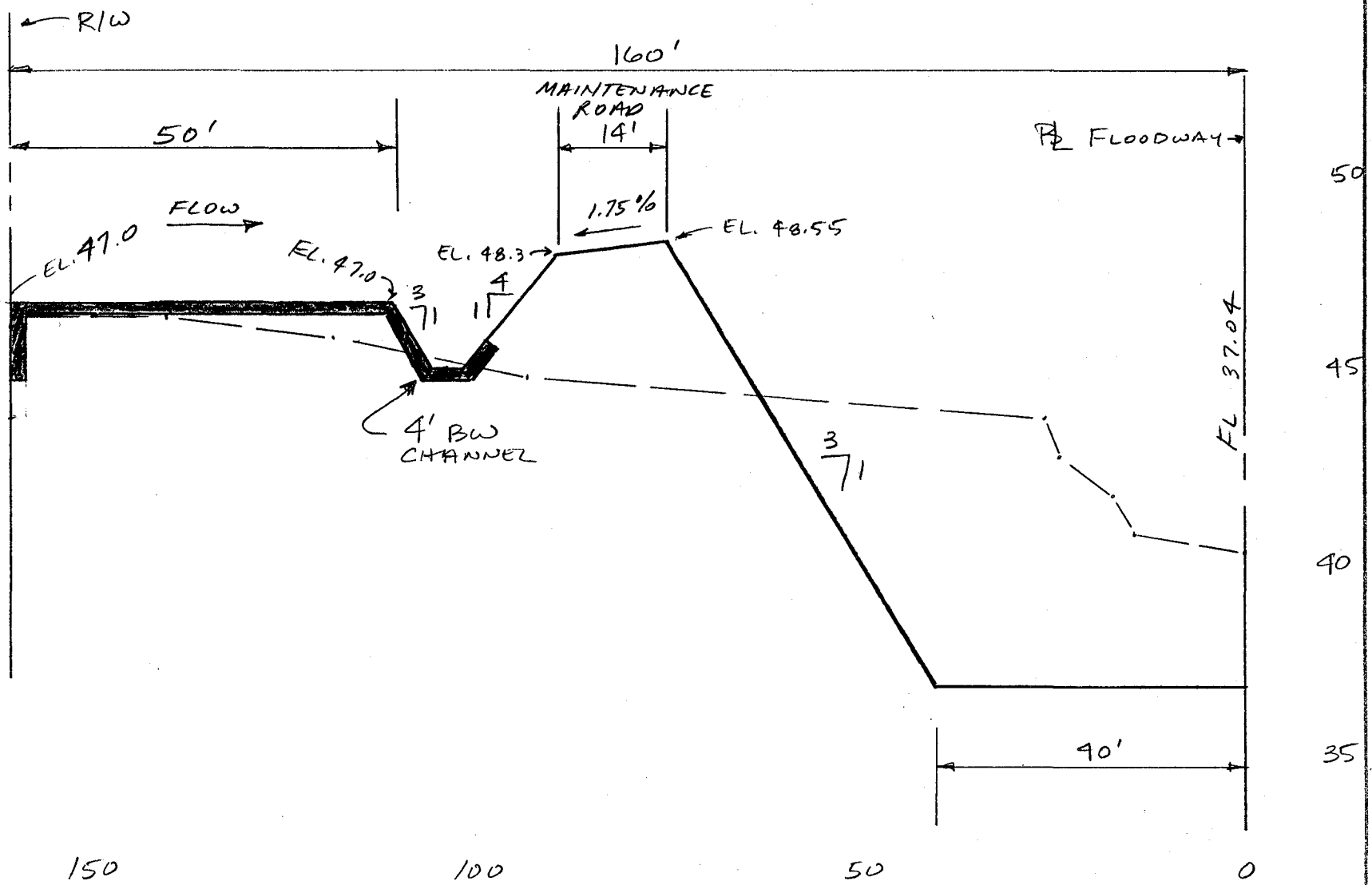
Job: SCS RWCD Floodway Rehab
Description: Collector channel design
Calculated by: JAA Date: 10-31-05 Sheet No. 14 of
Checked by: MSS Date:



℄ PROFILE STA. 78+55
HOR. 1" = 20' VERT. 1" = 4'

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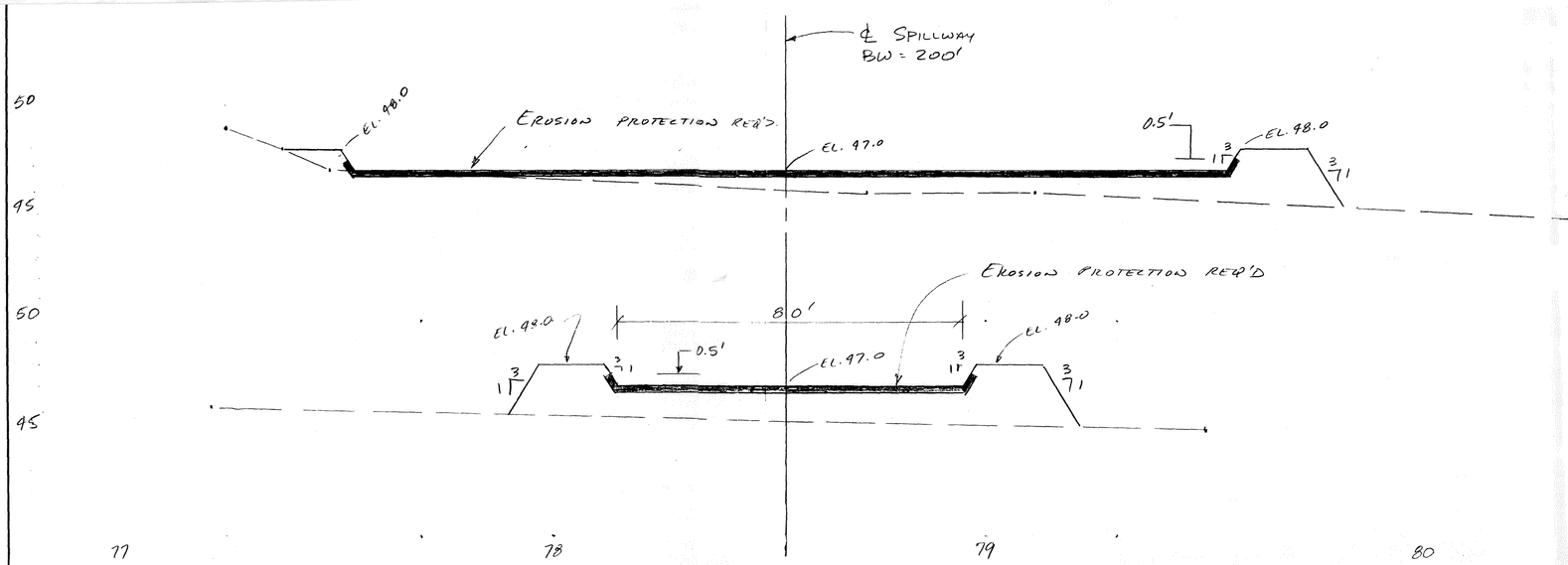
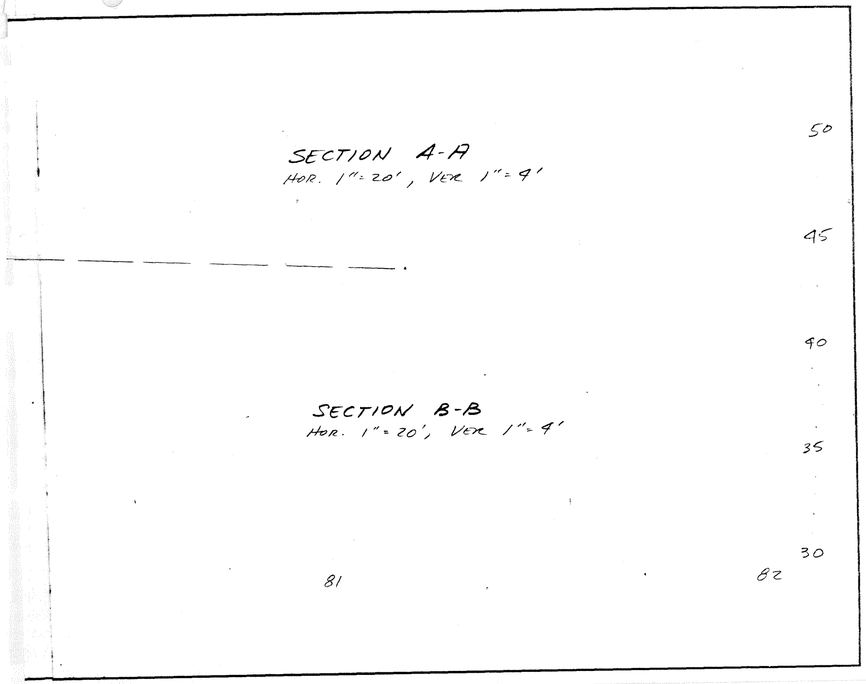
Job SCS RWCD Floodway Rch 6
Description Collector channel design
Calculated by JTAA Date 10-31-85 Sheet No. 15
Checked by MSS Date of



SECTION A-A @
HOR. 1" = 20', VER. 1" = 4'



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Job SCS RWCD Floodway Ch. 6
Description Collector channel design
Calculated by TAH Date 10-27-85 Sheet No. 16 of
Checked by MSS Date

I. HYDROLOGIC ANALYSIS OF APACHE TRAIL MINI PARK
LOCATED WITHIN SUBBASIN 15 OF RWCD REACH 6
POINT OF DISCHARGE IS STA. 137+50± TO 138+00± ℄ FLOODWAY.

(1) TOTAL DRAINAGE AREA (REF: "DRAINAGE STUDY")

PARCEL A = 2.68 Ac. (excludes diversion channel)
PARCEL B = 3.91 Ac.
PARCEL C = 4.80 Ac (includes lake)
TOTAL 11.39 Ac = 0.0178 sq.mi.

(2) TIME OF CONCENTRATION = 10 min = 0.17 hr.
(SEE: "DRAINAGE STUDY, SHT. 8")

(3) RUNOFF CURVE NUMBER
SOIL GROUP = B
40% Impervious ⇒ RCN = 98 ⇒ PRODUCT = 39.2
60% Desert Landscaping ⇒ RCN = 61 ⇒ PRODUCT = 36.6
100% Total TOTAL 76

WEIGHTED RCN = $\frac{\text{PRODUCT}}{\text{TOTAL \%}}$ = 76

APACHE TRAIL MINI PARK (CONT'D)

(4) STAGE - STORAGE
REFERENCES: "APACHE TRAIL MINI PARK PLANS, SHT. 4-7"

ELEV (NGVD)	Δh (FT)	AREA (Ac)	AVG. AREA (Ac)	INC. VOLUME (AF)	TOTAL VOLUME (AF)
45.0		0.62			0
	0.5		0.65	0.33	
45.5		0.68			0
	0.5		0.71	0.35	
46.0		0.73			0.35
	1.0		0.73	0.73	
47.0		0.73			1.08

ELEV. 46 ⇒ AREA = 79.4 in² = 31,760 ft² = 0.73 Ac.
ELEV. 45 ⇒ AREA = 67.1 in² = 26,840 ft² = 0.62 Ac.

13.1 + 40.6 + 8.4 + 5.0

APACHE TRAIL MINI PARK (CONT'D)

(5) STAGE - DISCHARGE

OUTLET IS PUMP (310 GPM CAPACITY) DISCHARGING THROUGH 6" PVC. NO DISCHARGE REGULATION SCHEDULE IS GIVEN, THEREFORE ASSUME ONLY WEIR FLOW ABOVE ELEV. 45.93

WEIR FLOW, $45.9 \leq WSE$

$Q = CLh^{3/2}$

$C = 3.3$, $L = 670'$

$Q = 2211\, h^{3/2}$

WSE (NGVD)	h (FT)	Q (cfs)
46.0	0	0
47.0	1	2211

APACHE TRAIL MINI PARK (CONT'D)

(6) TR-20 FLOODROUTING, SEE STRUCTURE 03 OUTPUT

$Q_{100} = 15.0$ cfs
$DHW_{100} = 46.01'$
Depth of flow over embankment = 0.01'
Embankment $Q_{100} = CLh^{3/2}$ $C = 3.3$, $L = 670'$, $h = 0.01$

$$Q_{100} = (3.3)(670)(0.01)^{3/2}$$
$$Q_{100} = 2.2 \text{ cfs}$$

(7) SUMMARY & CONCLUSION

Emergency spillway is not required for pond because, (1) the length prohibitively too long, (2) quantity of flow is relatively small, and (3) frequency of occurrence 1 in 100 years.

Must provide drainage connection for 6" PVC. No details provided.

IV HYDROLOGIC ANALYSIS OF SUNLIFE PARCEL BETWEEN STA. 92+00 ± TO 119+00 ±

TWO (2) POINTS OF DISCHARGE: STA 92+00 — 95+00 AND STA. 117+00 — 119+00

(1) DRAINAGE AREA

SUBBASIN (1) = 151.1 SQ.IN. = 34.7 Ac. = 0.0542 SQ.MI.
SUBBASIN (2) = 58.0 SQ.IN. = 13.3 Ac. = 0.0208 SQ.MI.
TOTAL = 209.1 SQ.IN. = 48.0 Ac = 0.0750 SQ.MI.

(2) TIME OF CONCENTRATION (use 2.0 fps avg. velocity)

SUBBASIN (1) = 1000' thru subdivision @ V = 2.0 fps.
$= \frac{1000'}{2 \text{ fps}} = 8.3$ min
use 10 min or 0.17 hr.

SUBBASIN (2) = 2350' thru subdivision @ V = 2.0 fps
$= \frac{2350'}{2 \text{ fps}} = 19.6$ min or 0.33 hr.

(3) RUNOFF CURVE NUMBER

TYPICAL LOT:

12' x 35'	ROAD	=	420 SF
20' x 50'	DRIVEWAY	=	1000 SF
15' x 50'	TRAILER	=	750 SF
			2170 SF

WEIGHTED RCN = 98, use 95

SUNLIFE PARCEL

(4) STAGE-STORAGE FOR BASIN AT 93+00± ~ 94+00±

STRUCTURE 4

ELEV (NGVD)	Δh (FT)	AREA (SF)	AVG. AREA (SF)	INC. VOLUME (CF)	TOTAL VOLUME (CF)	TOTAL VOLUME (AF)
42.9		0			0	0
	0.1		3900	390		
43.0		7800			390	0.01
	1.0		16138	16138		
44.0		24,475			16528	0.38
	1.0		26863	26863		
45.0		29250			43193	1.0
	0.9		31500	28350		
45.9		33750			71741	1.65
	0.1		34000	34000		
46.0		34250			105,741	2.43
	1.0		42163	42163		
47.0		50075			147904	3.40

SUNLIFE PARCEL

(5) STAGE-DISCHARGE FOR BASIN AT 93+00± ~ 94+00±

ASSUME WEIR FLOW OVER EMBANKMENT ONLY

STRUCTURE 4

WEIR FLOW
ELEV. ≥ 45.9

$Q = CLh^{3/2}$

C = 3.3, L = varies, see below

$Q = 3.3 Lh^{3/2}$

WSE or Elev. (NGVD)	h (ft)	L (ft)	Q (cfs)	
42.9	-	-	0	
43	-	-	0	use 0.01
44	-	-	0	use 0.02
45	-	-	0	use 0.03
45.9	0	0	0	use 0.04
46	0.1	25	2.6	
46.5	0.6	120	184.0	
47.	1.1	215	818.5	

SUNLIFE PARCEL

(6) STAGE-STORAGE FOR BASIN AT 115+00 ± ~ 119+00 ±

STRUCTURE 5

ELEV (NGVD)	Δh (ft)	AREA (SF)	AVG AREA (SF)	INC. VOLUME (CF)	TOTAL VOLUME (CF)	TOTAL VOLUME (AF)
41.5		0			0	0
	0.5		10275	5138		
42.0		20550			5138	0.12
	1.0		32113	32113		
43.0		43675			37,251	0.86
	1.0		49450	49450		
44.0		55225			86,701	1.99
	1.0		58238	58238		
45.0		61,250			144,939	3.33
	0.2		62860	12572		
45.2		64470			157,511	3.62
	0.3		66885	20066		
45.5		69300			177,577	4.08
	0.5		73325	36663		
46.0		77350			214,240	4.92

SUNLIFE PARCEL

(7) STAGE-DISCHARGE FOR BASIN AT 115+00± ~ 119+00±

ASSUME WEIR FLOW OVER EMBANKMENT ONLY.

STRUCTURE 5

WEIR FLOW, ELEV ≥ 45.2

$Q = CLh^{3/2}$

$C = 3.3$, $L =$ varies, see below

$Q = 3.3Lh^{3/2}$

WSE or Elev. (NGVD)	h (ft)	L (ft)	Q (cfs)	
41.5	–	–	0	
42.0	–	–	0	use 0.01
43.0	–	–	0	use 0.02
44.0	–	–	0	use 0.03
45.0	–	–	0	use 0.04
45.2	0	0	0	use 0.05
45.5	0.3	131	71.	
46.0	0.8	350	826	

SUNLIFE PARCEL

(8) TR20 FLOODROUTING, SEE STRUCTURE 04 & 05 OUTPUT

STRUCTURE 04 North basin
Q_{100} = 133 cfs
DHW_{100} = 46.36
Depth of Flow over Embankment = 0.46'

STRUCTURE 05 South basin
Q_{100} = 0.0 cfs
DHW_{100} = 44.99
Depth of flow over embankment = 0'

(9) SUMMARY & CONCLUSION

Spillway is required for flow over embankment for structure 04, but not for structure 05.

(10) DETERMINE EROSION PROTECTION REQUIREMENT

d = DEPTH OF FLOW = 0.46'
A = (0.46' x 139') = 63.9 ft²
Q = DISCHARGE = 133 cfs
V = AVERAGE VELOCITY = $\frac{Q}{A} = \frac{133}{63.9}$ = 2.1 fps

∴ PROTECTION NOT REQUIRED.

I HYDROLOGIC ANALYSIS OF MESA SHADOWS EAST BETWEEN STA. 138+00 I TO 156+00 I

POINT OF DISCHARGE IS STA. 153+50.

(1) TOTAL DRAINAGE AREA = 75.6 in² = 17.4 Ac. = 0.0272 SM

(2) TIME OF CONCENTRATION (use 2.0 fps avg. velocity)

ROOF TIME = 5 MIN.

TRAVEL TIME = 1420' thru subdivision @ V = 2.0 fps

$= \frac{1420'}{2 \text{ fps}} = 11.8$ min.

TOTAL TIME = 5 + 11.8 = 16.8 min = 0.28 hr.

(3.) RUNOFF CURVE NUMBER

TYPICAL LOT :	14' x 60'	ROAD	=	840 SF
	30' x 60'	FRONT LANDSCAPE	=	1800 SF
	30' x 60'	REAR YARD	=	1800 SF
	45' x 45'	HOUSE	=	2025 SF
	15' x 45	YARD BUFFER	=	675 SF
		TOTAL		7140 SF

$$\text{WEIGHTED RCN} = \frac{(2865 \times 98) + (4275 \times 61)}{7140} = 76$$

$$\text{WEIGHTED RUNOFF COEFFICIENT} = \frac{2865}{7140} = 0.37$$

MESA SHADOWS EAST – STA 138+00 TO 156+00

(4) STAGE-STORAGE FOR BASIN AT 153+00± ~ 156+00±

ELEV (NGVD)	Δh (FT)	AREA (SF)	AVG. AREA (SF)	INC. VOLUME (CF)	TOTAL VOLUME (CF)	TOTAL VOLUME (AF)
35.7		0			0	0
	0.3		625	188		
36.0		1250			188	0.004
	1.0		2563	2563		
37.0		3875			2751	0.06
	1.0		6263	6263		
38.0		8650			9014	0.21
	1.0		10700	10700		
39.0		12750			19714	0.45
	1.0		14600	14600		
40.0		16450			34314	0.79
	1.0		18350	18350		
41.0		20250			52,664	1.21
	1.0		22125	22125		
42.0		24000			74,789	1.72
	0.6		27150	16290		
42.6		30,300			91 079	2.09
	0.4		32400	12960		
43.0		34500			104,039	2.39

MESA SHADOWS EAST - STA. 138+00 TO 156+00

(5) STAGE - DISCHARGE FOR BASIN AT 153+00± ~ 156+00±

ASSUME WEIR FLOW OVER EMBANKMENT ONLY.

WEIR FLOW ELEV ≥ 42.6

$Q = CLh^{3/2}$

C = 3.3, L = varies, see below

$Q = 3.3 L h^{3/2}$

WSE or ELEV (NGVD)	h (FT)	L (FT)	Q (CFS)	
35.7	–	–	0	
36.0	–	–	0	use 0.01
37.0	–	–	0	use 0.02
38.0	–	–	0	use 0.03
39.0	–	–	0	use 0.04
40.0	–	–	0	use 0.05
41.0	–	–	0	use 0.06
42.0	–	–	0	use 0.07
42.6	0	0	0	use 0.08
43.0	0.4	140	116.9	

MESA SHADOWS EAST - STA 138+00 TO 156+00

(6) TR20 FLOODROUTING, SEE STRUCTURE 06 OUTPUT

Q_{100} = 0.08 cfs
DHW_{100} = 42.46
Depth of flow over Embankment = 0'

(7) SUMMARY & CONCLUSION

Emergency spillway is <u>not</u> required.

Hydrology for Inlet Structure @ Sta. 150+43

① Use Rational Method, $Q = CIA$

$A = 40.3\ in^2 = 9.3\ Ac.$

$C = 0.37$ *

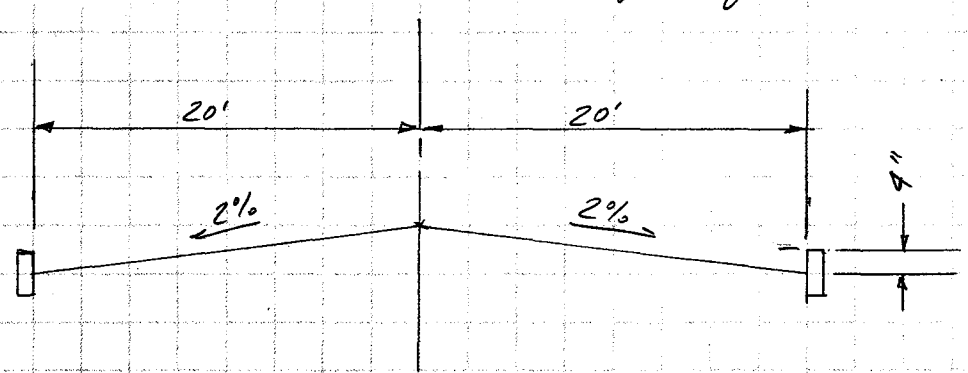
* "Hydrologic Analysis of Mesa Shadows East," sht. 27

T_c = Roof Time + Overland Flow Time
= 3 min + 1300' over pavement @ S = 0.7% (V = 1.7 fps)
= 3 min + $\frac{1300'}{1.7\ fps}$ = 3 min + 31 min = 34 min.

$I = 4.9$ in/hr. for 100 year storm

$Q = (0.37)(4.9)(9.3) = 16.9$ cfs

② Determine street hydraulic capacity



$L_c = 2\%$ $L_s = 0.3\%$

Street Hydraulics $Q_T = 2 \times 6.5\ cfs = 13\ cfs$

0.003	FPF
6.5	CFS
1.947005662	FPS

Hydrologic design:

The rational method as per Hydrologic Design for Highway Drainage in Arizona, Arizona Highway Department Bridge Division was used as a guideline for this section. The 100 year 24 hour storm was used with an associated rainfall depth of 3.40 inches. (See backup calculation herein for further details)

Areas associated for contributing runoff for this Section are as follows:

- from west side of RWCD canal maintenance road, to the west top of bank of the floodway channel
- from east side of RWCD Reach 6 right-of-way* to the east top of bank of the floodway channel.

Additional criteria:

- Operation and maintenance roads on both side of floodway have been designed with a grade of 1.75% draining away from the floodway channel into the east and west side collection system. Rationale for this is 1) eliminate ruts from drainage off the maintenance road from flowing over the banks of the main floodway channel causing maintenance problems and changing of "n" values over time. 2) Sloping

* Most of the east right of way has a block wall limiting its area. Where additional offsite area may contribute this additional area has been used.

the roadway away from the main floodway channel will limit vehicles from heading into the direction of the main floodway channel if slippage were to occur.

- the bank slope adjacent to the maintenance roads of the collector channel have been designed with a 4:1 slope to allow recovery if a vehicle should slippage occur.

- the bank slope of 3:1 was used to grade back to existing ground for these collector channel.

- limit the depth of water in the collector channels for safety reasons.

Description.

Three alternate channel configurations were analyzed for the east side collector system. The first alternate consisted of setting the minimum allowable velocity equal to 2 fps for the design discharge. This alternate required steep channel slopes which resulted in excessive cuts and quantities of excavation.

The second alternate used the method of setting the collector channel invert above the design high water in the main floodway to prevent or reduce backwater effects. This alternate produced mild channel slopes and velocities less than 2 fps and inadequate channel capacities. The third alternate used the method of setting the minimum permissible velocity at 2 fps to determine channel slopes in conjunction with inlets spaced at 500 ft. to eliminate long, steep channels.

The third alternate is considered to be the

most desirable due to adequate hydraulic capacity and low maintenance. A gravel underdrain is proposed at the inlets to drain the channel rapidly thus eliminating the potential for wet areas after raintall events.

Material Evaluation.

Earth Lining - An earth lining was evaluated for the east side collector system and it was found to have the lowest initial cost. However, some maintenance of the channel would be expected. Construction of an earth lined channel would be simple and the hydraulic characteristics are adequate for the design flow conditions.

Concrete Lining A concrete lining on the east side would have a high initial cost with little or no maintenance costs. This alternate would function very well hydraulically. The channel would have side slopes of 4:1 adjacent to the maintenance

road and 3:1 to get back to grade. The channel will have 0 depth at the upstream end and increase in depth toward the inlet. The concrete lining would eliminate the need for an underdrain at the inlet.

Gunite Lining A gunite lining would have a high initial cost with little or no maintenance. It will function well hydraulically and construction procedures would be simple. Channel side slope will be 4:1 adjacent to the maintenance road and 3:1 to get back to grade on the east side. The channel will have 0 depth at the upstream end and increase in depth toward the inlet. This alternate would eliminate the need for the gravel underdrain at the inlet due to the impervious ness of the gunite lining

Soil Cement Lining A soil cement lining would have a moderate initial cost with low maintenance costs. Hydraulically, it will function well. Channel side slopes will be 4:1 adjacent to the maintenance

road and 3:1 to get back to grade. Construction procedures will be simple and the need for the gravel underdrain would be eliminated. Channel depth would be 0 at the upstream end and increase toward the inlet.

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Job: SCS PWCD Reach 6
Description: East Side Collector Channel
Write up and recommendation.
Calculated by: R Beck Date: 2-10-86 Sheet No. 1
Checked by: M.S.S. Date: _____ of 1

Summary of Cost for all Alternatives.

Material	Quantity	Unit Cost	Cost.
Earth Lining	8864 yd^3 excav.	8.50/yd^3	75344.00
Concrete	1155 yd^3	165/yd^3	190575.00
Gunite	94500 ft^2	2.00/ft^2	189,000.00
Soil Cement	1750 yd^3	14.00/yd^3	24,500.00.

EAST SIDE COLLECTOR CHANNEL SYSTEM HYDROLOGIC/HYDRAULIC DESIGN

SUMMARY AND CONCLUSIONS

Three (3) alternative designs for the east and west collector channel systems were evaluated.

Alternate 1 used the method of minimum permissible velocity ≥ 2.0 fps for the design discharge. This alternate required steep channel slopes resulting in excessive depths of cut and quantities of excavation. Maintenance costs are not anticipated. Construction is considered infeasible and therefore this alternate is not recommended.

Alternate 2 used the method of setting the collector channel inverts above the design high water in the RWCD Floodway to prevent or reduce backwater effects. This alternate produced mild channel slopes resulting in flow velocities < 2.0 fps and inadequate channel capacities. Depths of cut and quantities of excavation are less than Alternate 1, however maintenance costs are anticipated because of siltation. This alternate is not recommended

Alternate 3 used the method of minimum permissible velocity ≥ 2.0 fps to determine channel slopes, in conjunction with ditch bottom inlets spaced at 500' to eliminate long, steep channels. Depths of cut and quantities of excavation are less than Alternate 1. Construction costs for Alternate 3 are greater because of the number of inlets required, however maintenance cost are not anticipated. This alternate is recommended.

Total number of inlets required is 20.

ADDENDUM to "HYDROLOGIC DESIGN FOR HIGHWAY DRAINAGE IN ARIZONA" April 1975 10/30/85

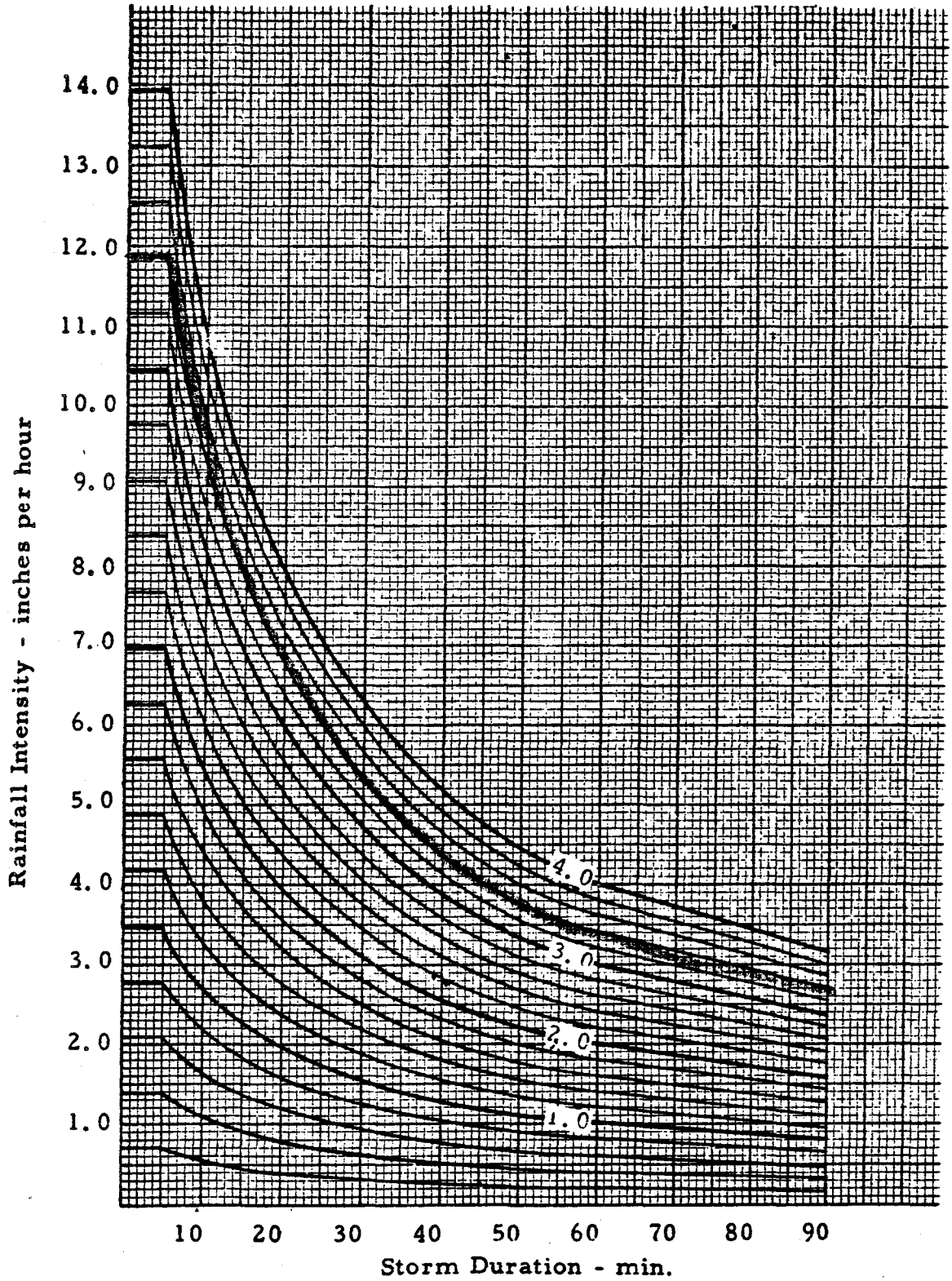
Steps to be used to determine precipitation values for various durations and return periods.

STEP 1. From the precipitation maps in the manual "Hydrologic Design for Highway Drainage in Arizona", determine the precipitation values for the 6 and 24 hour duration storms for return periods of 2, 5, 10, 25, 50 and 100 years. Tabulate these values in Table 1 in the column headed 'Map Values'

TABLE 1 Mesa

Return Period (Years)	Precipitation Values (inches)			
	6 hour duration		24 hour duration	
	Map Value	Corrected Value	Map Value	Corrected Value
2	1.1	1.10	1.3	1.30
5	1.6	1.58	1.8	1.82
10	1.9	1.89	2.2	2.18
25	2.3	2.30	2.7	2.60
50	2.6	2.63	3.0	3.01
100	3.0	3.02	3.4	3.40

NOTE: There is a possibility of making an error while reading the maps because, (1) a site is not easy to locate precisely on a series of 12 maps, (2) there may be some slight registration differences in printing, and (3) precise interpolation between isolines is difficult. In order to minimize any errors in reading the maps, these values should be plotted on the diagram "Precipitation Depth versus Return Period" Fig. 1.



For 100 year 24 hour duration P= 3.40 inches

Fig. 3-2

STANDARD DURATION RAINFALL - INTENSITY CURVES

Based on:
Weather Bureau
Technical Paper No. 40

△ Hydrology of collector channel for east side of R.O.W.

at Sta. 34+00 ~ 48+00

Use Rational Method $Q = CIA$ where $C = 0.38$ A.D.O.T. "Hydrologic Design for Highway Drainage" Pg. 53

Average of $C = 0.25$ (undisturbed soil & $C = 0.50$ (dirt road & embankment)

$A = \frac{1}{2}(114.5 + 91.5)(278.39) + (1120.17)(91.5)$

$= 131169.73\ ft^2 = 3.005$ acres

Tc:

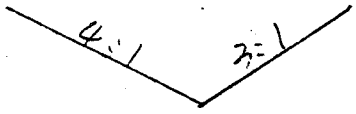
Short Grass Pasture $S = 0.0564$ ft/ft $L = 78'$ (NEH-4 Fig. 15.2)
Collector Channel assume $V = 2.5$ fps $L = 1398.56$

$Tc = [78/1.68 + 1398.56/2.5]/60 = 10.10$ mins.

Use $I = \cancel{1.13}\ 9.18$ in/hr (100 year 24 hour duration

$Q = CIA = 0.38 \times \cancel{1.13}\ 9.18 \times 3.005 = \cancel{1.34\ cfs}\ 10.48\ cfs$

△ Design of Collector Channel
Alt. No. 1
Use triangular collector channel



$n = 0.025$

$d = 1.05$ ft

$V = 2.75$ fps O.K.

4.	L BK
3.	R BK
0.	BASE
0.00536	FPF
0.025	N
1.05	DP
3.85875	AREA
7.64965245	WP
.5044346819	R
2.751316193	FPS
10.61664136	CFS

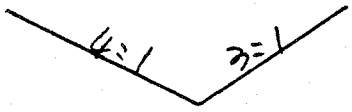
Inverts:

at Sta. 48+00 45.00

at Sta. 34+00 37.50

$S = 0.00536$ ft/ft

Alt. No. 2 Set inlet pipe at Sta. 41+00 N.G.



n = 0.0225

Inverts:

at Sta. 34+00 45.00

at Sta. 41+00 37.50

at Sta. 48+00 45.00

S = 0.01071 ft/ft

⇒ upstream side of channel

from Sta. 41+00

Q = 0.65 cfs

4.	L BK
3.	R BK
0.	BASE
0.01071	FPF
0.0225	N
0.3	DP
0.315	AREA
2.185614986	WP
.1441241948	R
1.866743921	FPS
.5880243351	CFS
0.32	DP
0.3584	AREA
2.331322651	WP
.1537324745	R
1.949234056	FPS
.6986054857	CFS
0.31	DP
0.33635	AREA
2.258468819	WP
.1489283346	R
1.908208561	FPS
.6418259495	CFS

△ Hydrology of Collector Channel for east side of R.O.W.

at Sta. 48+00 ~ 62+00

$A = 1400 \times 91.5 = 128100\ ft^2 = 2.935$ acres $\qquad C = 0.38$

Tc:

Short Grass Pasture $\quad S = 0.0564\ ft/ft \quad L = 78'$
Collector Channel $\quad$ assume $V = 2.5$ fps $\quad L = 1400'$

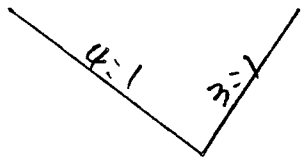
$T_c = [78/1.68 + 1400/2.5]/60 = 10.11$ mins.

Use $I = \cancel{1.13}\ 9.18$ in/hr (100 yr. ~~10 min.~~ 24 hr.)

$Q = CIA = 0.38 \times \cancel{1.13}\ 9.18 \times 2.935 = \cancel{1.26}\ 10.24$ cfs

△ Design of Collector Channel

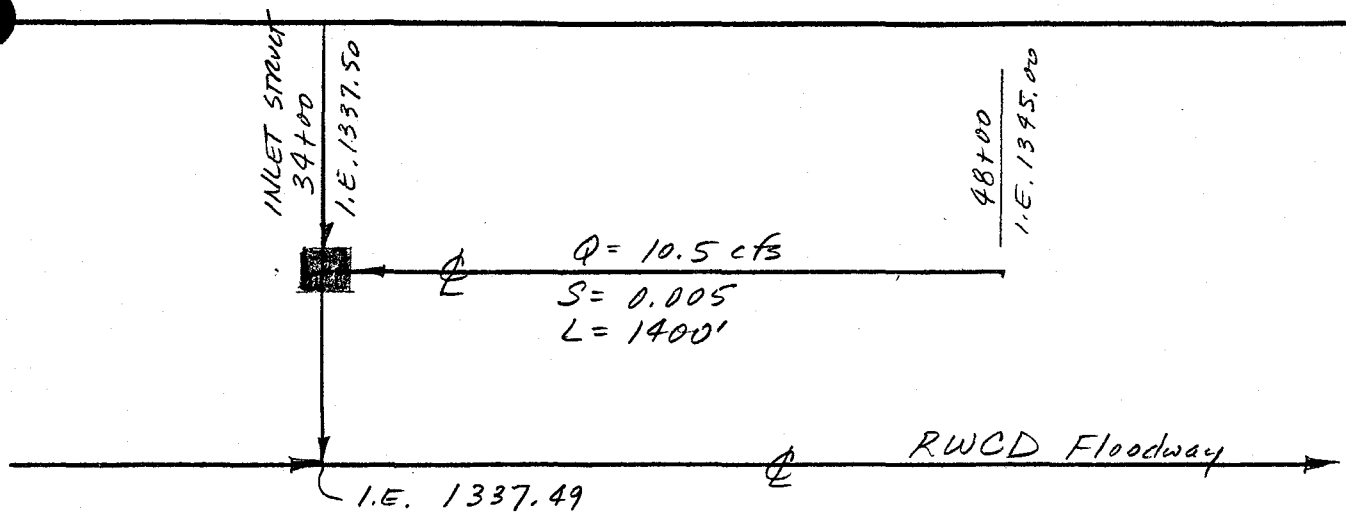
Alt. No. 1



$n = 0.025$
$d = 1.05$ ft
$V = 2.75$ fps
O.K.

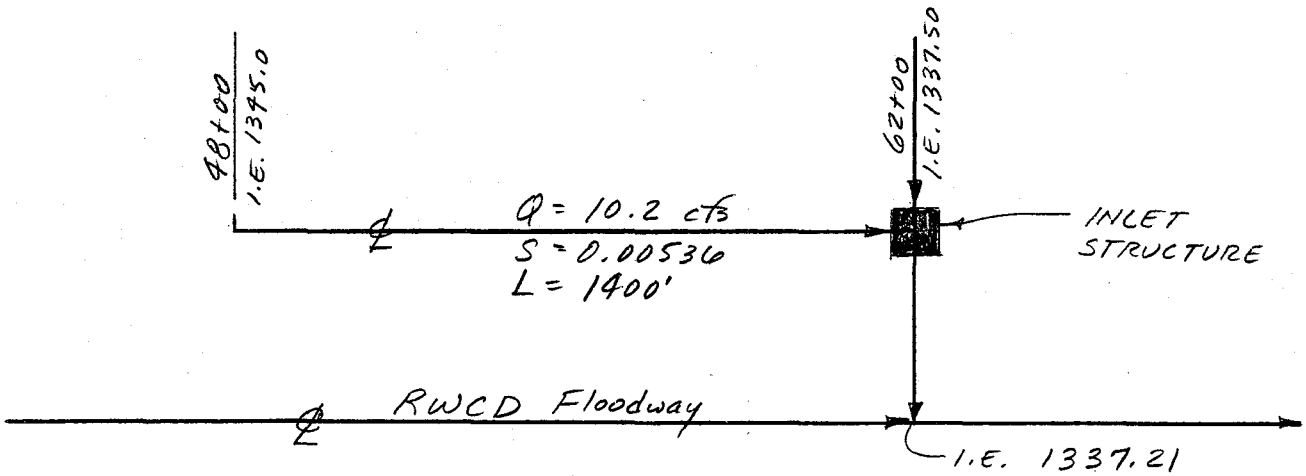
Inverts:

at Sta. 48+00 $\quad$ 45.00
at Sta. 62+00 $\quad$ 37.50 $\quad S = 0.00536$ ft/ft



ALT 1 SCHEMATIC DIAGRAM

Collector channel Sta. 34+00 to 48+00



ALT 1 SCHEMATIC DIAGRAM

Collector channel Sta 48+00 to 62+00

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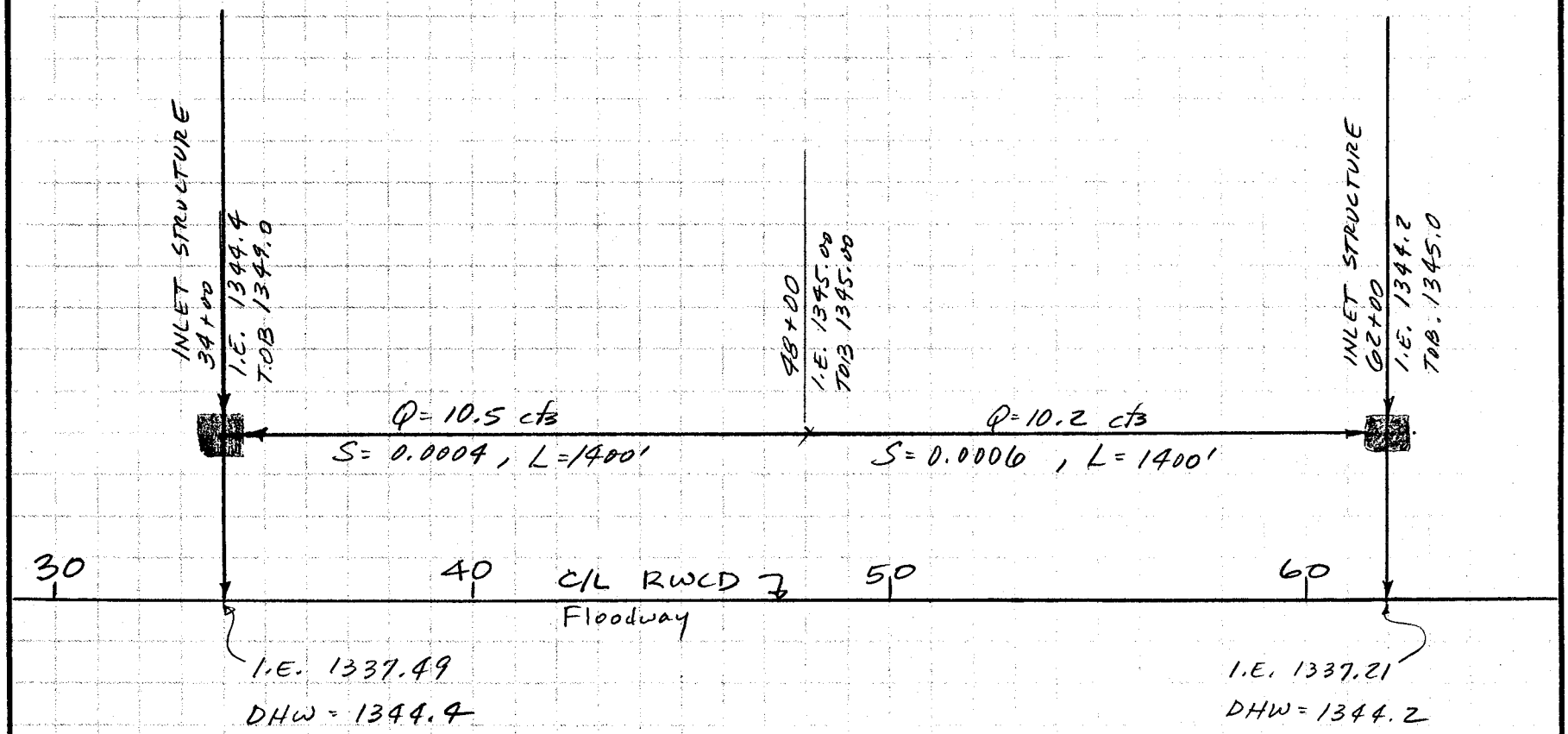
Description: Collector channel design
Calculated by: JTHH Date: 11-18-85 Sheet No. 3.2 of 19
Checked by: RB Date: 2-11-86



ALTERNATE 2 - SCHEMATIC DIAGRAM

Sta 34+00 to 48+00

4.	L BK	
3.	R BK	
0.	BASE	
0.0004	FPF	
0.025	N	
1.7	DP	= Depth OK
10.115	AREA	
12.38515159	WP	
.8167037706	R	
1.037987329	FPS	< 2.0 fps
10.49924183	CFS	

Sta 48+00 to 62+00

4.	L BK	
3.	R BK	
0.	BASE	
0.0006	FPF	
0.025	N	
0.8	DP	= Depth
2.24	AREA	
5.828306629	WP	
.3843311862	R	
.7671975293	FPS	
1.718522466	CFS	< 10.2 cfs not adequate

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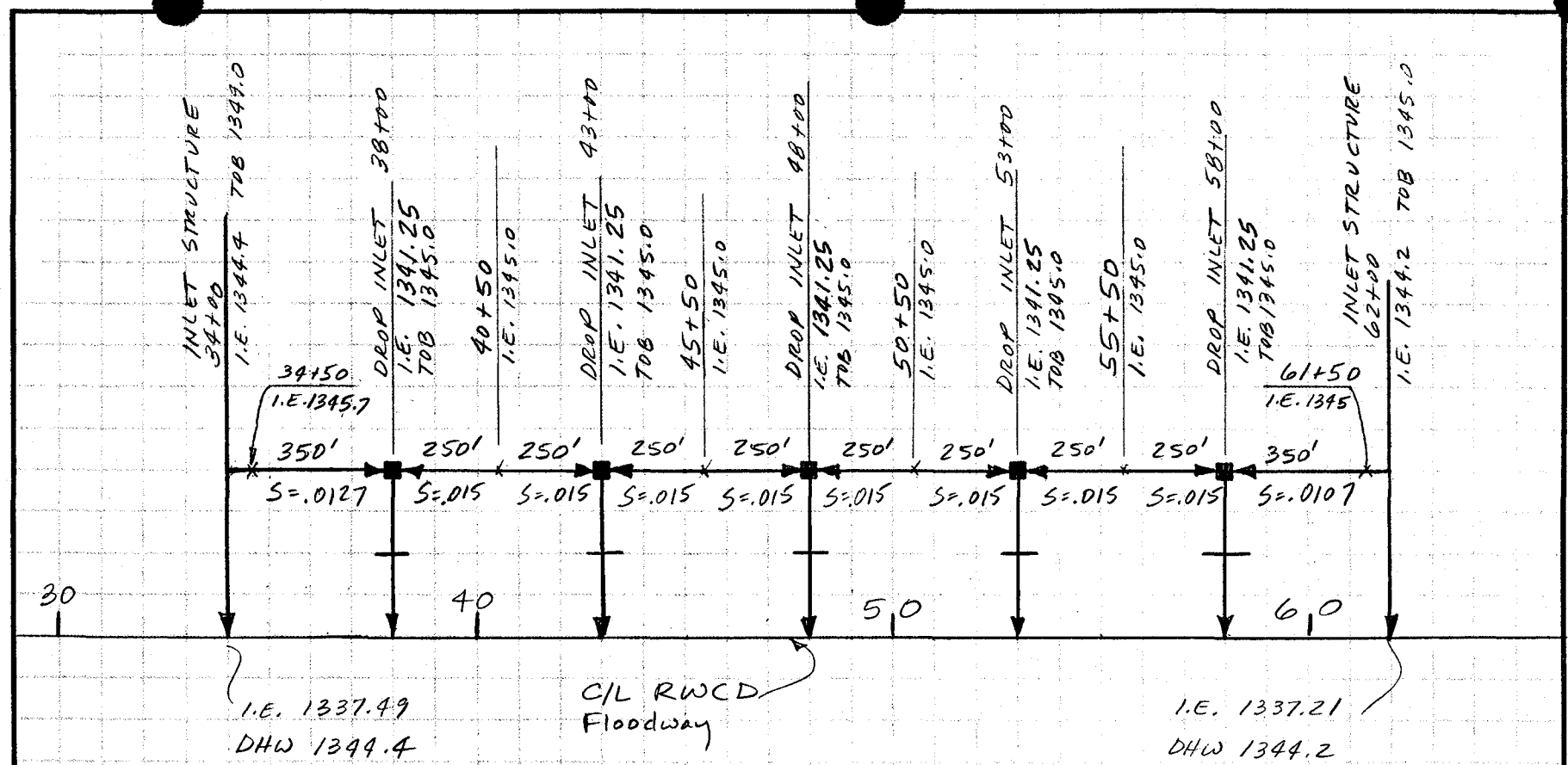
Job SCS RWCD Floodway Reach 6
Description Collector channel design
Calculated by JAH Date 11-19-85 Sheet No. 3.3
Checked by RB Date 2-11-86 of 19



ALTERNATE 3 - SCHEMATIC DIAGRAM

Discharge per channel segment = $\frac{\text{Total flow}}{\text{No. of segments}} = \frac{10.5}{10} = 1.05$ cfs

4.	L BK	
3.	R BK	
0.	BASE	
0.015	FPF	= SLOPE
0.025	N	
0.37	DP	
0.47915	AREA	
2.695591816	WP	
.1777531736	R	
2.288242585	FPS	OK
1.096411435	CFS	OK

QUANTITIES:
5 INLETS

△ Hydrology of collector channel for east side of R.O.W.

at Sta 63+00 ~ 78+55

Use Rational Method $Q = CIA$

where, $C = 0.38$* from A.D.O.T. "Hydrologic Design for Highway Drainage," pg 53

*Average of $C = 0.25$ (undisturbed soil) & $C = 0.50$ (dirt road & embankment)

$A = (1555' \times 88') = 136,840\ ft^2 = 3.14$ ac.

$T_c =$ 1555' collector channel @ $V = 2.5$ fps

$= \frac{1555'}{2.5\ fps} = 10.4$ min.

Use $I = 9.1$ in/hr (100 year - 10.4 min storm)

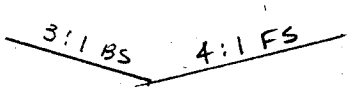
$Q = CIA = (0.38)(9.1)(3.14) = 10.9$ cfs

△ Design of Collector Channel

Alt No. 1 -

Use triangular channel collector

Outfall is to inlet structure at Sta. 78+55



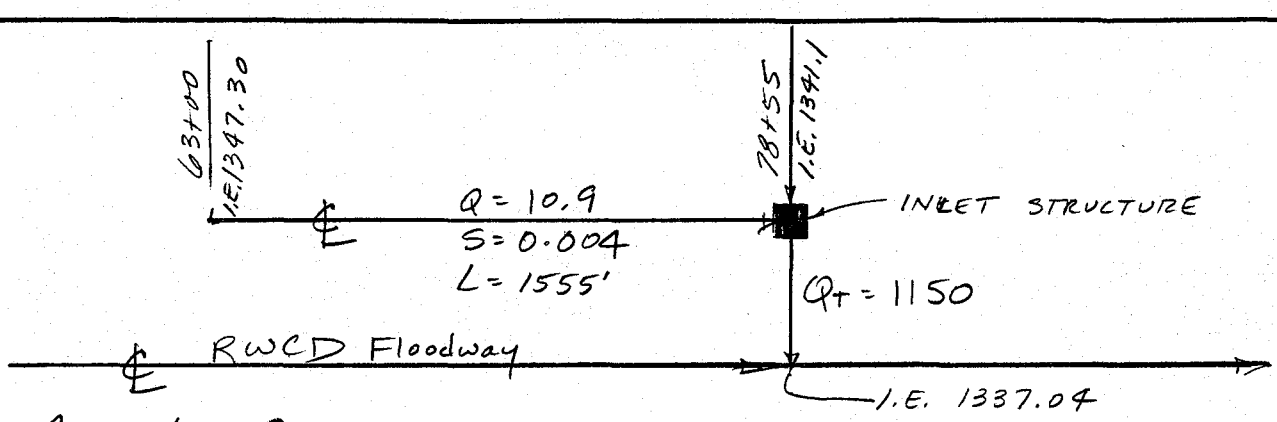
$n = 0.0225$

Invert of RWCD Floodway @ Sta. 78+55 = 1337.04

Invert of Collector Channel at Sta. 78+55 = 1341.10

" " " " " " 63+00 = 1347.30

See diagram next page.



ALT. 1 - SCHEMATIC DIAGRAM

Calculations for Collector Channel, Sta 63+00 to 78+55

4.	L BK
3.	R BK
0.	BASE
0.004	FPF
0.0225	Y
1.08	WP
4.0824	AREA
7.868213949	WP
.5188471013	R
2.691179597	FPS
10.98647159	CFS

△ Hydrology of collector channel for east side of R.O.W.

at Sta. 78+55 ± ~ 91+00 ±

Use Rational Method $Q = CIA$

where, $C = 0.38$* from A.D.O.T. "Hydrologic Design for Highway Drainage," pg 53

* Average of $C = 0.25$ (undisturbed soil) & $C = 0.50$ (dirt road & embankment)

$A =$ 40.2 sq.in. (planimeter) = 2.31 Ac.

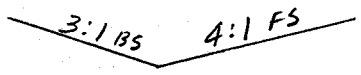
$T_c =$ 1345' collector channel @ $V = 2.5$ fps

$= \frac{1345'}{2.5 \text{ fps}} = 9.0$ min

Use $I = 9.6$ in/hr (100 year - 9 min storm)

$Q = CIA = (0.38)(9.6)(2.31) = 8.4$ cfs

△ Design of Collector Channel
Alt. No. 1
Outfall is to inlet structure @ Sta 78+55
Use triangular collector channel



$n = 0.0225$

Invert of RWCD Floodway @ Sta 78+55 = 1337.04
Invert of Collector Channel @ Sta. 78+55 = 1341.70
" " " " " " 89+50 = 1345.00

See diagram next page

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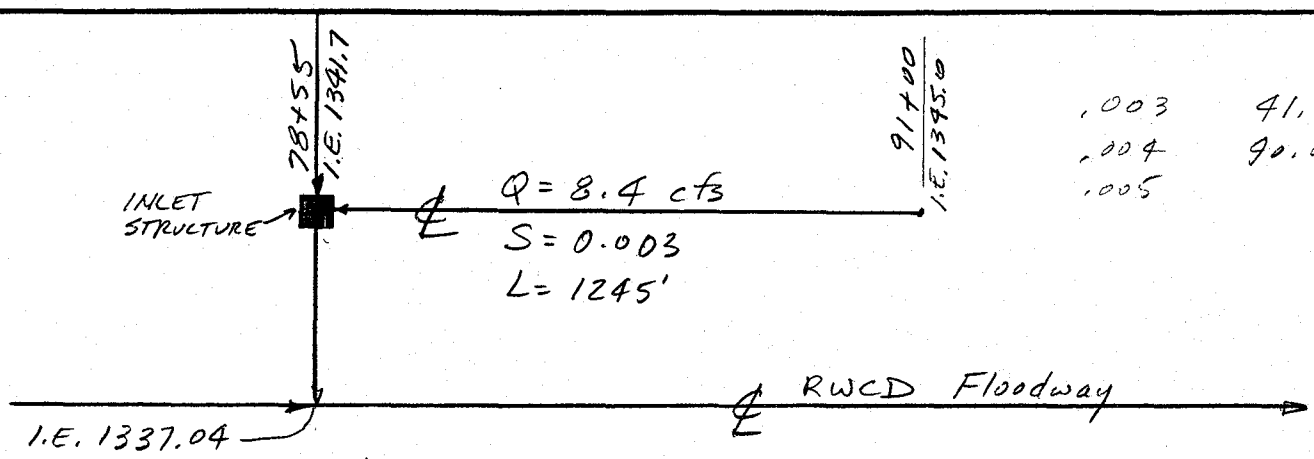

.003 41.27
.004 90.02
.005

ALT. 1 - SCHEMATIC DIAGRAM

Calculations for Collector Channel
Sta 78+55 to 91+00

4.	L BK
3.	R BK
0.	BASE
0.003	FRT
0.0225	T
1.04	D
3.7856	AREA
7.576798617	WP
0.499630542	R
2.272436385	FPS
8.602535179	CFS

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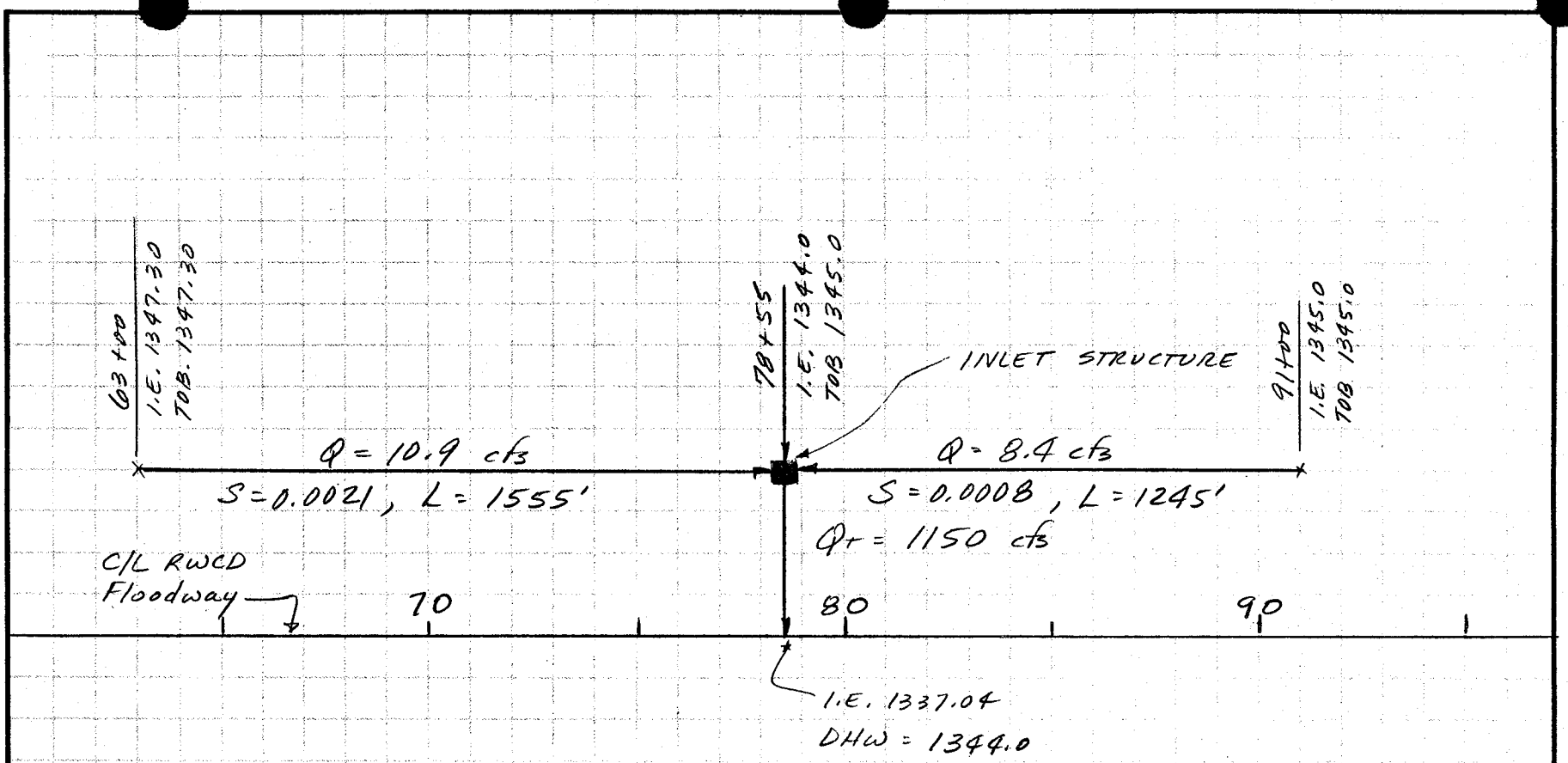
Job SCS RWCD Floodway Reach 6
Description Collector channel design
Calculated by JHH Date 11-18-85 Sheet No. 7.1
Checked by RB Date 2-11-86 of 19



ALTERNATE 2 - SCHEMATIC DIAGRAM

Sta 63+00 to 78+55

4.	L BK	
3.	R BK	
0.	BASE	
0.0021	FPF	
0.025	N	
1.	DP	
3.5	AREA	
7.285383286	WP	
.4804139827	R	
1.666751776	FPS	< 2.0 fps
5.833631215	CFS	< 10.9 cfs
		∴ not adequate

Sta 78+55 to 91+00

4.	L BK	
3.	R BK	
0.	BASE	
0.0008	FPF	
0.025	N	
1.	DP	
3.5	AREA	
7.285383286	WP	
.4804139827	R	
1.02874153	FPS	< 2.0 fps
3.600595355	CFS	< 8.4 cfs
		∴ not adequate

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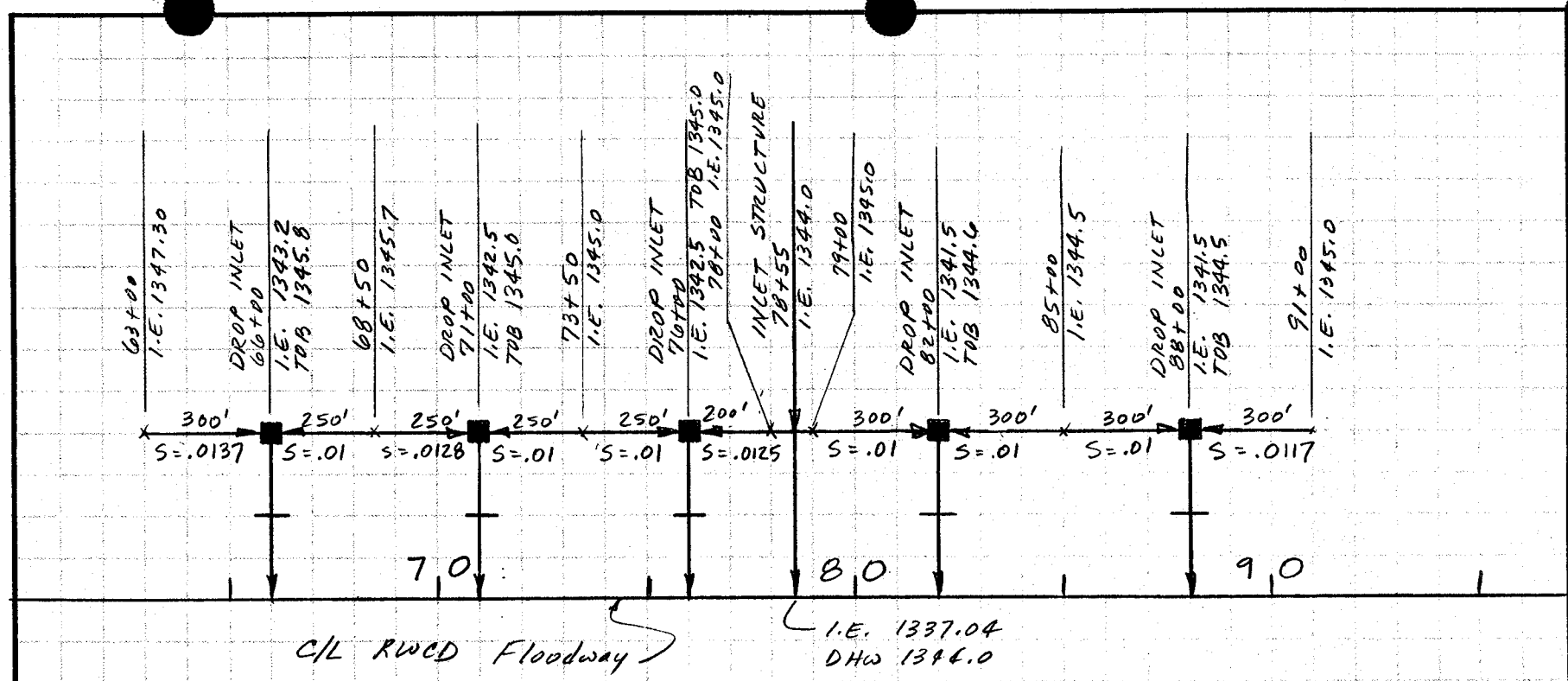
Job SCS RWCD Floodway Reach 6
Description Collector channel design
Calculated by VAH Date 11-19-85 Sheet No. 2.2
Checked by RB Date 2-11-86 of 19



ALTERNATE 3 - SCHEMATIC DIAGRAM

$$\text{Discharge per channel segment} = \frac{\text{Total discharge}}{\text{No. of segments}} = \frac{10.9 + 8.4}{10} = \frac{19.3}{10} = 1.9 \text{ cfs}$$

4.	L BK	
3.	R BK	
0.	BASE	
0.01	FPF	= minimum slope required.
0.025	N	
0.49	DP	
0.84035	AREA	
3.56983781	WP	
.2354028515	R	
2.255239413	FPS	> 2.0 fps OK
1.895190441	CFS	= 1.9 cfs

∴ adequate

QUANTITIES:
5 INLETS

△ Hydrology of collector channel for east side of R.O.W.

at Sta. 92+00 ~ 106+35

Use Rational Method $Q = CIA$,

where $C = 0.38$* from A.D.O.T. "Hydrologic Design for Highway Drainage," pg 53

*Average of $C = 0.25$ (undisturbed soil) & $C = 0.50$ (dirt road & embankment)

$A = 30.44$ SI (planimeter) $= 1.75$ Ac.

$T_c = 1435'$ collector channel @ $V = 2.5$ fps

$= \frac{1435'}{2.5 \text{ fps}} = 9.6$ min.

Use $I = 9.3$ in/hr (100 year - 9.6 min storm)

$Q = CIA = (0.38)(9.3)(1.75) = 6.2$ cfs

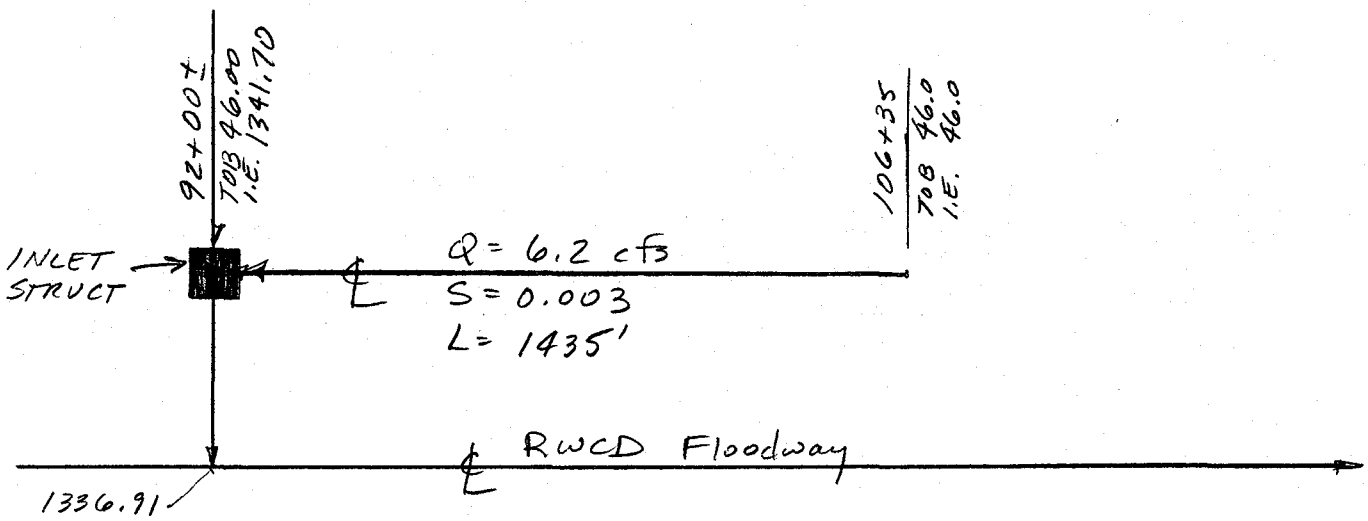
△ Design of Collector Channel
Alt. No. 1
Outfall is to inlet structure @ Sta 92+00 ±
Use triangular collector channel

3:1 BS 4:1 FS

$n = 0.0225$

Invert of RWCD Floodway @ Sta 92+00 ± = 1336.91
Invert of collector channel @ Sta 92+00 ± = 1341.7
" " " " " " 106+35 = 1346.0

See diagram next page



ALT. 1 - SCHEMATIC DIAGRAM

Calculations for Collector Channel
Sta 92+00 to 106+35

```
          4.     L BK
          3.     R BK
          0.     BASE
      0.003      FR
     0.0225       N
       0.92      DP
     2.9624     AREA
6.702552623       W
.4419808641       R
2.093231402      FPS
6.200988706      CFS
```

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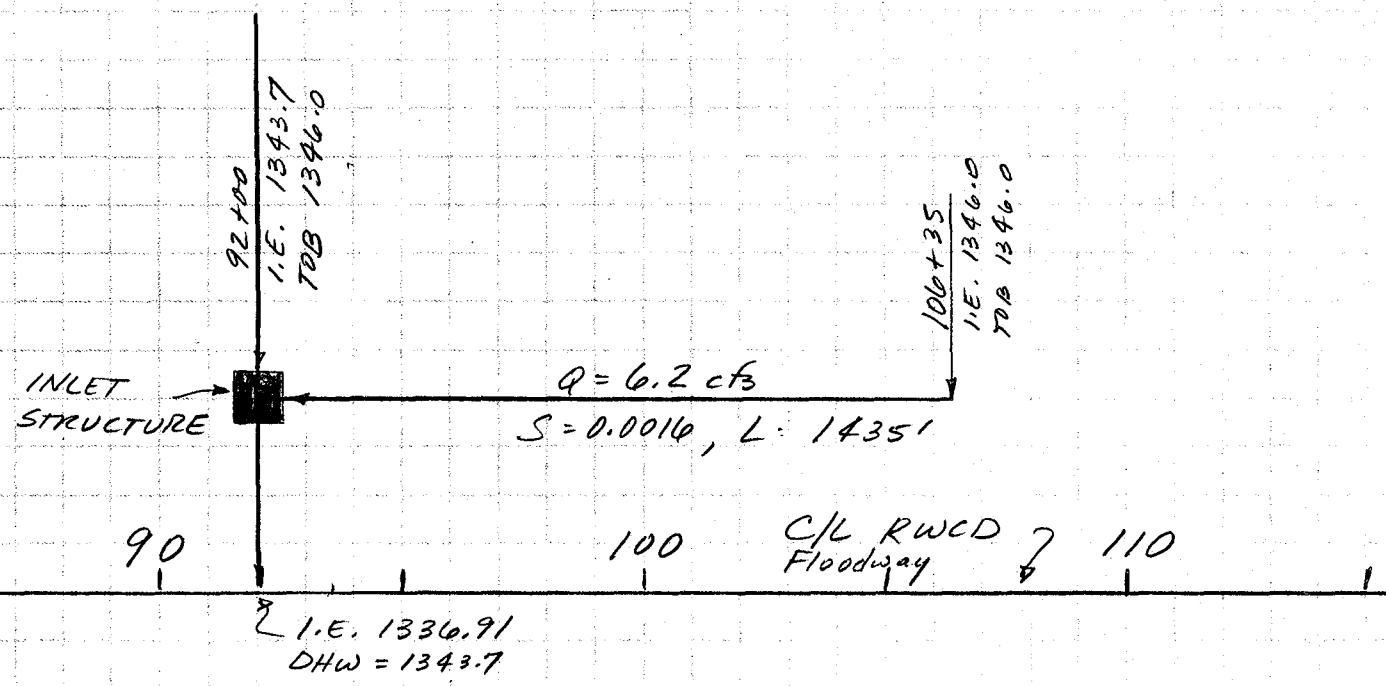
Job SCS RWCD Floodway Reach 6
Description Collector channel design
Calculated by JAM Date 11-18-85 Sheet No. 9.1
Checked by RB Date 2-11-86 of 19



ALTERNATE 2 - SCHEMATIC DIAGRAM

Sta. 92+00 to 106+35

4.	L BK	
3.	R BK	
0.	BASE	
0.0016	FPF	
0.025	N	
1.08	DP	
4.0824	AREA	
7.868213949	WP	
.5188471013	R	
1.531846281	FPS	< 2.0 cfs
6.253609258	CFS	

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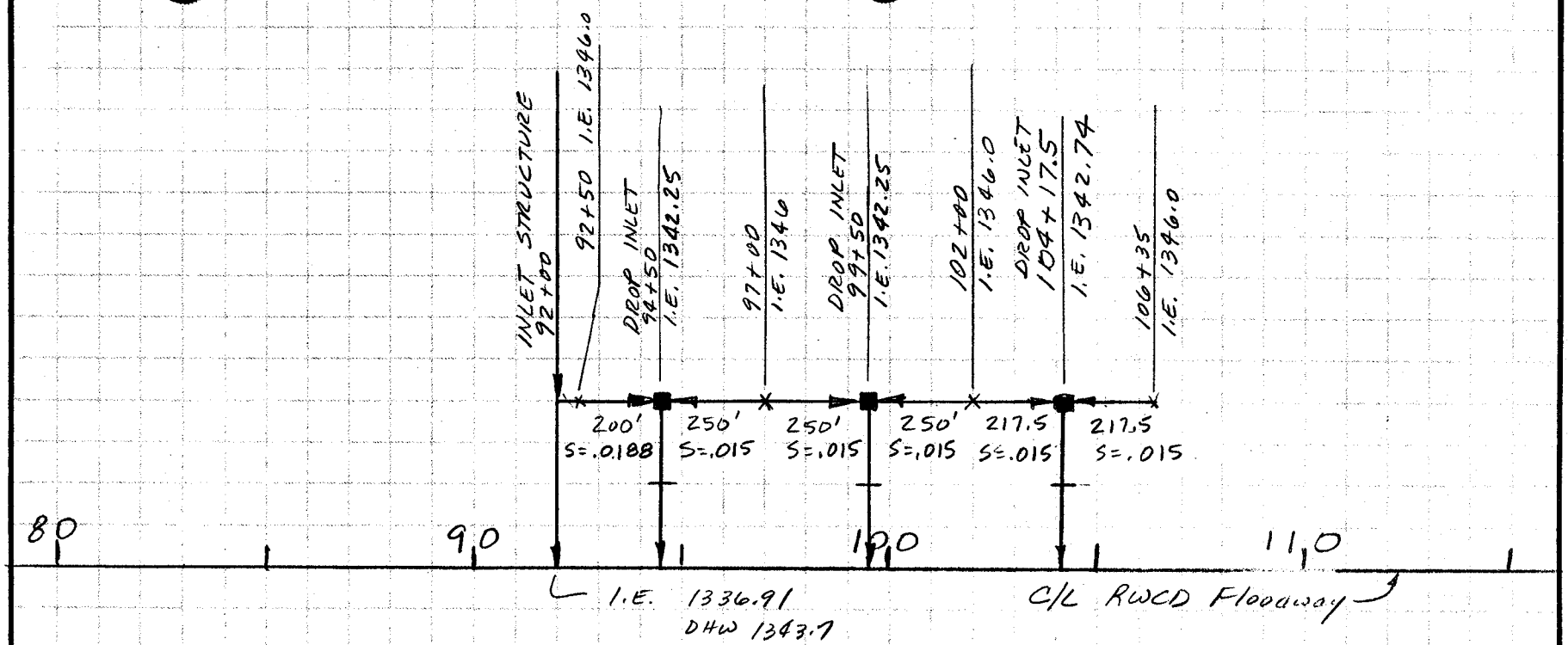


ALTERNATE 3 - SCHEMATIC DIAGRAM

$$\text{Discharge per channel segment} = \frac{\text{Total discharge}}{\text{No. of segments}} = \frac{6.2 \text{ cfs}}{6} = 1.0 \text{ cfs}$$

Sta 92+00 to 106+35

4.	L BK	
3.	R BK	
0.	BASE	
0.015	FPF	
0.025	N	
0.36	DP	
0.4536	AREA	
2.622737983	WP	
.1729490338	R	
2.24661981	FPS	> 2.0 fps OK
1.019066746	CFS	= 1.0 cfs, ∴ adequate

QUANTITIES:
3 INLETS

Job: SCS RWCD Floodway Reach 6
Description: Collector channel design
Calculated by: JAA Date: 11-19-85
Checked by: RB Date: 2-11-86
Sheet No. 9.2 of 19

△ Hydrology of collector channel for east side of R.O.W.

at Sta. 106+35 ~ 120+65

Use Rational Method $Q = CIA$,

where $C = 0.38$* from A.D.O.T. "Hydrologic Design for Highway Drainage," pg 53

*Average of $C = 0.25$ (undisturbed soil) & $C = 0.50$ (dirt road & embankment)

$A = 34.8$ SI (planimeter) $= 2.0$ Ac.

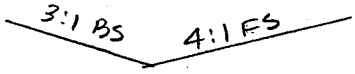
$T_c = 1430'$ collector channel @ $V = 2.5$ fps

$= \frac{1430'}{2.5 \text{ fps}} = 9.5$ min.

Use $I = 9.4$ in/hr (100 year - 9.5 min storm)

$Q = CIA = (0.38)(9.4)(2.0) = 7.1$ cfs

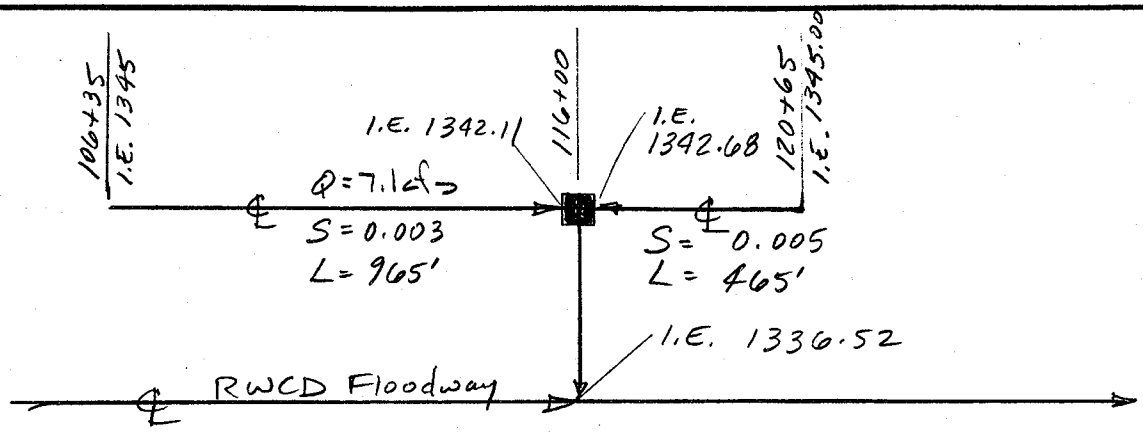
△ Design of Collector Channel
Alt. No. 1
Outfall is to inlet structure @ Sta 116+00 ±
Use triangular collector channel



$n = 0.0225$

Invert of RWCD Floodway at Sta. 116+00 ± = 1336.52
Invert of collector channel at Sta. 106+35 = 1345.00
" " " " " " 116+00 = 1342.11 (north)
" " " " " " 120+65 = 1345.00
" " " " " " 116+00 = 1342.68 (south)

See diagram next page



ALTERNATE 1 - SCHEMATIC DIAGRAM

Calculations for Collector Channel
Sta 106+35 to 116+00

```
          4.     L BK
          3.     R BK
          0.     BASE
      0.003      FRE
     0.0225        N
       0.97       DP
    3.29315     AREA
7.066821787       WP
.4660015632        R
2.168784791      FRS
7.142133634      CRS
```

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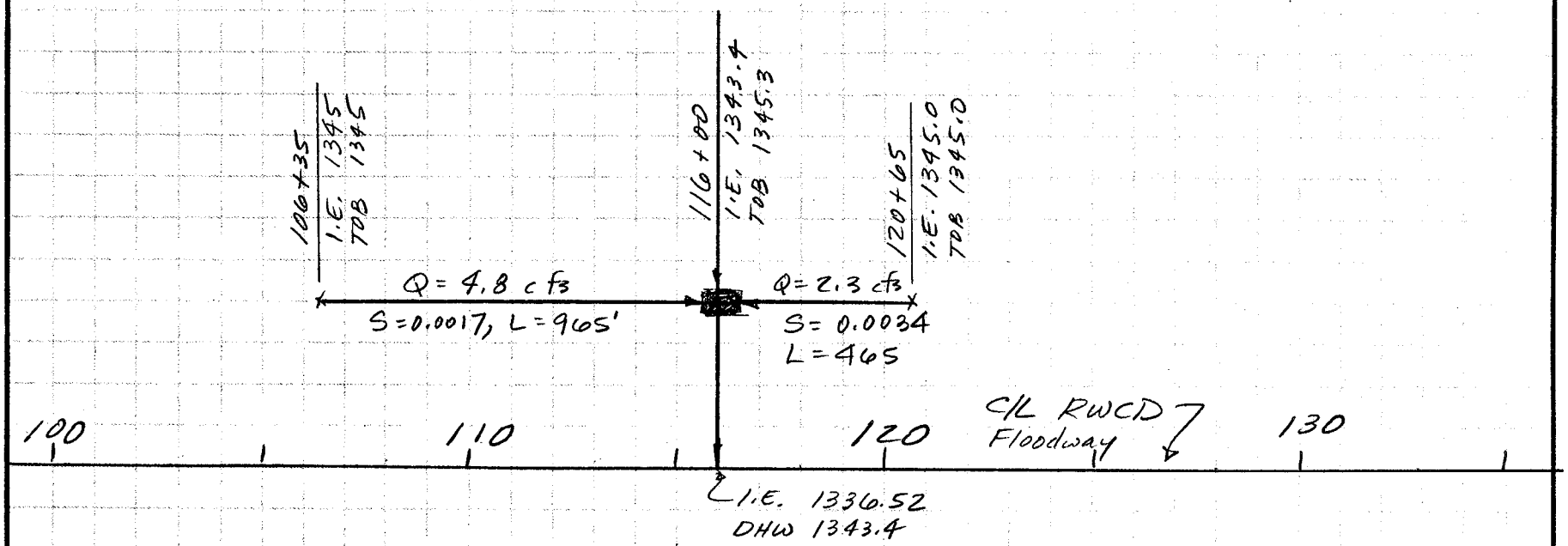
Phoenix 602 275-5400

Job SCS RWCD Floodway Reach 6
Description Collector channel design
Calculated by JAA Date 11-18-85 Sheet No. 11.1
Checked by RB Date 2-11-86 of 19



ALTERNATE 2 - SCHEMATIC DIAGRAM

Sta 106+35 to 116+00

4.	L BK	
3.	R BK	
0.	BASE	
0.0017	FPF	
0.025	N	
1.	DP	
3.5	AREA	
7.285383286	WP	
.4804139827	R	
.499635594	FPS	< 2.0 fps
5.248724578	CFS	

Sta 116+00 to 120+65

4.	L BK	
3.	R BK	
0.	BASE	
0.0034	FPF	
0.025	N	
0.7	DP	
1.715	AREA	
5.0997683	WP	
.3362897879	R	
1.66999982	FPS	< 2.0 fps
2.864049692	CFS	

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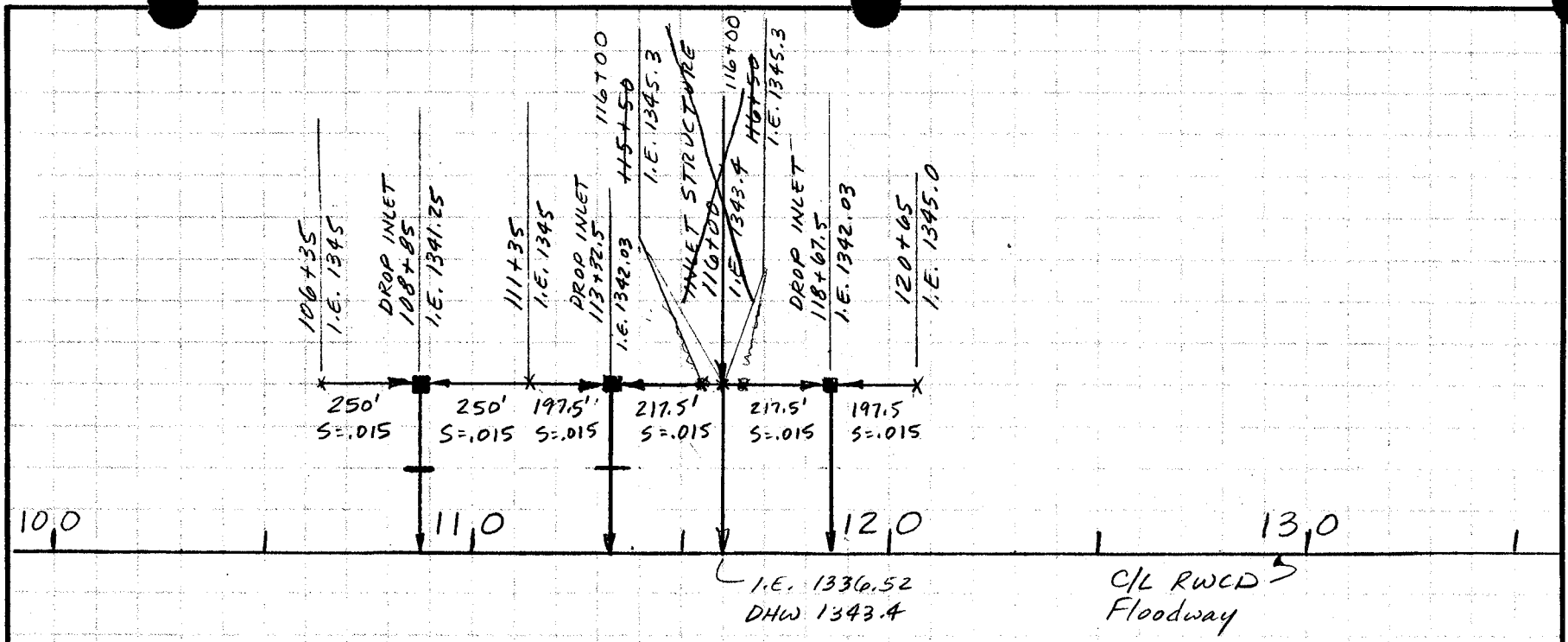
Job: SCS RWCD Floodway Reach 6
Description: Collector channel design
Calculated by: JAM Date: 11-18-85 Sheet No. 11.2
Checked by: RB Date: 2-11-86 of 19



ALTERNATE 3 - SCHEMATIC DIAGRAM

Discharge per channel segment = $\frac{\text{Total discharge}}{\text{No. of segments}} = \frac{7.1}{6} = 1.2$ cfs

Sta 106+35 to 120+65

4.	L BK	
3.	R BK	
0.	BASE	
0.015	FPF	
0.025	N	
0.38	DP	
0.5054	AREA	
2.768445649	WP	
.1825573134	R	
2.329495728	FPS	> 2.0 fps
1.177327141	CFS	≈ 1.2 cfs

∴ adequate

QUANTITIES:
3 INLETS

△ Hydrology of collector channel for east side of R.O.W.

at Sta. 127+50 ~ 140+50

Use Rational Method $Q = CIA$

where, $C = 0.38$* from A.D.O.T. "Hydrologic Design for Highway Design," pg 53

*Average of $C = 0.25$ (undisturbed soil) & $C = 0.50$ (dirt road & embankment)

$A = 19.84$ SI (planimeter) $= 1.14$ Ac.

$T_c = 1300'$ collector channel @ $V = 2.5$ fps

$= \frac{1300'}{2.5 \text{ fps}} = 8.7$ min.

Use $I = 9.8$ in/hr. (100 year - 8.7 min storm)

$Q = CIA = (0.38)(9.8)(1.14) = 4.2$ cfs

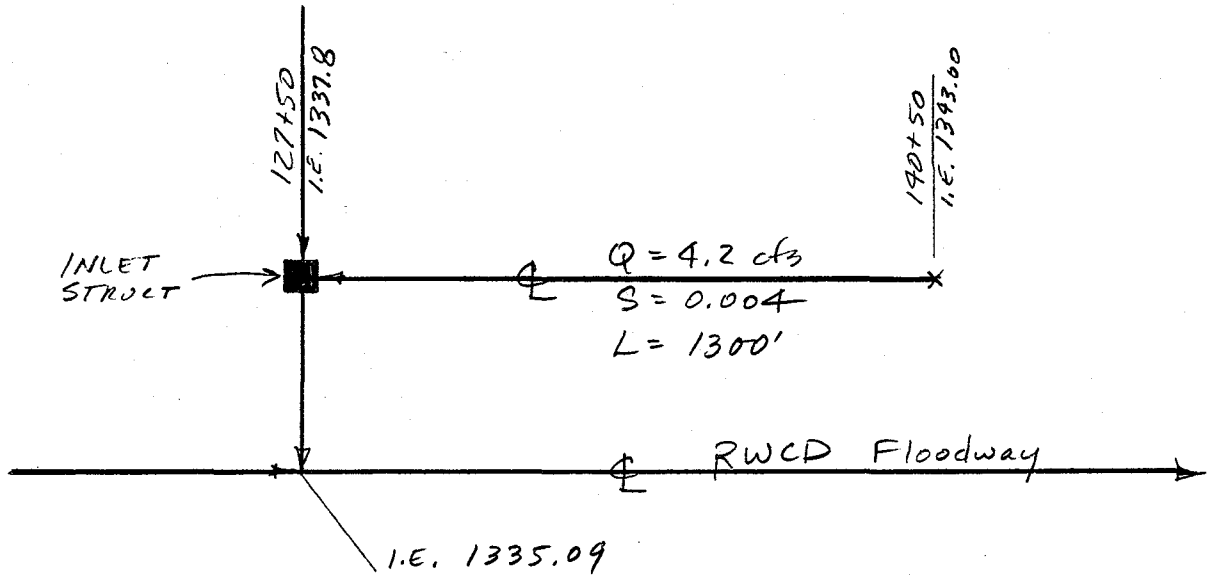
△ Design of Collector Channel
Alt. No. 1
Outfall is to inlet structure @ Sta
Use triangular collector channel

3:1 BS 4:1 FS

$n = 0.0225$

Invert of RWCD Floodway @ Sta. 127+50 = 1335.09
Invert of Collector Channel @ Sta 127+50 = 1337.80
" " " " " " 140+50 = 1343.00

See diagram next page.



ALTERNATE 1 - SCHEMATIC DIAGRAM

Calculations for Collector Channel
Sta 127+50 to 140+50

```
                 4.     L BK
                 3.     R BK
                 0.    BASE
             0.004      REF
            0.0225       N
              0.75       TP
           1.96875     AREA
       5.464037464       WP
       0.360310487       HR
       2.107850532      RAS
       4.149830735      DAS
```

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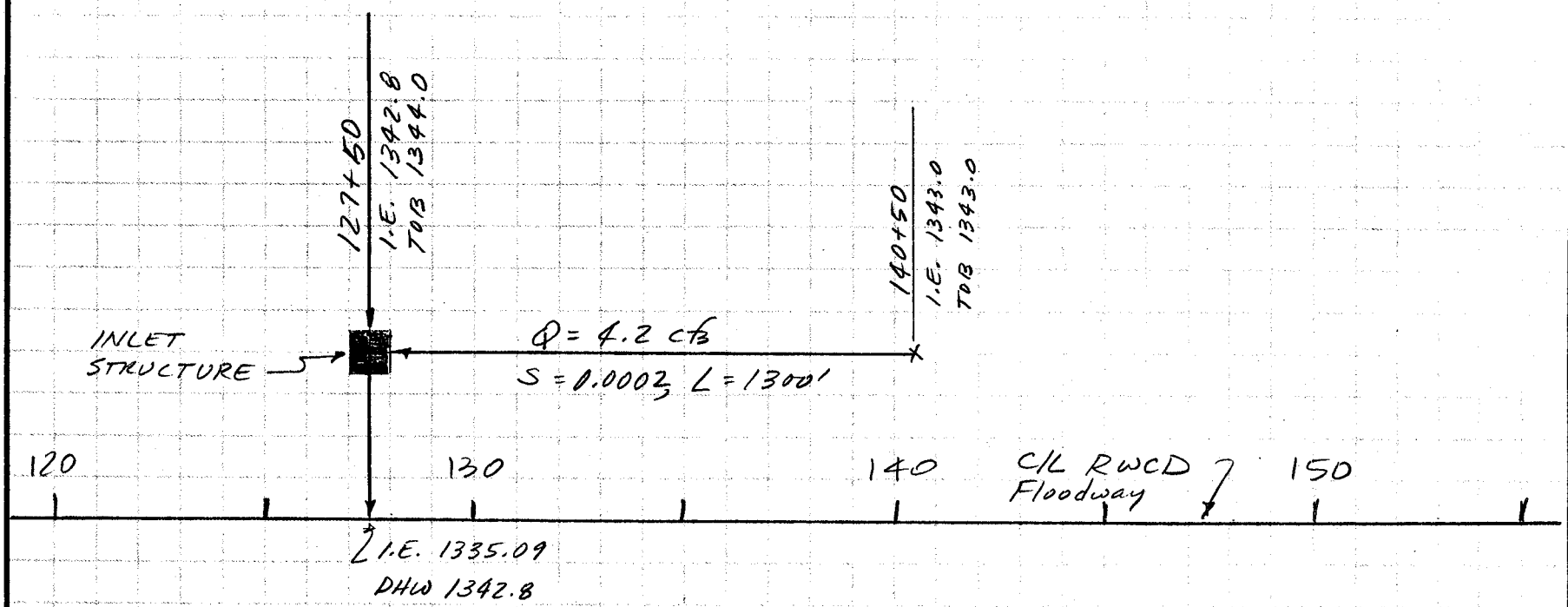

ALTERNATE 2 - SCHEMATIC DIAGRAM

Sta. 127+50 to 140+50

4.	L BK
3.	R BK
0.	BASE
0.0002	FPF
0.025	N
1.2	DP
5.04	AREA
4.742459943	WP
.5764967793	R
.5812028186	FPS
2.929262206	CFS

< 4.2 cfs

∴ not adequate

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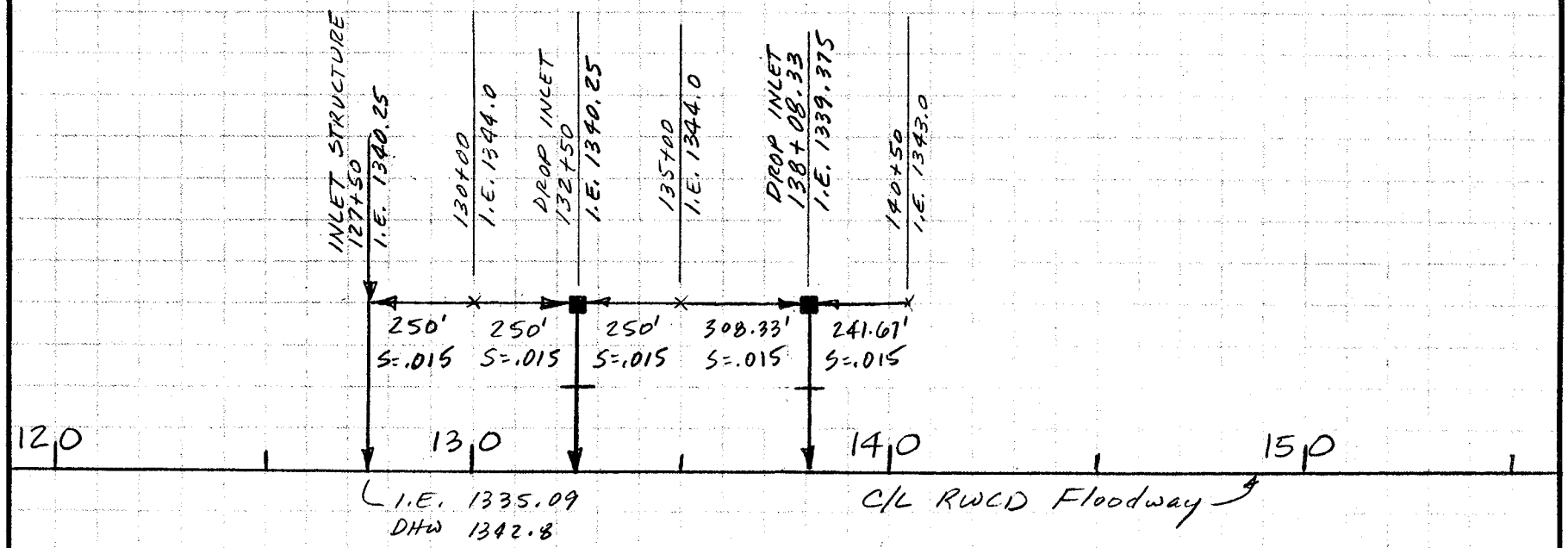
Job SCS RWCD Floodway Reach 6
Description Collector channel design
Calculated by JAA Date 11-19-85 Sheet No. 13.2
Checked by RB Date 2-11-86 of 19



ALTERNATE 3 - SCHEMATIC DIAGRAM

Discharge per channel segment = $\frac{\text{Total discharge}}{\text{No. of segments}} = \frac{4.2 \text{ cfs}}{5} = 0.8$ cfs

Sta 127+50 to 140+50

4.	L BK
3.	R BK
0.	BASE
0.015	FPF
0.025	N
0.45	DP
0.70875	AREA
3.278422479	WP
.2161862922	R
2.608911174	FPS
.849065795	CFS

> 2.0 fps
≈ 0.8 cfs, ∴ adequate

QUANTITIES
2 INLETS

△ Hydrology of collector channel for east side of R.O.W.

at Sta. 140+50 ~ 153+50

Use Rational Method $Q = CIA$

where, $C = 0.38^*$ from A.D.O.T. "Hydrologic Design for Highway Design," pg 53

* Average of $C = 0.25$ (undisturbed soil) & $C = 0.50$ (dirt road & embankment)

$A = 23.11$ SI (planimeter) $= 1.33$ Ac.

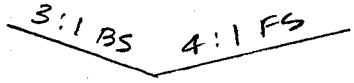
$T_c = 1300'$ collector channel @ $V = 2.5$ fps

$= \frac{1300'}{2.5} = 8.7$ min.

Use $I = 9.8$ in/hr (100 year - 8.7 min storm)

$Q = CIA = (0.38)(9.8)(1.33) = 5.0$ cfs

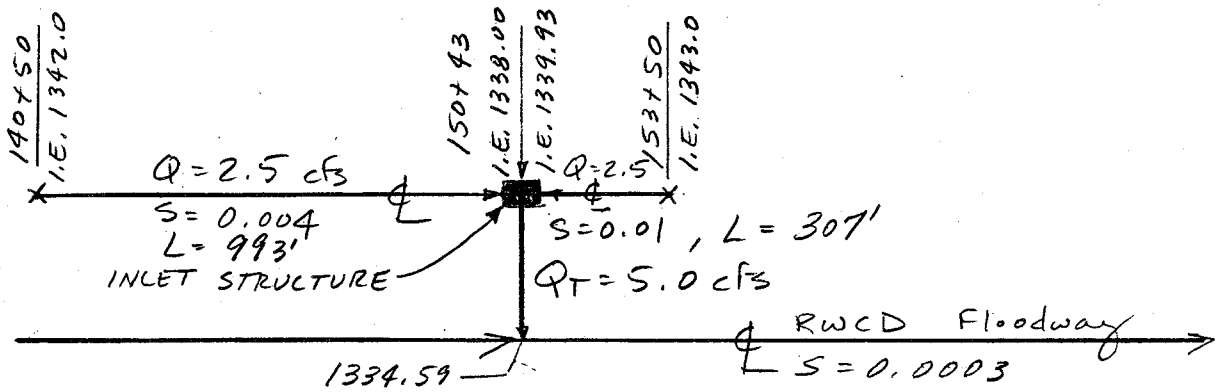
△ Design of Collector Channel
Alt. No. 1
Use triangular collector channel.
Outfall is to inlet structure at Sta. 150+43



$n = 0.0225$, Use $Q = 2.5$ cfs for each trib.

Invert of RWCD Floodway @ Sta 150+43 = 1334.59
No. Invert of Collector Channel @ Sta 150+43 = 1338.00
So. Invert " " " " Sta. 150+43 = 1339.93
Invert " " " " Sta 140+50 = 1342.00
Invert " " " " Sta 153+50 = 1343.00

See diagram next page.



ALTERNATE 1 - SCHEMATIC DIAGRAM

Calculations for Collector Channel Sta 140+50 to 150+43

4.	L BK
3.	R BK
0.	BASE
0.004	FPF
0.0225	N
0.62	DP
1.3454	AREA
4.516937637	WP
.2978566693	R
1.855458295	FPS
2.496333591	CFS

Calculations for Collector Channel Sta 150+43 to 153+50

4.	L BK
3.	R BK
0.	BASE
0.01	FPF
0.0225	N
0.53	DP
0.98315	AREA
3.861253141	WP
.2546194108	R
2.641092441	FPS
2.596590034	CFS

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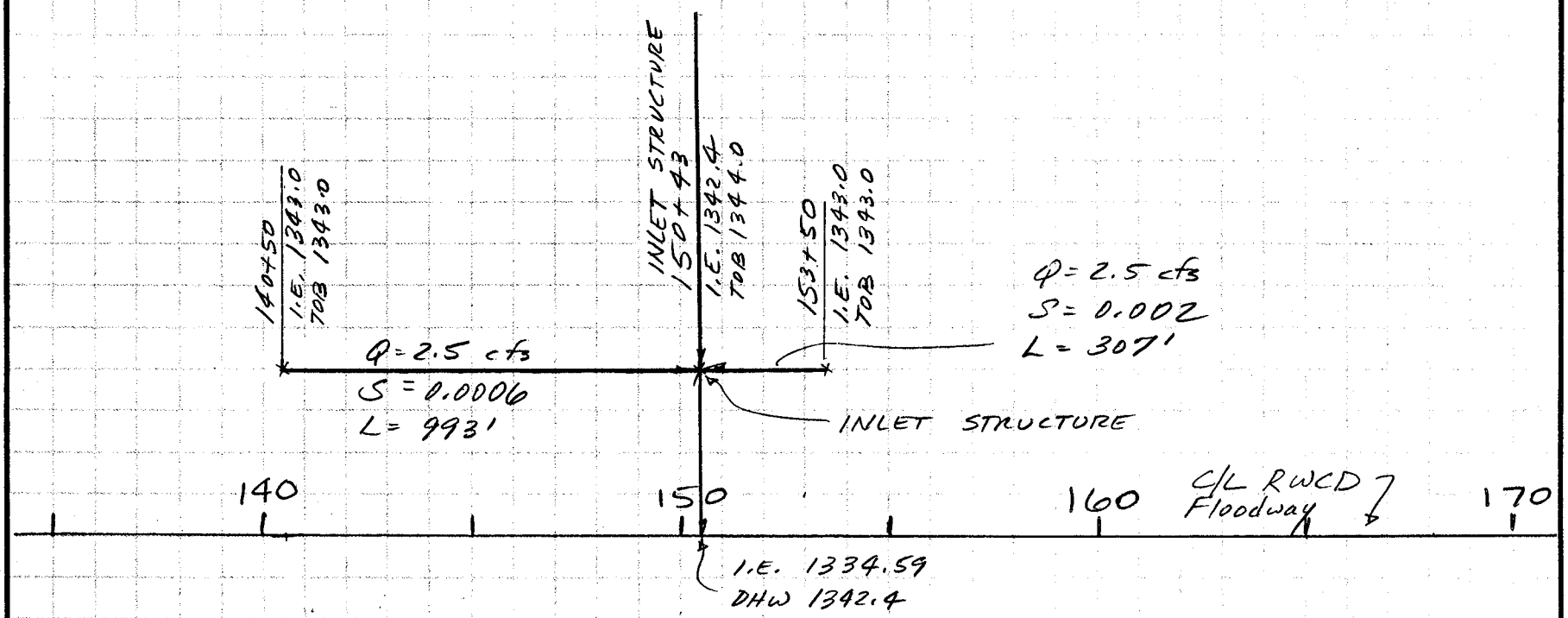
Phoenix 602 275-5400

Job SCS RWCD Floodway Reach 6
Description Collector channel design
Calculated by JAH Date 11-18-85 Sheet No. 15.1
Checked by RB Date 2-11-86 of 19



ALTERNATE 2 - SCHEMATIC DIAGRAM

Sta 140+50 to 150+43

4.	L BK	
3.	R BK	
0.	BASE	
0.0006	FPF	
0.025	N	
1.	DP	
3.5	AREA	
2.285383286	WP	
.4804139827	R	
0.890916299	FPS	< 2.0 fps
3.118207047	CFS	

Sta 150+43 to 153+50

4.	L BK	
3.	R BK	
0.	BASE	
0.002	FPF	
0.025	N	
0.74	DP	
1.9166	AREA	
5.391183631	WP	
.3555063472	R	
.329417922	FPS	< 2.0 fps
2.547962389	CFS	

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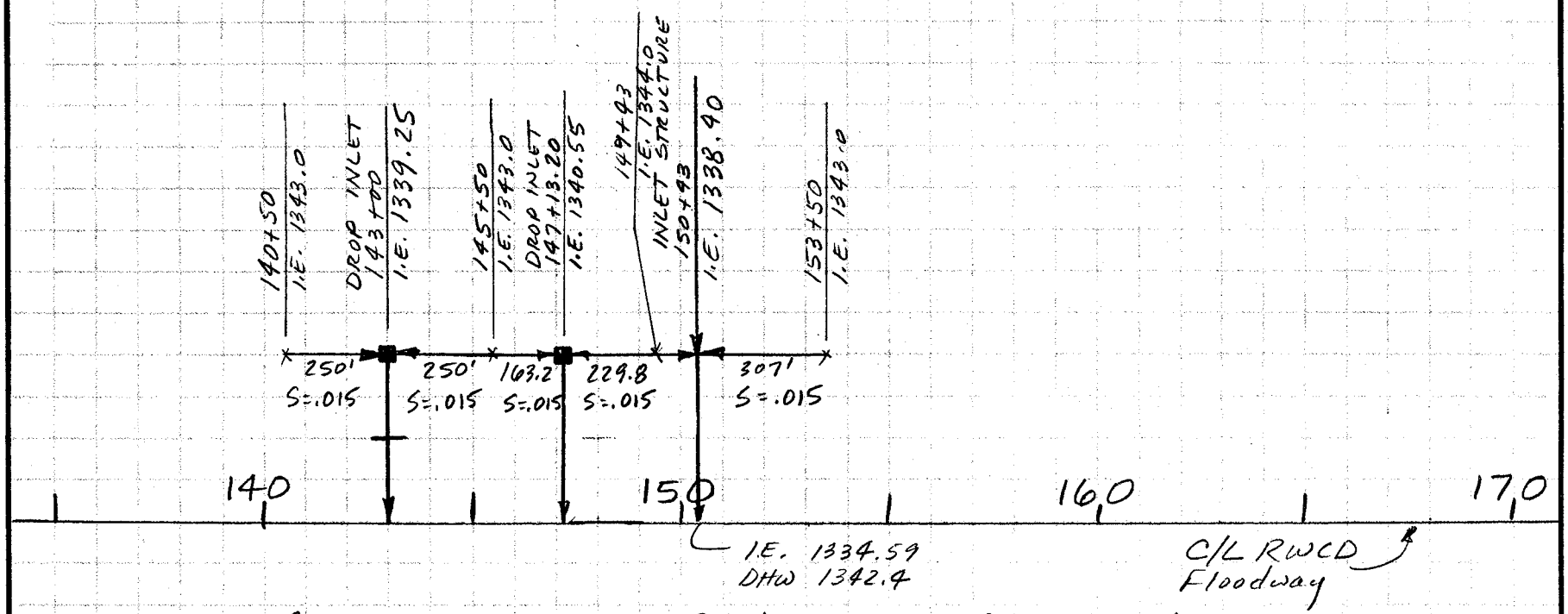


ALTERNATE 3 - SCHEMATIC DIAGRAM

Discharge per channel segment = $\frac{\text{Total discharge}}{\text{No. of segments}} = \frac{5.0}{5} = 1.0$ cfs

Sta 140+50 to 153+50

4.	L BK
3.	R BK
0.	BASE
0.015	FPF
0.025	N
0.37	DP
0.47915	AREA
2.695591816	WP
.1777531736	R
2.288242585	FPS > 2.0 fps
1.096411435	CFS ≈ 1.0 cfs, ∴ adequate

QUANTITIES
2 INLETS

LATERAL

DRAIN

DETAILS

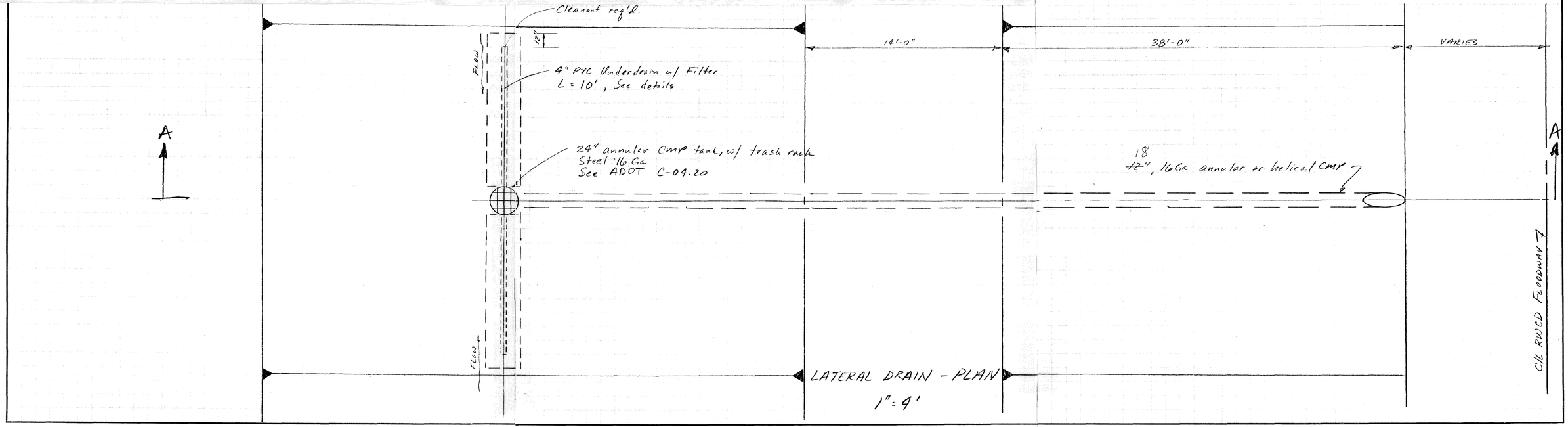
SUMMARY OF LATERAL DRAINS

STATION	ELEV A	ELEV B	ELEV C	ELEV D	L (FT)	H (FT)
38+00	1341.75	1337.95	1337.45	1339.92	62.3	3.8
43+00	1341.75	1337.90	1337.40	1339.92	62.1	3.9
48+00	1341.75	1337.84	1337.35	1339.92	61.9	3.9
53+00	1341.75	1337.79	1337.30	1339.92	61.7	4.0
58+00	1341.75	1337.74	1337.25	1339.92	61.5	4.0
66+00	1343.70	1337.56	1337.17	1341.87	53.4	6.1
71+00	1343.00	1337.54	1337.12	1341.17	56.0	5.5
76+00	1343.00	1337.49	1337.07	1341.17	55.8	5.5
82+00	1342.00	1337.48	1337.01	1340.17	59.6	4.5
88+00	1342.00	1337.41	1336.95	1340.17	59.3	4.6
94+50	1342.75	1337.26	1336.84	1340.92	55.9	5.5
99+50	1342.75	1337.23	1336.81	1340.92	55.8	5.5
104+17.5	1343.24	1337.09	1336.70	1341.41	53.4	6.1
108+85	1341.75	1337.09	1336.63	1339.92	59.0	4.7
113+32.5	1342.53	1336.98	1336.56	1340.70	55.6	5.6
118+67.5	1342.53	1336.89	1336.48	1340.70	55.3	5.6
132+50	1340.75	1335.56	1335.13	1338.92	57.0	5.2
138+08.33	1339.88	1335.43	1334.96	1338.05	59.9	4.5
143+00	1339.75	1335.28	1334.81	1337.92	59.8	4.5
147+13.20	1341.05	1335.09	1334.69	1339.22	54.1	6.0
Total					1159.4	99.0

$$L = \{42.5 + [(\text{Elev } C + 9.255 - \text{Ditch Invert})\ 4] - 2\}$$

$$H = \{(\text{Ditch Invert} + 0.5) - [(0.012 \times L) + \text{Elev. } C - 0.25]\}$$

$$\text{Elev. } B = \text{Elev } C + (0.012L) - 0.25$$



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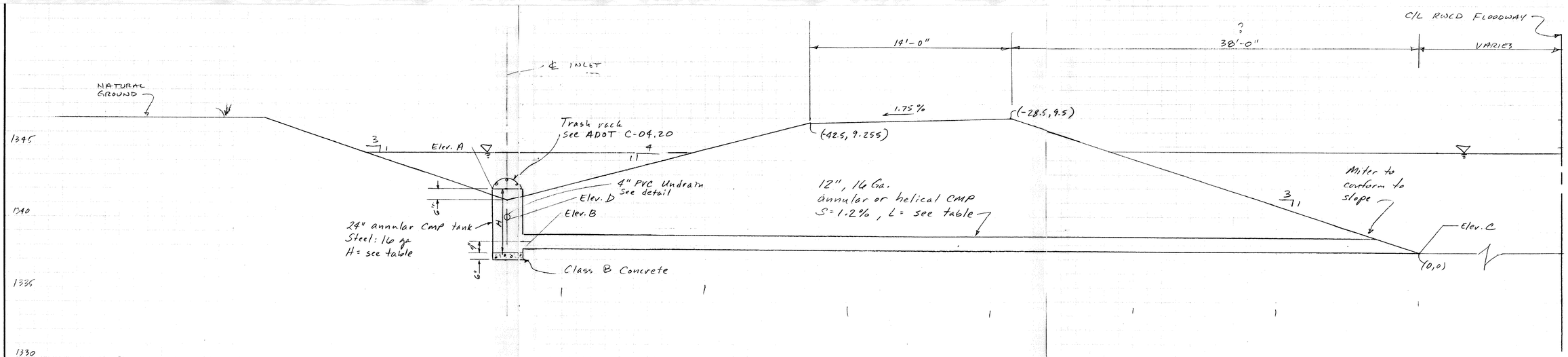
Phoenix 602 275-5400

Job: SCS RWCD Floodway Park
Description: Collector channel design
Calculated by: JAA Date: 11-19-85 Sheet No. 162
Checked by: RB Date: 2-11-86 of 19



TYPICAL LATERAL DRAIN - SECTION A-A

1" = 4'

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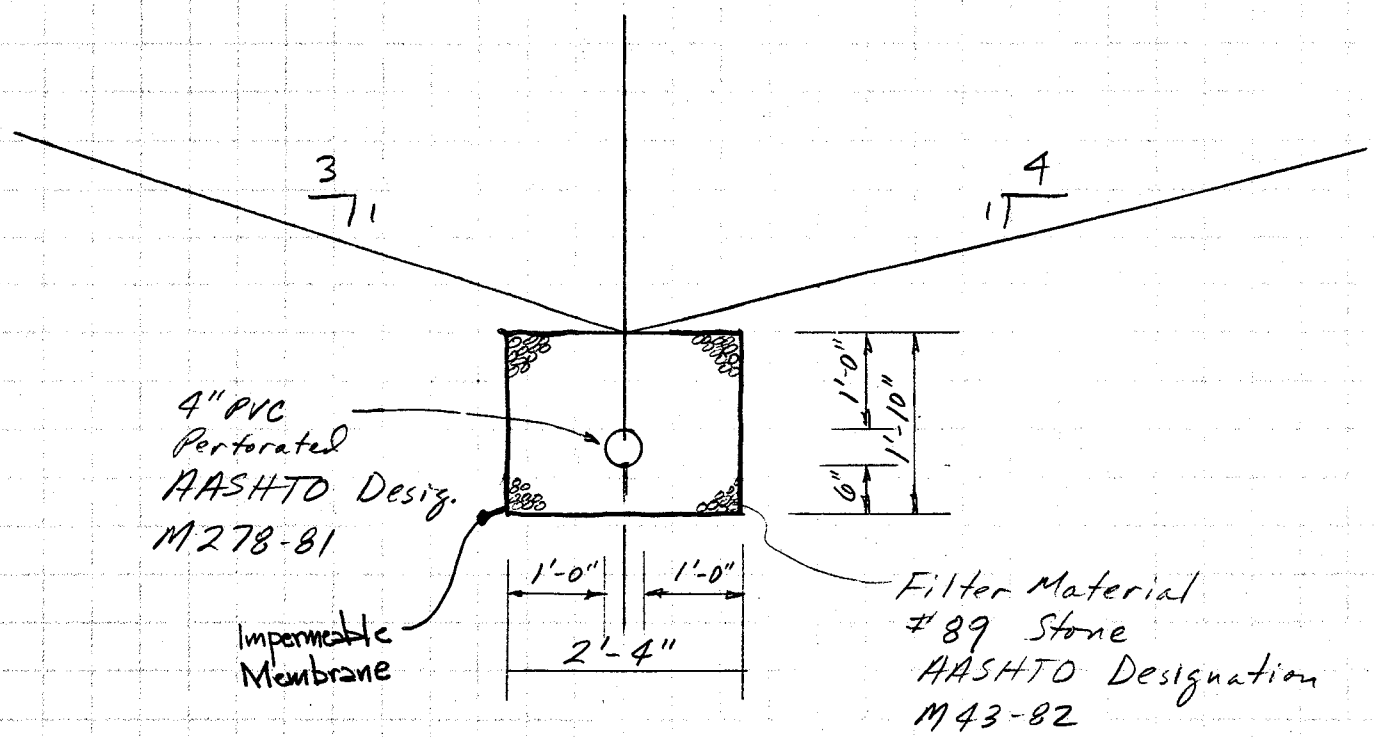
Phoenix 602 275-5400

Job SCS RWCD Floodway Ranch 6
Description Collector channel design
Calculated by JAA Date 11-19-85 Sheet No. 17
Checked by RB Date 2-11-86 of 19



UNDERDRAIN FILTER

1" = 2'-0"

4" PVC Perforated = 20 LF x 20 = 400 LF

Filter Material Quanitity = [(2'-4" x 1'-10") x (22'-0") x 20] ÷ 27
= 69.6 CY

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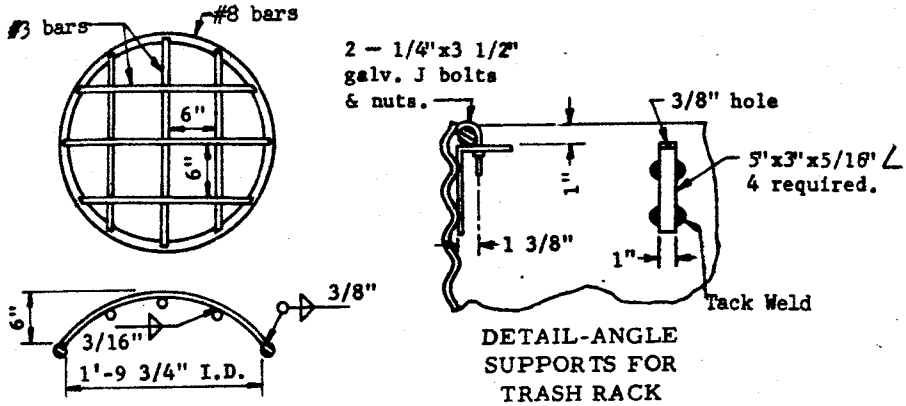
Phoenix 602 275-5400

Job SCS RWCD Reach 6
Description Trash rack detail for collector channel detail.
Calculated by R. Beck Date 2-11-86 Sheet No. 19
Checked by B.G.S. Date 2-11-86 of 19



DETAIL-TRASH RACK
STEEL TO BE GALVANIZED
AFTER FABRICATION

DETAIL-ANGLE
SUPPORTS FOR
TRASH RACK

TRASH RACK DETAIL

ADOT STD. C-4.20

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Job SCS RWCD Floodway Reach 6

Description Collector channel design

Calculated by JAA Date 11-20-85 Sheet No. 1

Checked by RB Date 2-11-86 of 7

EASTSIDE

COLLECTOR

CHANNEL

QUANTITIES

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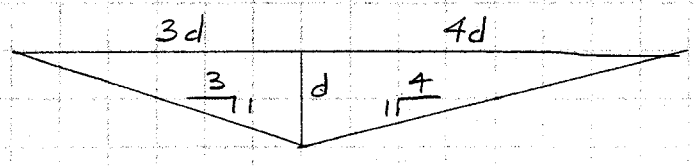
QUANTITIES

ITEM	UNIT	AMOUNT
1. Excavation	CY	8864
2. Lateral Drains	EA.	20
3.		
4. 4" PVC Perforated AASHTO Des. M278-81	LF	400
5. Filter Material #89 Stone AASHTO Des. M43-82	CY	69.6

EASTSIDE EARTHWORK

Eqn for computing average area =



$$\text{Area} = \frac{3d^2}{2} + \frac{4d^2}{2} = \frac{7d^2}{2}$$

Assuming that the uppermost station will have no area, the average area is

$$\text{Avg. Area} = \frac{1}{2} \cdot \frac{7d^2}{2} = \frac{7d^2}{4}$$

(1) Sta 34+00 to 38+00, $L = 200'$, $d = 6'$

Avg. Area = 63 ft^2, Volume exc. = 466.7 CY

(2.) Sta 38+00 to 40+50, $L = 250'$, $d = 6'$

Avg. Area = 63 ft^2, Volume exc. = 583.3 CY

(3) Sta 40+50 to 43+00, $L = 250'$, $d = 4.8'$

Avg. Area = 40.3 ft^2, Volume exc. = 373.1 CY

(4) Sta 43+00 to 45+50, $L = 250'$, $d = 4.8'$

Avg Area = 40.3 ft^2, Volume exc. 373.1 CY

(5) Sta 45+50 to 48+00, $L = 250'$, $d = 4.1'$

Avg. Area = 29.4 ft^2, Volume exc. = 272.2 CY

(6) Sta 48+00 to 50+50, $L = 250'$, $d = 4.1'$

Avg. Area = 29.4 ft^2, Volume exc. = 272.2 CY

(7) Sta. 50+50 to 53+00, L = 250', d = 4.5'

Avg. Area = 35.4 ft², Volume exc. = 328.1 CY

(8) Sta. 53+00 to 55+50, L = 250', d = 4.5'

Avg. Area = 35.4 ft², Volume exc. = 328.1 CY

(9) Sta. 55+50 to 58+00, L = 250', d = 4.0'

Avg. Area = 28.0 ft², Volume exc. = 259.3 CY

(10.) Sta. 58+00 to 61+50, L = 350', d = 4.0'

Avg. Area = 28.0 ft², Volume exc. = 363.0 CY

(11.) Sta 63+00 to 66+00, L = 300', d = 2.1'

Avg. Area = 7.7 ft², Volume exc. = 85.8 CY

(12) Sta 66+00 to 68+50, L = 250', d = 2.1'

Avg. Area = 7.7 ft², Volume exc. = 71.3 CY

(13) Sta. 68+50 to 71+00, L = 250', d = 0

Avg. Area = 0, Volume exc. = 0

(14) Sta. 71+00 to 73+50, L = 250', d = 0

Avg. Area = 0, Volume exc. = 0

(15) Sta. 73+50 to 76+00, L = 250', d = 2.8'

Avg. Area = 13.7 ft², Volume exc. = 127.0 CY

(16) Sta. 76+00 to 78+00, L = 200', d = 2.8'

Avg. Area = 13.7 ft², Volume exc. = 101.5 cy

(17) Sta. 79+00 to 82+00, L = 300', d = 3.1'

Avg. Area = 16.8 ft², Volume exc. = 186.9 cy

(18) Sta 82+00 to 85+00, L = 300', d = 3.1'

Avg. Area = 16.8 ft², Volume exc. = 186.9 cy

(19) Sta. 85+00 to 88+00, L = 300', d = 3.1'

Avg. Area = 16.8 ft², Volume exc. = 186.9 cy

(20) Sta. 88+00 to 91+00, L = 300', d = 3.1'

Avg. Area = 16.8 ft², Volume exc. 186.9 cy

(21) Sta. 92+50 to 94+50, L = 200', d = 3.3'

Avg. Area = 18.5 ft², Volume exc. = 136.9 cy

(22) Sta. 94+50 to 97+00, L = 250', d = 3.3'

Avg. Area = 18.5 ft², Volume exc. = 171.3 cy

(23) Sta. 97+00 to 99+50, L = 250', d = 3.0'

Avg. Area = 15.8 ft², Volume exc. = 145.8 cy

(24) Sta. 99+50 to 102+00, L = 250', d = 3.0'

Avg. Area = 15.8 ft², Volume exc. = 145.8 cy

(25) Sta. 102+00 to 104+17.5, L = 217.5', d = 2.8'

Avg. Area = 13.7 ft², Volume exc. = 110.5 cy

(26) Sta. 104+17.5 to 106+35, L = 217.5', d = 2.8'

Avg. Area = 13.7 ft², Volume exc. = 110.5 cy

(27) Sta 106+35 to 108+85, L = 250', d = 4.7'

Avg. Area = 37.8 ft², Volume = 350.4 cy

(28) Sta. 108+85 to 111+35, L = 250', d = 4.7'

Avg. Area = 37.8 ft², Volume = 350.4 cy

(29) Sta. 111+35 to 113+32.5, L = 197.5', d = 4.4'

Avg. Area = 33.4 ft², Volume exc. = 244.5 cy

(30) Sta 113+32.5 to 115+50, L = 217.5', d = 4.4'

Avg. Area = 33.4 ft², Volume exc = 269.1 cy

(31) Sta 116+50 to 118+67.5, L = 217.5', d = 2.5'

Avg. Area = 10.9 ft², Volume exc = 88.1 cy

(32) Sta. 118+67.5 to 120+65, L = 197.5', d = 2.5'

Avg. Area = 10.9 ft², Volume exc. = 79.7 cy

(33) Sta 127+50 to 130+00, L = 250', d = 4.0'

Avg. Area = 28.0 ft², Volume exc. = 259.3 cy

(34) Sta 130+00 to 132+50, L = 250', d = 4.5'

Avg. Area = 35.4 ft², Volume exc. = 328.1 CY

(35) Sta 132+50 to 135+00, L = 250', d = 4.5'

Avg. Area = 35.4 ft², Volume exc. = 328.1 CY

(36) Sta. 135+00 to 138+08.33, L = 308.33', d = 3.6'

Avg. Area = 23.0 ft², Volume exc = 262.6 CY

(37) Sta 138+08. to 140+50, L = 241.67', d = 3.6'

Avg. Area = 23.0 ft², Volume exc. = 205.9 CY

(38) Sta. 140+50 to 143+00, L = 250', d = 1.6'

Avg. Area = 4.5 ft², Volume exc. = 41.5 CY

(39) Sta. 143+00 to 145+50, L = 250', d = 1.6'

Avg. Area = 4.5 ft², Volume exc. = 41.5 CY

(40) Sta. 145+50 to 147+13.2, L = 163.2', d = 1.7'

Avg. Area = 5.1 ft², Volume exc = 30.6 CY

(41) Sta. 147+13.2 to 149+43, L = 229.8', d = 1.7'

Avg. Area = 5.1 ft², Volume exc. = 43.4 CY

(42) Sta 150+43 to 153+50, L = 307', d = 4.3'

Avg. Area = 32.4 ft², Volume exc. = 367.9 CY

East Side

Ref: Design of Urban Drainage Systems.

Hydraulic Data.

$Q = 5.0$ cfs
18" CMP, $n = .024$
$S = .00803$ ft/ft.

Minimum tailwater conditions. (no flow in floodway) TW=0.

$V = 3.27$ fps.

pg. 77 Plate 1.36d for d=18" and Q=5 cfs ⇒ $d_{50} = 0.35'$ $d_{max} = 0.53'$

Apron Length = 30'
Apron width upstream = 3 x dia. pipe = 4.5'
Apron width downstream = Length Apron + Dia. Pipe = 31.5'
Apron thickness = $1.5 d_{max} = 0.80'$
Bottom grade = 0%

Maximum tailwater conditions.

$V = 2.83$ fps

pg. 78 plate 1.36e for d=18" and Q=5 cfs ⇒ $d_{50} = 0.25'$ $d_{max} = .38'$

Apron length = 35'
Apron width upstream = 3 x dia pipe = 4.5'
Apron width downstream = .4La + dia pipe = 15.5'
Apron thickness = $1.5 d_{max} = .57'$
Bottom grade = 0%.

Erosion Protection for E. Side Collector Channel Outlet Pipes.

Ref: Design of Urban Drainage Systems.

For Q = 3.0 cfs.

Minimum Tailwater Conditions (no flow in floodway) TW = 0

pg. 77 plate 1.36d for d = 18" and Q = 3 cfs ⇒ d_{50} = 0.35' d_{max} = 0.53'

Apron length = 10'
Apron width US = 4.5'
Apron width DS = 11.5'
Apron thickness = 0.80'
Bottom grade = 0 %

Maximum Tailwater Conditions (full flow in floodway)

pg. 78 plate 1.36e for d = 18" and Q = 3 cfs ⇒ d_{50} = 0.20' d_{max} = 0.3'

Apron length = 10'
Apron width US = 4.5'
Apron width DS = 5.5'
Apron thickness = .45'
Bottom grade = 0 %.

Use. Length Apron = 10'
Apron width US = 4.5'
Apron width DS = 11.5'
Apron thickness = 0.8'
Bottom grade = 0 %.

Note, Use same apron configuration for outlets w/ Q = 2.0 cfs.

SUMMARY OF INLET LOCATIONS
EAST SIDE COLLECTOR CHANNEL. (22 inlets)

Station

31+42
33+00
43+00
48+00
53+00
58+00
66+00
71+00
76+00
82+00
88+00
94+50
99+50
104+17.5
108+85
113+32.5
118+67.5
132+50
138+08.33
143+00
147+13.20
159+15.

Job SCS RWCD Rosedale

Description East Collector Channel Summary

Calculated by R Beck Date 2-5-86 Sheet No. 2 of 3

Checked by M.S.S. Date

Station	Q	Inv 1	L1	Inv 2	L2	Inv 3	Inv 4	L4	Inv 5	L5
31+42	1.9 / 2.8 > 4.7	37.51	605	38.24	7.5	45.77	46.09	99	46.26	151
38+00	3/2 > 5	37.45	62.3	37.95	3.3	41.25	45.7	350	45.0	250
43+00	2/2 > 4	37.40	62.1	37.90	3.35	41.25	45.0	250	45.0	250
48+00	2/2 > 4	37.35	61.9	37.84	3.41	41.25	45.0	250	45.0	250
53+00	2/2 > 4	37.30	61.7	37.79	3.46	41.25	45.0	250	45.0	250
58+00	2/3 > 5	37.25	61.5	37.74	3.51	41.25	45.0	250	45.0	350
66+00	2/2 > 4	37.17	53.4	37.56	5.64	43.20	47.3	300	45.7	250
71+00	2/2 > 4	37.12	56.0	37.54	4.96	42.50	45.7	250	45.0	250.
76+00	2/1 > 3	37.07	55.8	37.49	5.01	42.50	45.0	250	45.0	200.
82+00	2/2 > 4	37.01	59.6	37.48	4.02	41.50	45.0	300	44.5	300
88+00	2/2 > 4	36.95	59.3	37.41	4.09	41.50	44.5	300	45.0	300
94+50	1/1 > 2	36.84	55.9	37.26	4.99	42.25	46.0	200	46.0	250
99+50	1/1 > 2	36.81	55.8	37.23	5.02	42.25	46.0	250	46.0	250
104+17.5	1/1 > 2	36.70	53.4	37.09	5.65	42.74	46.0	217.5	46.0	217.5

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Job: SCS RWCD Reaches

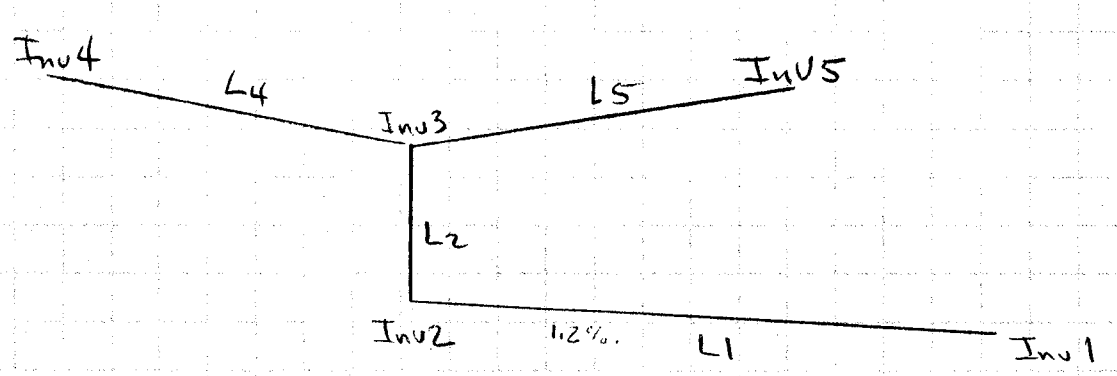
Description: East Collector Channel Summary

Calculated by: R. Bode Date: 2-5-86

Checked by: M.S.S. Date:

Sheet No. 3 of 3

Station	Q	Inv 1	L1	Inv 2	L2	Inv 3	Inv 4	L4	Inv 5	L5
108+85	2/1 > 3	36.63	59.0	37.09	4.16	41.25	45.0	250	45.0	250
113+32.5	1/1 > 2	36.56	55.6	36.98	5.05	42.03	45.0	197.5	45.3	217.5
118+67.5	1/1 > 2	36.48	55.3	36.89	5.14	42.03	45.3	217.5	45.0	197.5
132+50	1/1 > 2	35.13	57.0	35.56	4.69	40.25	44.0	250	44.0	250
138+08.33	1/1 > 2	34.96	59.9	35.43	3.95	39.38	44	308.33	43	241.67
143+00	1/1 > 2	34.81	59.8	35.28	3.97	39.25	43	250	43	250
147+13.20	1/1 > 2	34.69	54.1	35.09	5.46	40.55	43	163.2	44	229.8
159+15	4.7/4.7 > 9.3	32.70	46.5	33.25	7.70	40.95	41.81	215.0	41.81	215.0



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East Side Collector Channel
South of Broadway Rd.

Drainage Area:

Pavement $\frac{294' \times 40'}{43560} = 0.27$ ac. $c = 0.90$

Bare Soil $\frac{0.5(300)(350)}{43560} = 1.21$ ac. $c = 0.50$

weighted "c" $= \frac{(0.27 \times .90) + (1.21 \times 0.5)}{1.48}$

"c" = 0.57.

Total Area = 1.48 ac.

Tc = 10 min. (minimum)

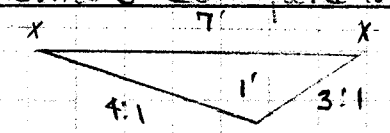
$I_{100} = 9.18$ in/hr.

$Q_{100} = CiA$

$= 0.57(9.18)(1.48) = 7.74$ cfs

Q w/ freeboard $= 1.2(7.74) = 9.3$ cfs

Channel Configuration.



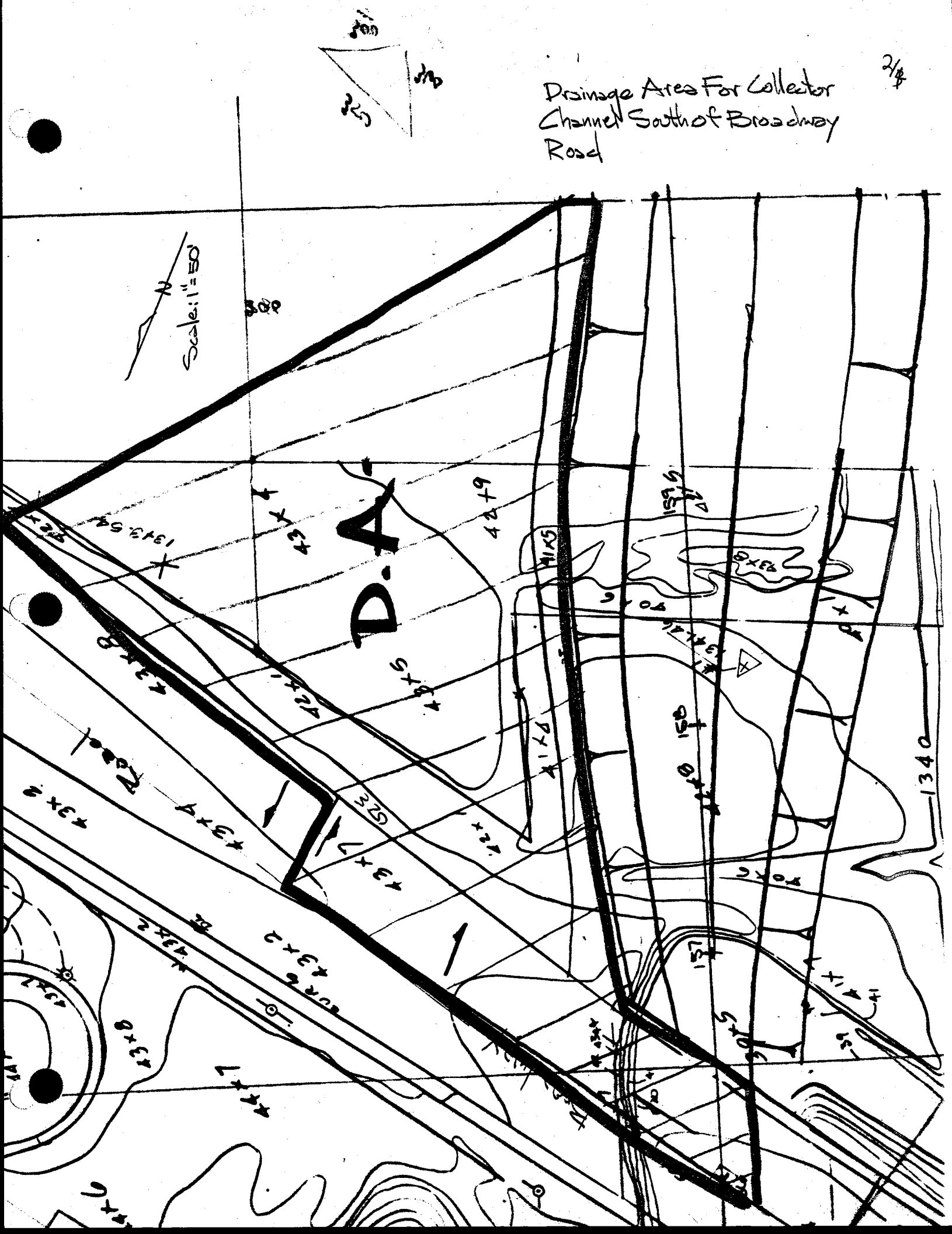
A = 3.5
R = 0.5

n = .025

Set inlet at Sta 161+30.

Drainage Area For Collector Channel South of Broadway Road

2/4

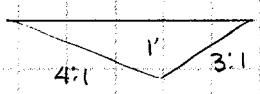


E. Side Collector Channel S. of Broadway.

Sta 157 to 161+30.

Channel Configuration.

Let S = .015



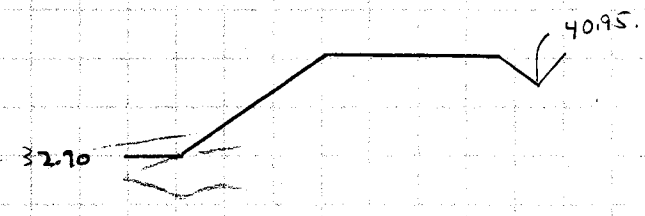
$A = 3.5$
$R = 0.5$
$R^{2/3} = .6298$
$S = .004$ $S^{1/2} = .0632$
$n = .025$

$Q = \frac{1.49}{.025}(3.5)(.6298)(.0632) = 8.3$ cfs ∴ ok

$V = 2.4$ fps ok

Inlet Location @ Sta 159+15.

Invert elev. @ Sta 159+15 for collector channel.



Slope = .004.
$S^{1/2} = .0632$

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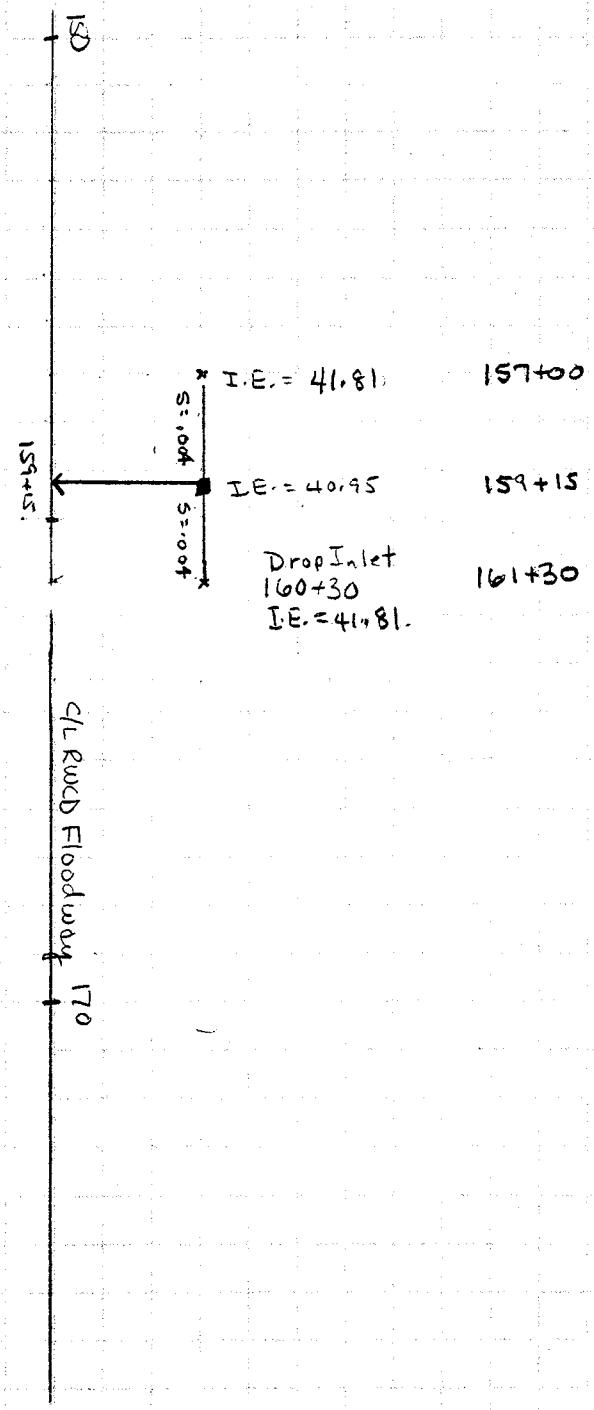
Job: SCS RWCD Reach 6

Description: E. Collector Channel Design

Calculated by: R. Beck Date: 2-5-86 Sheet No. 4

Checked by: M.S.S. Date: _____ of 4



Drainage Area = 0.65 acres

T_c = 100' overland flow and 150' channel flow @ 2.5 fps

$T_c = [100/1.7 + 150/2.5]/60 = 2.0$ minutes

I_{100} = in/hr.

C = 0.50 dirt road & bare soil.

$Q = CIA = 0.5(\quad)(.65) =$ cfs

Q_{100} (w/freeboard) $= 1.2 Q_{100} = 1.2(\quad) =$ cfs.

Collector Channel Design

Use triangular channel 1' deep w/ slope = .002

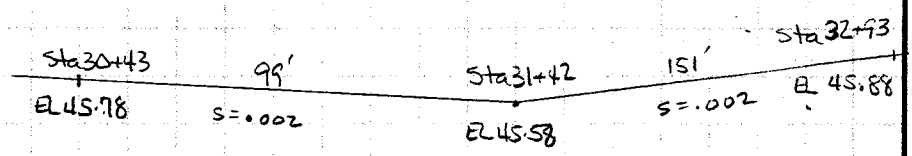
Length of channel = 250'

n = .025
A = 3.5
P = 7
R = 0.5
S = .002

$$Q = \frac{1.49}{.025}(3.5)(.5)^{2/3}(.002)^{1/2} = 5.88 \text{ cfs } \underline{ok.} \qquad (4.7 \text{ req'd})$$

Collector Channel Limits Sta 30+43 to Sta 32+93
Drop Inlet Located at Sta 31+42.

Sta	Elev	Floodway Channel Elev
30+43	45.78	37.52
31+42	45.58	
32+93	45.88	37.50

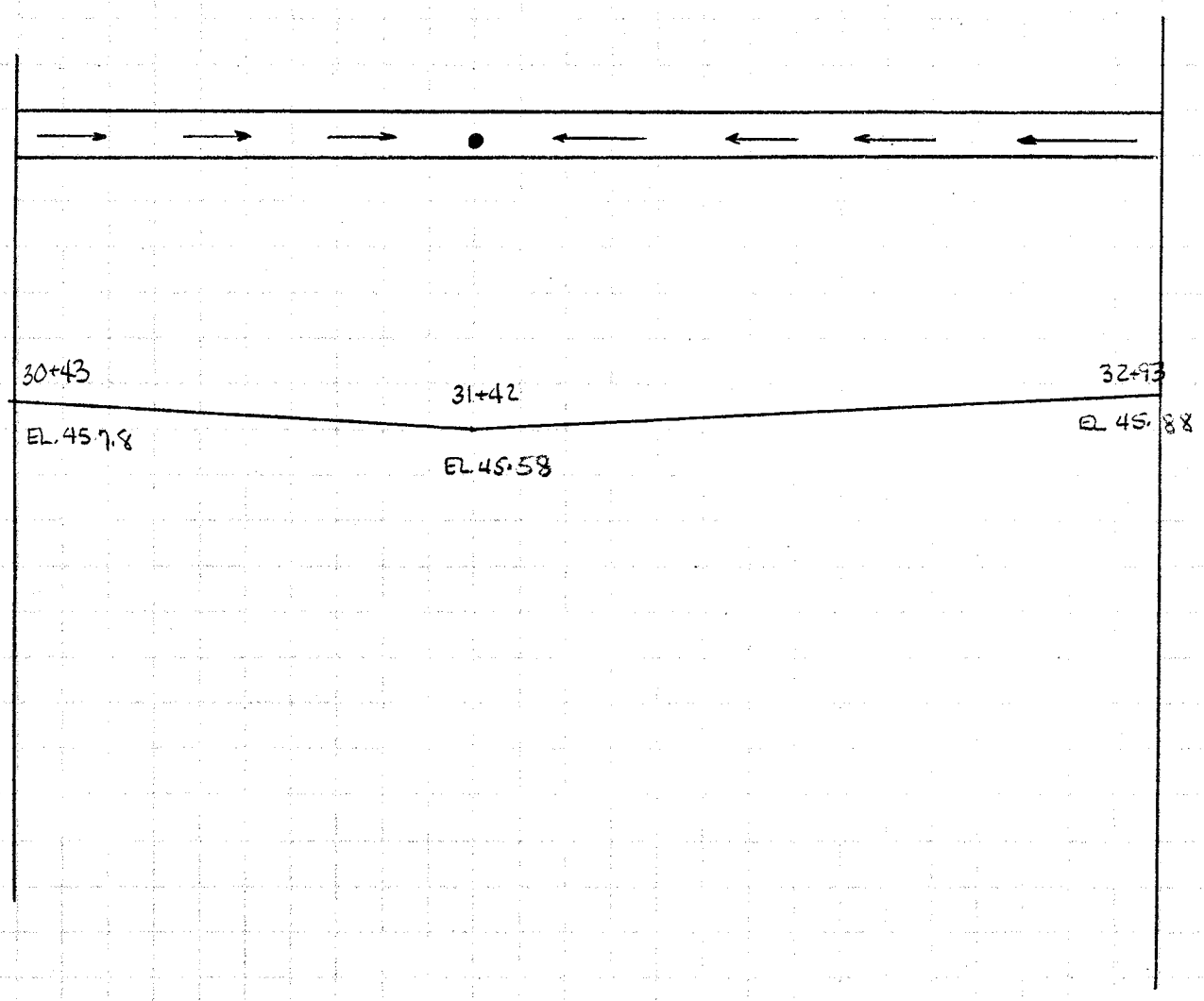


East Side Collector Channel North of Brown Rd.

Sta 30+43 to Sta 32+93

Inlet Structure at Sta 31+42

Collector Channel Slope = .002 ft/ft.



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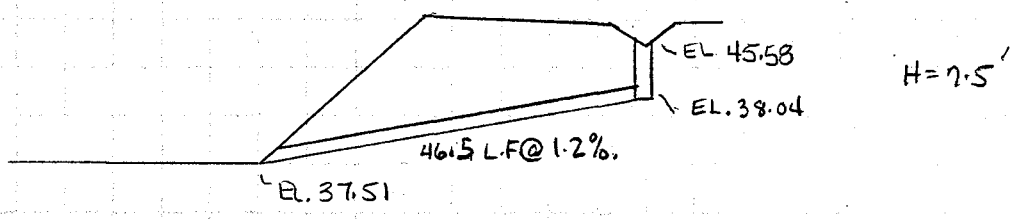
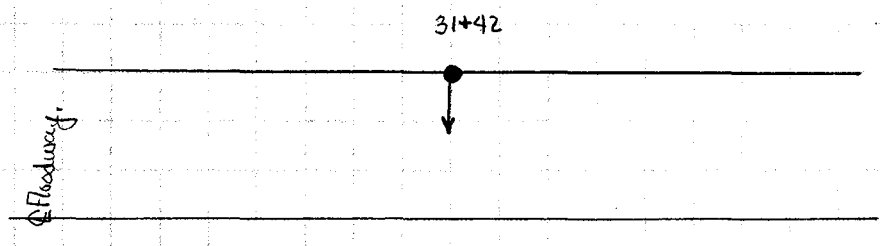
Job: RWCD Reach 6
Description: East side collector channel N. of Brown Rd.
Calculated by: R Beck Date: 2-4-86 Sheet No. 3
Checked by: M.S.S. Date: _____ of 3

East Side Collector Channel

Inlet at Sta. 31+42.





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Job RWCD Reach 6 E101012
Description Project Feature Ranking
Calculated by M. Shapiro Date 2/9/86 Sheet No. 1
Checked by B.G.S. Date of 1

Ranking System 1-10 points (pts.)

Based On:

Items	Multiplier
Cost (C)	2
Maintenance (M)	1
Availability (A)	1
Ease of Construction (E)	0.5
Aesthetics (AE)	0.5
Hydraulic Performance (H)	1
Total available points	60

Project Feature: East Side Collector Channel (Linings)

Item	Type of Material					
	Earth	Concrete	Gunite	Soil Cement		
C	10	6	6	8		
M	6	10	9	9		
A	10	8	8	9		
E	10	8	8	9		
AE	10	7	7	9		
H	8	10	10	9		
Total # of pts.	54	47.5	46.5	52		

Recommended Material for Project Feature: Earth Lining

Description

The west side collector channel for RWCD Floodway Reach 6 is situated along the west right-of-way line and must be accomodated in an area that has a minimum width of 7.5 ft. Given the close constraints of the location, the collector channel must serve to pick up stormwater from the maintenance road and carry it to a point of discharge into the floodway while maintaining an adequate velocity. The channel is to slope continuously in the direction of flow of the main floodway channel. Inlets are to be located at intervals of 600 ft. Some inlets are spaced closer together due to the termination of the collector channel at major street intersections. Items considered in the evaluation of the collector channel include cost, availability of materials, ease of construction, operation and maintenance, and hydraulic performance.

Material Evaluation

Earth Lining - An earth lined collector channel on the west side would have the advantages of low cost and simple construction. Maintenance costs would be anticipated due to low velocities. The slope of the channel will be 0.001 ft/ft and 6 inches deep at the upstream end and 12 inches deep at the downstream end at the inlet. The capacity of the channel is 5.2 cfs and the velocity is 1.5 fps. Periodic maintenance would be required to remove any silt accumulation in the bottom of the channel. The channel will have side slopes of 4:1 adjacent to the maintenance road and 3:1 slopes coming back to grade at the west right-of-way line. The cost of construction for the earth lined channel is $15,300.00. However, as previously stated, maintenance costs should be anticipated for this alternative.

Concrete Lined - A concrete lined collector channel on the west side would have the advantages of adequate capacity and sufficient velocity to be considered self-cleaning. Maintenance costs are not anticipated for this alternative. The slope of the channel will be .001 ft/ft and 6 inches deep at the upstream end and 12 inches deep at the inlet. The channel will have side slopes of 4:1 adjacent to the maintenance road, with a bottom width of 6 inches and 3:1 slopes coming back to grade at the west right-of-way line. The capacity of the channel is 9.5 cfs and the velocity is 2.4 fps. The cost of construction for this alternative would be $184,800.00. Maintenance costs are not anticipated for this alternative. The construction materials are readily available and construction procedures are expected to be simple.

Shotcrete or Gunite A collector channel constructed of shotcrete or gunite would have good hydraulic characteristics. The slope of the channel would be .001 ft/ft and 6 inches deep at the upstream end and 12 inches deep at the inlet. The channel will have side slopes of 4:1 adjacent to the maintenance road, with a bottom width of 6 inches and 3:1 side slopes coming back to grade at the west right of way line The capacity of the channel is 7.8 cfs and the velocity is 1.94 fps. While materials are readily available, the construction of the channel is expected to be difficult due to shaping the channel to the design configuration prior to placement of the lining. The cost of construction for this alternative is $183,000.00 and maintenance costs are not anticipated.

Soil Cement- A collector channel constructed of soil cement would have adequate capacity however the velocity is less than 2 fps and therefore some maintenance would be anticipated. The slope of the channel would be .001 ft/ft and 6 inches deep at the upstream end and 12 inches deep at the inlet. The channel will have side slopes of 4:1 adjacent to the maintenance road and 3:1 side slopes coming back to grade at the west right of way line. The capacity of the collector channel would be 5.7 cfs and the velocity would be 1.6 fps. A small amount of siltation could be expected for this alternative however, silt accumulations are expected to be minimal and the channel could be flushed out with a hose which is a relatively easy maintenance operation. Materials are readily available as the on-site materials are suitable for modification with cement. It should be noted that

the economy of using soil-cement for the collector system is dependent on using soil-cement on other features of the project. Construction of the collector system using soil-cement would be simple to accomplish. Adequate compaction of the material could be achieved with small rolling equipment and compaction around structures could be achieved by using mechanical hand-held tampers. An estimate of cost for this alternative is $28043. It should be re-stated that the economics of this alternative depends on its use on other project features.

Corrugated Steel Lining- The corrugated steel lining was considered due to the small width available for the collection system. Ease of maintenance was also considered. This alternative would have the advantage of providing simple maintenance procedures for removing silt accumulations by using a hose and flushing out the system. The slope of the channel would be .001 ft/ft. The capacity of the channel is 5.8 cfs and the velocity would be 1.6. Minor accumulations of silt could be expected but as previously stated, the maintenance procedure would be simple. The corrugated lining is available through Armco Construction Products. Construction of the channel would be somewhat more difficult due to the hand labor associated with the backfilling procedure. The cost for this alternative is $170996.00 and minor maintenance is anticipated.

Half Concrete Pipe Lining - The half concrete pipe lining concept originated with the consideration of the corrugated steel lining. The concrete would have better hydraulic characteristics than the corrugated lining and therefore would be maintenance free if the velocity was such that the system would be self-cleaning. Concrete pipe manufacturers were contacted and asked about supplying a half pipe section. Half pipe sections are not available and would require special ordering and manufacturing. The pipe would have to be cut after it was poured which would be an expensive operation. Although this alternative has advantages over the other alternatives it is not considered feasible to manufacture and also would require extensive hand labor to backfill.

Summary of Cost for All Alternatives.

Material	Quantity	Unit Cost	Total Cost.
Earth Lining	1809 yd^3 Excavation	8.50/yd^3	15,380.
Concrete Lining	1120 yd^3 in place	165./yd^3	184,800.
Shotcrete or Gunite Lining	91605 ft^2 in place	2.00/ft^2	183,210.
Soil Cement Lining	2262 yd^3 in place (8.00/yd for excav. and 6.00/yd for S-C)	14.00/yd^3	28,043.
Corrugated Steel Lining	12214 ft.	14.00/ft.	170,996.
Half Concrete Pipe Lining	Not considered feasible due to cost and availability.		

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Job RWCD-R6

Description West collector channel design.

Calculated by R Beck Date 11-25-85 Sheet No. 1

Checked by M.S.S. Date _____ of 23

Westside Collector
Channel System
Hydrologic Design.

Hydrology of collector channel for west side of R/W.

See typical plan sheet 3

Use Rational Method, $Q = ciA$.
where $C = 0.50$ (dirt road and embankment).

$A = 600' \times 51'_{AVG.} = 30600\ ft^2 = 0.70\ ac.$

T_c: 600' @ 2.5fps through channel $= \frac{600}{2.5}$

$T_c = 4$ min.

$I_{100} = 11.9$ inches per hr. for 100 year storm.

$Q_{100} = ciA = 0.5(11.9)(0.70) = 4.17$ cfs

Q_{100} w/ freeboard $= 1.2\,Q_{100} = 1.2 \times 4.17 = 5.0$ cfs

Collector Channel Design.

Try CMP 36"

use $n = .025$
$S = .0001$

$V = \frac{1.49}{.025} R^{2/3} S^{1/2}$
$= 59.6(.825)(.0316)$
$= 1.55$

$Q = A \cdot V$
$= 5.5$ cfs

ok

$Area = \frac{1}{2}\pi r^2$
$= 0.5(\pi)(1.5)^2$
$= 3.53\ ft^2$

$W.P. = \pi r$
$= 4.71$

$R = A/WP$
$= 3.53/4.71$
$= 0.75$

$R^{2/3} = .825$

$S^{1/2} = .0316$

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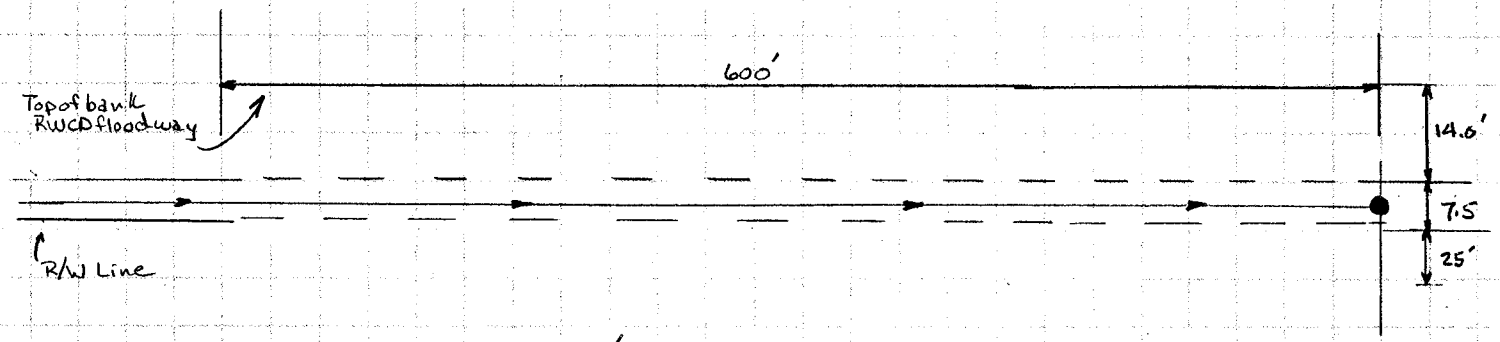
Job: SCS RWCD Reaches

Description: West side Gall Ch.

Calculated by: R. Beck Date: 11-15-85 Sheet No. 3

Checked by: M.S.S. Date: of 23

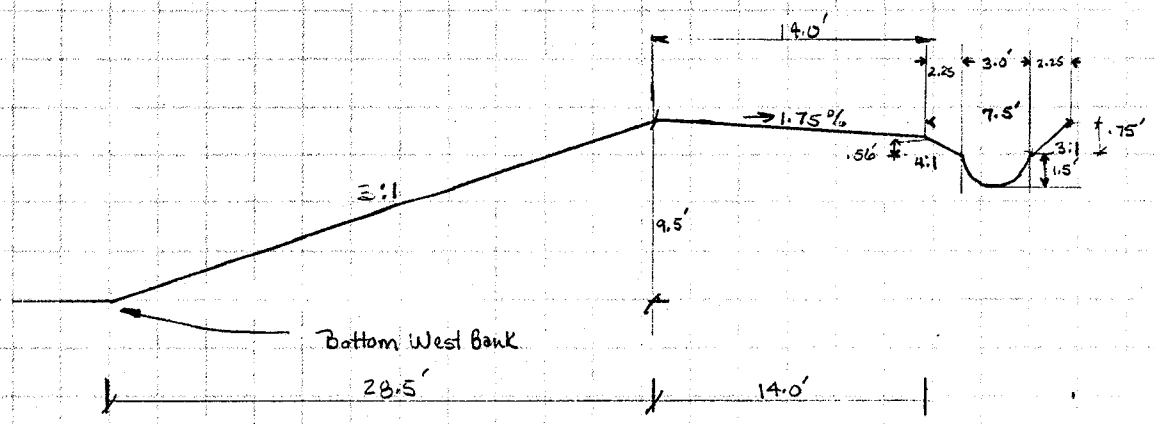


Area = 600 x 51' = 30600 ft² = 0.70 ac.

TYPICAL WEST SIDE PLAN

1" = 100'

Formula for computing invert elevation of west side collector channel at inlets



Invert of Collector Channel = Main Channel Bottom + 9.5' − (.0175x14') − .56' − 1.5'
= Main Channel Bottom + 7.20

Westside Inlet locations.

Begin Sta.		℄ Invert main channel.	Invert Riser	Invert West Collector Channel
no inlet 29+04.87		46.40		53.60
32+37.99	(N. R/W line Brown Rd.)	37.50	38.04	44.70
no inlet 33+67.99	(S. R/W line Brown Rd)	37.45		44.65
39+67.99		37.39	37.93	44.59
45+67.99		37.33	37.87	44.53
51+67.99		37.27	37.81	44.47
57+67.99		37.21	37.75	44.41
63+67.99		37.15	37.69	44.35
69+67.99		37.09	37.63	44.29
75+67.99		37.03	37.57	44.23
81+67.99		36.97	37.51	44.17
87+67.99		36.91	37.45	44.11
90+00.00	(N. R/W. Line Univ. Dr.)	36.88	37.42	44.08
no inlet 91+78.87	(S R/W Line Univ. Dr.)	36.86		44.06
97+78.87		36.79	37.33	43.99
103+78.87		36.70	37.24	43.90
109+78.87		36.61	37.15	43.81
115+78.87		36.52	37.06	43.72
121+72.08	(N. R/W line Apache Blvd.)	36.37	36.91	43.57
no inlet 123+52.08	(S. R/W line Apache Blvd).	35.98		43.18

Higley Road.

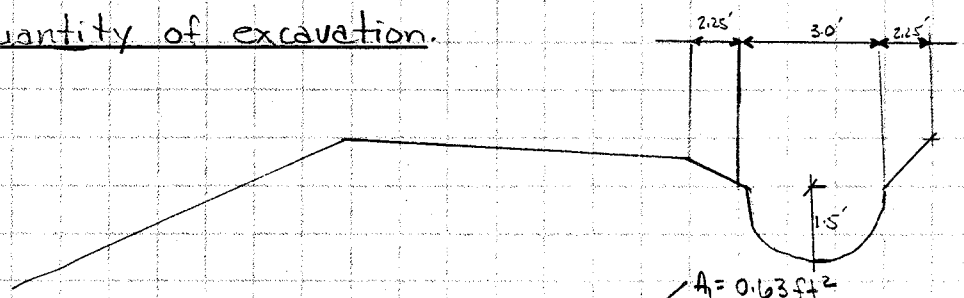
no inlet 126+11.45	(Approx S. R/W line Higley Rd.)			
132+11.45		35.06	35.60	42.26
138+11.45		34.88	35.42	42.08
144+11.45		34.70	35.24	41.90
150+11.45.		34.52	35.06	41.72
153+93.00	(N. R/W line Broadway Rd)	34.35	34.89	41.55
no inlet 156+55.00	(S. R/W line Broadway Rd)			
161+30.00	End of Project	31.24	31.78	38.44

Quantities and
Estimate of Cost

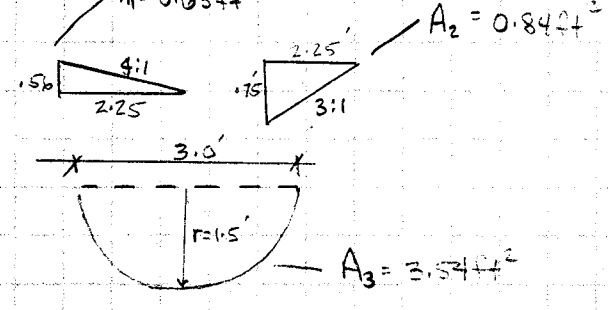
- Lateral Drains -
West side, collector channel.

Westside Collector Channel.

Quantity of excavation.



Area of Channel Cross Section:



$A_1 + A_2 + A_3 = A_{TOTAL}$

$.63 + .84 + 3.54 = 5.0 ft^2$

Length of channel = Length of project − street crossings

$16130 - (130 + 120 + 440 + 120) = 15320'$

$16130 - 810 = 15320'$

Excavation = $15320 ft \times 5.0 ft^2 = 76600 ft^3$

$76600/27 = 2837$ yd^3 excavation.

Channel Quantities

Excavation:	2837 yd^3	4.00/yd^3
half 36" CMP:	15320 ft.	14.00/ft
Drop Structures:	21	250 ea.
12" CMP (44.75'x21)	940.0 ft.	5.00/ft.
Concrete (.06 yd^3 x 21)	1.26 yd^3	165./yd^3
Rip-Rap (1 yd^3 x 21)	21 yd^3	30.00/yd^3

Cost Summary

Excavation	2837 X 4.00
half CMP	15320 X 14.00
Drop Structures	21 X 250.00
12" CMP	940 X 5.00
Concrete	1.26 X 165.00
Rip-Rap	21 X 30.00

Ref.: Design of Urban Drainage Systems.
Note: Design procedure reference: USDA-SCS

Hydraulic Data.

Q = 5.0 cfs
18" CMP n = .024
S = 0.09385

Minimum Tailwater Conditions: (no flow in floodway) TW = 0

V = 16.9 fps.
pg. 77 Plate 1.36d for d = 18" and Q = 5.0 cfs ⇒ $d_{50} = 0.35'$, $d_{max} = 0.53'$

Apron length = 30'
Apron width upstream = 3 X dia. pipe = 4.5'
Apron width downstream = Length apron + dia pipe = 31.5'
Apron thickness = 1.5 d_{max} = 0.80'
Bottom grade = 0%

Maximum Tailwater Conditions: (full flow in floodway) TW = 7.0'

V = 2.8 fps
pg. 78 plate 1.36e for d = 18" and Q = 5.0 cfs ⇒ $d_{50} = 0.20'$, $d_{max} = 0.30'$

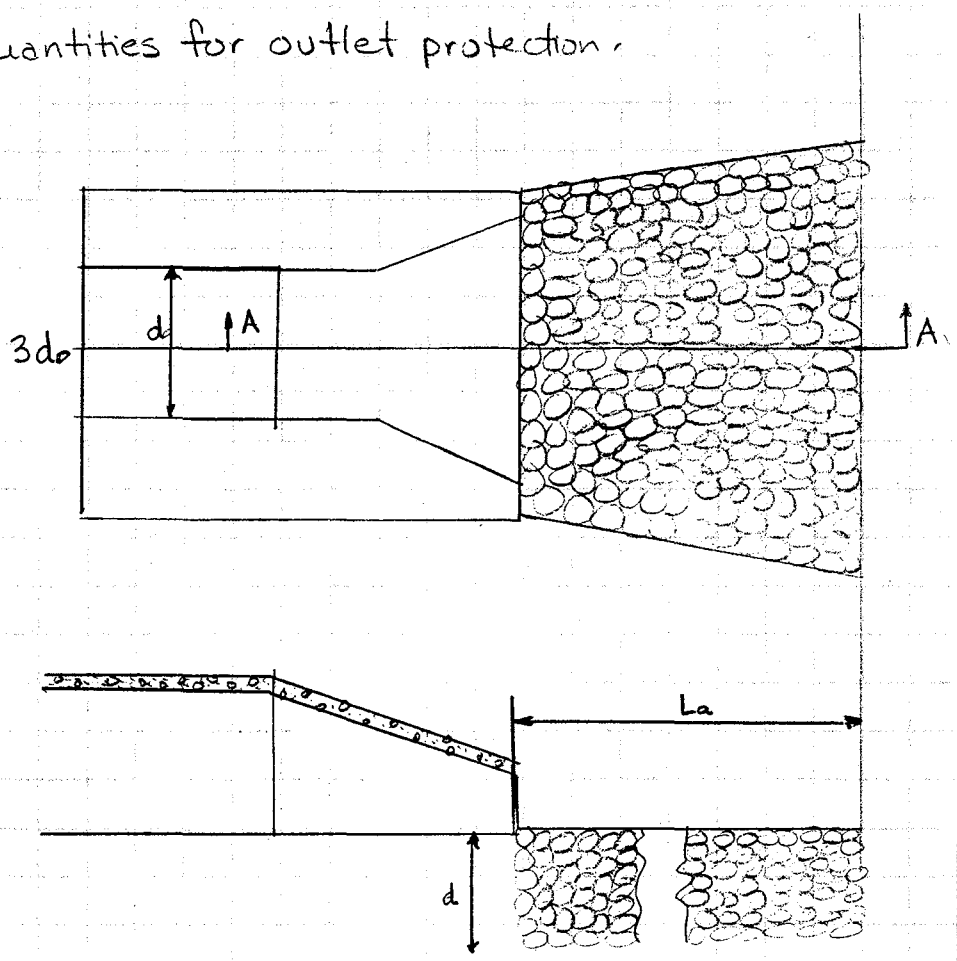
Apron length = 35'
Apron width upstream = 3 X pipe dia. = 4.5'
Apron width downstream = dia pipe + 0.4 L_a = 14.5'
Apron thickness = 1.5 d_{max} = 0.45' (0.5' min.)
Bottom grade = 0%.

Filter Blanket:

Quantities for outlet protection.

21 outlet pipes

Alternate materials
1) dumped rip rap
2) grouted rip rap
3) concrete



Section A-A

Concrete outlet aprons (6" thickness)

Area of apron = $\frac{4.5+31.5}{2} \times 35 = 630 ft^2$

Volume of apron = $630 ft^2 \times 0.5 ft = 315 ft^3$

Total Volume of aprons = $315 ft^3 \times 21$ aprons $\times \frac{1 yd^3}{27 ft^3} = 245 yd^3$ concrete.

Volume of excavation = $630 ft^2 \times 21$ aprons $\times \left(\frac{10}{12}\right) \times \frac{1}{27} = 408 yd^3$ excavation

Volume of sand (4" cushion) = $630 \times 21 \times \frac{4}{12} \times \frac{1}{27} = 163 yd^3$ sand

Dumped Rip Rap Outlet Aprons $d_{50} = 4''$ $d_{max} = 6''$

Area of Apron = $630 ft^2$
Depth of Apron = $1.5 d_{max} = 10''$
Volume of riprap = $630 \times \frac{10}{12} \times 21 \times \frac{1}{27} = 408 yd^3$

Area of filter cloth: $630 \times 21 \times 1.1$ (10% for overlap) $= 14553 ft^2$

Volume of Sand (4" sand cushion) = $163 yd^3$

Volume of excavation $630 \times 21 \times \frac{14}{12} \times \frac{1}{27} = 572 yd^3$

Grouted Rip Rap Outlet Aprons

Area of Apron = $630 ft^2$
Depth of Apron = 10"
Volume of RipRap = $408 yd^3$ (grouted)
Area of filter cloth = $14553 ft^2$
Volume of sand (4") = $163 yd^3$
Volume of excavation = $572 yd^3$

Summary of Quantities For Outlet Apron Alternatives.

	Concrete	Sand	Excavation	Rip Rap	Filter Cloth	Grouted Rip Rap
Concrete	245 yd^3	163 yd^3	408 yd^3	—	—	—
Dumped Rip Rap	—	163 yd^3	572 yd^3	408 yd^3	14553 ft^2	—
Grouted Rip Rap	—	163 yd^3	572 yd^3	—	14553 ft^2	408 yd^3

Unit Cost

Concrete	165./yd^3
Sand	15./yd^3
Excavation	8./yd^3
Rip Rap	30./yd^3
Filter Cloth	9¢/ft^2
Grouted Rip Rap	60./yd^3

Cost Comparison of 3 Alternatives.

Concrete $245(165) + 163(15) + 408(8) =$ 46134.00

Dumped Rip Rap $163(15) + 572(8) + 408(30) + (14553 \times .09) =$ 20571.00

Grouted Rip Rap. $163(15) + 572(8) + 14533(.09) + 408(60) =$ 32809.00

Westside Inlet locations.

	Begin Sta.		℄ Invert main channel.	Invert Riser	Invert West Collector Channel
no inlet	29+04.87		46.40		53.60
	32+37.99	333 (N. R/W line Brown Rd.)	37.50	38.04	44.70
no inlet	33+67.99	(S. R/W line Brown Rd)	37.45		44.65
	39+67.99	600 ✓	37.39	37.93	44.59
	45+67.99	600 ✓	37.33	37.87	44.53
	51+67.99	600 ✓	37.27	37.81	44.47
	57+67.99	600 ✓	37.21	37.75	44.41
	63+67.99	600 ✓	37.15	37.69	44.35
	69+67.99	600 ✓	37.09	37.63	44.29
	75+67.99	600 ✓	37.03	37.57	44.23
	81+67.99	600 ✓	36.97	37.51	44.17
	87+67.99	600 ✓	36.91	37.45	44.11
	90+00.00	232 (N R/W Line Univ. Dr.)	36.88	37.42	44.08
no inlet	91+78.87	(S R/W Line Univ. Dr.)	36.86		44.06
	97+78.87	600 ✓	36.79	37.33	43.99
	103+78.87	600 ✓	36.70	37.24	43.90
	109+78.87	600 ✓	36.61	37.15	43.81
	115+78.87	600 ✓	36.52	37.06	43.72
	121+72.08	593 (N. R/W line Apache Blvd.)	36.37	36.91	43.57
no inlet	123+52.08	(S. R/W line Apache Blvd).	35.98		43.18

Higley Road.

no inlet	126+11.45	(Approx S. R/W line Higley Rd.)			
	132+11.45	600 ✓	35.06	35.60	42.26
	138+11.45	600 ✓	34.88	35.42	42.08
	144+11.45	600 ✓	34.70	35.24	41.90
	150+11.45	600 ✓	34.52	35.06	41.72
	153+93.00	381 (N. R/W line Broadway Rd)	34.35	34.89	41.55
no inlet	156+55.00	(S. R/W line Broadway Rd)			
	161+30.00	475 End of Project	31.24	31.78	38.44

L = 12214

Westside Collector Channel

The westside collector channel for RWCD reach 6 is situated along the west R/W line and must be accommodated in an area that has a minimum width of 7.5'. Given the close constraints of the location, the collector channel must serve to pick up storm-water from the maintenance road and carry it to a point of discharge into the floodway while maintaining an adequate velocity. Inlets are to be located at intervals of 600'. Some inlets are closer together due to the termination of the collector channel at street R/W's. The following alternative designs are to be considered:

Trapezoidal — Earth Lined: Considered to be the least expensive, the earth lined channel does not produce velocities sufficient for the channel to be self-cleaning. With $Q_{100} = 5.5$ cfs, the velocity was found to be less than 2 fps. Maintenance is likely to be a problem due to siltation. Cost ≈ $15,380

Trapezoidal — Concrete: While a concrete collector channel would function hydraulically, the cost is considered high. Velocity is above 2 fps and has sufficient capacity. Cost ≈ $183210.

Trapezoidal — Shotcrete or Gunite: Good hydraulic characteristics but cost is high. Capacity is 7.8 and velocity is 1.94. Cost ≈ $183210.

Trap gold

Soil Cement — Very economical, particularly if soil-cement is used on main floodway channel. Hydraulic characteristics are marginal however, this type of channel lining could be maintained by using hose to flush out silt. Capacity = 6.9 Vel = 1.72 Cost ≈ $28043

Corrugated Steel Lining - Capacity = 5.8, Vel = 1.64 Cost ≈ 170,996
Not economical when compared to soil-cement. Soil Cement actually has better hydraulic characteristics.

half circle

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Job RWCD Reach 6

Description Westside Collector Channel.
Cost Summary

Calculated by R Beck Date 12-27-85 Sheet No. 16

Checked by M.S.S. Date of 23

	Capacity	Velocity	Cost
Concrete Trapezoidal	9.5	2.38	183,210
Soil Cement Trapezoidal	6.9	1.72	28,043
Gunite or Shotcrete Trapezoidal	7.8	1.94	183,210
Earth Lined Trapezoidal	6.2	1.60	15,380
Corrugated Steel Lining	5.8	1.64	170,996
Half Conc. Pipe Lining	10.8	3.05	Not feasible to manuf.

Ameron 252-7111.

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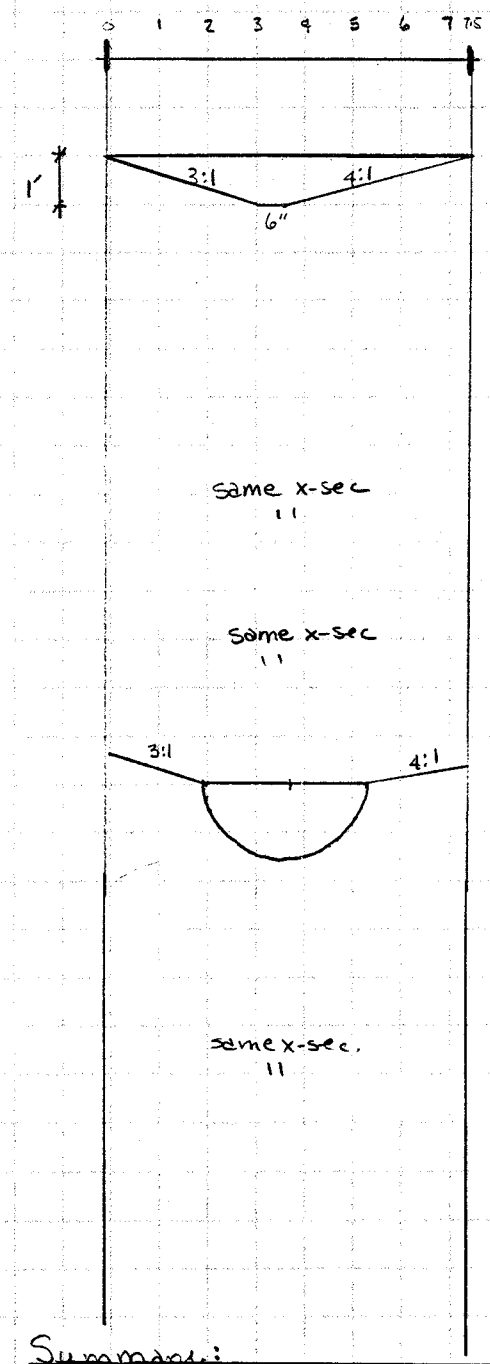
Job RWCD Reach 6
Description Westside Collector Channel
Alternate materials.
Calculated by R. Beck Date 12-26-85 Sheet No. 17
Checked by M.S.S. Date of 23

Westside Collector Channel.

Soil Cement $n = .018$

$Q = \frac{1.49}{.018}(4)(.65)(.032) = 6.9$

$V = 1.72$ fps.



① Concrete

Area. $= \frac{1}{2}(4\times1) + (0.5\times1) + \frac{1}{2}(3\times1)$

$= 2 + 0.5 + 1.5$

$= 4 ft^2$

$W.P = 4 + 0.5 + 3 = 7.5$

$R = 4/7.5 = .53 \Rightarrow R^{2/3} = .65$

Conc. $\Rightarrow n = .013$

$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$

$= \frac{1.49}{.013}(4)(.65)(.032)$

$= 9.5$ cfs ok.

$V = \frac{9.5}{4} = 2.38$ fps

② Gunite or Shotcrete $\Rightarrow n = .016$; $Q = \frac{1.49}{.016}(4)(.65)(.032)$

$= 7.75$ cfs ok.

$V = \frac{7.75}{4} = 1.94$ fps

③ Earth lined. $\Rightarrow n = .02$ $Q = \frac{1.49}{.02}(4)(.65)(.032)$

$= 6.2$ cfs ok

$\frac{6.2}{4} = 1.6$ fps

④ Corrugated Steel Lining.

$n = .024$

$Q = \frac{1.49}{.024}(3.53)(.83)(.032)$

$= 5.8$ cfs ok

Area $= 3.53 ft^2$

$W.P = 4.71$

$R = .75$

$R^{2/3} = .83$

$V = \frac{5.8}{3.53} = 1.64$ fps

⑤ Half Conc. Pipe Lining $n = .013$

$Q = \frac{1.49}{.013}(3.53)(.83)(.032)$

$= 10.75$ cfs. ok.

$V = \frac{10.75}{3.53} = 3.05$ fps

Summary:

Concrete Trapezoidal	Q = 9.5	V = 2.38	ok
Soil Cement Trapezoidal	Q = 6.9	V = 1.72	ok?
Gunite or Shotcrete Trapezoidal	Q = 7.75	V = 1.94	ok.
Earth Lined Trapezoidal	Q = 6.2	V = 1.6	N.G. cannot maintain
Corrugated Steel Lining - ½ circle	Q = 5.8	V = 1.64	ok
Half Conc. Pipe Lining - ½ circle	Q = 10.75	V = 3.05	ok

Total Length of Collector Channel = 12214.

① Concrete Trapezoidal

Assume 4" thickness.

Surface Area per foot x total footage

Surface Area of Channel = 7.5 x 12214 = 91605 ft^2 @ 2.00/ft^2 ⇒ $183210.

Volume of Concrete = 91605 x 0.33 = 30230 ft^3

= 1119.6 yd^3

② Gunite or Shotcrete: Trapezoidal.

Surface Area of Channel = 91605 ft^2 @ 2.00/ft^2 ⇒ $183210

③ Earth Lined: Trapezoidal.

X-Sec Area = 4 ft^2

Volume of excavation = $\frac{12214 \times 4}{27}$ = 1809 yd^3 @ 8.50/yd^3 ⇒ $15380.

④ Soil Cement :

8" plating: ⇒ Volume = $91605 \times (\frac{8}{12}) = 61070 ft^3$
$= 2262 yd^3$ @ 6.00/yd^3 ⇒ \$13571.

1809 yd^3 excavation @ 8.00/yd^3 = 14472. + 14472

\$28,043

⑤ Corrugated Steel Lining

12214 l.f. x \$14/ft @ \$14/ft ⇒ \$170,996

⑥ Half Conc. Pipe Lining - not considered.

West Side Collector Channel North of Brown Rd.

Drainage Area = $\frac{200 \times 14}{43560}$ = .064 ac.

$T_c = \frac{200}{2.5 \times 60} = 1.3$ min. T_c = length of channel / avg. vel.

$I_{100} = 11.9$ in/hr

C = 0.50 dirt road

$Q = CiA = 0.5(11.9)(.064) = .38$ cfs

Q_{100} (w/ freeboard) $1.2(.38) = 0.5$ cfs

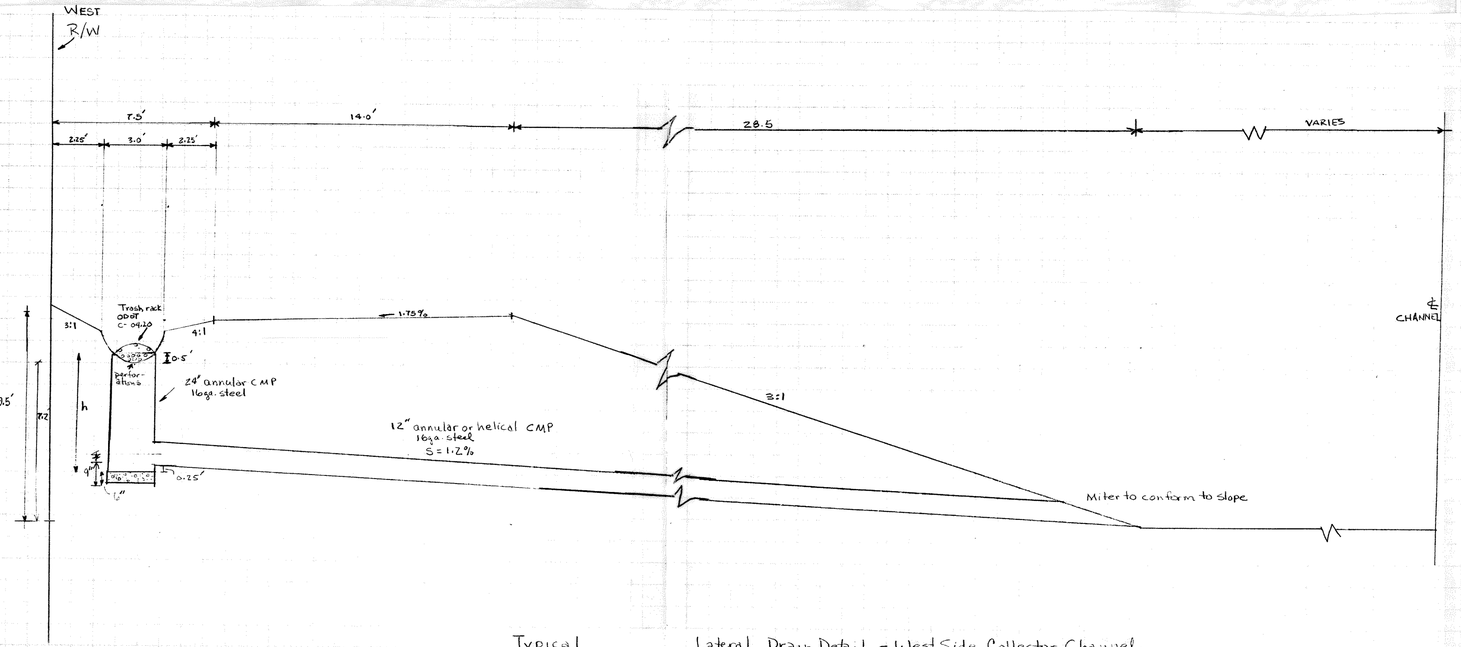
Collector Channel Design: To be consistent with other reaches of west side collector channel.

Install one add'l inlet near Brown Rd. r/w line. at Sta 32+13.

Sta	Floodway Elev	Collector Channel Invert.
32+13	37.50	37.50 + 9.5 − (.0175 × 14) − 1 = 45.76

Limits of westside collector channel

Sta 30+43 to 32+13 ⇒ Length = 170′



Typical Lateral Drain Detail - West Side Collector Channel.
1" = 4'

Length of 12" pipe required per drain: 2.25' + 14.0' + 28.5' = 44.75'
(see attached drawing)

Height of 24" pipe required per drain: 7.2' - 0.54' + 0.25' + 0.5' = 7.41'
(see attached drawing)

7.2' = Elev. collector channel minus elevation main channel bottom.

0.54' = elevation difference of 12" pipe inverts upstream and downstream.

0.25' = 12" pipe invert minus riser bottom.

0.50' = portion of 24" pipe above channel bottom.

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Job: SCS RWCD Rosacha
Description: West Side Collector System
Calculated by: BBeals Date: 12-27-86 Sheet No. 19A
Checked by: MSD Date: _____ of 23

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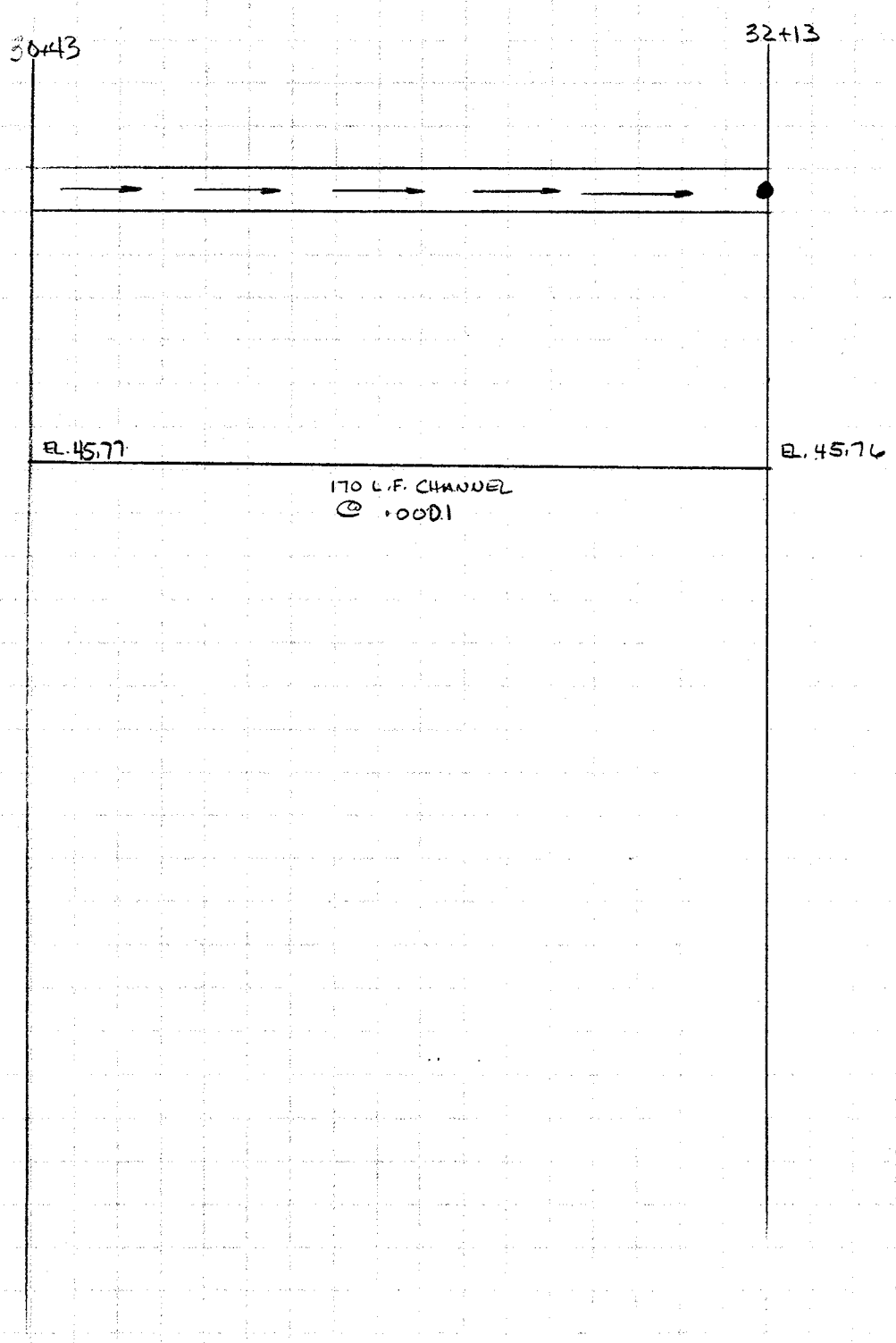
Job: SCS RWCD Reach 6

Description: Westside Collector Channel N. of Brown Rd.

Calculated by: R. Beck Date: 2-4-86 Sheet No. 21

Checked by: MSS. Date: _____ of 23



SUMMARY OF INLET LOCATIONS
WESTSIDE COLLECTOR CHANNEL. (22 inlets)

Station

32+13
39+68
45+68
51+68
57+68
61+10
69+68
75+68
81+68
87+68
90+00
97+79
103+79
109+79
115+79
121+72
132+11
138+11
144+11
150+11
153+93
161+30

West Side Collector Channel
S. of Broadway Rd.

Drainage Area.

$$\frac{335 \times \left(\frac{20+110}{2}\right) + 240 \times \left(\frac{10+20}{2}\right)}{43560} = 0.54\text{ac.}$$

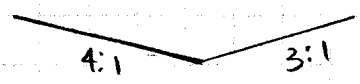
Bare Soil "c" = 0.50

Tc = 10min. (minimum) ⇒ i = 9.18 in/hr.

Q = CiA

0.5 (9.18)(0.54) = 2.5cfs.

Use triangular channel w/ 4:1 and 3:1 side slopes. 1' depth



Limits of Channel.
154+82 to 161+30

Set inlet at Sta 161+30

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Job RWCD Reach 6 E101012
Description Project Feature Ranking

Calculated by M. Shapiro Date 2/9/86 Sheet No. 1
Checked by _____ Date _____ of 1

Ranking System 1-10 points (pts.)

Based On:

Items	Multiplier
Cost (C)	2
Maintenance (M)	1
Availability (A)	1
Ease of Construction (E)	0.5
Aesthetics (AE)	0.5
Hydraulic Performance (H)	1
Total available points	60

Project Feature: West Side Collector Channel (Linings)

Item	Type of Material					
	Earth	Concrete	Gunite	Soil Cement	C.M.P.	Half Conc. Pipe
C	9	5	5	8	6	2
M	6	9	9	9	9	9
A	10	8	8	9	6	2
E	10	7	7	9	7	7
AE	10	8	7	9	5	6
H	6	9	8	8	7	9
Total # of pts.	50	43.5	42	46.5	40	30.5

Recommended Material for Project Feature: Earth Linings

Description

The east side collector channel is designed to discharge into the floodway at intervals of 500.ft. The west side collector channel is designed to discharge into the floodway at intervals of 600ft. Three alternative methods of discharge were considered.

Spillway structure: Spillway structures were considered as an alternative for conveying flow from the collector system to the main floodway channel. This concept would require a dip section in the maintenance road to convey water from the collector channel to the spillway structure. This feature was considered undesirable from a maintenance aspect. Drainage across the maintenance road could result in erosion gullies and soft spots which could make it difficult to drive vehicles through these areas. Protection could be provided in the dip section, however, there would be an additional

cost associated with providing such protection.

Catch Basin A standard ADOT catch basin was considered to convey water from the collector channel to the main floodway channel. The catch basin would function hydraulically and maintenance is not anticipated. Construction is considered simple and most contractors would be familiar with the detail. The cost of providing such a catch basin would be about $2000.

Corrugated Standpipe Drop Structure - A corrugated standpipe with a concrete bottom and corrugated outlet pipe was also considered and found to be the most desirable alternative based on cost, ease of construction, and hydraulic performance. In addition, the structures are available through Armco Construction Products. The cost for the drop structure is 600.00.

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Job RWCD Reach 6 E101012
Description Project Feature Ranking

Calculated by M. Shapiro Date 2/9/86 Sheet No. 1
Checked by B.G.S. Date _____ of 1

Ranking System 1-10 points (pts.)

Based On:

Items	Multiplier
Cost (C)	2
Maintenance (M)	1
Availability (A)	1
Ease of Construction (E)	0.5
Aesthetics (AE)	0.5
Hydraulic Performance (H)	1
Total available points	60

Project Feature: Inlet structures for the collector channel

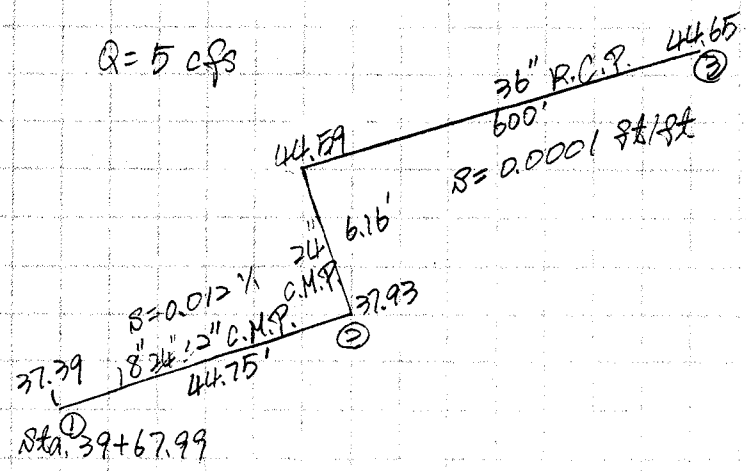
Item	Type of Material					
	Spillway	A.D.O.T. C.B.	C.M.P. Drop Structure			
C	9	7	8			
M	4	7	8			
A	8	8	8			
E	8	6	7			
AE	5	8	7			
H	8	8	8			
Total # of pts.	44.5	44	47			

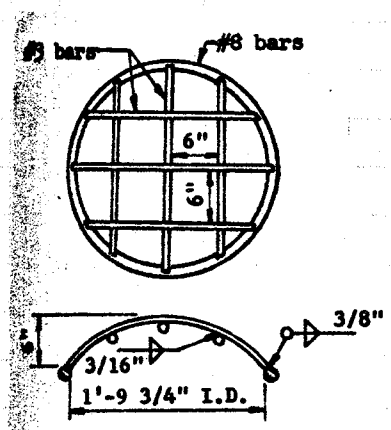
Recommended Material for Project Feature: C.M.P. Drop Structure

Two different alternates were evaluated based on the "STORM" runs. (See Sect. 4 for "STORM" program) Alternate No. 1 structure consists of a half 36 inch concrete pipe, a 24 inch CMP drop structure with a trash rack, and an 18 inch CMP. Alternate No. 2 is a modified Alternate No. 1 with a half 36 inch Corrugated Metal Pipe instead of a half 36 inch concrete pipe. For each alternate, two runs has been made for full- and no- flow conditions within the floodway. A normal depth calculation was performed by using "CIRCØ1I" program for the 18 inch CMP. (See Sect. 4 for "CIRCØ1I" program description) This was used as the tailwater control for the no-flow condition within the floodway.

Based on the hydraulic grade line analyses, the bottom of 24 inch CMP drop shaft must be protected for high velocity (≈17 fps). Two alternates would function hydraulically. The construction cost is considered high.

1. Inlet at Sta. 39+67.99 (Sta. 33+67.99 ~ 39+67.99)





DETAIL-TRASH RACK
STEEL TO BE GALVANIZED AFTER FABRICATION

#3 bars: 2 - 1.81' & 4 - 1.59'

Net area = $\frac{\pi}{4}(1.8125)^2 - (2\times1.81 + 4\times1.59)\times(\frac{3/8}{12}) = 2.268\ ft^2$

Gross area = $\frac{\pi}{4}2^2 = \pi\ ft^2$

$R = 2.268/\pi = 0.722$

$K_e = K_t = 1.45 - 0.45R - R^2 = 0.604$ ("Design of Small Dams" Pg. 473 App. B)

$K_j = 0.70$ (90° junction loss factor) "Design of Urban Highway Drainage" Pg. 8-35

$K_m = 0.05$ (User's Manual Pg. 2-15)

2. Problem Set Up:

① 600' of corrugated steel channel lining (36" diameter) n = 0.024
S = 0.0001 ft/ft.

② Drop structure - 24" C.M.P. n = 0.024 with trash rack

③ 44.75' of 12" C.M.P. with S = 0.012 ft/ft.

3. "STORM" run Trial #1

Set Up —

(i) 44.75' 12" C.M.P. & 6.66' drop structure 24" C.M.P. & 600' half 36" C.M.P.

(ii) Use $K_j = 0.00$, $K_e = 0.60$ & $K_m = 0.05$

Results —

(i) Found 12" C.M.P. to be inadequate.

(ii) Try 24" C.M.P. for inlet pipe size & use half 36" R.C.P.

4. "STORM" run Trial #2

Set Up —

(i) Use $K_j = 0.70$ (90° junction loss factor), $K_e = K_t = 0.60$ & $K_m = 0.05$.

(ii) Use 44.75' 24" C.M.P. & half 36" R.C.P.

Results —

(i) Full Flow Condition —

① Works Hydraulically. Inlet velocity (1.6 fps) is too small.

(ii) No Flow condition —

① Inlet velocity (1.6 fps) is too small.

② Velocity in drop structure of 32.2 fps is too large.

③ Try 18" C.M.P. for inlet pipe size.

5. "STORM" run Trial #3

Set Up –

(i) Change 24" C.M.P. to 18" C.M.P.

Results –

(i) Full Flow Condition –

① Works hydraulically. Inlet velocity is 2.8 fps.

(ii) No Flow Condition –

① Velocity in drop structure of 22.5 fps is too large.

② Try increase inlet pipe slope.

6. "STORM" run Trial #4

Set Up –

(i) Set height of drop structure to 2.5 ft. Then S = 0.1050 ft/ft

Results –

(i) No Flow Condition –

① Velocity in drop structure only 14.4 fps.

② Need mini. depth of 3 feet of drop structure.

7. "STORM" run Trial #5 for 600 ft. of half 36" R.C.P.

Problem Set Up — (Also see pg. #5)

(i) Q = 5 cfs with 4475 ft. of 18" C.M.P., 3 ft. of drop structure (24" C.M.P.) and 600 ft. of half 36" R.C.P.

(ii) Use $K_j = 0.70$ (90° junction loss factor), $K_e = 0.60$ & $K_m = 0.05$.

(iii) Control T.W. = 44.40 (Full) or 37.94 (No Flow)

Results —

(i) Full Flow Condition —

① Works hydraulically. Inlet velocity is 2.8 fps.

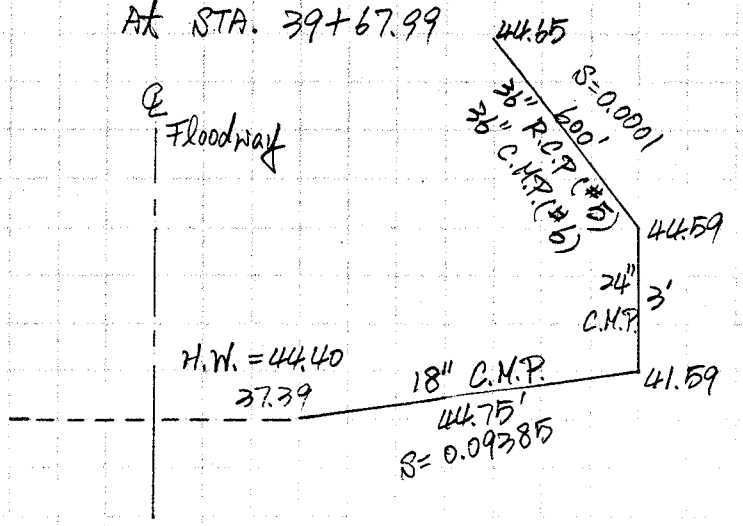
(ii) No Flow Condition — (H.W = 37.94 from WCLOW.OUT)

① Velocity in drop structure is 16.9 fps. Special protection is needed.

② Outlet velocity = 8.5 fps.

Design sketch for Trial #5 and #6

At STA. 39+67.99



Q = 5 cfs

Trial #5 (half 36" R.C.P.)

{ Full Flow — WCOL5.DAT
Low Flow — WCOL51.DAT

Trial #6 (half 36" C.M.P.)

{ Full Flow — WCOL6.DAT
Low Flow — WCOL61.DAT

At No Flow condition:

[Trial #6] Q = 5.00, D = 1.5', n = 0.024, S_o = 0.09385%,
WCLOW.OUT Y_n = 0.55', V = 8.46 fps i.e. H.W. = 37.94

8. "STORM" run Trial #6 for 600 ft. of half 36" C.M.P.

Problem Set Up —

(i) Same as Trial #5 but n = 0.024 for half 36" C.M.P.

Results:

(i) Full Flow Condition —

① At most upstream of half 36" C.M.P. the water depth over the banks but Q was assumed to be 5 cfs which should be close to zero.

② Inlet velocity = 2.8 fps.

8. (Cont'd)

Results (Cont'd)

(ii) No Flow Condition —

① Again, Q should be close to zero at the most upstream of 36" C.M.P.

② Velocity in drop structure is 16.9 fps.

③ Outlet velocity = 8.5 fps.

Water surface profile calculations has been performed only at inlet Sta. 38+00 with total flow of 5 cfs. The collector channel is a triangular, earth channel with a slope of 4:1 adjacent to maintenance roadway and with a slope of 3:1 grading back to the natural ground. Due to the small design flow and limiting earthwork for collector channel, low velocities occurred through the collector channel. Some maintenance would be required at the junction with the drainage pipe. An 18 inch CMP was modeled in the computations. Again, tailwater control for the no-flow condition was found by using "CIRCØ1I" program for the normal depth calculation. Outlet velocity of the pipe in this condition would be used for apron design.

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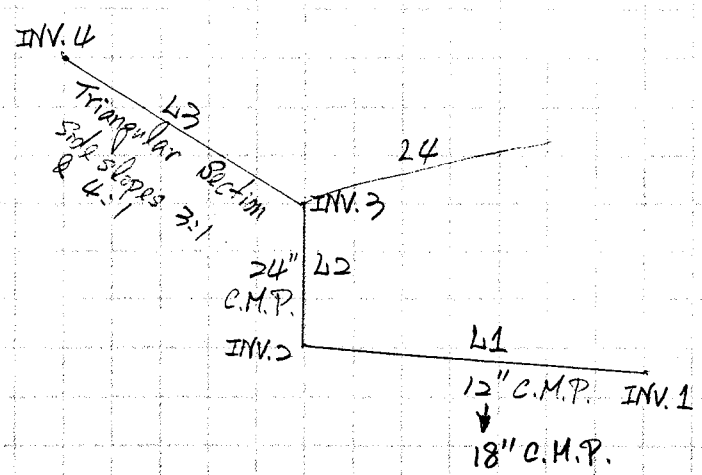
Job: 808 RWCD Floodway Reach 6 - E101012
Description: Comparative Design Studies
East side Collector Channel Design
Calculated by: B. Gerd Bur Date: 12/19/85 Sheet No. 2
Checked by: M.S.S. Date: _____ of 4

SUMMARY OF EAST COLLECTOR CHANNEL

H.W.	STATION	Q.	INV. 1	L1	INV. 2	L2	INV. 3	L3	INV. 4
44.40	38+00	3/2 > 5	37.45	62.3	37.95	3.3	41.25	250'	45.7
	43+00	3/2 > 4	37.40	62.1	37.90	3.35	41.25	250'	45.0
	48+00	3/2 > 4	37.35	61.9	37.84	3.41	41.25	250'	45.0
	53+00	3/2 > 4	37.30	61.7	37.79	3.46	41.25	250'	45.0
	58+00	3/2 > 5	37.25	61.5	37.74	3.51	41.25	250'	45.0
	66+00	3/2 > 4	37.17	53.4	37.56	5.64	43.20	350'	45.0
	71+00	3/2 > 4	37.12	56.0	37.54	4.96	42.50	300'	47.3
	76+00	2/1 > 3	37.07	55.8	37.49	5.01	42.50	250'	45.7
	82+00	3/2 > 4	37.01	59.6	37.48	4.02	41.50	250'	45.7
	88+00	3/2 > 4	36.95	59.3	37.41	4.09	41.50	250'	45.0
	94+50	1 > 2	36.84	55.9	37.36	4.99	42.25	300'	45.0
	99+50	1 > 2	36.81	55.8	37.33	5.02	42.25	300'	45.0
	104+17.5	1 > 2	36.70	53.4	37.09	5.65	42.74	300'	45.0
	108+85	2/1 > 3	36.63	59.0	37.09	4.16	41.25	300'	44.5
	113+32.5	1 > 2	36.56	55.6	36.98	5.05	42.03	300'	44.5
	118+67.5	1 > 2	36.48	55.3	36.89	5.14	42.03	300'	45.0
	132+50	1 > 2	35.13	57.0	35.56	4.69	40.25	200'	46.0
	138+08.33	1 > 2	34.96	59.9	35.43	3.95	39.38	250'	46.0
	143+00	1 > 2	34.81	59.8	35.28	3.97	39.25	250'	46.0
	147+13.20	1 > 2	34.69	54.1	35.09	5.46	40.55	250'	46.0
								217.5'	46.0
								217.5'	46.0
								250'	45.0
								250'	45.0
								197.5'	45.0
								217.5'	45.3
								217.5'	45.3
								197.5'	45.0
								250'	44.0
								250'	44.0
								308.33'	44.0
								241.67'	43.0
								250'	43.0
								250'	43.0
								163.2	43.0
								229.8	44.0



1. Collector Channel Inlet at Sta. 38+00 Trial # 2

① For Full Flow Condition

(i) H.W. Elev. = 44.40

(ii) Use more cross sections to avoid the computation error #5.

(iii) 62.30 ft of 18" C.M.P. with 3.3 ft of 24" C.M.P. drop structure.

$$\left(D = \left(\frac{2.159\,Qn}{S^{1/2}}\right)^{.375} \text{ (ft) the minimum size of pipe} \right.$$

$$S = \frac{37.95 - 37.45}{62.3} = 0.0080 \text{ ft/ft}$$

$$\left. Q = 5 \text{ cfs},\ n = 0.024 \qquad D = 1.489 \text{ ft} = 17.87 \text{ in.} \approx 18'' \right)$$

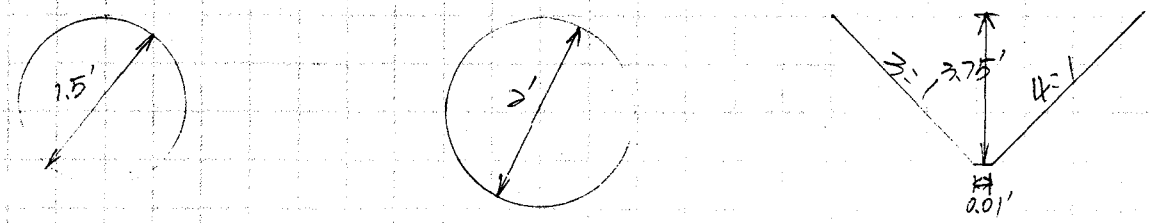
(iv) 350 ft and 250 ft of triangular earth ditch with side slopes of 3:1 and 4:1.

Results:

(i) Velocities are too small inside the collector channel at Sta. 10+63.30 ~ Sta. 13+07.91 (V < 2 fps)

(ii) Velocity at inlet is 2.83 fps.

Trial #2 Cross Sections



Sec. 1 Sec. 2 Sec. 3.

② For No Flow Condition

(i) H.W. Elev. = 38.66 (from ECLOW2.OUT 37.45+1.21=38.66)

Results:

(i) Velocity at inlet Sta. 38+00 is 3.27 fps.

(ii) Velocity at bottom of drop structure is 15.15 fps.

(iii) Velocities are smaller than 2 fps between Sta. 10+63.30. and Sta. 10+99.84.

EROSION ANALYSIS

An erosion analysis was performed using the tractive power approached as outlined in the SCS Publication "Design of Open Channels" (TR-25). Flows of the 100 year frequency in the aged condition, and 50 percent Q100 in the as-built condition were analyzed.

Hydraulic data for the analyses was obtained from a back-water analysis utilizing the WSPG computer model (Final for Mod. No. 3). Soil parameters were taken from the "Soil Mechanics Report (Final)" for Reach 6 dated November 25, 1985 and the Addendum dated December 17, 1985.

Cross-sections were selected for analysis on the basis of significant changes in soil properties, channel geometry and flow characteristics.

The calculations presented here supercede the tractive power analysis performed by WTI (and found in the above referenced Soil Mechanics Report and Addendum) using preliminary normal depth calculations. The results of this analysis should also

be considered as approximate with respect to the actual location of erosive and non-erosive reaches. Exact limits will be determined in the Preliminary Design Phase of the study.

Erosive reaches, requiring either bank or bed or both stabilization were found at:

Broadway Rd bridge	sta	154+20 to 158+05
Apache/Higley Rd. bridge	sta	121+13.05 to 127+25
Inlet Channel to North Terminus of Floodway	sta	29+00 to 30+18

Bank stabilization will also be required wherever side slopes are steeper than 2 to 1 or where overbank flows are expected to be flowing over the banks.

Erosive reaches within the collector channels are as follows;

Collector channel North of University	Section 1123 to 1131
Collector Channel South of Adobe	Section 1175 to 1183

Only the Q100 aged condition was analyzed for inlet channels.

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Job SCS RWCD FLOODWAY REACH 6
Description Tractive Power
Calculated by M.C. Date 2-5 Sheet No. 3
Checked by R Beck Date 2-11-86 of 4

Location	Condition	Allowable Tractive Power (lbs/ft sec)	Calculated Tractive Power (lbs/ft sec)	Remarks
Sta 158+19 to Sta 161+30	Q100 aged	0.18	0.14	Non-Erosive bed and banks
	½Q100 as-built	0.18	0.0523	
Sta 158+05 to Sta 158+19	Q100 aged	0.18	0.18	Erosive bed Non-Erosive banks
	½Q100 as-built	0.18	0.0635	
Sta 154+32 to Sta 158+19	Q100 aged	0.18	0.249	Erosive bed and banks
	½Q100 as-built	0.18	0.102	
Sta 154+20 to Sta 158+19	Q100 aged	0.18	0.18	Erosive bed Non-Erosive banks
	½Q100 as-built	0.18	0.0754	
Sta 127+25 to Sta 140+00	Q100 aged	0.18	0.147	Non-Erosive bed and banks
	½Q100 as-built	0.18	0.105	
Sta 127+00 to Sta 127+25	Q100 aged	0.18	0.18	Erosive bed Non-Erosive banks
	½Q100 as-built	0.18	0.14	
Sta 121+13.05 to Sta 127+00	Q100 aged	0.24	0.26	Erosive bed and banks
	½Q100 as-built	0.24	0.19	
Sta 91+97.84 to Sta 121+13.05	Q100 aged	0.24	0.11	Non-Erosive bed and banks
	½Q100 as-built	0.24	0.099	

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Job SCS RWCD FLOODWAY REACH 6
Description TRACTIVE POWER
Calculated by M.C. Date 2-5 Sheet No. 4
Checked by P. Beck Date 2-11-86 of 4

Location	Condition	Allowable Tractive Power (lbs/ft sec)	Calculated Tractive Power (lbs/ft sec)	Remarks
Sta 30+18 to Sta 91+97.84	Q100 aged ½Q100 as-built	3.0 3.0	0.11 0.08	Non-Erosive bed and banks
Sta 29+00 to Sta 30+18	Q100 aged	3.0	29	Erosive bed and banks
Sta 64+03 Collector South of Adobe, Sections 1175 to 1183	Q100 aged	3.0	3.87	Erosive bed and banks
Sta 89+11 Collector North of University, Sections 1123 to 1131	Q100 aged	3.0	5.28	Erosive bed and banks
Sta 60+60 Collector North of Adobe	Q100 aged	3.0	0.34	Non-Erosive

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Job: SCS KWCD Reach 6
Description: Mod. No. 3
Summary of Tractive Power Analysis.
Calculated by: R. Beck Date: 1-7-86 Sheet No. 1
Checked by: MSS Date: of 3

Summary of Findings

Station	50% Q_{100}	depth	τ_{all}	τ_b	τ_s	τ_{bc}	τ_{sc}	τ_{bt}	τ_{st}
128+79.37	950.	4.051	0.19	.0458	.0412				
128+84.37	950.	4.060	0.19	.0446	.0410				
140+00.00	1200.	4.906	0.19	.0477	.0431				
153+50.00	1200.	6.267	0.19	.0282	.0253				
158+90.67	1200.	6.471.	0.19	.0184	.0166	.0194	.0174	.0194	.0174

All areas are non-erosive.

Station	Q_{100}	τ_{all}	τ_b	τ_s	τ_{bc}	τ_{sc}	τ_{bt}	τ_{st}
128+79.37	1900	0.19	.066	.058				
128+84.37	1900	0.19	.066	.058				
140+00.00	2400	0.19	.0824	.1077				
153+50.00	2400	0.19	.0579	.0521				
158+90.67	2400	0.19	.046	.041	.048	.044	.048	.044

All areas are non-erosive

$S_o = .001166$ 1/1

Station	b	Floodway Invert	WS elev +2'	HORIZ DISTANCE FROM CONST. ℄ to TOP BANK	HORIZ DISTANCE FROM TOP BANK TO R/W EAST SIDE	WEST SIDE	Dist from Const ℄ to R/W. East	West
140	90.00	33.72	43.15	73.29	41.71	21.71	115'	95'
141	89.34	33.60	43.13	73.26	41.74	21.74	115'	95'
142	88.66	33.48	43.11	73.22	41.78	21.78	115'	95'
143	88.00	33.36	43.09	73.19	41.81	21.81	115'	95'
144	87.34	33.24	43.07	73.16	41.84	21.84	115'	95'
145	86.66	33.12	43.01	73.00	42.00	22.00	115'	95'
146	86.00	33.00	43.00	73.00	42.00	22.00	115'	95'
147	85.34	32.88	42.99	73.00	42.00	22.00	115'	95'
148	84.66	32.76	42.98	72.99	42.01	22.01	115'	95'
149	84.00	32.64	42.97	72.99	42.01	22.01	115'	95'
150	83.34	32.52	42.96	72.99	42.01	22.01	115'	95'
151	82.66	32.40	42.95	72.98	42.02	22.02	115'	95'
✓ 152	82.00	32.28	42.94	72.98	42.02	22.02	115'	95'
✓ 153	81.34	32.16	42.94	73.01	No cross-section @ this station.			
✓ 153+50.	81.00	32.04	42.94	73.20	32.8'	30.2'	106'	104'

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Job: SCS RWCD Reach 6

Description: Modification No. 3
Cross Section Data

Calculated by: R. Beck Date: 1-7-86

Checked by: W.S.S. Date:

Sheet No. 7 of 3

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Job SCS RWCD Reach 6
Description Mod. No. 3 Cross Section Data
Calculated by R. Roach Date 1-7-86
Checked by M.S.S. Date
Sheet No. 3 of 3

$S_o = -.0011660\%$ (Mod. No. 3)

Station	b	Floodway Invert	WS Elev		WS Elev +2'
140+00	90.00	33.72 (calc'd)	41.15	↓Se=.00028	43.15
141+00	89.34	33.60	41.13		43.13
142+00	88.66	33.48	41.11		43.11
143+00	88.00	33.36	41.09		43.09
144+00	87.34	33.24	41.07		43.07
145+00	86.66	33.12	41.01	↓ Se=.000082	43.01
146+00	86.00	33.00	41.00		43.00
147+00	85.34	32.88	40.99		42.99
148+00	84.66	32.76	40.98		42.98
149+00	84.00	32.64	40.97		42.97
150+00	83.34	32.52	40.96		42.96
151+00	82.66	32.40	40.95		42.95
152+00	82.00	32.28	40.94		42.94
153+00	81.34	32.16	40.94		42.94
153+50	81.00	32.04	40.94		42.94

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Job RWCD Reach 6 E101012

Description Tractive Power Calculations

Calculated by M. Shapiro Date 2/11/86 Sheet No. 1

Checked by B.G.S. Date _____ of 1

See the Tractive Power Calculations, bluelines of Alt. No. 2 and "WSPG" for Modification No. 3 under seperate cover for further details.

Erosion Protection

Main Floodway Channel.

Erosion Protection will be required in areas of the main floodway channel. The tractive power method of determining erosive reaches was used to determine the extent of erosion protection required. Two conditions were analyzed: Q_{100} aged and 50% Q_{100} as-built. The following reaches were found to be erosive: Sta 158+05 to 158+19 erosive bed. Sta 154+32 to 158+19 erosive bed and banks. Sta 154+20 to 158+19 erosive bed. Sta. 127+00 to 127+25 erosive bed. Sta 121+13.05 to 127+00 erosive bed and banks. Sta 29+00 to 30+18 erosive bed and banks.

Materials under consideration for bed and bank protection include: riprap, gunite, concrete, soil cement, revetment mattress, and gabions.

Erosion Protection for main floodway channel by station.

Sta 29+00 to 30+18	Erosive bed and banks	11387 ft^2
Sta 121+13 to 127+00	Erosive bed and banks	47770 ft^2
Sta 127+00 to 127+25	Erosive bed	1625 ft^2
Sta 154+20 to 158+19	Erosive bed	20156 ft^2
Sta 154+32 to 158+19	Erosive banks	15139 ft^2
Sta 158+05 to 158+19	Erosive bed	1260 ft^2
	Total =	97337 ft^2

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Job: SCS RWCD Reach 6
Description: Erosion Protection for main floodway channel.
Calculated by: R. Beck Date: 2-10-86 Sheet No. 3
Checked by: MSS Date: of 3

Material	Quantity	Unit Cost	Cost
Rip Rap (cu. yd.) (ass'd thickness = 18")	5408	20/yd³	108160
Gunite (ft²)	97377	2/ft²	194754
Concrete (ft²)	97377 (4" thick)	2/ft²	194754
Soil Cement (yd³)	7275 4907 (stairstep) 2368 (12" plate)	6.00/yd³ = 29442 22.00/yd³ = 52,096	81538
Revetment Mattress (ft²)	97377	3./ft²	292131
Gabions (yd²)	10815	65/yd²	702975
Grouted Rip rap (cu yd) (ass'd thickness = 18")	5408	40/yd²	216320

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Job RWCD Reach 6 E101012
Description Project Feature Ranking
Calculated by M. Shapiro Date 2/9/86 Sheet No 1
Checked by B.G.S. Date _____ of 1

Ranking System 1-10 points (pts.)

Based On:

Items	Multiplier
Cost (C)	2
Maintenance (M)	1
Availability (A)	1
Ease of Construction (E)	0.5
Aesthetics (AE)	0.5
Hydraulic Performance (H)	1
Total available points	60

Project Feature: Erosion Protection For Main Channel

Item	Type of Material						
	RipRap	Gunite	Concrete	Soil Cement	Revetment Mat	Gabions	Grouted RipRap
C	8	7	7	9	5	3	6
M	6	9	10	9	9	8	7
A	8	10	10	10	7	8	8
E	9	10	9	10	10	7	7
AE	9	6	6	9	6	7	7
H	7	9	10	9	8	8	8
Total # of pts.	46	50	51.5	55.5	42	37	42

Recommended Material for Project Feature: Soil Cement

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Job RWCD Reach C 101012
Description Project Feature Ranking
Calculated by M. Shapiro Date 2/9/86 Sheet No. 1
Checked by B. G. S. Date _____ of 1

Ranking System 1-10 points (pts.)

Based On:

Items	Multiplier
Cost (C)	2
Maintenance (M)	1
Availability (A)	1
Ease of Construction (E)	0.5
Aesthetics (AE)	0.5
Hydraulic Performance (H)	1
Total available points	60

Project Feature: Erosion Under Broadway Rd Bridge (Lining)

Item	Type of Material					
	Concrete	Gunite				
C	8	8				
M	10	9				
A	9	9				
E	9	10				
AE	8	7				
H	9	9				
Total # of pts.	52.5	51.5				

Recommended Material for Project Feature: Concrete Lining

Erosion Protection

Major Inlet Structures

The major inlet structures on Reach 6 are all located on the east side of the floodway. Erosion protection will be required for each structure. Protection is to be placed on the upstream side of the inlet structure, where the flows are being collected and channeled to the spillway. The spillway itself will be protected and an outlet apron provided. Materials under consideration for erosion protection are riprap, gunite, concrete, soil cement, revetment mattress and gabions. A description of each material is given in the section on erosion protection for the main floodway channel. A cost comparison of the subject materials is shown in the following summary.

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Job: SCS RWCD Reach 6

Description: Erosion Protection for Major Inlet Structures

Calculated by: R. Beck Date: 2-10-86. Sheet No. 2

Checked by: MSS Date: _____ of 2

Material	Quantity	Unit Cost	Cost.
RipRap (cu.yd.)	3060 yd^3	20.00	61200.
Gunite (ft^2)	55056 ft^2	2.00	110112.
Concrete (ft^2)	55056 ft^2	2.00	110112.
Soil Cement (yd^3)	3060 yd^3	14.00 includes excavation.	42840
Revetment mattress (ft^2)	55056 ft^2	3.00	165168
gabions (yd^2)	6117 yd^2	65.00	397605
Grouted RipRap (cu yd)	3060 yd^3	40.00	122400

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Job RWCD Reach 6 E101012
Description Project Feature Ranking

Calculated by M. Shapiro Date 2/9/86 Sheet No 1
Checked by B.G.S. Date _____ of 1

Ranking System 1-10 points (pts.)

Based On:

Items	Multiplier
Cost (C)	2
Maintenance (M)	1
Availability (A)	1
Ease of Construction (E)	0.5
Aesthetics (AE)	0.5
Hydraulic Performance (H)	1
Total available points	60

Project Feature: Erosion Protection For Major Inlet Structures

Item	Type of Material						
	RipRap	Gunite	Concrete	Soil Cement	Revetment Mat.	Gabions	Grouted RipRap
C	8	7	7	9	5	3	6
M	6	9	10	9	9	8	7
A	8	10	10	10	7	8	8
E	9	10	9	10	10	7	7
AE	9	6	6	9	6	7	7
H	1	3	10	9	5	7	8
Total # of pts.	40	44	51.5	55.5	39	36	42

Recommended Material for Project Feature: Soil Cement

Dumped RipRap

This kind of protection consists of rock courses placed on gravel filters on bank slopes and channel beds. Dumped riprap has the advantages of relatively simple maintenance procedures. Damage can be repaired by the addition of more rock to the existing installation. Dumped rip rap has a natural appearance and will blend in well with other features of the floodway project. The cost of dumped rip rap varies according to the quantity and an average cost is taken to be 20.00/yd^3.

Gunite: Gunite protection would consist of a 4" layer of gunite on bed and banks. This type of protection is particularly adaptable to locations where the hydraulic efficiency of the surface is important. Other locations where gunite is suitable is in areas with steep channel banks where rip rap or soil-cement cannot be used. Bank protection underneath existing bridge structures is another

area where gunite could be used due to the limited space available for construction. The cost of gunite channel protection is $2.00/ft^2

<u>Grouted riprap</u> - This type of protection consists of rock riprap having voids filled with portland cement concrete grout to form a monolithic armor. Grouted rock rip rap has application in areas where rock of sufficient size for ordinary rock rip rap is not economically available. Grouting protects the stones from the full force of the water and integrates a greater mass to resist movement. This type of protection is rigid without high strength and support by the banks must be maintained. The cost of grouted rip rap is $40/yd^3

Concrete. This method of protection consists of paving the channel bed and banks with reinforced portland cement concrete. It is particularly adaptable to areas where the hydraulic efficiency is important. The cost is high, however, when sufficiently large quantities are involved and alignment will permit the use of a slip-form paver, the cost will be reduced. The cost for concrete channel lining 4" thick is $2.00/ft^2.

Revetment mattress The revetment system consists of a heavy-duty nylon mattress placed on a slope surface and filled with fine aggregate concrete mortar. When the mortar hardens, the mat can act as a concrete armor against the erosive action of fast moving water. Revetment panels, in 60 inch widths, are sewn together to match the dimensions of a slope and form a continuous system without joints or overlaps. Only rough grading of the slope is required and the outside edges are toed

into trenches for protection against undercutting and scour. The mattress is available in filter point design which is designed with open-weave filter units that relieve hydrostatic uplift pressure or uniform cross-section which forms a slab-like impermeable surface. According to the manufacturer, this product is not recommended for applications where the velocities exceed 10 fps. The cost of the revetment system is 3.00 /ft^2.

Gabions - This type of channel protection consists of connected baskets fabricated of wire mesh or woven wire fencing filled with rock and adequately anchored to the banks. Usually this application is limited to locations where the rock economically available is too small for ordinary rock riprap, or where grouted protection is unsuited because of fineness of stone or insecurity of bedding or foundation. The baskets vary in length from 6 to 12 feet and vary in depth from 1 to 3 feet.

the cost of the larger gabions is 75.00/yd² and the cost of the smaller gabions is 65.00/yd².

Soil Cement- Soil cement is a mixture of pulverized soil material and measured amounts of portland cement and water compacted to a high density. The soils on RWCD Reach 6 have been identified as suitable for modification using portland cement. However, further testing will be required to establish a job mix for each area of the project requiring protection.

Soil cement can be mixed in place using traveling mixing machines or mixed in a central mixing plant. If the in-place soils are suitable for modification as they are, then the traveling mixing machine is the most efficient method of placement. Whatever type of mixing equipment is used the objectives are the same. The curing time for soil-cement is the same as for concrete and errors in grade or alignment can be corrected by trimming the soil-cement while

it is still green. If a soft subgrade is encountered during construction, it will require undercutting and replacement with a suitable material. This is necessary to achieve the required compaction of the soil-cement. On most projects, the soil-cement is constructed in stair-step fashion by placing and compacting the soil-cement in horizontal layers stairstepped up the embankment. However, thinner slope protection may be adequate for small embankments. A 6 to 12 inch thick layer of soil-cement can be placed parallel to the face of the embankment rather than in horizontal layers. Generally the plating method should not be used on slopes steeper than 3:1.

The cost of soil-cement depends on the quantity required for the job. The cost for 8" lifts of plating is \$6.00/yd^3 and the cost for stairstep construction is \$22/yd^3

Greiner Engineering

Greiner Engineering Sciences, Inc.
Tucson 602 327-3413
Phoenix 602 275-5400

The east and west collector systems have a total of 40 outlet structures which are to be analyzed for erosion protection. The structures discharge into the main floodway and splash aprons are to be provided for each. Materials considered for outlet protection include the following: concrete, riprap, grouted riprap, gabions, soil cement, revetment mattress, and gunite. The aprons were analyzed for the Q_{100} discharge for full flow condition in the channel and no flow condition in the floodway. The following table summarizes the quantity and cost of materials.

Greiner Engineering

Greiner Engineering Sciences, Inc.
Tucson 602 327-3413
Phoenix 602 275-5400

Job SCS RWCD Reach 6
Description Erosion Protection for collector channel outlets.
Calculated by R. Beck Date 2-10-86 Sheet No. 2
Checked by M.S.S. Date of 2

Material	Quantity	Unit Cost	Cost
Rip Rap (cu.yd)	816 yd^3	20/yd^3	16,320
Gunite (ft^2)	25200 ft^2	2/ft^2	50,400
Concrete (ft^2)	25200 ft^2	2/ft^2 (4" thick)	50,400
Soil Cement (yd^3)	933 yd^3	6/yd^3	5600
Revetment Mattress (ft^2)	25200 ft^2	3/ft^2	75600
Gabions (yd^2)	2800 yd^2	65/yd^2	182,000
Grouted RipRap (cu.yd)	816 yd^3	40/yd^3	32,640

Greiner Engineering

Greiner Engineering Sciences, Inc.
Tucson 602 327-3413
Phoenix 602 275-5400

Job RWCD Reach 6 E101012
Description Project Feature Ranking
Calculated by M. Shapiro Date 2/9/86 Sheet No. 1
Checked by B.G.S. Date _____ of 1

Ranking System 1-10 points (pts.)

Based On:

Items	Multiplier
Cost (C)	2
Maintenance (M)	1
Availability (A)	1
Ease of Construction (E)	0.5
Aesthetics (AE)	0.5
Hydraulic Performance (H)	1
Total available points	60

Project Feature: Erosion Protection For Collector Channel Outlets

Item	Type of Material						
	Rip Rap	Gunite	Concrete	Soil Cement	Revetment Mat	Gabions	Grouted Rip Rap
C	9	7	7	10	6	3	8
M	7	8	10	9	9	8	8
A	8	10	10	10	7	8	8
E	9	6	6	9	6	7	7
AE	9	6	6	9	6	7	7
H	8	9	9	9	8	8	9
Total # of pts.	50	47	49	57	42	37	48

Recommended Material for Project Feature: Soil Cement

Erosion Protection for 42" pipe at Sta. 143+66.

Erosion Protection must be provided for the existing 42" pipe which is located on the east side of the floodway at Sta 143+66. The discharge for the 100-year storm is 118 cfs with an outlet velocity of 18 fps. This discharge must cross the maintenance road on the east side and the outlet apron will extend across the maintenance road. Therefore, any material that is specified in this area must be suitable for use as a roadway surface. This would eliminate the use of gabions, rip rap, grouted rip rap and revetment mattress. The materials which are to be considered for this installation include concrete, gunite, soil-cement and are summarized in the following table.

Greiner Engineering

Greiner Engineering Sciences, Inc.

Tucson 602 327-3413
Phoenix 602 275-5400

Job: SCS RWCD Reach 6

Description: Erosion Protection for 42" pipe at Sta 143+66

Calculated by: R. Beck Date: _____ Sheet No. 2

Checked by: M.S.S. Date: _____ of 2

Material	Quantity	Unit Cost	Cost
Gunite (ft^2)	$2325 ft^2$	$2.00/ft^2$	4650.
Concrete (ft^2)	$2325 ft^2$	4" thick $2.00/ft^2$	4650.
Soil Cement (yd^3)	$86 yd^3$	$6 yd^3$	516.

Greiner Engineering

Greiner Engineering Sciences, Inc.
Tucson 602 327-3413
Phoenix 602 275-5400

Job RWCD Reach 6 E101012
Description Project Feature Ranking
Calculated by M. Shapiro Date 2/9/86 Sheet No. 1
Checked by B.G.S. Date _____ of 1

Ranking System 1-10 points (pts.)

Based On:

Items	Multiplier
Cost (C)	2
Maintenance (M)	1
Availability (A)	1
Ease of Construction (E)	0.5
Aesthetics (AE)	0.5
Hydraulic Performance (H)	1
Total available points	60

Project Feature: Erosion Protection for 42" pipe at sta. 143+66

Item	Type of Material					
	Gunite	Concrete	Soil Cement			
C	5	5	10			
M	6	10	6			
A	9	9	10			
E	8	7	9			
AE	7	8	9			
H	9	9	9			
Total # of pts.	41.5	45.5	54			

Recommended Material for Project Feature: Soil Cement

Erosion Protection for 36" pipe S. of University Dr.

Located on the east side of the floodway and South of University Drive is an existing 36" pipe which is to remain in place after the floodway is constructed. A headwall and outlet protection will be required. The headwall is proposed to be a reinforced concrete headwall for a 36" pipe using the MAG Standard 501-4. Materials under consideration for the erosion protection include the following: riprap, gunite, concrete, soil cement, Revetment mattress, gabions and grouted rip rap. A summary is shown in the following table.

Greiner Engineering

Greiner Engineering Sciences, Inc.

Tucson 602 327-3413
Phoenix 602 275-5400

Job: SCS RWCD Reach 6

Description: Erosion Protection for 36" pipe S. of University Drive.

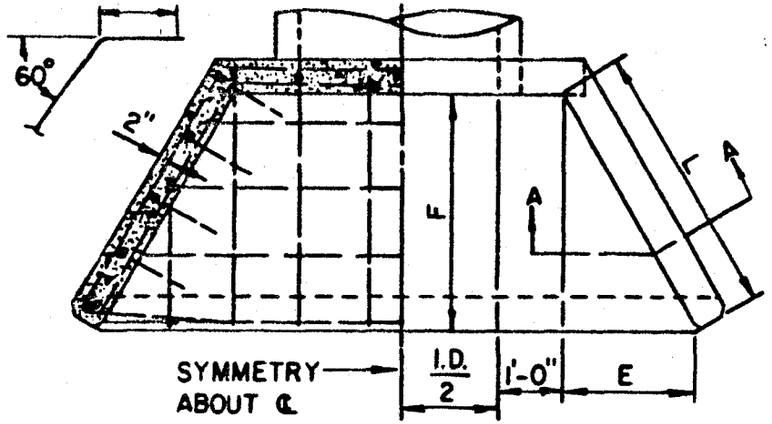
Calculated by: R. Beck Date: 2-10-86. Sheet No. 2

Checked by: M.S.S. Date: _____ of 2

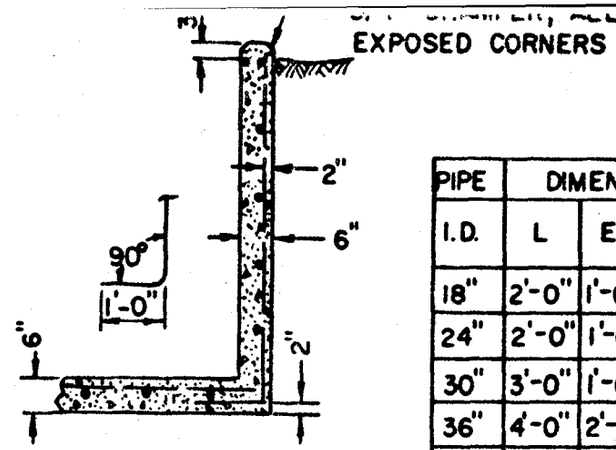
Material	Quantity	Unit Cost	Cost
Rip Rap (cu yd)	57	20/yd³	1140
Gunite (ft²)	1550	2/ft²	3100
Concrete (ft²)	1550	2/ft² (4" thick)	3100
Soil Cement (yd³)	57	6/yd³	342
Revetment Mattress (ft²)	1550	3/ft²	4650
Gabions (yd²)	172	65/yd²	11180
Grouted riprap (yd³)	57	40/yd³	2280.

The headwall will require 2.01 yd³ concrete and 150 lbs. steel.

Existing 36" Pipe S. of University Drive

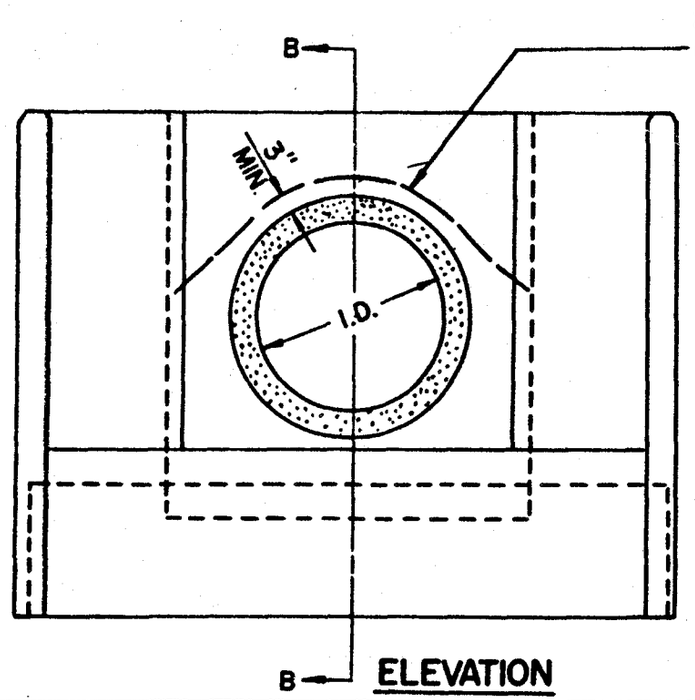


PLAN

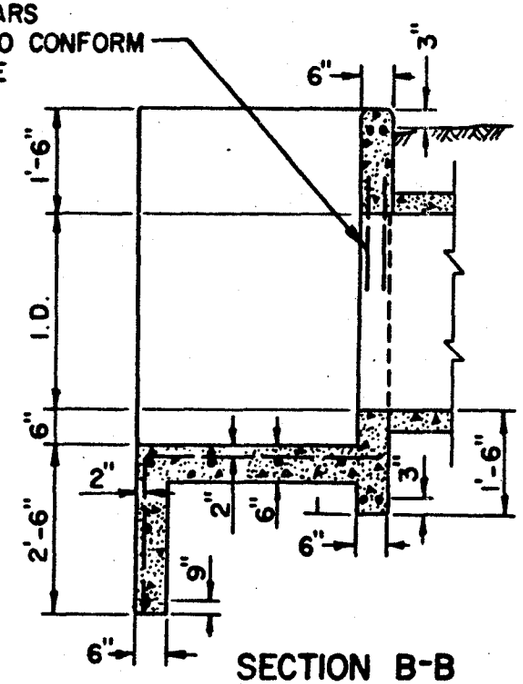


SECTION A-A

PIPE	DIMENSIONS			QUANTITIES		
I.D.	L	E	F (APPRX)	C.Y. CONC. C.M.P.	C.Y. CONC. R.C.P.	REINF. STL. LBS.
18"	2'-0"	1'-0"	1'-9"	0.97	0.96	65
24"	2'-0"	1'-0"	1'-9"	1.11	1.07	78
30"	3'-0"	1'-6"	2'-7"	1.50	1.44	108
36"	4'-0"	2'-0"	3'-6"	2.08	2.01	150
42"	5'-0"	2'-6"	4'-4"	2.71	2.63	205
48"	6'-0"	3'-0"	5'-2"	3.39	3.30	270
54"	7'-0"	3'-6"	6'-1"	4.14	4.02	335
60"	8'-0"	4'-0"	6'-11"	4.96	4.80	410



ELEVATION



SECTION B-B

NOTES

1. ALL CONCRETE SHALL BE CLASS A. PER SECT. 725
2. ALL REINFORCING BARS SHALL BE #4 EXCEPT #6 BARS OVER PIPE. BAR SPACING APPROXIMATELY 1'-0" C TO C UNLESS OTHERWISE NOTED.
3. 30° WING WALL FLARE SHOWN; 45° NORMALLY DESIRABLE.

DETAIL NO.				DETAIL NO.
501-4	STANDARD DETAIL	HEADWALL IRRIGATION 18" TO 60" PIPE		501-4

Greiner Engineering

Greiner Engineering Sciences, Inc.

Tucson 602 327-3413
Phoenix 602 275-5400

Job RWCD Reach 6 E101012
Description Project Feature Ranking
Calculated by M. Shapiro Date 2/9/86 Sheet No 1
Checked by _____ Date _____ of 1

Ranking System 1-10 points (pts.)

Based On:

Items	Multiplier
Cost (C)	2
Maintenance (M)	1
Availability (A)	1
Ease of Construction (E)	0.5
Aesthetics (AE)	0.5
Hydraulic Performance (H)	1
Total available points	60

Project Feature: Erosion Protection for the 36" Pipe South of Univ.

Item	Type of Material						
	Rip Rap	Gunite	Concrete	Soil Cement	Revetment Mat	Gabions	Grouted Rip Rap
C	9	7	7	10	6	3	8
M	7	8	10	9	9	8	8
A	8	10	10	10	7	8	8
E	9	6	6	9	6	7	7
AE	9	6	6	9	6	7	7
H	8	9	9	9	8	8	9
Total # of pts.	50	47	49	57	42	37	48

Recommended Material for Project Feature: Soil Cement

SCS-AS-146
REV. 2-73

SHEET 1 OF 4 SHEETS

ABSTRACT OF PROPOSALS RECEIVED

AT Rm 3030-Fed. Bldg., Phoenix, AZ
(PLACE OF OPENING)

DATE OPENED 8-8-84 INV. NO. SCS-30-AZ-84

ADDENDA TO BE ACKNOWLEDGED:

NOS. 1 & 2

	Name and Address of Bidder:	Name and Address of Bidder:	Name and Address of Bidder:	Name and Address of Bidder:	Name and Address of Bidder:
	Pulice Construction, Inc 2035 W. Mountain View Road Phoenix, AZ 85021 RWCD, Reach-3	Ball & Brosamer, Inc. Ball, Ball & Brosamer Inc. a Joint Venture P.O. Box 1007 Danville, CA 94526	R.E. Monks Construction Co P.O. Box 25579 Colorado Springs, CO 80936	Hunter Contracting Co. 9401 South Copper Rd. P.O. Box 900 Gilbert, AZ 85234	M.M. Sundt Construction Co. 3949 E. Irvington Rd. P.O. Box 27507 Tucson, AZ 85726
Total Bid $	2,909,797.35	2,996,464.28	3,577,554.18	3,711,236.28	3,935,895.80
ACCEPTANCE PERIOD	60 Calendar Days	60 Calendar Days	60 Calendar Days	60 Calendar Days	60 Calendar Days
ADDENDA NUMBERS ACKNOWLEDGED	1 & 2	1 & 2	1 & 2	1 & 2	1 & 2
BID GUARANTEE (Type and Amount)	Bid Bond - 20%	Bid Bond - 20%	Bid Bond - 20%	Bid Bond - 20%	Bid Bond - 20%
DELIVERY PERIOD	270 Calendar Days	270 Calendar Days	270 Calendar Days	270 Calendar Days	270 Calendar Days
DISCOUNT	N/A	N/A	N/A	N/A	N/A

ITEM NO.	WORK OR MATERIAL	QUANTITY AND UNIT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT
	Bid Schedule-Blue Sheet											
1.	Clearing & Grubbing	220 AC	$ 250.00	$ 55,000.00	$ 530.00	$ 116,600.00	$ 315.00	$ 69,300.00	$1,150.00	$ 253,000.00	$1,300.00	$ 286,000.00
2.	Mobilization	L.S	XXX	50,000.00	XXX	75,000.00	XXX	87,000.00	XXX	104,000.00	XXX	40,000.00
3.	Water	225,000 MG	2.50	375,000.00	2.50	375,000.00	2.50	375,000.00	2.50	375,000.00	2.50	375,000.00
4.	Channel Excavation, Common	2,235,261CY	.61	1,363,509.21	.68	1,519,977.48	.85	1,899,971.85	.80	1,788,208.80	.75	1,676,445.75
5.	Basin Excavation, Common	66,545 CY	.62	41,257.90	.68	45,250.60	.94	62,552.30	1.00	66,545.00	.85	56,563.25
6.	Structure Excavation, Common	4,244 CY	4.00	16,976.00	3.00	12,732.00	3.00	12,732.00	5.00	21,220.00	10.00	42,440.00
7.	Structure Backfill	1,131 CY	7.00	7,917.00	5.00	5,655.00	4.60	5,202.60	12.00	13,572.00	10.00	11,310.00
8.	Earth Fill	482,848 CY	.20	96,569.60	.20	96,569.60	.33	159,339.84	.50	241,424.00	.40	193,139.20
9.	Drain Fill	614 CY	27.50	16,885.00	20.00	12,280.00	33.00	20,262.00	16.00	9,824.00	20.00	12,280.00
10.	Concrete	1,110 CY	145.00	160,950.00	180.00	199,800.00	139.00	154,290.00	158.00	175,380.00	200.00	222,000.00
11.	Cement	1,661 Bb	20.00	33,220.00	15.00	24,915.00	17.90	29,731.90	16.20	26,908.20	17.00	28,237.00
12.	Steel Reinforcement	278,342 LB.	.42	116,903.64	.40	111,336.80	.37	102,986.54	.39	108,553.38	.30	83,502.60
13.	24" Diameter Concrete Pipe, Class III	67 LF	55.00	3,685.00	25.00	1,675.00	27.75	1,859.25	38.00	2,546.00	50.00	3,350.00
14.	Loose Rock Riprap	7,910 CY	21.00	166,110.00	10.00	79,100.00	17.75	140,402.50	16.00	126,560.00	28.00	221,480.00
15.	Grouted Rock Riprap	4,546 CY	30.00	136,380.00	20.00	90,920.00	33.30	151,381.80	30.00	136,380.00	45.00	204,570.00

SCS–AS–146a
Rev. 9–73

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET 2 OF 4 SHEETS

CONTINUATION SHEET

ABSTRACT OF PROPOSALS RECEIVED

INV. NO. SCS-30-AZ-84

ITEM NO.	WORK OR MATERIAL	QUANTITY AND UNIT	Name and Address of Bidder: Pulice Construction Co. 2035 W Mountain View Rd. Phoenix, AZ 85021		Name and Address of Bidder: Ball & Brosamer Inc. Ball, Ball & Brosamer Inc.		Name and Address of Bidder: R.E. Monks Const. Co. P.O. Box 25579 Colorado Springs, Co		Name and Address of Bidder: Hunter Contracting Co. P.o. Box 900 Gilbert, AZ 85234		Name and Address of Bidder: M.M. Sundt Const. Co. P.O. Box 27507 Tucson, AZ 85726	
			UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT
16.	Guardrail	112 LF	$ 22.00	$ 2,464.00	$ 25.00	$ 2,800.00	$ 16.80	$ 1,881.60	$ 21.00	$ 2,352.00	$ 20.00	$ 2,240.00
17.	Fence	262 LF	16.00	4,192.00	15.00	3,930.00	15.80	4,139.60	14.85	3,890.70	15.00	3,930.00
18.	Surveys	LS	XXX	60,800.00	XXX	50,000.00	XXX	77,000.00	XXX	60,000.00	XXX	55,000.00
19.	12" Corrugated Metal Pipe	90 LF	29.00	2,610.00	15.00	1,350.00	22.00	1,980.00	9.00	810.00	20.00	1,800.00
	Sub Total			2,710,429.35		2,824,891.48		3,357,013.78		3,516,174.08		3,519,287.80
	Bid Schedule-Yellow											
1.	Mobilization	LS	XXX	3,000.00	XXX	5,000.00	XXX	15,000.00	XXX	1.00	XXX	10,000.00
2.	Clearing & Grubbing	12 AC	250.00	3,000.00	800.00	9,600.00	545.00	6,540.00	1,500.00	18,000.00	2,000.00	24,000.00
3.	Trailwater Pump Relocation	LS	XXX	23,000.00	XXX	25,000.00	XXX	31,700.00	XXX	25,000.00	XXX	100,000.00
4.	Pond Excavation	38,864 CY	1.00	38,864.00	.70	27,204.80	1.00	38,864.00	.80	31,091.20	2.00	77,728.00
5.	Structure Excavation	2,727 CY	4.00	10,908.00	4.00	10,908.00	3.00	8,181.00	5.00	13,635.00	10.00	27,270.00
6.	Channel Excavation	1,355 CY	2.00	2,710.00	6.00	8,130.00	1.80	2,439.00	1.00	1,355.00	6.00	8,130.00
7.	Structure Backfill	2,438 CY	7.00	17,066.00	5.00	12,190.00	3.80	9,264.40	5.00	12,190.00	10.00	24,380.00
8.	Earthfill	7,500 CY	.20	1,500.00	.20	1,500.00	.65	4,875.00	.50	3,750.00	.50	3,750.00
9.	18" Corrugated Metal Pipe	104 LF	30.00	3,120.00	10.00	1,040.00	33.00	3,432.00	35.00	3,640.00	50.00	5,200.00
10.	15" High Pressure PVC Pipe	6,100 LF	15.00	91,500.00	10.00	61,000.00	15.45	94,245.00	12.00	73,200.00	21.50	131,150.00
11.	Surveys	LS	XXX	4,700.00	XXX	10,000.00	XXX	6,000.00	XXX	13,200.00	XXX	5,000.00
	Subtotal			199,368.00		171,572.80		220,540.40		195,062.20		416,608.00

SCS-AS-146
REV. 2-73

SHEET 3 OF 4 SHEETS

ABSTRACT OF PROPOSALS RECEIVED

AT Rm 3030-Fed Bldg., Phoenix, AZ
(PLACE OF OPENING)

DATE OPENED 8-8-84 INV. NO. SCS-30-AZ-84

ADDENDA TO BE ACKNOWLEDGED:

NOS. 1 & 2

	Name and Address of Bidder:	Name and Address of Bidder:	Name and Address of Bidder:	Name and Address of Bidder:	Name and Address of Bidder:
	Richard P. Murray Co. P.O. Drawer G Chandler, AZ 85224	Consolidated Utility Contracting Inc. P.O. Box 6059 21617 N 21st Ave. Glendale, AZ 85312	Kokosing Construction Company, Inc. P.O. Box 226 Water Ford Road Fredericktown, OH 43019	Parapet Constructors 1018 E. Guadalupe Rd. Tempe, AZ 85283	Fisher Contracting Co. P.O. Box 6537 Phoenix, AZ 85005
	Total Bid $ 4,346,666.11	Total Bid $ 4,589,175.50	Total Bid $ 4,841,798.90	Total Bid $ 4,890,135.76	Total Bid $ 5,178,548.70
ACCEPTANCE PERIOD	60 Calendar Days	30 Calendar Days	60 Calendar Days	60 Calendar Days	60 Calendar Days
ADDENDA NUMBERS ACKNOWLEDGED	1 & 2	1 & 2	1 & 2	1 & 2	1 & 2
BID GUARANTEE (Type and Amount)	Bid Bond - 20%	Bid Bond - 20%	Bid Bond - 20%	Bid Bond - 20%	Bid Bond - 20%
DELIVERY PERIOD	270 Calendar Days	270 Calendar Days	270 Calendar Days	270 Calendar Days	270 Calendar Days
DISCOUNT	N/A	N/A	N/A	N/A	N/A

ITEM NO.	WORK OR MATERIAL	QUANTITY AND UNIT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT
	Bid Schedule-Blue Sheet											
1.	Clearing & Grubbing	220 AC	$ 500.00	$ 110,000.00	$ 260.00	$ 57,200.00	$ 150.00	$ 33,000.00	$ 770.00	$ 169,400.00	$1,000.00	$ 220,000.00
2.	Mobilization	L.S.	XXX	150,000.00	XXX	93,600.00	XXX	275,000.00	XXX	218,300.00	XXX	125,000.00
3.	Water	225,000 MG	2.50	375,000.00	2.50	375,000.00	2.50	375,000.00	2.50	375,000.00	2.50	375,000.00
4.	Channel Excavation, Common	2,235,261CY	.91	2,034,087.51	1.00	2,235,261.00	1.39	3,107,012.79	1.08	2,414,081.88	1.10	2,458,787.10
5.	Basin Excavation, Common	66,545 CY	2.00	133,090.00	1.00	66,545.00	1.10	73,199.50	1.42	94,493.90	1.10	73,199.50
6.	Structure Excavation, Common	4,244 CY	5.00	21,220.00	3.50	14,854.00	5.00	21,220.00	2.50	10,610.00	4.30	18,249.20
7.	Structure Backfill	1,131 CY	10.00	11,310.00	13.00	14,703.00	5.00	5,655.00	10.00	11,310.00	25.00	28,275.00
8.	Earth Fill	482,848 CY	.60	289,708.80	1.40	675,987.20	.22	106,226.56	.57	275,223.36	1.20	579,417.60
9.	Drain Fill	614 CY	25.00	15,350.00	7.50	4,605.00	20.00	12,280.00	18.60	11,420.40	35.00	21,490.00
10.	Concrete	1,110 CY	345.00	382,950.00	156.00	173,160.00	120.00	133,200.00	175.00	194,250.00	170.00	188,700.00
11.	Cement	1,661 Bb	50.00	83,050.00	39.00	64,779.00	16.00	26,576.00	17.00	28,237.00	17.00	28,237.00
12.	Steel Reinforcement	278,342 LB	.40	111,336.80	.52	144,737.84	.45	125,253.90	.40	111,336.80	.45	125,253.90
13.	24" Diameter Concrete Pipe, Class III	67 LF	50.00	3,350.00	62.00	4,154.00	65.00	4,355.00	56.00	3,752.00	28.00	1,876.00
14.	Loose Rock Riprap	7,910 CY	13.00	102,830.00	13.00	102,830.00	14.00	110,740.00	25.20	199,332.00	30.00	237,300.00
15.	Grouted Rock Riprap	4,546 CY	50.00	227,300.00	39.00	177,294.00	34.00	154,564.00	65.00	295,490.00	44.00	200,024.00

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U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET 4 OF 4 SHEETS

CONTINUATION SHEET

ABSTRACT OF PROPOSALS RECEIVED

INV. NO. SCS-30-AZ-84

ITEM NO.	WORK OR MATERIAL	QUANTITY AND UNIT	Name and Address of Bidder: Richard P. Murray Co. P.O. Drawer G Chandler, AZ 85224		Name and Address of Bidder: Consolidated Utility Contracting Inc.		Name and Address of Bidder: Kokosing Construction Company, Inc.		Name and Address of Bidder: Parapet Constructors 1018 E. Guadalupe Rd. Tempe, AZ 85283		Name and Address of Bidder: Fisher Contracting Co. P.O. Box 6537 Phoenix, AZ 85005	
			UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT
16.	Guardrail	112 LF	$ 22.00	$ 2,464.00	$ 27.00	$ 3,024.00	$ 25.00	$ 2,800.00	$ 20.00	$ 2,240.00	$ 22.00	$ 2,464.00
17.	Fence	262 LF	15.00	3,930.00	19.00	4,978.00	17.00	4,454.00	15.00	3,930.00	15.00	3,930.00
18.	Surveys	LS	XXX	60,000.00	XXX	87,249.50	XXX	90,000.00	XXX	96,750.00	XXX	95,000.00
19.	12" Corrugated Metal Pipe	90 LF	20.00	1,800.00	23.00	2,070.00	20.00	1,800.00	25.00	2,250.00	17.00	1,530.00
	Subtotal			4,118,777.11		4,302,031.54		4,662,336.75		4,517,407.34		4,783,733.30
	Bid Schedule-Yellow											
1.	Mobilization	LS	XXX	10,000.00	XXX	13,000.00	XXX	100.00	XXX	6,200.00	XXX	23,000.00
2.	Clearing & Grubbing	12 AC	3,100.00	37,200.00	260.00	3,120.00	250.00	3,000.00	588.00	7,056.00	2,825.00	33,900.00
3.	Tailwater Pump Relocation	LS	XXX	25,000.00	XXX	15,600.00	XXX	19,000.00	XXX	30,000.00	XXX	55,000.00
4.	Pond Excavation	38,864 CY	1.00	38,864.00	1.30	50,523.20	1.10	42,750.40	1.42	55,186.88	1.20	46,636.80
5.	Structure Excavation	2,727 CY	5.00	13,635.00	3.90	10,635.30	2.75	7,499.25	2.47	6,735.69	4.30	11,726.10
6.	Channel Excavation	1,355 CY	2.00	2,710.00	1.30	1,761.50	3.50	4,742.50	2.47	3,346.85	1.10	1,490.50
7.	Structure Backfill	2,438 CY	10.00	24,380.00	11.62	28,329.56	5.00	12,190.00	10.00	24,380.00	25.00	60,950.00
8.	Earthfill	7,500 CY	1.00	7,500.00	3.90	29,250.00	.22	1,650.00	.57	4,275.00	1.20	9,000.00
9.	18" Corrugated Metal Pipe	104 LF	25.00	2,600.00	28.60	2,974.40	45.00	4,680.00	37.00	3,848.00	28.00	2,912.00
10.	15" High Pressure PVC Pipe	6,100 LF	10.00	61,000.00	19.50	118,950.00	13.50	82,350.00	37.00	225,700.00	22.00	134,200.00
11.	Surveys	LS	XXX	5,000.00	XXX	13,000.00	XXX	1,500.00	XXX	6,000.00	XXX	16,000.00
	Sub Total			227,889.00		287,143.96		179,462.15		372,728.42		394,815.40

Government Engineers Estimate $ 5,096,507

SCS-AS-146
REV. 2-73

SHEET 1 OF 6 SHEETS

ABSTRACT OF PROPOSALS RECEIVED

AT Phoenix Arizona
(PLACE OF OPENING)

DATE OPENED 9-8-82 INV. NO. SCS-5 AZ-82

ADDENDA TO BE ACKNOWLEDGED:
NOS. 1,2 & 3

RWCD, Reach-2

	Name and Address of Bidder: M. M. Sundt Const Co. 4101 East Irvington Rd P.O. Box 27507 Tucson, Arizona 85726	Name and Address of Bidder: K.E.C. Company 200 N. Sherman Ave. P.O. Box 607 Corona, CA 91720	Name and Address of Bidder: Ball, Ball and Brosamer Inc. 300 Camille Ave P.O. Box 1007 Danville, CA. 94526	Name and Address of Bidder: Peter Kiewit Sons Co Box 1055 Glendale, Arizona 85311	Name and Address of Bidder: OWL Constructors 2465 Campus Drive Irvine, CA 92715
Total Bid	$4,866,337.00	$5,064,801.11	$5,076,342.20	$5,335,000.00	$5,362,342.40
ACCEPTANCE PERIOD (Days)	60	60	60	60	60
ADDENDA NUMBERS ACKNOWLEDGED	1-2-3	1-2-3	1-2-3	1-2-3	1-2-3
BID GUARANTEE (Type and Amount)	SF-24-(20%)	SF-24-(20%)	SF-24 (20%)	SF-24 (20%)	SF-24 (20%)
DELIVERY PERIOD Calendar Days	470	470	470	470	470
DISCOUNT	0	0	0	0	0

ITEM NO.	WORK OR MATERIAL	QUANTITY AND UNIT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT
	Schedule 1*											
1	Clearing & Crubbing	169AC	500.00	84,500.00	300.00	50,700.00	500.00	84,500.00	88.00	14,872.00	1,060.00	179,140.00
2	No work											
3	Mobilization	L.S.	XXX	85,000.00	XX	150,000.00	XX	280,000.00	XX	60,457.90	XX	135,000.00
4	Water	200,000m gal	2.50	500,000.00	2.50	500,000.00	2.50	500,000.00	250	500,000.00	2.50	500,000.00
5	Channel Ex., Common	1,900,000CY	0.77	1,463,000.00	0.85	1,615,000.00	0.60	1,140,000.00	1.15	2,185,000.00	0.90	1,710,000.00
6	R/C Channel Ex., Comm.	106,120 CY	0.85	90,202.00	0.55	58,366.00	0.90	95,508.00	1.15	122,038.00	1.00	106,120.00
7	Structure Ex, Comm.	5,200 CY	5.00	26,000.00	4.00	20,800.00	7.00	36,400.00	0.40	2,080.00	3.00	15,600.00
8	No Work											
9	Structure Backfill	8,000 CY	5.00	40,000.00	3.50	28,000.00	15.00	120,000.00	4.75	38,000.00	5.00	40,000.00
10	Earth Fill	200,000 CY	0.60	120,000.00	020	40,000.00	0.20	40,000.00	0.10	20,000.00	0.50	100,000.00
11	Drain Fill	2,200 CY	20.00	44,000.00	35.00	77,000.00	10.00	22,000.00	25.00	55,000.00	22.00	48,400.00
12	Concrete, Class 4000X	11,077 CY	79.00	875,083.00	89.00	985,853.00	110.00	1,218,470.00	82.00	908,314.00	75.00	830,775.00
13	Cement	16,615 Bbls	17.00	282,455.00	16.00	265,846.00	17.00	282,455.00	16.00	265,840.00	19.00	315,685.00
14	Steel reinforcement	1,597,896Lb	0.30	479,308.80	0.31	495,285.76	0.30	479,308.80	0.30	479,308.80	0.20	319,539.20
15	4" AC pipe	545 LF	10.00	5,450.00	10.00	5,450.00	8.00	4,360.00	8.00	4,360.00	12.00	6,540.00

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U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET 2 OF 6 SHEETS

CONTINUATION SHEET

ABSTRACT OF PROPOSALS RECEIVED

INV. NO. SCS-5-AZ-82

ITEM NO.	WORK OR MATERIAL	QUANTITY AND UNIT	Name and Address of Bidder: M. M. Sundt Construction Company		Name and Address of Bidder: K.E.C. Company		Name and Address of Bidder: Ball, Ball & Brosamer, Inc.		Name and Address of Bidder: Peter Kiewit Sons' Co.		Name and Address of Bidder: OWL Constructors	
			UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT
16	6" AC Pipe	318 L.F.	15.40	4,897.20	25.00	7,950.00	10.00	3,180.00	11.00	3,498.00	14.00	4,452.00
17	18" CMP	64 L.F.	25.00	1,600.00	42.00	2,688.00	25.00	1,600.00	16.00	1,024.00	30.00	1,920.00
18	36" CMP	104 L.F.	40.00	4,160.00	62.00	6,448.00	40.00	4,160.00	24.50	2,548.00	50.00	5,200.00
19	Special Fittings	L.S.	XX	10,000.00	XX	2,278.00	XX	2,000.00	XX	600.00	XX	3,000.00
20	Loose Rock Riprap	45,500 CY	10.00	455,000.00	11.00	500,500.00	10.00	455,000.00	10.00	455,000.00	13.00	591,500.00
21	Grouted Rock Riprap	726 CY	30.00	21,780.00	45.00	32,670.00	50.00	36,300.00	41.00	29,766.00	35.00	25,410.00
22	Metal Work	L.S.	XX	500.00	XX	1,000.00	XX	1,000.00	XX	2,550.00	XX	1,000.00
23	Surveys	L.S.	XX	70,000.00	XX	74,000.00	XX	50,000.00	XX	80,000.00	XX	70,000.00
24	Guardrail	528 L.F.	15.00	7,920.00	22.63	11,950.00	25.00	13,200.00	21.50	11,352.00	17.00	8,976.00
	TOTAL SCHEDULE #1			$4,670,856.00		$4,931,784.76		$4,869,441.80		$5,241,608.70		$5,018,257.20
	Bid Schedule # 2											
1	Dip Crossing Excav.	876 CY	1.00	876.00	2.50	2190.90	1.00	876.00	1.50	1,314.00	2.00	1,752.00
2	Structure Excav. Comm	160 CY	5.00	200.00	6.00	960.00	7.00	1,120.00	7.00	1,120.00	3.00	480.00
3	Structure BAckfill	72 CY	5.00	360.00	1200	864.00	15.00	1,080.00	6.25	450.00	8.00	576.00
4	Queen Creek Earthfill	380,000 CY	0.40	152,000.00	0.25	95,000.00	0.40	152,000.00	0.12	45,600.00	0.75	285,000.00
5	Concrete, Class 4000X	88 CY	100.00	8,800.00	100.00	8,800.00	150.00	13,200.00	200.00	17,600.00	250.00	22,000.00
6	Cement	132 Bbls	18.00	2,376.00	16.00	2,112.00	17.00	2,244.00	16.00	2,112.00	19.00	2,508.00
7	Steel Reinforcement	14,601 Lbs	0.50	7,300.50	0.35	5,110.35	0.40	5,840.40	0.30	4,380.30	0.20	2,920.20
8	Loose Rock Riprap	797 CY	10.50	8,368.50	15.00	11,955.00	20.00	15,940.00	15.00	11,955.00	17.00	13,549.00
9	Asphalt Concrete Pavemet	1,320 SY	10.00	13,200.00	2.00	2,640.00	10.00	13,200.00	6.50	8,580.00	10.00	13,200.00
10	Road Relocation	700 L.F.	2.00	1,400.00	5.00	3,500.00	2.00	1,400.00	0.40	280.00	3.00	1,100.00
	TOTAL SCHEDULE #2			$195,431.00		$133,131.35		206,900.40		$93,391.30		$344,085.20

SCS-AS-146
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SHEET 3 OF 6 SHEETS

ABSTRACT OF PROPOSALS RECEIVED

AT Phoenix Arizona
(PLACE OF OPENING)

DATE OPENED 9-8-82 INV. NO. SCS-5 AZ-82

ADDENDA TO BE ACKNOWLEDGED:
NOS. 1,2 & 3

	Name and Address of Bidder:	Name and Address of Bidder:	Name and Address of Bidder:	Name and Address of Bidder:	Name and Address of Bidder:
	Police Construction Inc. 2035 West Mountain View Road Phoenix, Arizona 85021	BRUTOCO Eng, Const Inc. P.O. Box 429 Fontana, Ca. 82835	Mid State Landscape Co P.O. Box 3073 Lexington, Ohio 44904	Richard P. Murray Co. Inc. P.O. Drawer G Chandler, Arizona 85224	S.J. Groves & Sons Company 1000 W. Hwy #55 P.O. Box 35666 Phoenix, Arizona 85069
Total Bid $	5,493,124.63	5,563,130.21	5,576,713.96	5,619,816.25	5,948,330.04
ACCEPTANCE PERIOD (Days)	60	60	60	60	60
ADDENDA NUMBERS ACKNOWLEDGED	1-2-3	1-2-3	1-2-3	1-2-3	1-2-3
BID GUARANTEE (Type and Amount)	SF-24 (20%)	SF-24 (20%)	SF-24 (20%)	SF-24 (20%)	SF-24 (20%)
DELIVERY PERIOD (Calendar Days)	470	470	470	470	470
DISCOUNT	0	0	0	0	0

ITEM NO.	WORK OR MATERIAL	QUANTITY AND UNIT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT
	Schedule 1*											
1	Clearing & Crubbing	169 AC	216	36,504.00	350.00	59,150.00	527.00	89,063.00	762.00	128,778.00	500.00	84,500.00
2	No work											
3	Mobilization	L.S.	XX	57,000.00	XX	50,000.00	XX	87,000.00	XX	136,000.00	XX	270,000.00
4	Water	200,000 Mgal	2.50	500,000.00	2.50	500,000.00	2.50	500,000.00	2.50	500,000.00	2.50	500,000.00
5	Channel Ex., Common	1,900,000CY	0.90	1,710,000.00	1.00	1,900,000.00	1.04	1,976,000.00	0.75	1,425,000.00	1.00	1,900,000.00
6	R/C Channel Ex., Comm.	106,120 CY	0.95	100,814.00	1.40	148,568.00	1.15	122,038.00	1.29	136,894.80	1.00	106,120.00
7	Structure Ex, Comm.	5,200 CY	1.25	6,500.00	6.00	31,200.00	2.75	14,300.00	5.00	26,000.00	4.00	20,800.00
8	No Work											
9	Structure Backfill	8,000 CY	3.50	28,000.00	5.00	40,000.00	4.90	39,200.00	8.00	64,000.00	7.50	60,000.00
10	Earth Fill	200,000 CY	0.40	80,000.00	0.80	160,000.00	0.29	58,000.00	0.33	66,000.00	0.50	100,000.00
11	Drain Fill	2,200 CY	14.00	30,800.00	15.00	33,000.00	11.00	24,200.00	14.00	30,800.00	32.00	70,400.00
12	Concrete, Class 4000X	11,077 CY	90.00	996,930.00	90.00	996,930.00	82.00	908,314.00	127.00	1,406,779.00	100.00	1,107,700.00
13	Cement	16,615 Bbls	24.00	398,760.00	15.00	249,225.00	17.00	282,455.00	25.19	418,531.85	18.00	299,070.00
14	Steel reinforcement	1,597,896Lb	0.30	479,308.80	0.28	447,354.88	0.32	511,262.72	0.305	487,297.28	0.32	511,262.72
15	4" AC pipe	545 LF	6.00	3,270.00	9.00	4,905.00	5.00	2,725.00	7.00	3,815.00	8.00	4,360.00

SHEET 4 OF 6 SHEETS

CONTINUATION SHEET

ABSTRACT OF PROPOSALS RECEIVED

INV. NO. SCS-5-AZ-82

ITEM NO.	WORK OR MATERIAL	QUANTITY AND UNIT	Name and Address of Bidder: Police Construction, Inc. UNIT PRICE	AMOUNT	Name and Address of Bidder: BRUTOCO Eng & Const. Inc. UNIT PRICE	AMOUNT	Name and Address of Bidder: Mid State Landscape UNIT PRICE	AMOUNT	Name and Address of Bidder: Richard P. Murray Co. Inc. UNIT PRICE	AMOUNT	Name and Address of Bidder: S.J. Groves & Sons Co. Inc. UNIT PRICE	AMOUNT
16	6" AC Pipe	318 L.F.	10.50	3,339.00	10.00	3,180.00	16.00	5,088.00	12.00	3,816.00	8.00	2,544.00
17	18" CMP	64 LF	52.00	3,328.00	24.00	1,536.00	20.00	1,280.00	16.50	1,056.00	37.00	2,368.00
18	36" CMP	104 L.F.	32.00	3,328.00	50.00	5,200.00	38.00	3,952.00	35.00	3,640.00	40.00	4,160.00
19	Special Fittings	L.S.	XX	600.00	XX	2,000.00	XX	1,700.00	XX	2,000.00	XX	1,500.00
20	Loose Rock Riprap	45,500 CY	12.50	568,750.00	12.00	546,000.00	11.75	534,625.00	10.00	455,000.00	11.00	500,500.00
21	Grouted Rock Riprap	726 CY	54.00	39,204.00	30.00	21,780.00	32.00	23,232.00	30.00	21,780.00	30.00	21,780.00
22	Metal Work	LS	XX	575.00	XX	1,000.00	XX	450.00	xx	2,000.00	XX	400.00
23	Surveys	LS	XX	95,500.00	XX	55,000.00	XX	115,000.00	XX	80,000.00	XX	95,000.00
24	Guardrail	528 L.F.	17.50	9,240.00	16.50	8,712.00	18.00	9,504.00	25.00	13,200.00	18.00	9,504.00
	TOTAL SCHEDULE #1			$5,151,750.80		$5,264,740.88		$5,309,388.72		$5,412,387.93		$5,671,968.72
	Bid Schedule # 2											
1	Dip Crossing Excav.	876 CY	0.75	657.00	6.00	5,256.00	1.62	1,419.12	3.00	2,628.00	1.00	876.00
2	Structure Excav. Comm	160 CY	5.50	880.00	5.00	800.00	6.50	1,040.00	5.00	800.00	4.00	640.00
3	Structure BAckfill	72 CY	9.00	648.00	20.00	1,440.00	4.90	352.80	8.00	576.00	7.50	540.00
4	Queen Creek Earthfill	380,000 CY	0.80	304,000.00	0.65	247,000.00	0.58	220,400.00	0.43	163,400.00	0.60	228,000.00
5	Concrete, Class 4000X	88 CY	60.00	5,280.00	110.00	9,680.00	148.00	13,024.00	92.00	8,096.00	100.00	8,800.00
6	Cement	132 Bbls	24.00	3.168.00	15.00	1,980.00	17.20	2,270.40	15.50	2,046.00	18.00	2,376.00
7	Steel Reinforcement	14,601 Lbs	0.33	4,818.33	0.33	4,818.33	0.32	4,672.32	0.32	4,672.32	0.32	4,672.32
8	Loose Rock Riprap	797 CY	12.50	9,962.50	15.00	11,955.00	13.80	10,998.60	10.00	7,970.00	11.00	8,767.00
9	Asphalt Concrete Pavemet	1,320 SY	8.00	10,560.00	8.00	10,560.00	8.90	11,748.00	12.00	15,840.00	15.00	19,800.00
10	Road Relocation	700 LF	2.00	1,400.00	7.00	4,900.00	2.00	1,400.00	2.00	1,400.00	2.70	1,890.00
	TOTAL SCHEDULE #2			$341,373.83		$298,389.33		$267,325.24		$207,428.32		$276,361.32

SCS-AS-146
REV. 2-73

SHEET 5 OF 6 SHEETS

ABSTRACT OF PROPOSALS RECEIVED

AT Phoenix Arizona
(PLACE OF OPENING)

DATE OPENED 9-8-82 INV. NO. SCS-5 AZ-82

ADDENDA TO BE ACKNOWLEDGED:
NOS. 1,2 & 3

	Name and Address of Bidder:	Name and Address of Bidder:	Name and Address of Bidder:	Name and Address of Bidder:	Name and Address of Bidder:
	TGK Constructors, Inc. 2502 E. University Suite 100 P.O. Box 2300 Phoenix, AZ 85002	Carver Corporation 517 W. Bradley El Cajon, CA 92020			
	Total Bid $ 6,252,783.15	Total Bid $6,302,854.66	Total Bid $	Total Bid $	Total Bid $
ACCEPTANCE PERIOD (Days)	60	60	60	60	60
ADDENDA NUMBERS ACKNOWLEDGED	1-2-3	1-2-3	1-2-3	1-2-3	1-2-3
BID GUARANTEE (Type and Amount)	SF-24 (20%)	SF-24 (20%)	SF-24 (20%)	SF-24 (20%)	SF-24 (20%)
DELIVERY PERIOD (Calendar Days)	470	470	470	470	470
DISCOUNT	0	0	0	0	0

ITEM NO.	WORK OR MATERIAL	QUANTITY AND UNIT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT
	Schedule 1*											
1	Clearing & Crubbing	169 AC	150.00	25,350.00	1200.00	202,800.00						
2	No work											
3	Mobilization	L.S.	XX	198,615.00	XX	100,000.00						
4	Water	200,000 Mgal	2.50	500,000.00	2.50	500,000.00						
5	Channel Ex., Common	1,900,000CY	1.20	2,280,000.00	1.20	2,280,000.00						
6	R/C Channel Ex., Comm.	106,120 CY	1.50	159,180.00	1.20	127,344.00						
7	Structure Ex, Comm.	5,200 CY	10.00	52,000.00	4.00	20,800.00						
8	No Work											
9	Structure Backfill	8,000 CY	10.00	80,000.00	5.00	40,000.00						
10	Earth Fill	200,000 CY	0.25	50,000.00	0.36	72,000.00						
11	Drain Fill	2,200 CY	15.00	33,000.00	10.00	22,000.00						
12	Concrete, Class 4000X	11,077 CY	85.00	941,545.00	78.00	864,006.00						
13	Cement	16,615 Bbls	18.00	299,070.00	19.00	315,685.00						
14	Steel reinforcement	1,597,896Lb	0..39	479,308.80	0.40	639,078.40						
15	4" AC pipe	545 LF	5.00	2,725.00	5.00	2,725.00						

SCS-AS-146a
Rev. 9-73

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET 6 OF 6 SHEETS

CONTINUATION SHEET

ABSTRACT OF PROPOSALS RECEIVED

INV. NO. SCS-5-AZ-82

ITEM NO.	WORK OR MATERIAL	QUANTITY AND UNIT	Name and Address of Bidder: TGK Constructor Inc. UNIT PRICE	AMOUNT	Name and Address of Bidder: Carver Corporation UNIT PRICE	AMOUNT	Name and Address of Bidder: UNIT PRICE	AMOUNT	Name and Address of Bidder: UNIT PRICE	AMOUNT	Name and Address of Bidder: UNIT PRICE	AMOUNT
16	6" AC Pipe	318 L.F.	5.00	1,908.00	8.00	2,544.00						
17	18" CMP	64 LF	20.00	1,280.00	19.00	1,216.00						
18	36" CMP	104 L.F.	40.00	4,160.00	36.00	3,744.00						
19	Special Fittings	L.S.	XX	3,200.00	XX	2,500.00						
20	Loose Rock Riprap	45,500 CY	14.00	637,000.00	16.00	728,000.00						
21	Grouted Rock Riprap	726 CY	30.00	21,780.00	33.00	23,958.00						
22	Metal Work	LS	XX	1,000.00	XX	450.00						
23	Surveys	LS	XX	100,000.00	XX	87,200.00						
24	Guardrail	528 L.F.	17.00	8,976.00	9.00	4,752.00						
	TOTAL SCHEDULE #1			$8,880,097.80		6,040,802.40						
	Bid Schedule # 2											
1	Dip Crossing Excav.	876 CY	1.50	1,314.00	1.06	928.56						
2	Structure Excav. Comm	160 CY	6.50	1,040.00	4.70	752.00						
3	Structure BAckfill	72 CY	10.00	720.00	7.80	561.60						
4	Queen Creek Earthfill	380,000 CY	0.80	304,000.00	0.50	190,000.00						
5	Concrete, Class 4000X	88 CY	350.00	30,800.00	190.00	16,720.00						
6	Cement	132 Bbls	18.00	2,376.00	19.00	2,508.00						
7	Steel Reinforcement	14,601 Lbs	0.35	5,110.35	0.40	5,840.40						
8	Loose Rock Riprap	797 CY	15.00	11,955.00	16.10	12,831.70						
9	Asphalt Concrete Pavemet	1,320 SY	10.00	13,200.00	22.00	29,040.00						
10	Road Relocation	700 LF	3.10	2,170.00	4.10	2,870.00						
	TOTAL SCHEDULE #2			$372,685.35		$262,052.26						

FLOOD CONTROL DISTRICT of Maricopa County

TABULATION OF BIDS

AGUA FRIA RIVER IMPROVEMENT
THOMAS ROAD TO I-10

PROJECT: PROJECT NO. 85-16

DATE OPENED: AUG. 6, 1985

SH. 1 OF 1

BID ITEM NO.	DESCRIPTION	APPROX. QUANTITY & UNIT	ENGINEER'S ESTIMATE		SUNDT		KIEWIT		J W J		BALL, BALL & BROSAMER			
			UNIT PRICE	BID TOTAL	UNIT PRICE	BID TOTAL	UNIT PRICE	BID TOTAL	UNIT PRICE	BID TOTAL	UNIT PRICE	BID TOTAL	UNIT PRICE	BID TOTAL
201	CLEARING & GRUBBING	1 L.S.	83,500	83,500.00	81,000	81,000.00	80,000	80,000.00	90,000	90,000.00	90,000	90,000.00		
203	CHANNEL EXCAVATION	1,083,200 C.Y.	1.10	1,191,520.00	0.93	1,007,376.00	1.00	1,083,200.00	1.15	1,245,680.00	2.40	2,599,680.00		
	(INCLD. FILL, SEE SECT. 211)													
212	LEVEE EMBANKMENT	439,200 C.Y.	0.40	175,680.00	0.25	109,800.00	0.30	131,760.00	.50	219,600.00	0.30	131,760.00		
215.3	GEOTEXTILE FABRIC	1,000 S.Y.	6.00	6,000.00	2.00	2,000.00	4.00	4,000.00	1.30	1,300.00	6.00	6,000.00		
220.1	DUMP RIPRAP	5,530 C.Y.	16.00	88,480.00	16.00	88,480.00	40.00	221,200.00	15.00	82,950.00	15.00	82,950.00		
220.3	GRAVEL FILTER BLANKET	130 C.Y.	19.00	2,470.00	20.00	2,600.00	40.00	5,200.00	15.00	1,950.00	20.00	2,600.00		
221.1	SOIL CEMENT (INCLD.	267,690 C.Y.	6.80	1,821,720.00	7.00	1,875,300.00	9.00	2,411,100.00	7.35	1,969,065.00	6.00	1,607,400.00		
	GRADE CONTROL STRUCT & TOWERS)													
221.2	CEMENT FOR SOIL CEMENT	64,900 TON	75.00	4,867,500.00	68.00	4,413,200.00	68.00	4,413,200.00	77.65	5,039,485.00	70.00	4,543,000.00		
350.1	REMOVAL OF EXISTING IMPROVE-	1 L.S.	50,000	50,000.00	35,000	35,000.00	15,000	15,000.00	110,000	110,000.00	10,000	10,000.00		
	MENTS													
420	REMOVE & RESET FENCE, SIGNS	1 L.S.	12,400	12,400.00	10,000	10,000.00	15,000	15,000.00	15,000	15,000.00	12,000	12,000.00		
	& BASES													
501	DRIVING PILES	1 L.S.	18,000	18,000.00	19,000	19,000.00	15,000	15,000.00	15,000	15,000.00	20,000	20,000.00		
525	PNEUMATICALLY PLACED MOTAR	440 S.Y.	10.50	4,620.00	18.00	7,920.00	34.00	14,960.00	40.00	17,600.00	50.00	22,000.00		
727	REINFORCING STEEL	3,500 LB	0.45	1,575.00	0.60	2,100.00	1.00	3,500.00	0.50	1,750.00	1.00	3,500.00		
901	MOBILIZATION	1 L.S.	250,500	250,500.00	238,000	238,000.00	197,880	197,880.00	270,000	270,000.00	250,000	250,000.00		
902	FIELD OFFICE	1 L.S.	15,000	15,000.00	5,000	5,000.00	5,000	5,000.00	10,000	10,000.00	25,000	25,000.00		
903	CONSTRUCTION SURVEYING	1 L.S.	95,000	95,000.00	111,000	111,000.00	120,000	120,000.00	70,000	70,000.00	40,000	40,000.00		
	TOTAL			8,683,965.00		8,007,776.00		8,736,000.00		9,159,380.00		9,445,890.00		

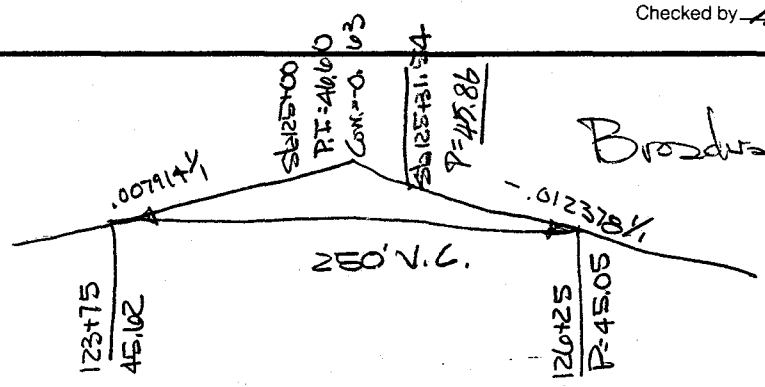
+728,224.00

Greiner Engineering

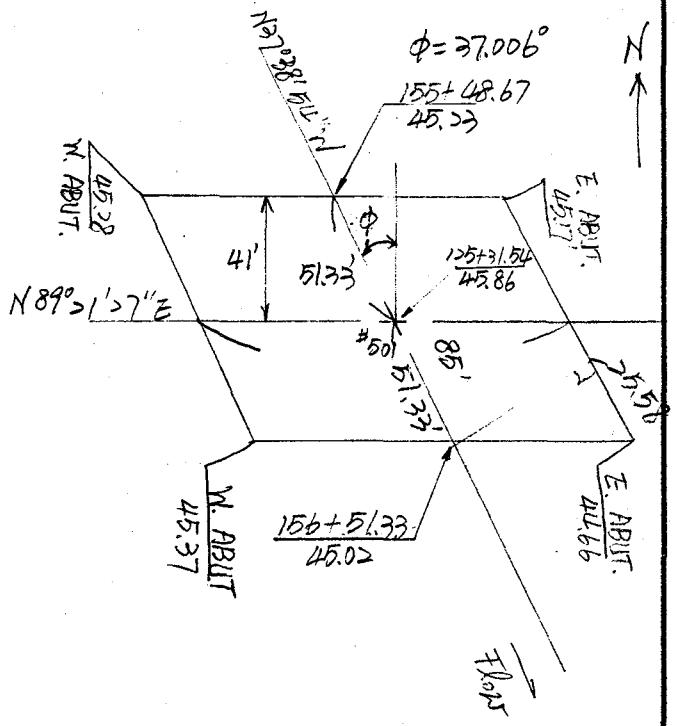
Greiner Engineering Sciences, Inc.

Tucson 602 327-3413
Phoenix 602 275-5400

Job: E101012 - J1616
Description: RWCD Floodway
Comparative Design Studies
Calculated by: Gary Sun Date: 9/19/85 Sheet No. 1
Checked by: M.S.S. Date: of 4



Broadway Road Bridge over R.W.C.D. Floodway

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H.W. 41.20

As-Built Finish Grade 40.00

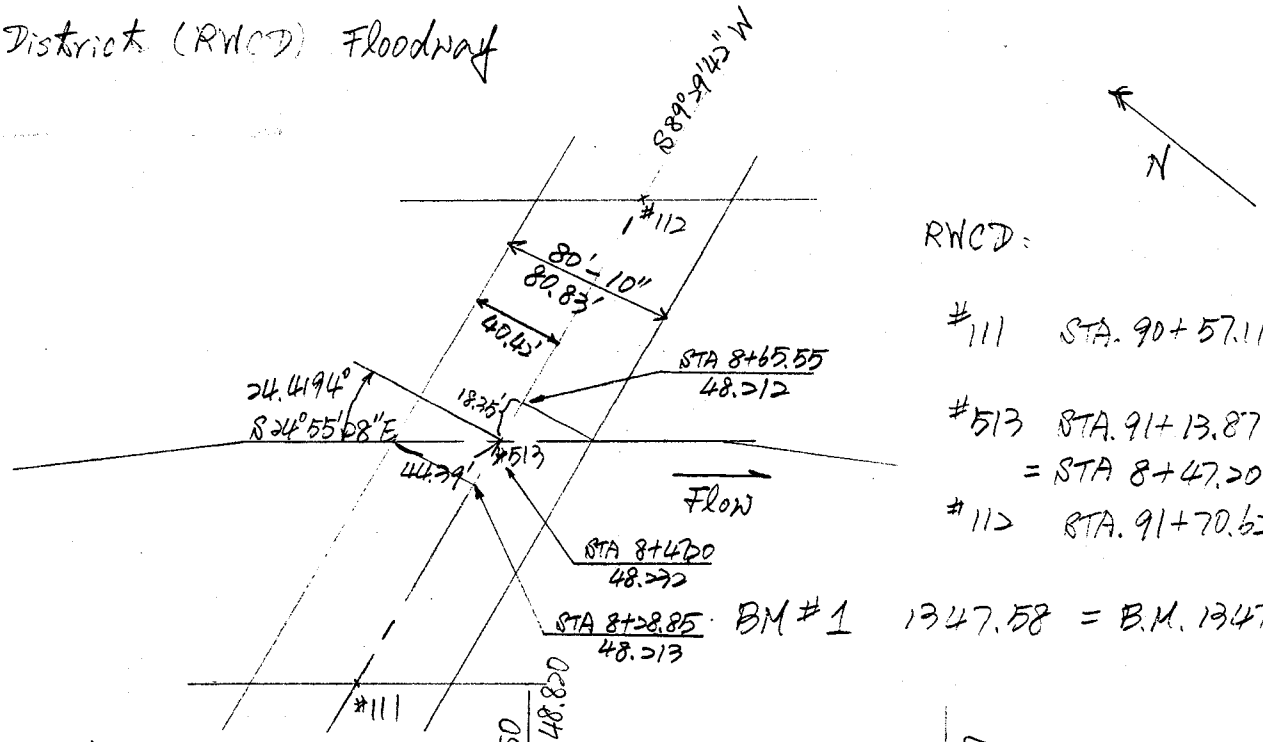
B.M.: SCS 1344.89 O.K.

Greiner Engineering

Greiner Engineering Sciences, Inc.

Tucson 602 327-3413
Phoenix 602 275-5400

University Drive crossing at Roosevelt Water Conservation District (RWCD) Floodway



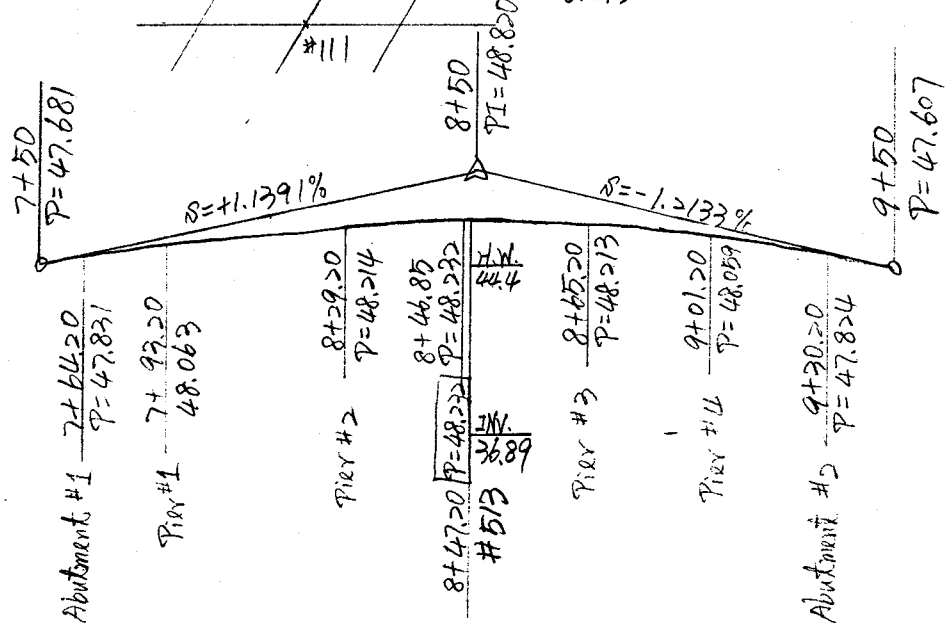
RWCD:

#111 STA. 90+57.11

#513 STA. 91+13.87
= STA 8+47.20 U.D.

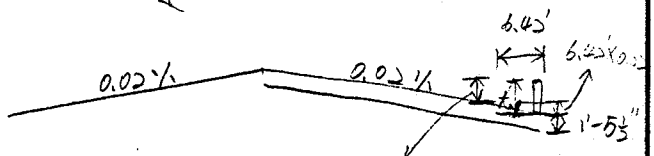
#112 STA. 91+70.62

BM #1 1347.58 = B.M. 1347.58



upstream RWCD STA. 90+69.48

downstream RWCD STA. 91+58.26



(2'-3⅝")+(1'-3")+6"
= 4.052'

$t = 4.052' + (\cancel{1'-5\tfrac{1}{2}"}) + 6.42 \times 0.02 = \cancel{5.639}\ 4.180'$
$\approx \cancel{5.511'}\ 4.18'$

Greiner Engineering

Greiner Engineering Sciences, Inc.

Tucson 602 327-3413
Phoenix 602 275-5400

Job RWCD Reach 6 E101012

Description Vertical Curve Calc's @ University Drive

Calculated by Gary Sun Date 9/23/85 Sheet No. 2.1

Checked by M.S.S Date _____ of 4

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#2

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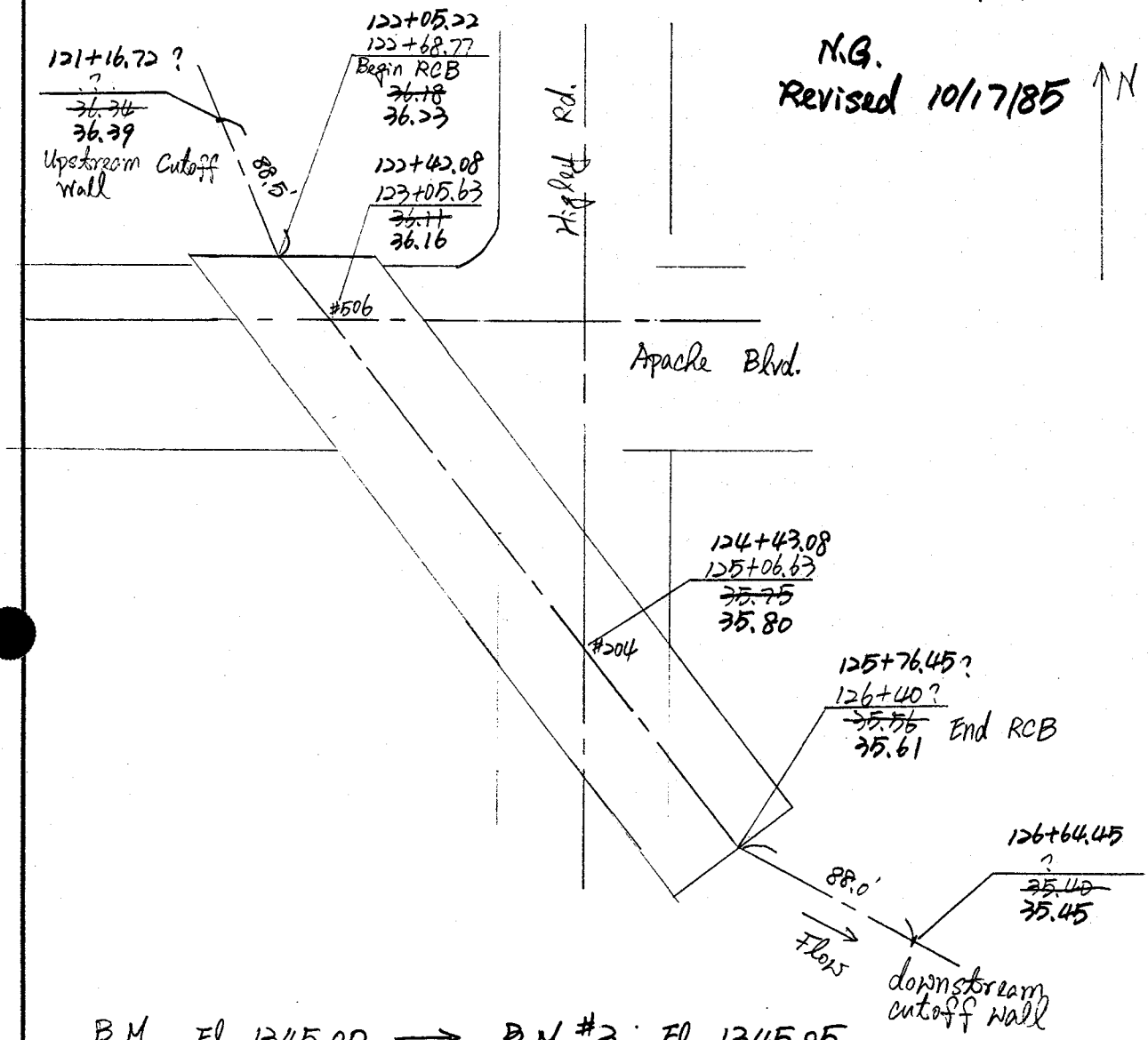
Greiner Engineering

Greiner Engineering Sciences, Inc.

Tucson 602 327-3413
Phoenix 602 275-5400

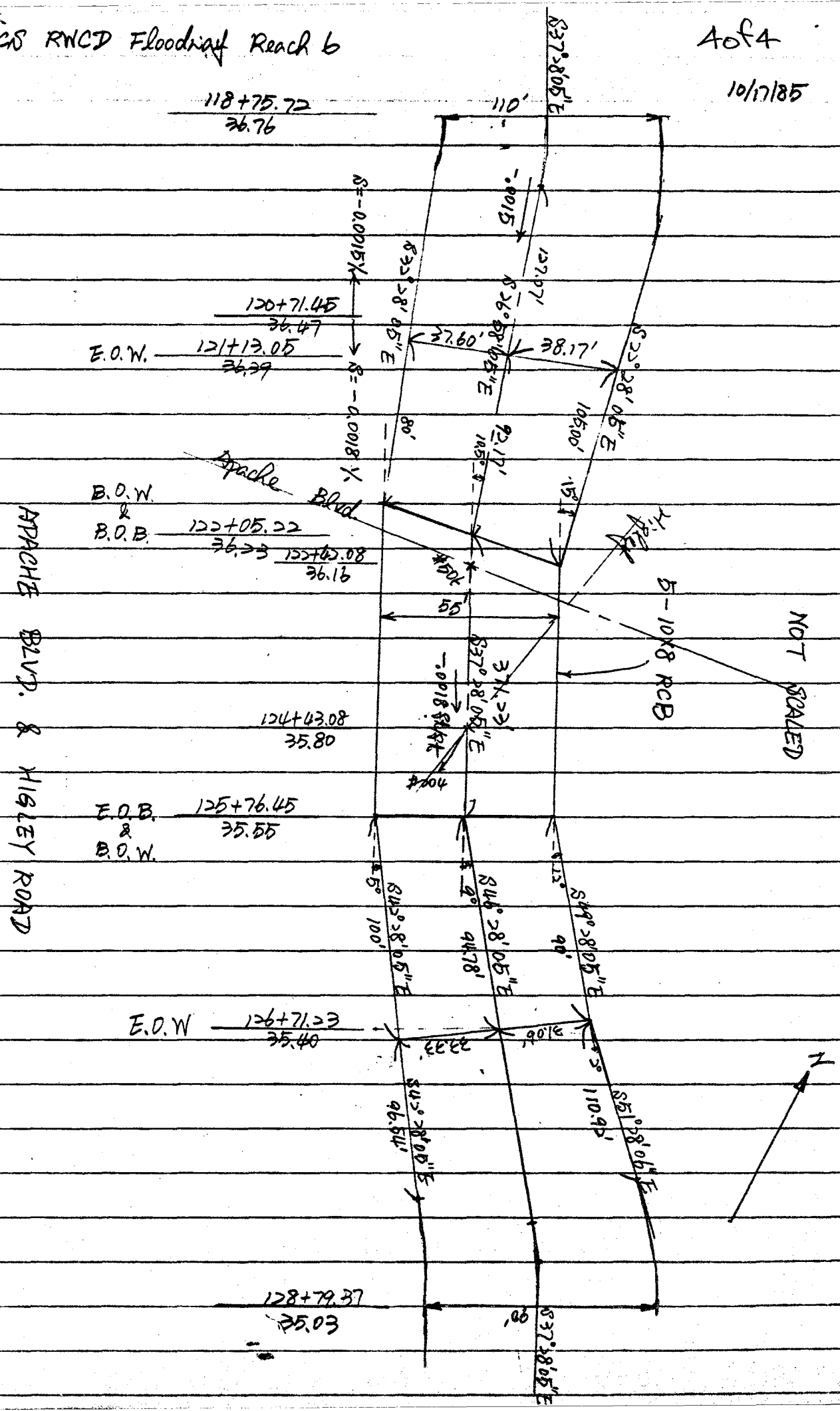
Job E101012 - J1616
Description RWCD Floodwall
Box Culvert at APACHE BLVD. & HIGLEY Rd.
Calculated by Gary Sun Date 9/23/85 Sheet No. 3
Checked by M.S.S. Date of 4

Proposed Box Culvert at Apache Blvd. & Higley Rd.



B.M. El. 1345.00 → B.M #3 El. 1345.05

BCS RWCD Floodway Reach 6

4 of 4

10/17/85