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CONCEPT DESIGN REPORT

FOR THE

19th AVENUE LANDFILL BANK PROTECTION AND FLOOD-CONTROL LEVEES

Prepared for:

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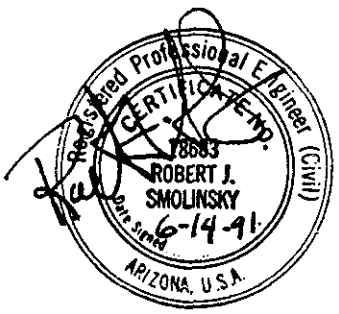

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EXECUTIVE SUMMARY

This report provides the design parameters for the 19th Avenue landfill bank protection, flood-control levees, and associated grade-control structure. It represents one element of the design phase of the landfill's environmental clean-up project. The design phase follows a series of planning and feasibility studies that have evaluated several alternatives. The final evaluation and selection process is outlined in the Remedial Action Plan (RAP) prepared by Dames & Moore in June, 1989.

Since the landfill is located within the Salt River's 100-year floodplain, and since it straddles a portion of the main channel, the recommended alternative calls for the construction of bank protection and a series of protected flood-control levees to prevent inundation and refuse washout during the 100-year event. The recommended alternative also includes a grade-control structure to prevent excessive degradation of the channel bed. This in turn will limit the required burial depth for the bank/levee protection.

The preliminary location, alignment and design criteria for the bank protection, levees, and grade-control structure were described in the RAP. This concept report provides more specific design parameters which can be used to prepare the construction drawings or plans.

These design parameters were established using the results of a detailed hydraulic and geomorphic analysis. The hydraulic analysis was performed to establish the top-of-levee elevations and to provide the average hydraulic properties which are required to conduct the geomorphic analysis. The geomorphic analysis (i.e., erosion or scour analysis) was performed to define the required burial depth for the bank protection and the grade-control structure.

The analyses occurred along a two-mile segment of the Salt River. The downstream limit of the study reach is located approximately 3500 feet downstream of the 19th Avenue bridge. The upstream limit is located approximately 1000 feet upstream of the 7th Avenue bridge. The minimum design discharge used in the hydraulic analyses was 195,000 cubic feet per second. This discharge corresponds to the existing 100-year discharge.

The analyses were conducted using state-of-the-art technology. All analytical procedures are briefly described, and the specific equations used are provided in the appendices to this report. The methodologies employed are those that are commonly used and/or accepted for use by most of the local, state and federal agencies who either have jurisdiction over or interest in the various aspects of this project.

Two alternative designs are discussed in the report. The results of the two design analyzes are compared to the results of the existing-conditions analysis to provide a basis for determining the relative impact and/or effectiveness of each alternative.

Both design alternatives assume that a grade-control structure will be located immediately downstream of the 19th Avenue bridge. They further assume that the north-bank levee adjacent to Cell A will, for the most part, follow the alignment of the existing bank from the grade-control structure to just upstream of the existing 15th Avenue outfall channel.

With the north bank fixed at its present location, the existing 500-foot-wide river channel between the two landfill cells will need to be widened an additional 100 feet to create an approximate 600-foot-wide channel (i.e., top-width). Consequently, all material removed to accommodate the wider section would come from Cell A-1, which is located adjacent to the south bank.

The distinct differences between the two design alternatives, and how they were selected, are described as follows:

Alternative A. For this alternative, the proposed south-bank flood-control bank/levee protection would only extend from the eastern boundary of Cell A-1 to its western boundary. Consequently, the existing south bank between the grade-control structure and the western boundary of Cell A-1 would not be altered. The majority of this excluded bank is currently protected with rock riprap. This alternative corresponds to the recommendation presented in the Remedial Action Plan (RAP).

Alternative B. For this alternative, continuous flood-control bank/levee protection would be provided along the south bank from the grade-control structure to just upstream of the eastern boundary of Cell A-1. This alternative was formulated during the course of this investigation after it became apparent that Alternative A would adversely impact adjacent properties and structures. These adverse impacts are described in the following paragraphs.

The results of the hydraulic analyses indicate that Alternative A will increase the 100-year water-surface elevation immediately upstream of the landfill by an average of 0.5 feet. Alternative B limits the increase to 0.1 feet. The latter increase is within the accuracy range generally associated with the applied model. Consequently, the increase can be considered insignificant. However, an increase of 0.5 feet is unacceptable, since it raises some concerns regarding the impact it would have on the conveyance capacity of the 7th Avenue bridge.

In addition, both alternatives significantly increase the velocity of flow within the main channel between the grade-control structure and the eastern boundary of the landfill. Consequently the erosion potential along the banks and bed is significantly increased. This is not a problem for Alternative B, since the proposed bank/levee protection would

be designed accordingly; however, Alternative A relies on the existing bank protection. Since it appears that the existing bank protection is not capable of withstanding the increased erosion potential, Alternative A increases the risk of bank failure which in turn could cause significant damage and/or loss to both public and private property, including the 19th Avenue bridge.

Considering the adverse impacts associated with Alternative A, it was concluded that Alternative B may prove to be the most cost-effective alternative if the feasibility study were revised to include the cost of future litigation, flood-damage repair, or the cost of widening the channel to offset the adverse impacts. Consequently, Alternative B is the recommended alternative. However, the design parameters for both alternatives are provided for comparative purposes.

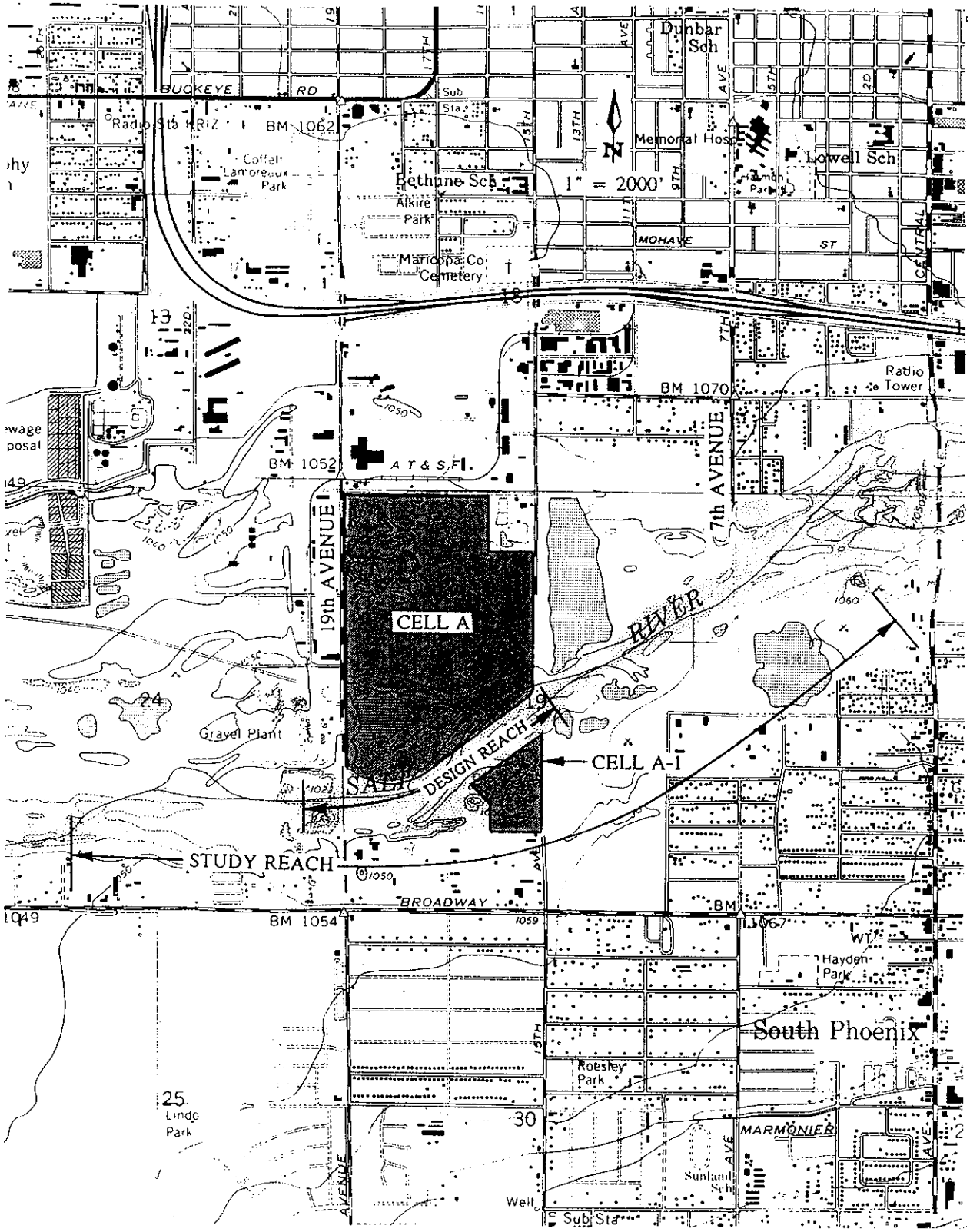
I. INTRODUCTION

This report presents the results of a hydraulic and geomorphic analysis of the Salt River in the immediate vicinity of the 19th Avenue Landfill. The study reach begins approximately 3500 feet downstream of the 19th Avenue bridge and ends approximately 1000 feet upstream of the 7th Avenue bridge (see Figure 1.1).

The purpose of the analysis was to establish the design parameters for the proposed flood-control bank/levee protection measures that will ultimately be constructed along all or a portion of the design reach; and the grade-control structure that will ultimately be installed immediately downstream of the 19th Avenue bridge. The design reach begins approximately 400 feet downstream of the 19th Avenue bridge, and ends approximately 100 feet upstream of the landfill's eastern boundary.

Three site conditions (one existing and two design) were analyzed both hydraulically and geomorphically. It was necessary to evaluate existing conditions in order to determine the relative impact of the two design conditions. The hydraulic analyses were performed to establish the design top-of-levee elevations and to provide the average hydraulic properties within the main channel which are required to conduct the geomorphic analyses. The geomorphic analyses were performed to quantify the erosion or scour potential along the study reach. Consequently, the results of the geomorphic analyses were used to define the required burial depth for both the bank/levee protection and the grade-control structure.

It was not intended that this report address the need to provide either the bank/levee protection or the grade-control structure. This requirement was addressed as part of the "Remedial Investigation and Feasibility Study" (RIFS), prepared by Dames & Moore in 1988 (Reference 1). The RIFS evaluated several environmental clean-up



19th Ave. Landfill

FIGURE 1.1
PROJECT LOCATION MAP

alternatives and presented a detailed background history of the landfill and the project area. The final evaluation of alternatives and the recommendation to provide some form of flood/erosion control to prevent inundation and refuse-washout during the 100-year flow event was presented in the "Remedial Action Plan" (RAP), prepared by Dames & Moore in 1989 (Reference 2).

Since the design phase, of which this report represents one element, follows the planning phase that both the RIFS and the RAP symbolize, these two documents should be considered an integral part of, or precursor to, this concept design report.

II. DESCRIPTION OF DESIGN ALTERNATIVES

Two design alternatives were evaluated. Both alternatives assume improvements will only occur within the design reach. The only difference between the two alternatives is the extent of bank/levee protection to be provided. The paragraphs that follow give a detailed description of the common and distinct design features associated with the two alternatives.

2.1 COMMON DESIGN FEATURES

At the conclusion of the planning phase, the flood-control components of the recommended plan consisted of two continuous levees (one for each segregated cell of the landfill) and one grade-control structure. In addition, the plan provided the proposed location, alignment, and some of the design criteria for both the bank/levee protection measures and the grade-control structure.

As previously mentioned, the grade-control structure will be located immediately downstream of the 19th Avenue bridge. The purpose of the grade-control structure is to prevent excessive long-term degradation of the channel bed, which in turn will limit the required burial depth for the bank/levee protection. During the planning phase, it was assumed that the grade-control structure would be constructed of soil cement. In addition, the anticipated burial depth was estimated to be approximately thirty feet. The grade-control structure itself, and its location, are an integral part of both alternatives.

With respect to the two flood-control levees, the RAP stated that the earthen levees would be protected with soil cement at a side slope that should not exceed 1.5 to 1 (horizontal to vertical). It further stipulated that the height of the levees should be set

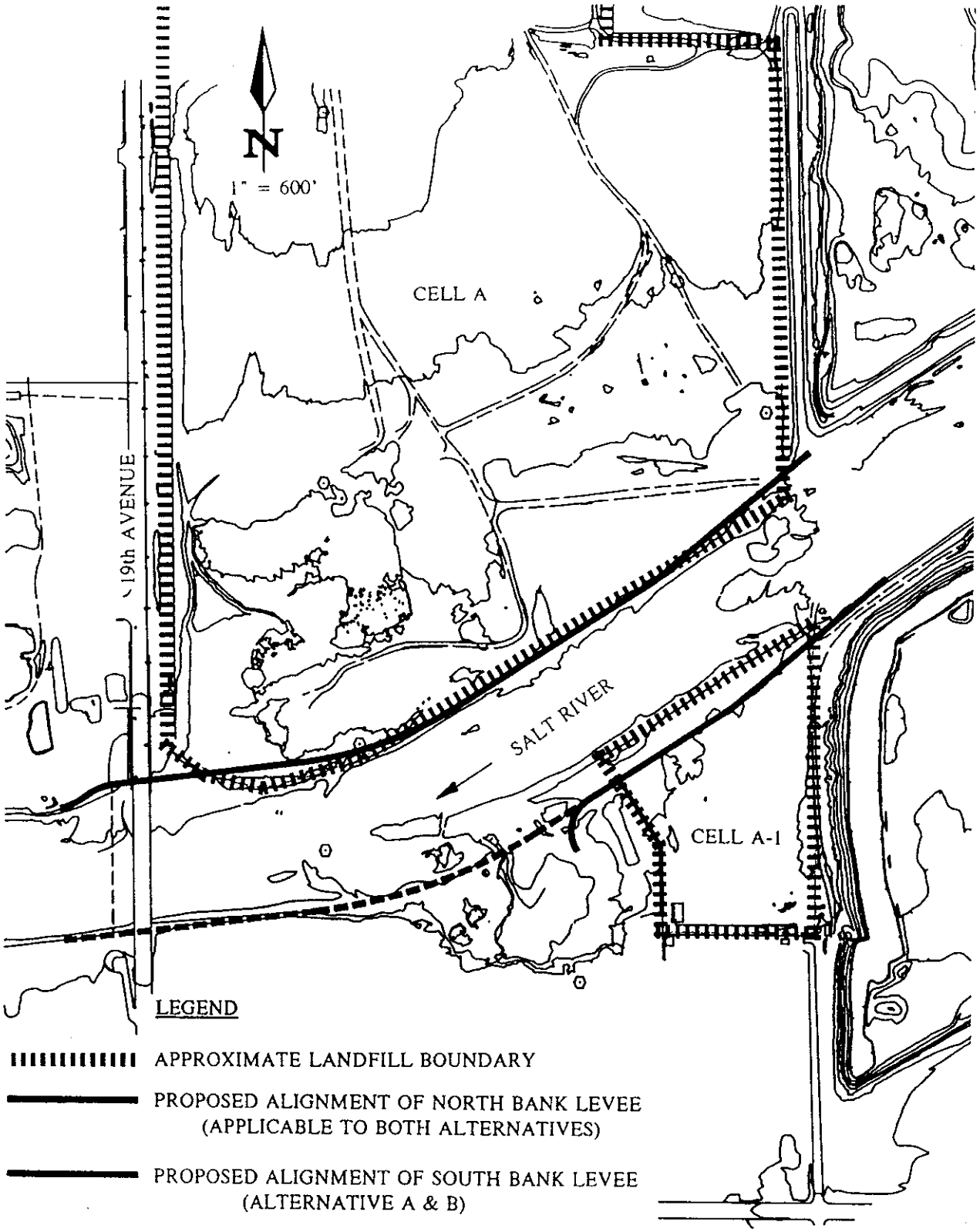
three feet above the contained 100-year water-surface elevations. These criteria were adopted for this study, and were held constant for both alternatives.

In an effort to increase the capacity of the main channel in the vicinity of the landfill, and thus prevent an unacceptable rise in the 100-year water-surface profile, the RAP recommended that the width of existing channel section along the design reach be increased from 500 to 600 feet. Project planners recognized that in order to accommodate a wider section it would be necessary to remove and relocate some of the refuse. The alignment presented in the RAP indicates that all refuse removed at the upstream end of the design reach will come from Cell A-1, and that all refuse removed at the downstream end will come from Cell A (see Figure 2.1). The recommended alignment and the width of the design section are also common features of both alternatives. A typical section of the design channel is provided as Figure 2.2. This section is situated between the two landfill cells.

2.2 ALTERNATIVE A

Since the flood-control aspects of the overall project center around the two landfill cells, the original intent was to limit the extent of the two levees to their respective Salt River boundaries. Consequently, the RAP states that the levee adjacent to Cell A (on the north side of the river) would extend from the proposed grade-control structure to a point located approximately 100 feet upstream of its eastern boundary. Likewise, for Cell A-1 (on the south side of the river), the RAP states that the levee would extend from the cell's western boundary to a point located approximately 100 feet upstream of its eastern boundary.

The extent of protected bank/levee described in the RAP constitutes Alternative A.



LEGEND

APPROXIMATE LANDFILL BOUNDARY

PROPOSED ALIGNMENT OF NORTH BANK LEVEE (APPLICABLE TO BOTH ALTERNATIVES)

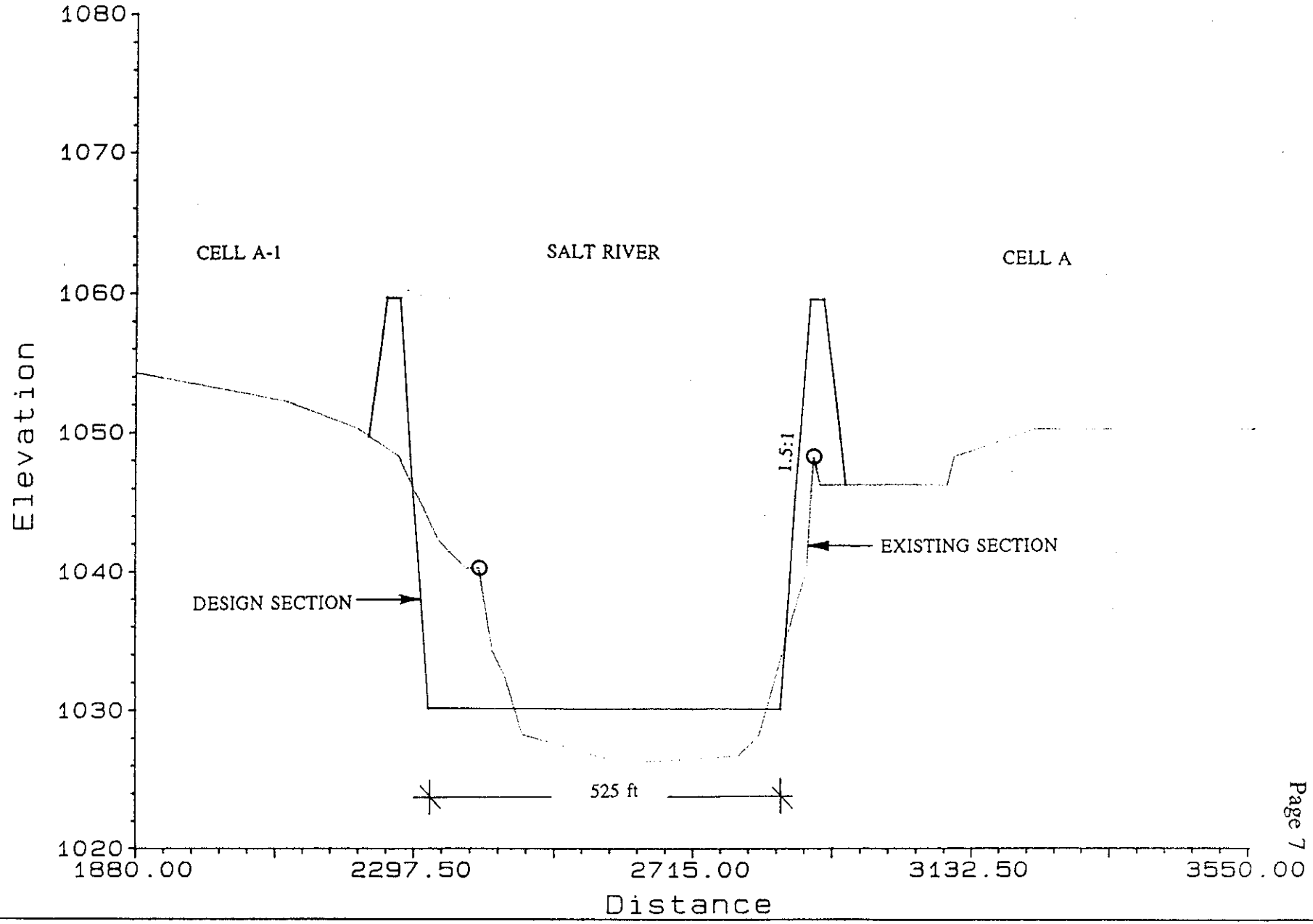
PROPOSED ALIGNMENT OF SOUTH BANK LEVEE (ALTERNATIVE A & B)

EXTENSION OF SOUTH BANK LEVEE (ALTERNATIVE B)

GRADE-CONTROL STRUCTURE

FIGURE 2.1: DESIGN FEATURES MAP

FIGURE 2.2. TYPICAL SECTION OF THE CONCEPT DESIGN CHANNEL



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2.3 ALTERNATIVE B

When the RAP specified the extent of bank/levee protection required to prevent inundation and refuse washout, it did not consider the impact channelization might have on the existing channel banks that are within the design reach, but outside the boundaries of the two landfill cells; nor did it consider the impact channelization might have on the 100-year water surface elevations immediately upstream of the design reach.

When it became apparent that Alternative A would have an adverse impact on adjacent properties and/or structures, the south-bank levee associated with Cell A-1 was extended downstream to the grade-control structure. Consequently, this alternative expands the level of flood protection during the 100-year event to include the south overbank between the grade-control structure and Cell A-1's western boundary.

III. METHODOLOGY

3.1 HYDRAULIC ANALYSES

Hydraulic analyses of both existing and design conditions were performed using the U.S. Army Corps of Engineers HEC-2 backwater model (Reference 3) in conjunction with the project's 1990 topographic maps. As previously stated, three site conditions were analyzed using the HEC-2 model (i.e., existing conditions and two design conditions). The analysis of existing conditions was performed to evaluate the relative impact of both design alternatives on (1) the flow velocities within the main channel, and (2) the upstream water-surface elevations.

The 1984 Flood Insurance Study (FIS) provided the starting water-surface elevations for all analyses. The 100-year peak discharge used in the analyses was 195,000 cfs. The existing-condition's roughness coefficient (i.e., Manning's n-value) for the main channel was set at 0.040. Both of these values are consistent with those used in the 1984 FIS. The location of the HEC-2 cross sections are shown on Figure 3.1.

Since the 19th Avenue bridge is located immediately downstream of the landfill, a special bridge routine was included in each HEC-2 model to account for the backwater effects associated with the bridge. However, since the 7th Avenue bridge is located at the upstream limit of the study reach, there was no need to incorporate a special bridge routine for this bridge in any of the models.

Portions of the two design-condition analyses utilized the HEC-2's channel-improvement option. The width of the design section (i.e., bottom width) between the two leveed banks was set at 525 feet. As previously stated, the side slopes of the design section were set at 1.5 to 1. Since the average depth of the design section is

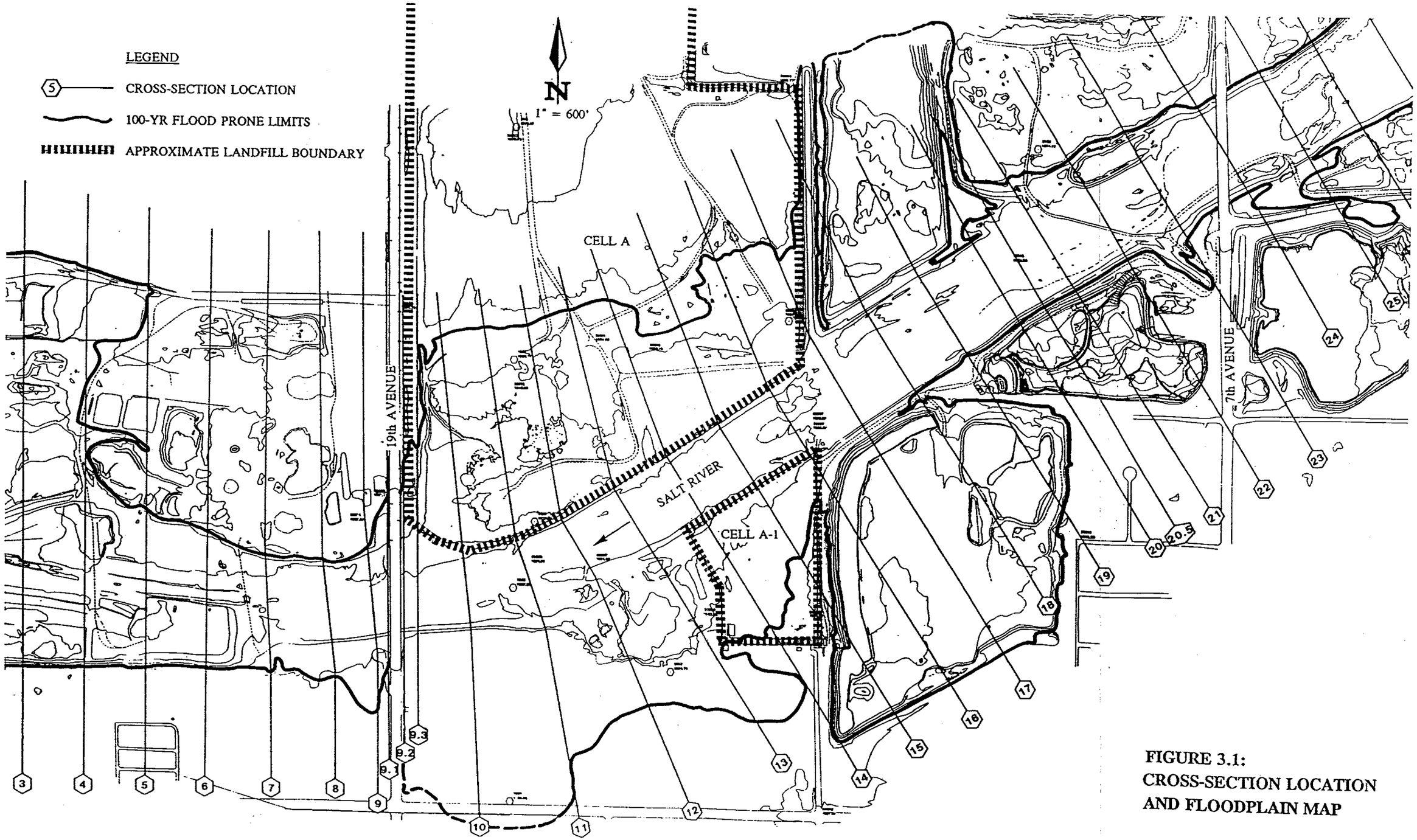


FIGURE 3.1:
CROSS-SECTION LOCATION
AND FLOODPLAIN MAP

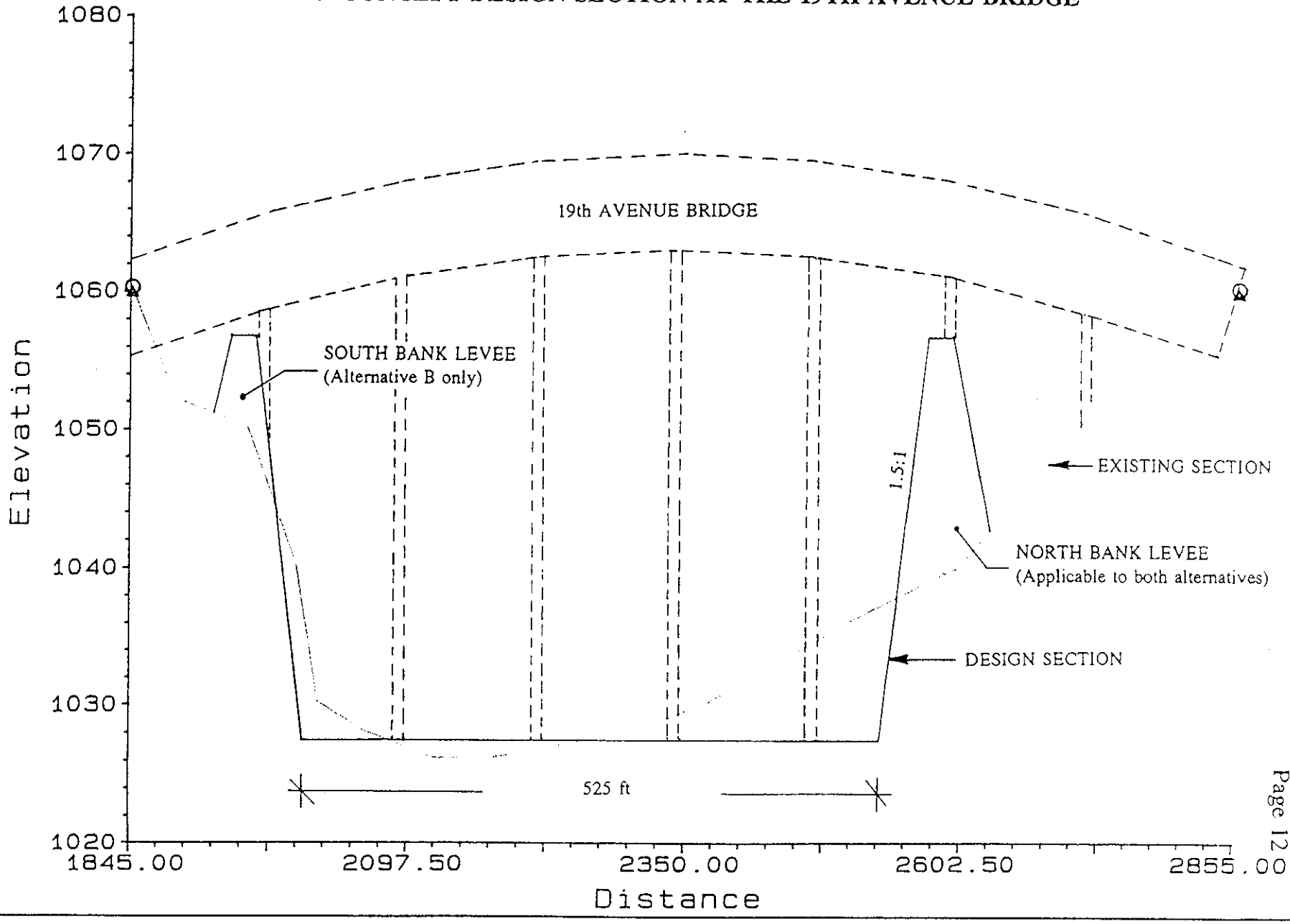
approximately 27 feet, the average design top width is approximately equal to 606 feet. For both design alternatives, the north bank of the design channel extends beneath the 19th Avenue bridge in a manner that will result in a loss of approximately 10 percent of the bridge's existing conveyance area (see Figure 3.2). This reduction in bridge area is necessary to accommodate the design channel cross-section through the bridge section and to minimize the extent of refuse removal required from Cell A of the landfill. The analyses presented within this report demonstrate that the remaining open area of the bridge provides more than adequate conveyance and freeboard for the design flow. Additionally, existing bridge pier toe-downs are more than adequate for the predicted local scour at the bridge.

In accordance with the RAP, it is assumed that the bank/levee system will be protected with soil cement. To account for the improved hydraulic efficiency associated with soil-cement bank protection, the roughness coefficient along the design reach was reduced from 0.040 to 0.035. However, if alternative forms of bank protection (i.e., rock riprap or gabion baskets) are required as a condition of the Section 404 permit, the accepted design alternative will be re-evaluated using the appropriate roughness coefficient, and new top-of-levee elevations will be established accordingly.

3.2 GEOMORPHIC ANALYSES

The purpose of a geomorphic analysis is to provide an estimate of the erosion or scour potential along a particular reach, if such a potential exists. Generally, qualitative geomorphic analyses determine if the potential for erosion exists; the threshold conditions under which it occurs; and the extent of erosion observed during or following particular flow events. Quantitative analyses use theoretically and/or empirically derived equations or models to estimate the magnitude of erosion under a given set of flow conditions and design circumstances.

FIGURE 3.2. CONCEPT DESIGN SECTION AT THE 19TH AVENUE BRIDGE



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The two previously referenced planning-phase reports provide a brief qualitative assessment of the erosion potential along the Salt River in the vicinity of the study reach. The analyses performed in conjunction with this design report were limited to providing a quantitative assessment of the long-term degradation depth and the total depth of scour that might be expected to occur within the design reach during the 100-year event. However, the results of the two design-condition analyses were compared to the results of the existing-conditions analysis in order to evaluate the relative impact of channelization on both the upstream and downstream reaches.

3.2.1 General Design Considerations

When the results of a geomorphic analysis are used for design purposes, both the short-term and long-term response must be evaluated. Typically, the short-term response is that which applies to a particular design storm event. The long-term response is a measure of the cumulative effect that occurs when a reach is continually subjected to a series of more-frequent flow events (i.e., average-annual flow events).

The long-term contribution to the design-scour depth can be estimated using either the anticipated equilibrium bed slope or the depth at which an erosion-resistent or armor layer is expected to form. Since all alluvial channels have an ability to transport both water and sediment, the sediment-transport capacity at a given point in time can be estimated using the appropriate hydraulic parameters and the sediment composition along the design reach. If the capacity exceeds the incoming supply, which is usually the case when the upstream watershed is urbanized, the channel will adjust its bed slope in the downward direction in an attempt to reduce its transport capacity. Once a state of equilibrium exists between the supply and transport capacity for the dominant or more-frequently occurring discharge, the degradation process will be arrested unless something occurs that alters either the incoming supply or the transport capacity.

However, during this degradation process, the hydraulic stresses responsible for sediment transport are continually being reduced. As the stresses decrease, larger particles can no longer be transported. A natural sorting process begins which can result in the formation of a armor layer if there is an appreciable quantity of particles present that resist movement. This will occur even when the sediment transport capacity for a smaller size range is not balanced with its incoming supply, since the armor layer shields the finer particles in the sublayer from transport. Consequently, the degradation process is arrested.

Since armor layers are characteristic of the Salt River under existing conditions, armoring calculations were used to estimate the long-term degradation depth that is expected to occur on the downstream side of the proposed grade-control structure. However, within the design reach (i.e., upstream of the grade-control structure) the long-term response was estimated using a conservative estimate of the equilibrium slope.

The short-term contribution to the design-scour depth is typically estimated using the depth of the low-flow channel in combination with the various scour components associated with the design storm event (in this case, the 100-year event). The depth of the low-flow channel is included when the capacity of the main or primary channel section greatly exceeds the magnitude of annual flow events. This discrepancy typically results in the formation of a low-flow channel which can migrate laterally within the confines of the main channel. Along the design reach, the applicable 100-year scour components are general scour, bed-form scour, bend scour, local scour at bridge piers and abutments, and local scour below grade-control (i.e., drop) structures.

General scour results in a lowering of the streambed by the entrainment of channel bed sediments within the flow column. Bed-form scour results from the development of bed forms which are created by stress imbalances at the water/streambed interface. Local

scour results from local disturbances or abrupt changes in the flow path. The former local-scour condition applies to obstructions such as bridge piers, dikes and accumulations of debris. The latter condition applies to bridge abutments or drops which develop on the downstream side of grade-control structures.

Typically, with the exception of bend scour and local scour, all scour-components are uniformly applied along both banks within the design reach. However, since the bend scour and local scour components are only effective within a localized area referred to as the "zone of influence", the geometry of this zone had to be defined before any portion of the respective component could be used, in part, to define the required burial depth of embankment protection measures.

The "zone of influence" associated with the bend-scour component is located along the outer (concave) bank of the channel bend (see Figure 3.3). For design purposes, it is normally assumed that the upstream limit of this zone corresponds to the point of curvature associated with the bend. The downstream limit of the zone is approximated as a function of the depth of flow and the relative roughness of the channel. The distance estimated using these flow parameters is applied from the downstream point of tangency associated with the bend.

The "zone of influence" associated with bridge piers can be defined as an inverted cone, with its apex at the bottom of the scour hole (see Figure 3.4). The diameter near the apex is assumed equal to the obstruction width (10 feet in this case). For sand and fine gravel, the side slope of the cone is assumed to be approximately 2.75:1 (horizontal to vertical). Consequently, the diameter of the inverted base of the cone is a function of the local-scour depth. Since the magnitude of this scour component varies in both the lateral and longitudinal directions, a portion of the computed depth may not be applicable to the design of the bank protection.

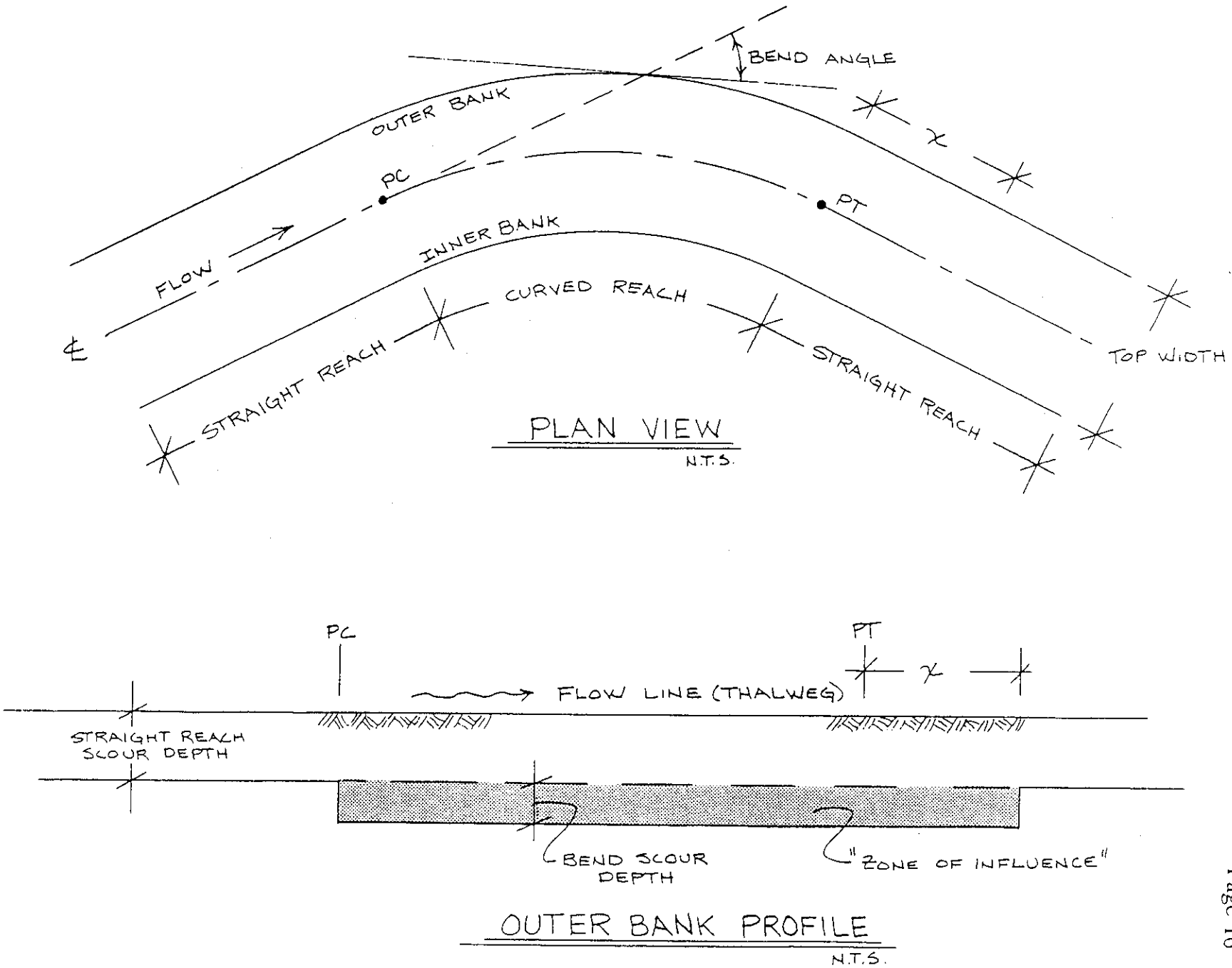
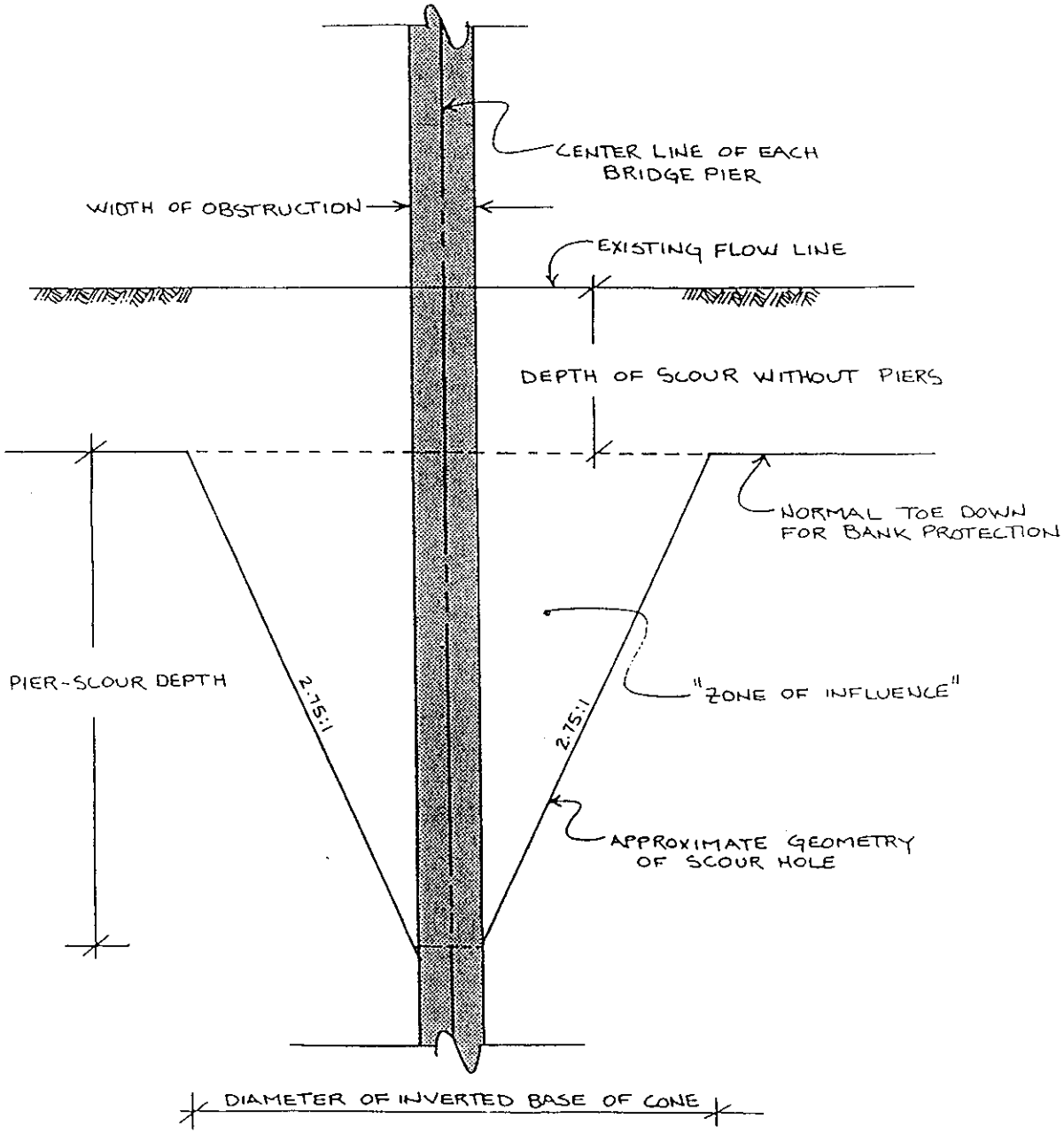


FIGURE 3.3
"ZONE OF INFLUENCE" ALONG A CHANNEL BEND

FIGURE 3.4
"ZONE OF INFLUENCE" FOR A BRIDGE PIER

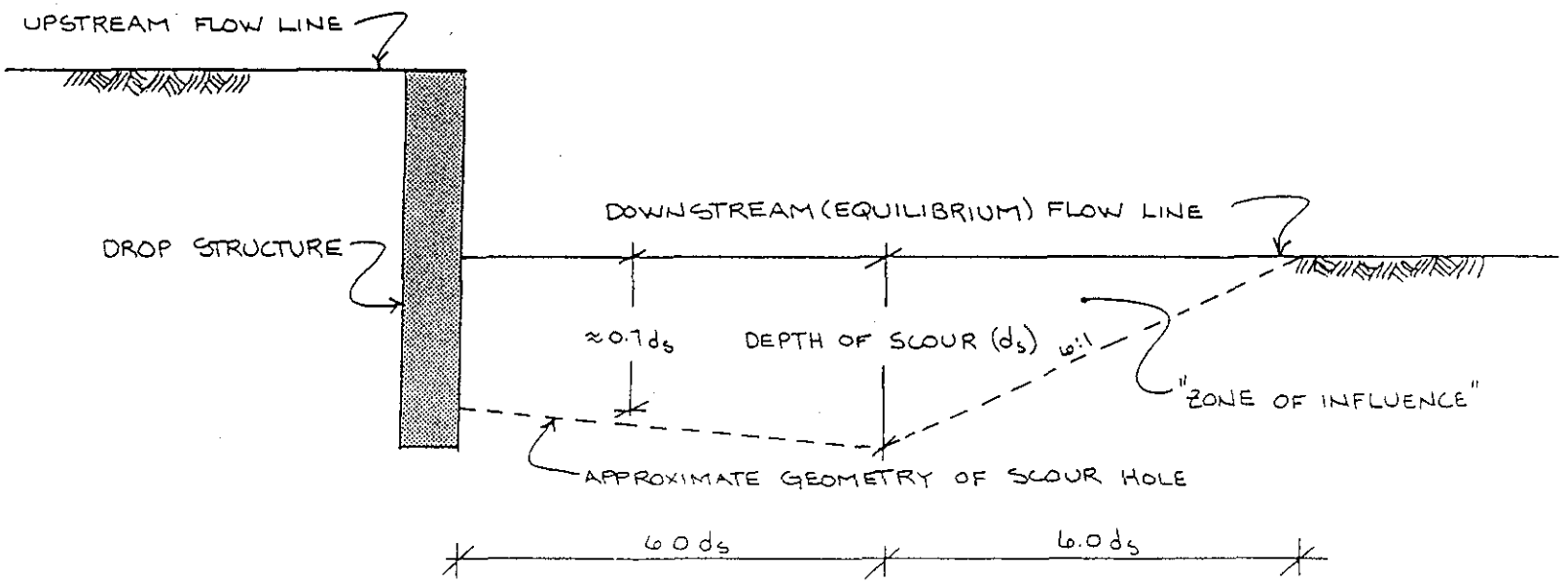


The geometry of the "zone of influence" for a grade-control structure is also a function of the computed local-scour depth (see Figure 3.5). On the downstream side of the grade-control structure, the "zone of influence" begins at a depth that is approximately equal to 70 percent of the computed depth of scour. The location of the maximum scour depth occurs downstream of the grade-control structure a distance that is approximately six times the computed depth of scour. Downstream of this location, the geometry of the scour hole is approximated by using a 6:1 return slope. However, for design purposes, it is assumed that the maximum scour depth occurs immediately downstream of the grade-control structure.

Outside the local "zones of influence", the 100-year scour depth is based on the summation of the general-scour depth, the bed-form scour depth, and the low-flow incisement depth times a 1.3 safety factor. The purpose of the safety factor is to account for non-uniform flow velocities and sediment distributions within the design reach. The long-term component is then added to the resultant to obtain the total scour and the design burial depth for the bank protection. Within the "zones of influence," the applicable local-scour depths are included before the 1.3 safety factor is applied.

Once the design depth(s) of scour were computed at the appropriate locations along the design reach, they were compared to the computed armoring depths. Although the primary purpose of computing the armoring depths was to define the anticipated long-term degradation depth at the downstream side of the grade-control structure, channel bed armoring will also arrest scour that occurs during individual flow events. Consequently, if the design scour depths exceeded the depths to armoring within the design reach, the burial depths for the bank protection would be limited to the armoring depths.

FIGURE 3.5. "ZONE OF INFLUENCE" FOR A DROP STRUCTURE



3.2.2 Computation of the Long-term Degradation Depths

For the purpose of this analysis, the equilibrium bed slope within the design reach was assumed equal to 0.1 percent. This slope was selected using the results of previous studies, which are briefly described in the following paragraphs.

As part of the Rio Salado Project for the City of Tempe, the CRSS Commercial Group computed a design equilibrium slope for the Salt River that was equal to approximately 0.15 percent (Reference 4). The median diameter of the sediment material used in the CRSS analysis (10 millimeters) is consistent with the median diameter along the design reach. The bottom-width of the design section used in their analysis was approximately equal to 950 feet. From a computational standpoint, the wider section would be expected to produce a steeper equilibrium slope than that which would be applicable to the design reach.

As part of the East Papago and Hohokam Freeway projects for the Arizona Department of Transportation, Simons, Li and Associates (SLA) computed an equilibrium slope for the Salt River that was approximately equal to 0.13 percent (Reference 5). This equilibrium slope was based on the conditions that currently exist along that portion of the Salt River that will parallel the East Papago Freeway. Since the existing channel section is not capable of conveying the entire 100-year peak discharge, one would expect to see a steeper equilibrium slope than the one associated with the design reach.

Considering the results reported in the previous studies, the application of a 0.1 percent equilibrium slope within the design reach is considered to be a reasonably conservative assumption. To determine the long-term degradation depth at any given point along the design reach, the equilibrium slope is first subtracted from the existing

bed slope, and then multiplied by the distance from the grade-control to the design point of interest.

The armoring depths relative to the two reaches under consideration (i.e., downstream and design) were computed using the procedure outlined in Reference 6. The specific equations used from this reference were Equations 5.5 and 5.6. These equations are presented in Appendix A as Equations A.1 and A.2. For Equation A.2, it was assumed that the thickness of the armor layer was twice the diameter of the sediment particle required to resist transport under design flow conditions. The size of this sediment particle is first determined using Equation A.1. As with the other scour components, a safety factor of 1.3 was applied to the computed depths.

3.2.2 Computation of the 100-Year Scour Components

The general-scour component was estimated using SLA's sediment-routing model, QUASED (Reference 7). Using three separate input files that collectively define (1) the geometry of the study reach; (2) the sediment inflow conditions associated with the reach; and (3) the hydrologic and sediment characteristics inherent to the reach, the QUASED model computes and compares the bed-material transport capacity of each designated sub-reach with its incoming sediment supply.

During the computational process, if the transport capacity of a particular sub-reach exceeds the incoming supply, degradation occurs. The degradation depth (i.e., general scour depth) is then estimated by the program using the deficit volume and the surface area of the bed within the associated sub-reach. If the incoming sediment supply exceeds the transport capacity, deposition occurs and the depth is again determined using the volumetric difference and the area of the bed within the subreach. This computational

procedure is repeated for each sediment-size fraction, and for each discharge or time step on the discretized hydrograph.

The sediment-size fractions used in the analyses were based on the combined results of a sieve analysis of two surface and two subsurface sediment samples obtained near the landfill from the bed of the Salt River. These samples were collected and analyzed by Sergent, Hauskins & Beckwith (SHB). The composite distribution curve is shown on Figure 3.6.

In an effort to provide conservative estimates of the general-scour depth for all site conditions analyzed, it was assumed that the amount of sediment supplied to the upstream limit of the study reach would be zero. This clear-water-inflow assumption is reasonable considering (1) the size of the sediment particles within the surface layer of the streambed; (2) the intensity of in-channel sand and gravel mining that occurs upstream of the study reach; (3) the amount of vegetation that exists along the channel bed immediately upstream of the 7th Avenue bridge; and (4) the significantly wider channel section that also exists immediately upstream of the 7th Avenue subreach.

The hydrograph used in the analysis was obtained from Reference 8. This hydrograph, which is shown on Figure 3.7, assumes that the 100-year peak discharge is equal to approximately 215,000 cfs. Consequently, the results of the general-scour analyses will be slightly conservative, since the actual design peak discharge is 195,000 cfs.

The remaining scour components (i.e., bed-form scour, bend scour, and local scour at the bridge piers, the bridge abutments, and the grade-control structure) were computed using two SLA publications (References 6 & 9) and one Federal Highway Administration publication (Reference 10).

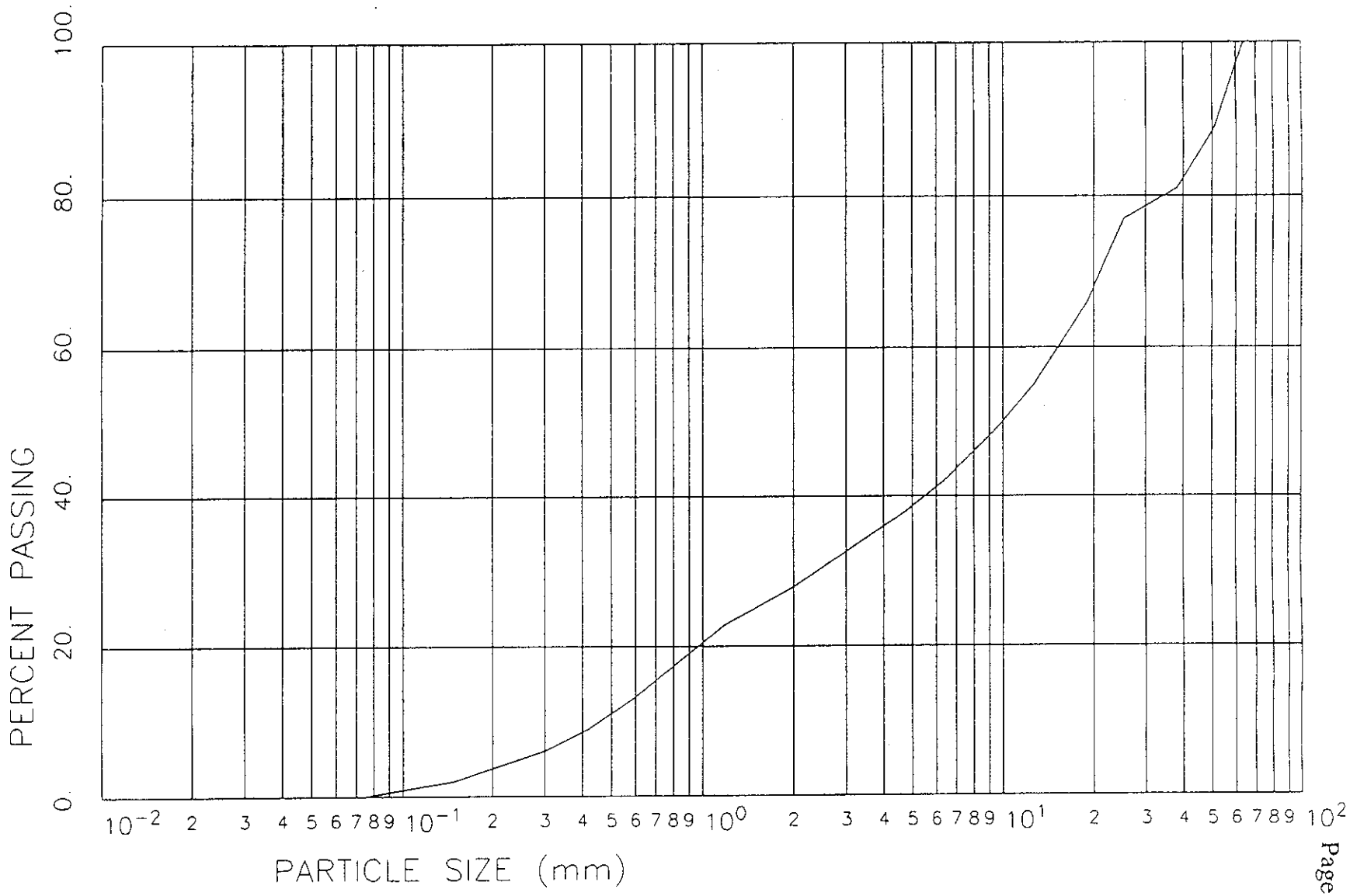


FIGURE 3.6. SEDIMENT-DISTRIBUTION CURVE FOR QUASED ANALYSIS

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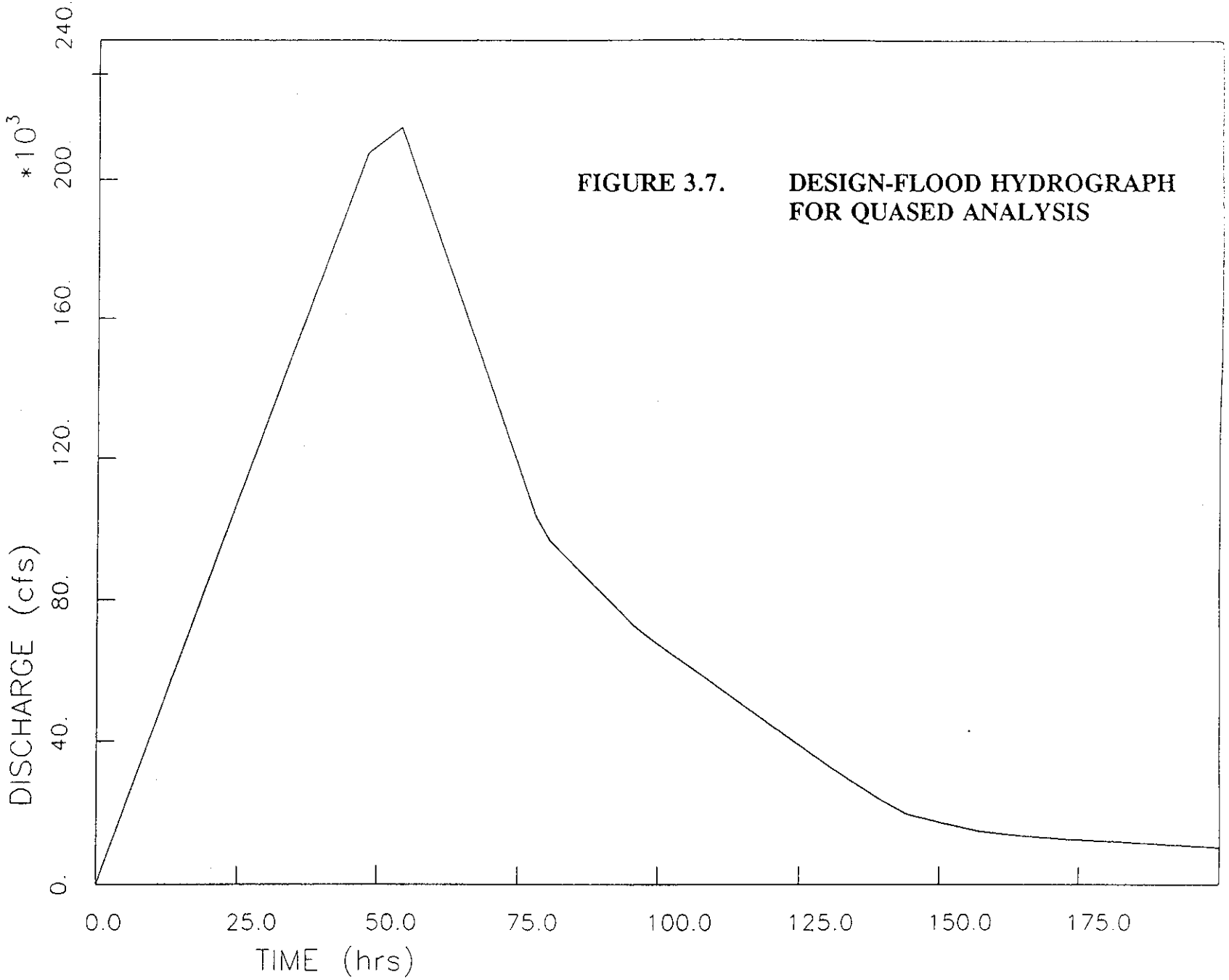

FIGURE 3.7. DESIGN-FLOOD HYDROGRAPH FOR QUASED ANALYSIS

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Water Resources & Civil Engineering Consultants

Bed-form scour, bend scour, and local scour at the bridge piers were estimated using the procedures outlined in Reference 6. The specific equations used from this document were Equations 4.25, 5.25 and 5.15, respectively. These equations are presented in Appendix A as Equations A.3 through A.5. Local scour at the bridge abutments was estimated using the one of the relationships provided in Reference 10. The specific equation used was Equation 5.5.24. This equation is presented in Appendix A as Equation A.6.

Local scour below the proposed grade-control structure was estimated using Equation A.7. This equation was developed using the results of a physical model study which was conducted by SLA (Reference 9).

The length of the "zone of influence" for the bend-scour component is equal to the length of the outer-bank curve plus a distance that is determined using Equation A.8. This equation was developed by I.L. Rozovskii in 1961 (Reference 11).

IV. DISCUSSION OF RESULTS

4.1 HYDRAULIC ANALYSES

Hard copies of both the input and output listings for the HEC-2 analyses are provided in Appendix B.

The limits of the existing 100-year floodplain are shown on Figure 3.1. Although the limits compare favorably with those reported as part of the 1984 FIS, the water-surface elevations determined as part of this design report are consistently higher than those reported as part of the FIS. The discrepancy appears to be the result of the failure of the FIS to exclude ineffective-flow areas from the total cross-sectional area associated with particular sections. A discussion of how ineffective-flow areas should be modeled is provided in Reference 3. However, since the primary purpose of the existing-conditions analysis is to provide a basis for evaluating the relative impact associated with the two design alternatives, this discrepancy is not necessarily pertinent to the study.

Table 4.1 summarizes a portion of the results of both the existing-conditions and design-conditions analyses. In addition, it quantifies the difference between the existing and design water-surface elevations and flow velocities. Table 4.2 provides the average hydraulic parameters that were used to define the magnitude of the 100-year scour components (excluding general scour).

Based on the results of the hydraulic analyses, Alternative B has a lesser impact on the upstream water-surface elevations than does Alternative A. In fact, the impact associated with Alternative B can be considered insignificant. For reasons discussed in the following paragraphs, the impact associated with Alternative A actually may be considered as being adverse.

TABLE 4.1-A: EXISTING VS DESIGN WATER-SURFACE ELEVATIONS AND FLOW VELOCITIES FOR ALTERNATIVE A

CROSS SECTION NO.	ALT-A WATER SURFACE ELEV.	EXISTING WATER SURFACE ELEV.	WATER SURFACE CHANGE (ft)	ALT-A FLOW VELOCITY (fps)	EXISTING FLOW VELOCITY (fps)	FLOW VELOCITY CHANGE (ft)
1.00	1044.27	1044.27	0.00	10.38	10.38	0.00
2.00	1044.98	1044.98	0.00	10.51	10.51	0.00
3.00	1045.76	1045.76	0.00	9.88	9.88	0.00
4.00	1046.38	1046.38	0.00	9.48	9.48	0.00
5.00	1046.61	1046.61	0.00	11.80	11.80	0.00
6.00	1047.21	1047.21	0.00	13.88	13.88	0.00
7.00	1047.94	1047.94	0.00	17.10	17.10	0.00
8.00	1050.24	1050.24	0.00	16.63	16.63	0.00
9.00	1052.48	1052.12	0.36	13.58	15.06	-1.48
9.10	1052.67	1053.71	-1.04	13.57	12.68	0.89
9.20	1053.51	1054.41	-0.90	13.16	11.99	1.17
9.30	1053.59	1054.86	-1.27	13.49	11.64	1.85
10.00	1054.36	1056.13	-1.77	12.86	9.55	3.31
11.00	1055.42	1056.68	-1.26	11.69	8.57	3.12
12.00	1056.68	1057.16	-0.48	10.02	8.33	1.69
13.00	1056.53	1057.13	-0.60	12.69	10.34	2.35
14.00	1057.02	1057.53	-0.51	12.71	10.23	2.48
15.00	1057.52	1057.70	-0.18	12.73	11.04	1.69
16.00	1058.02	1058.06	-0.04	12.74	11.07	1.67
17.00	1058.90	1058.41	0.49	11.73	10.98	0.75
18.00	1059.39	1058.73	0.66	11.52	11.80	-0.28
19.00	1059.63	1059.08	0.55	12.57	12.85	-0.28
20.00	1060.03	1059.51	0.52	13.83	14.14	-0.31
20.50	1061.44	1061.01	0.43	11.23	11.42	-0.19
21.00	1061.70	1061.29	0.41	11.36	11.56	-0.20
22.00	1061.63	1061.23	0.40	14.75	15.02	-0.27
23.00	1063.01	1062.70	0.31	13.77	13.98	-0.21
24.00	1064.37	1064.14	0.23	12.73	12.85	-0.12
25.00	1065.16	1064.95	0.21	12.83	12.95	-0.12
26.00	1065.86	1065.68	0.18	13.13	13.23	-0.10
27.00	1067.48	1067.34	0.14	10.74	10.81	-0.07

TABLE 4.1-B: EXISTING VS DESIGN WATER-SURFACE ELEVATIONS AND FLOW VELOCITIES FOR ALTERNATIVE B

CROSS SECTION NO.	ALT-B WATER SURFACE ELEV.	EXISTING WATER SURFACE ELEV.	WATER SURFACE CHANGE (ft)	ALT-B FLOW VELOCITY (fps)	EXISTING FLOW VELOCITY (fps)	FLOW VELOCITY CHANGE (ft)
1.00	1044.27	1044.27	0.00	10.38	10.38	0.00
2.00	1044.98	1044.98	0.00	10.51	10.51	0.00
3.00	1045.76	1045.76	0.00	9.88	9.88	0.00
4.00	1046.38	1046.38	0.00	9.48	9.48	0.00
5.00	1046.61	1046.61	0.00	11.80	11.80	0.00
6.00	1047.21	1047.21	0.00	13.88	13.88	0.00
7.00	1047.94	1047.94	0.00	17.10	17.10	0.00
8.00	1050.24	1050.24	0.00	16.63	16.63	0.00
9.00	1052.48	1052.12	0.36	13.58	15.06	-1.48
9.10	1052.67	1053.71	-1.04	13.57	12.68	0.89
9.20	1053.51	1054.41	-0.90	13.16	11.99	1.17
9.30	1053.66	1054.86	-1.20	13.15	11.64	1.51
10.00	1054.09	1056.13	-2.04	13.14	9.55	3.59
11.00	1054.66	1056.68	-2.02	13.12	8.57	4.55
12.00	1055.20	1057.16	-1.96	13.10	8.33	4.77
13.00	1055.76	1057.13	-1.37	13.09	10.34	2.75
14.00	1056.31	1057.53	-1.22	13.08	10.23	2.85
15.00	1056.86	1057.70	-0.84	13.07	11.04	2.03
16.00	1057.41	1058.06	-0.65	13.05	11.07	1.98
17.00	1058.36	1058.41	-0.05	11.99	10.98	1.01
18.00	1058.89	1058.73	0.16	11.75	11.80	-0.05
19.00	1059.15	1059.08	0.07	12.82	12.85	-0.03
20.00	1059.58	1059.51	0.07	14.09	14.14	-0.05
20.50	1061.07	1061.01	0.06	11.39	11.42	-0.03
21.00	1061.34	1061.29	0.05	11.53	11.56	-0.03
22.00	1061.29	1061.23	0.06	14.98	15.02	-0.04
23.00	1062.74	1062.70	0.04	13.95	13.98	-0.03
24.00	1064.17	1064.14	0.03	12.83	12.85	-0.02
25.00	1064.98	1064.95	0.03	12.93	12.95	-0.02
26.00	1065.70	1065.68	0.02	13.22	13.23	-0.01
27.00	1067.36	1067.34	0.02	10.81	10.81	0.00

15m MUE OUTFALL

TABLE 4.2: AVERAGE HYDRAULIC PROPERTIES USED IN SCOUR ANALYSES

CROSS SECTION NO.	DEPTH OF FLOW (ft)	HYDRAULIC DEPTH (ft)	CHANNEL DISCHARGE (cfs)	CHANNEL FLOW VELOCITY (fps)	CHANNEL FLOW WIDTH (ft)	CHANNEL FLOW AREA (ft^2)	ENERGY SLOPE o/o	CHANNEL FROUDE NO.
EXISTING-CONDITIONS								
7-9	24.10	18.10	194431	16.26	669.98	11988.06	0.4309	0.68
9-11 & 13-17	29.61	24.48	168778	11.20	641.69	15152.43	0.1445	0.41
ALTERNATIVE A								
9-11 & 13-17	26.63	24.81	194705	12.81	613.78	15231.25	0.1308	0.46
ALTERNATIVE B								
9-11 & 13-17	26.26	24.55	195000	13.09	607.10	14907.93	0.1382	0.47

When the flow regime along a watercourse is subcritical, water-surface profiles are controlled by the hydraulics of downstream sections. Based on the results of the existing-conditions analysis, the hydraulic-control section for the upstream reach (i.e. Sections 18 through 24) is located at the landfill's eastern boundary where flow overtops the main channel and inundates the landfill's surface. In order to prevent inundation of the landfill during the 100-year event, a new downstream control section must be established to offset the impact of total containment of the 100-year discharge.

Within the study reach, there are two existing downstream sections that can serve as the hydraulic control section. One section is located on the downstream side of the 19th Avenue bridge, and the other section is located on the upstream side of the bridge. It should be noted that the bridge itself is not a controlling section in this instance. To a certain extent, the width of the design section dictates which control section to use. However, since the width of the design section is limited by the landfill, the proposed channelization scheme must be evaluated using both control sections to determine which produces the most desirable results.

Since the south bank levee associated with Alternative A is limited to the Salt River boundary of Cell A-1, the control section for this alternative is located somewhere between the cell's western boundary and 19th Avenue. With the control section at this location, the average increase in the water-surface elevation between Sections 18 and 24 is approximately 0.5 feet.

For Alternative B, the south bank levee extends all the way to the grade-control structure. Consequently, the control section for this alternative is located immediately downstream of the grade-control structure. With the control section at this location, the average increase between Sections 18 and 24 is approximately 0.1 feet.

The increase associated with Alternative A does not appear to significantly alter the existing 100-year floodprone area between the landfill and the 7th Avenue bridge. Nor does it appear to significantly reduce the amount of freeboard associated with the numerous flood-control levees that flank this reach. However, it appears that this increase may adversely affect the capacity of the 7th Avenue bridge.

Using the results of the existing-conditions analysis, the water-surface elevation at Section 24 was checked against the design water-surface elevation for the 7th Avenue bridge. According to the bridge plans, the design elevation at the bridge, which was based on 200,000 cfs, is 1058.9 feet MSL. Since the minimum low-chord elevation for the bridge is approximately 1065.0 feet MSL, it appears that approximately six feet of freeboard was included in the bridge design. In contrast, the existing water-surface elevation at Section 24 was determined to be 1064.14 feet MSL. As previously mentioned, this latter elevation does not include head-losses attributable to the bridge.

Consequently, there appears to be some question regarding the bridge's ability to convey the entire 100-year peak discharge beneath its superstructure with adequate freeboard. It is not known at this time if the bridge plans and the project topo are based on the same datum. However, given the magnitude of the discrepancy, it would be advisable to design the channelized reach in such a manner so as to avoid any relative increase in the tailwater elevations associated with the 7th Avenue bridge.

Alternative B accomplishes this goal by limiting the average rise in the tailwater elevations to less than one-tenth of a foot. This increase is within the relative accuracy range associated with the HEC-2 program. Consequently, most floodplain engineers would agree that a relative increase of this magnitude can be considered insignificant. Therefore, it can be said that Alternative B in no way materially alters the existing hydraulics of the 7th Avenue bridge.

Based on these results, Alternative B appears to be the most effective alternative.

4.2 GEOMORPHIC ANALYSES

Table 4.3 summarizes the results of the general-scour analysis of the entire study reach. However, only the maximum general scour depth occurring within the design reach was used in combination with the other scour components to define the total depths of scour for both existing and design conditions.

The design results shown in this table were obtained using the Alternative B channelization scheme. However, the results are applicable to both design alternatives. It was not necessary to conduct a separate analysis for Alternative A, since the maximum depths of scour for Alternative B occur within the upstream segment of the design reach where the design section is common to both alternatives.

Table 4.4 summarizes the results of the entire scour analysis, including general scour. Five distinct subreaches are represented in the table for each of the three conditions analyzed. Since the design scour depths within a given subreach will vary as a function of the applicable scour component(s), the design burial depths for a particular segment of bank protection will also vary along the design reach in accordance with its location.

Along the straight reaches and along the inner bank of the curved reaches, the general-scour, bed-form scour, and low-flow channel incisement depths were used to define 100-year scour depths. Along the outer bank of the curved reaches, the bend-scour component was also included. In the immediate vicinity of the bridge, all or a portion of the pier-scour component was also included if the bank protection lay within the associated "zone of influence". In this particular instance, only the proposed north

TABLE 4.3: RESULTS OF GENERAL-SCOUR ANALYSIS

ANALYSIS OF EXISTING CONDITIONS						ANALYSIS OF DESIGN CONDITIONS					
CROSS SECTION NO.	EXISTING THALWEG ELEV.	THALWEG ELEV. @ PEAK	FINAL THALWEG ELEV.	CHANGE @ PEAK (ft)	FINAL CHANGE (ft)	CROSS SECTION NO.	DESIGN THALWEG ELEV.	THALWEG ELEV. @ PEAK	FINAL THALWEG ELEV.	CHANGE @ PEAK (ft)	FINAL CHANGE (ft)
3	1020.0	1020.6	1020.8	0.62	0.81	3	1020.0	1020.8	1021.2	0.84	1.18
4	1022.0	1022.6	1022.8	0.63	0.82	4	1022.0	1022.8	1023.2	0.84	1.18
5	1024.0	1024.6	1024.8	0.63	0.83	5	1024.0	1023.1	1022.9	-0.87	-1.09
6	1024.0	1022.3	1021.8	-1.66	-2.19	6	1024.0	1023.1	1022.8	-0.93	-1.25
7	1026.0	1023.9	1023.3	-2.13	-2.74	7	1026.0	1024.9	1024.6	-1.06	-1.43
8	1026.0	1023.6	1022.9	-2.39	-3.08	8	1026.0	1026.0	1026.0	0.00	0.00
9	1026.0	1023.5	1022.7	-2.53	-3.30	9	1027.0	1027.0	1027.0	0.00	0.00
9.1	1026.0	1024.1	1023.6	-1.88	-2.43	9.1	1027.2	1026.8	1026.6	-0.36	-0.58
9.2	1026.0	1025.9	1025.8	-0.08	-0.20	9.2	1027.3	1026.9	1026.7	-0.36	-0.58
9.3	1026.0	1025.9	1025.8	-0.07	-0.19	9.3	1027.4	1027.0	1026.8	-0.36	-0.58
10	1026.0	1025.9	1025.8	-0.08	-0.22	10	1027.8	1027.4	1027.2	-0.36	-0.58
11	1026.0	1025.9	1025.8	-0.08	-0.20	11	1028.3	1028.0	1027.8	-0.36	-0.58
12	1026.0	1026.1	1026.0	0.14	0.01	12	1028.8	1028.3	1028.1	-0.51	-0.78
13	1026.0	1026.2	1026.0	0.17	0.02	13	1029.4	1028.9	1028.6	-0.51	-0.78
14	1026.0	1026.2	1026.0	0.17	0.01	14	1029.9	1029.4	1029.1	-0.51	-0.78
15	1026.0	1026.0	1025.9	0.03	-0.15	15	1030.4	1030.1	1029.9	-0.35	-0.50
16	1027.0	1027.0	1026.9	0.02	-0.13	16	1031.0	1030.6	1030.5	-0.35	-0.50
17	1030.0	1030.0	1029.9	0.00	-0.12	17	1031.5	1031.2	1031.0	-0.32	-0.46
18	1030.5	1030.3	1030.3	-0.16	-0.16	18	1032.0	1031.8	1031.8	-0.20	-0.20
19	1032.0	1031.8	1031.8	-0.18	-0.18	19	1032.0	1031.8	1031.8	-0.22	-0.22
20	1034.0	1033.8	1033.8	-0.20	-0.20	20	1034.0	1033.8	1033.8	-0.24	-0.24
20.5	1034.0	1033.8	1033.8	-0.16	-0.16	20.5	1034.0	1033.8	1033.8	-0.20	-0.20
21	1034.0	1033.1	1032.7	-0.90	-1.26	21	1034.0	1033.1	1032.8	-0.89	-1.24
22	1035.0	1033.8	1033.3	-1.23	-1.69	22	1035.0	1033.8	1033.4	-1.22	-1.65
23	1036.0	1034.9	1034.5	-1.12	-1.52	23	1036.0	1035.0	1034.6	-1.05	-1.42
24	1038.0	1037.1	1037.0	-0.94	-1.02	24	1038.0	1037.1	1037.1	-0.87	-0.93
25	1038.0	1037.2	1037.1	-0.84	-0.92	25	1038.0	1037.2	1037.1	-0.83	-0.89
26	1038.0	1037.2	1037.1	-0.84	-0.92	26	1038.0	1037.2	1037.1	-0.81	-0.87

TABLE 4.4: SUMMARY OF RESULTS OF SCOUR ANALYSIS

REACH	GENERAL SCOUR DEPTH (ft)	BED-FORM SCOUR DEPTH (ft)	BEND SCOUR DEPTH (ft)	LOW-FLOW CHANNEL DEPTH (ft)	ABUTMENT SCOUR DEPTH (ft)	PIER SCOUR DEPTH (ft)	DROP SCOUR DEPTH (ft)	100-YEAR SCOUR DEPTH (ft)	LONG-TERM SCOUR DEPTH (ft)	DESIGN SCOUR DEPTH (ft)
EXISTING CONDITIONS										
STRAIGHT (D/S BRIDGE)	3.30	3.62	N/A	2.00	N/A	N/A	N/A	11.60	21.5 / 13.00	21.5
STRAIGHT (U/S BRIDGE)	0.22	1.72	N/A	2.00	N/A	N/A	N/A	5.12	21.5 / 13.00	18.12
CURVED (OUTER BANK)	0.22	1.72	5.30	2.00	N/A	N/A	N/A	12.01	21.5 / 13.00	21.5
CURVED (INNER BANK)	0.22	1.72	N/A	2.00	N/A	N/A	N/A	5.12	21.5 / 13.00	18.12
BRIDGE (S. ABUTMENT)	0.22	1.72	5.30	2.00	7.13	(21.67)	N/A	21.28	21.5 / 13.00	21.5
BRIDGE (N. ABUTMENT)	0.22	1.72	N/A	2.00	56.15	(21.67)	N/A	78.11	21.5 / 13.00	21.5
ALTERNATIVE A										
STRAIGHT (D/S GCS)	N/A	N/A	N/A	N/A	N/A	N/A	21.85	28.41	5.00 / 13.00	41.41
STRAIGHT (U/S GCS)	0.78	2.24	N/A	2.00	N/A	N/A	N/A	6.53	21.5 / 1.00	7.53
CURVED (OUTER BANK)	0.78	2.24	5.44	2.00	N/A	N/A	N/A	13.60	21.5 / 1.00	14.60
CURVED (INNER BANK)	0.78	2.24	N/A	2.00	N/A	N/A	N/A	6.53	21.5 / 1.00	7.53
BRIDGE (S. ABUTMENT)	0.78	2.24	5.44	2.00	2.24	(22.06)	N/A	16.51	21.5 / 1.00	17.51
BRIDGE (N. ABUTMENT)	0.78	2.24	N/A	2.00	N/A	5.88	N/A	14.17	21.5 / 1.00	15.17
ALTERNATIVE B										
STRAIGHT (D/S GCS)	N/A	N/A	N/A	N/A	N/A	N/A	22.17	28.82	5.0 / 13.00	41.82
STRAIGHT (U/S GCS)	0.78	2.34	N/A	2.00	N/A	N/A	N/A	6.66	21.5 / 1.00	7.66
CURVED (OUTER BANK)	0.78	2.34	5.39	2.00	N/A	N/A	N/A	13.66	21.5 / 1.00	14.66
CURVED (INNER BANK)	0.78	2.34	N/A	2.00	N/A	N/A	N/A	6.66	21.5 / 1.00	7.66
BRIDGE (S. ABUTMENT)	0.78	2.34	5.39	2.00	N/A	(22.20)	N/A	13.66	21.5 / 1.00	14.66
BRIDGE (N. ABUTMENT)	0.78	2.34	N/A	2.00	N/A	N/A	N/A	14.30	21.5 / 1.00	15.30

( ) Denotes computed value that is not applicable for design purposes.

bank will be close enough to the bridge piers to be affected by pier scour. Within the bridge reach, an abutment-scour component was also included since the approaches to the 19th Avenue bridge can force a significant quantity of overbank flow through the bridge section under both existing conditions and Alternative-A conditions.

It should be noted that, for each subreach, the individual 100-year components shown in the table, including the low-flow component, represent the actual computed values. The 100-year scour depths represent the summation of the individual components (to the left of this column) times the 1.3 safety factor.

The results of the long-term degradation analyses are also shown in Table 4.4. Since the maximum equilibrium depth at the upstream limit of the design reach was limited to one foot, this value was selected as the minimum long-term equilibrium depth for the entire design reach. Within the design reach, the computed armoring depth for both existing and design conditions was determined to be approximately 16.5 feet. When the safety factor is applied, the design value becomes 21.5 feet. Within that portion of the existing-conditions reach located immediately downstream of the grade-control structure, the computed armoring depth was determined to be approximately 3.85 feet. When the safety factor is applied, the depth becomes 5.0 feet. This value is based on the uniform-flow hydraulics of a 1000-foot-wide channel section. This width approximates the average width of the existing main channel and the width of a future channel, should one be constructed.

However, since the grade-control structure will be located a short distance upstream of an existing 26-foot-deep gravel pit, the 5-foot armoring depth was not used to define the design burial depth for the grade-control structure. Instead, the grade-control was designed using an approximation of the depth of a potential head-cut. Designing the grade-control structure in this manner will guard against the possibility of

a headcut migrating upstream from the brink of the gravel pit. Headcuts are typically defined as migratory vertical drops in the upstream profile of earthen channels. In this particular instance, the headcutting process will be initiated as flow plunges into the gravel pit during the design storm event. Both physical and mathematical model studies of in-stream gravel pits have shown that the maximum depth of the headcut is approximately equal to one-half the depth of the pre-flood pit (Reference 12). Consequently, since the depth of the existing gravel pit is approximately equal to 26 feet, the maximum head-cut depth is predicted to be approximately 13 feet.

The results just discussed are included under the long-term scour-depth column. In this column, the top number represents the computed armoring depth, which includes a safety factor, and the bottom number either represents the head-cut depth or the equilibrium degradation depth. For all existing-condition subreaches, and for the two design-condition straight reaches located downstream of the grade-control structure, the bottom number represents the head-cut depth. For the remaining design subreaches, the bottom number represents the long-term equilibrium depth.

With the exception of the two design reaches located downstream of the grade-control structure, the final design scour depths were chosen in the following manner. First, the equilibrium depth or the head-cut, whichever was applicable, was added to the 100-year scour depth. This quantity was then compared to the armoring depth for that particular reach. The smaller of the two values was then selected as the total or design scour depth for that reach. For the two excluded design reaches, the armoring depth was ignored for the reasons previously discussed. Consequently, the total or design scour depths for these two reaches were based on the sum of the 100-year scour depths and the head-cut depths.

Generally speaking, channelization (coupled with the installation of the grade-control structure) will not adversely alter the erosion potential that currently exists outside the limits of the design reach. Although channelization significantly increases flow velocities within the design reach, it does not significantly alter the velocity of flow in either the upstream or downstream direction. Consequently, one would not expect any adverse geomorphic impacts on the upstream and downstream reaches after the channelization or bank protection project is complete. Although a comprehensive scour analysis was not performed on these reaches, the results of the general-scour analysis, as summarized in Table 4.3, supports this conclusion.

In addition, channelization will not adversely affect the existing stability of the 19th Avenue bridge. The design plans for the bridge indicate that the bridge piers were founded at an elevation of 915 feet MSL. This is approximately 112 feet below the design bed elevation. Since the maximum local-scour depth for the bridge piers was estimated to be approximately 22 feet, channelization will not adversely impact the bridge.

The results discussed thus far apply only to the erosion potential associated with the channel bed. As previously stated, the results of the hydraulic analysis clearly demonstrates that the velocity of flow within the main channel will increase significantly under either design alternatives. Consequently, the erosion potential associated with the channel banks will also increase in response to the increased flow velocities. For Alternative B, the entire channelized reach is protected to prevent bank erosion. However, for Alternative A, the stability of the south bank between the grade-control structure and the western boundary of Cell A-1 is questionable.

It is recognized that the majority of the south bank along this segment of the design reach is currently protected with rock riprap. However, if the design flow velocity

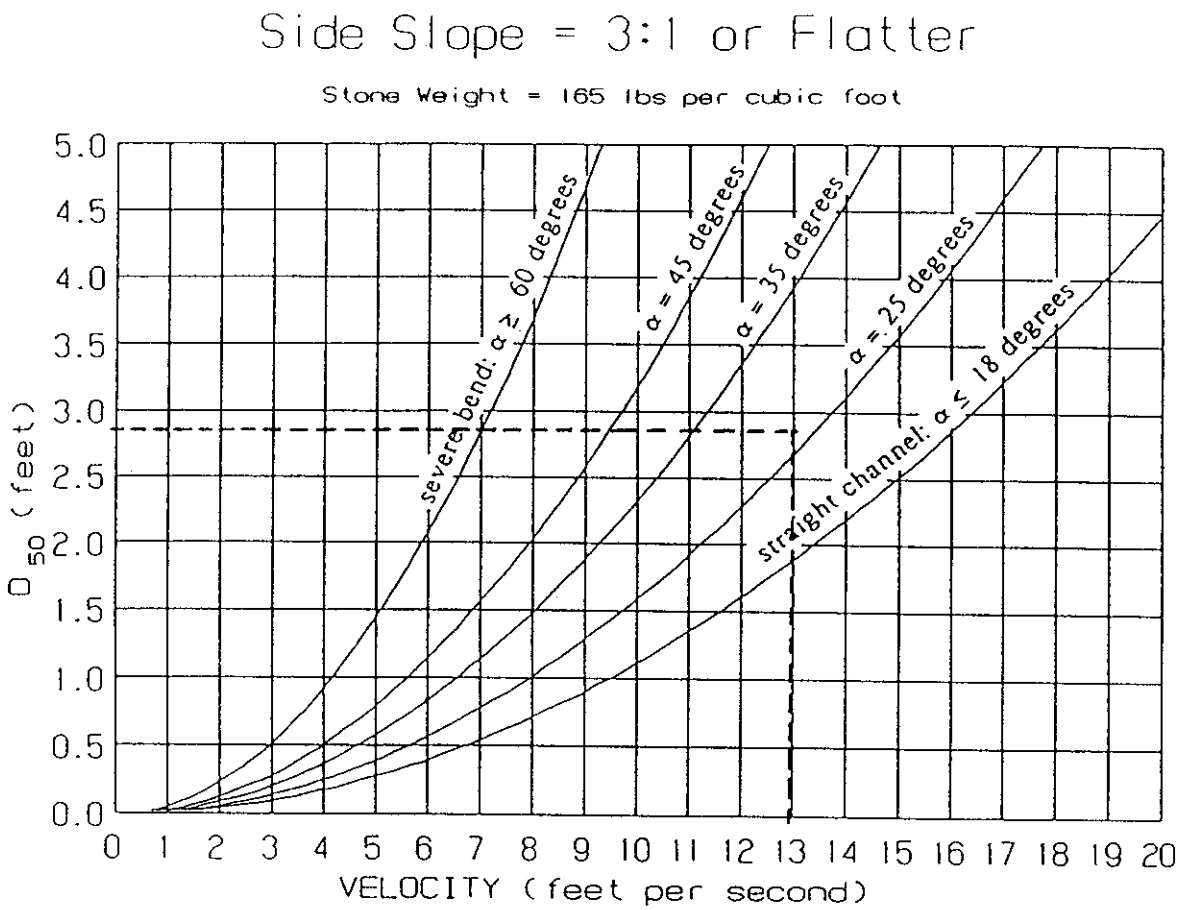
associated with Alternative A were used originally to design the rock-riprap protection, the D_{50} size of the riprap would have to be approximately three feet (see Figure 4.1). The thickness of the riprap blanket would have to be approximately six feet. In addition, the design toe-down depths for the protection would have to conform to the appropriate values presented in Table 4.4. A field inspection of the existing bank protection does not appear to support this current design criteria. In addition, it does not appear that the upstream limit of the existing protection was designed to prevent it from being outflanked. Consequently, the stability of the existing rock-riprap protection is questionable under Alternative-A conditions.

In an effort to quantify the increased erosion potential associated with the south bank, a scour-width equation (developed by a staff member of SLA), was applied using the results of the hydraulic analyses. Although this equation, provided as Equation A.8 in Appendix A, applies to unprotected alluvium banks, the results indicate that a three-fold increase in the erosion potential is possible. Under existing conditions, the potential bank-erosion distance was estimated to be approximately 85 feet. However, under Alternative A, the estimated distance was determined to be approximately 240 feet.

Although a detailed qualitative and/or quantitative lateral-migration analysis of the existing bank was not conducted as part of this study, all empirical data supports the fact that the outer bank of a channel bend is far more susceptible to erosion than are the banks along straight reaches. Increasing the velocity of flow entering the bend will most certainly increase the erosion potential. If the southern bank between Cell A-1 and 19th Avenue is not properly stabilized, portions of the south bank, including the bridge abutment and the approach roadway, may be in jeopardy.

From a design standpoint, the two alternatives evaluated produce similar geomorphic responses. However, considering the potential inadequacy of the existing

FIGURE 4.1: RIPRAP DESIGN CHART



SOURCE: SIMONS, LI & ASSOCIATES, INC. (1988)

FOR ALTERNATIVE A

BEND ANGLE ≈ 26.5°

AVERAGE VELOCITY OF APPROACH FLOW: 13.0 fps

D_{50} REQUIRED FOR RIPRAP PROTECTION: 2.85 ft (3.0 ft)

THICKNESS OF RIPRAP BLANKET: 2(D_{50}) OR 6.0 ft

rock-riprap bank protection along the south bank near 19th Avenue, Alternative B will provide the greatest measure of protection.

V. CONCLUSIONS AND RECOMMENDATIONS

The results of the hydraulic analyses indicate that Alternative A will increase upstream water-surface elevations by approximately 0.5 feet. The increase associated with Alternative B was limited to 0.1 feet, which is within the accuracy range of the applied model. Therefore, the relative impact associated with Alternative B can be considered insignificant. The significance of the Alternative A impact is not known for certain at this time. However, it would be advisable to avoid any interaction between the proposed channelization scheme and the hydraulics of the 7th Avenue bridge by selecting Alternative B.

The results of the geomorphic analyses indicate that both alternatives will significantly increase the erosion potential associated with the design reach. In an effort to minimize construction costs, Alternative A limits the extent of soil-cement bank/levee protection to those banks within the design reach that are currently unprotected. However, the results of this study raise some questions regarding the ability of the existing rock-riprap bank protection to withstand the increased erosion potential. Therefore, to avoid the possibility of future damage, which could be linked to the proposed channelization scheme, engineering judgment dictates selection of Alternative B.

Normally, studies of this type evaluate the cost-effectiveness of each alternative. However, in this particular instance, the only difference between the two alternatives is the extent of bank/levee protection required within the design reach. Since the average cost of soil-cement bank protection is approximately $1,200,000 per lineal mile, and Alternative B will require an additional four-tenths mile of soil-cement protection, it is reasoned that cost of materials for Alternative A would be approximately $500,000 less than would be the cost of materials for Alternative B.

However, if the cost of potentially future flood damage and/or possible litigation were considered in the final analysis of Alternative A, Alternative B could, in the long run, prove to be the most cost-effective flood-control and erosion-control alternative for the 19th Avenue landfill. As previously stated, this alternative will prevent inundation and refuse-washout during the 100-year flow event without adversely impacting adjacent properties and/or structures. Consequently, Alternative B is the recommended alternative.

Table 5.1 provides the recommended burial depths and elevations for the bank protection and the grade-control structure. In addition, the top of levee elevations are also provided. Although Alternative A is not the recommended alternative, the values associated with this alternative are also included for comparative purposes.

During the planning phase of the overall project, it was recommended that the flood-control levees be protected using soil cement. Although other forms of bank protection can promote, enhance and/or support vegetation (which theoretically increases the aesthetic quality of the completed project), SLA endorses the initial recommendation to use soil cement because of its effectiveness, durability, and extremely low maintenance costs. To ensure that the final cost of the soil cement product is kept at a minimum, Appendix C provides a discussion of some of the cost-optimization techniques that can be considered when utilizing soil cement as a bank/levee protection measure.

TABLE 5.1: DESIGN PARAMETERS

ALTERNATIVE A

CROSS SECTION NO.	WATER SURFACE ELEV. (MSL)	LEVEE CREST ELEV. (MSL)	FLOW LINE ELEV. (MSL)	N-BANK SCOUR DEPTH (ft)	N-BANK TOE-DOWN ELEV. (MSL)	S-BANK SCOUR DEPTH (ft)	S-BANK TOE-DOWN ELEV. (MSL)
8.0	1050.2	1053.2	1026.0	41.4	984.6	41.4	N/A
9.0	1052.5	1055.5	1027.0	41.4	985.6	41.4	N/A
9.0	1052.5	1055.5	1027.0	7.5	1019.5	14.6	N/A
9.1	1052.7	1055.7	1027.2	15.2	1012.0	17.5	N/A
9.2	1053.5	1056.5	1027.3	15.2	1012.1	17.5	N/A
9.3	1053.6	1056.6	1027.4	15.2	1012.2	17.5	N/A
10.0	1054.4	1057.4	1027.8	7.5	1020.3	14.6	N/A
11.0	1055.4	1058.4	1028.3	7.5	1020.8	14.6	N/A
12.0	1056.7	1059.7	1028.8	7.5	1021.3	14.6	N/A
13.0	1056.5	1059.5	1029.4	7.5	1021.8	14.6	1014.8
14.0	1057.0	1060.0	1029.9	7.5	1022.4	7.5	1022.4
15.0	1057.5	1060.5	1030.4	7.5	1022.9	7.5	1022.9
16.0	1058.0	1061.0	1031.0	7.5	1023.4	7.5	1023.4
17.0	1058.9	1061.9	1031.5	7.5	1024.0	7.5	1024.0

ALTERNATIVE B

CROSS SECTION NO.	WATER SURFACE ELEV. (MSL)	LEVEE CREST ELEV. (MSL)	FLOW LINE ELEV. (MSL)	N-BANK SCOUR DEPTH (ft)	N-BANK TOE-DOWN ELEV. (MSL)	S-BANK SCOUR DEPTH (ft)	S-BANK TOE-DOWN ELEV. (MSL)
8.0	1050.2	1053.2	1026.0	41.8	984.2	41.8	984.2
9.0	1052.5	1055.5	1027.0	41.8	985.2	41.8	985.2
9.0	1052.5	1055.5	1027.0	7.7	1019.3	14.7	1012.3
9.1	1052.7	1055.7	1027.2	14.7	1012.5	15.3	1011.9
9.2	1053.5	1056.5	1027.3	14.7	1012.6	15.3	1012.0
9.3	1053.7	1056.7	1027.4	14.7	1012.7	15.3	1012.1
10.0	1054.1	1057.1	1027.8	7.7	1020.1	14.7	1013.1
11.0	1054.7	1057.7	1028.3	7.7	1020.7	14.7	1013.7
12.0	1055.2	1058.2	1028.8	7.7	1021.2	14.7	1014.2
13.0	1055.8	1058.8	1029.4	7.7	1021.7	14.7	1014.7
14.0	1056.3	1059.3	1029.9	7.7	1022.2	7.7	1022.2
15.0	1056.9	1059.9	1030.4	7.7	1022.8	7.7	1022.8
16.0	1057.4	1060.4	1031.0	7.7	1023.3	7.7	1023.3
17.0	1058.4	1061.4	1031.5	7.7	1023.8	7.7	1023.8

V. REFERENCES

1. Dames & Moore, "Remedial Investigation/Feasibility Study, 19th Avenue Landfill," prepared for City of Phoenix, Draft, June 10, 1988.

2. Dames & Moore, "Remedial Action Plan for 19th Avenue Landfill," prepared for City of Phoenix, Final Draft, June, 1989.

3. U.S. Army Corps of Engineers, "HEC-2: Water Surface Profiles, Users Manual," September, 1982, updates, September, 1988.

4. CRSS Commercial Group, Inc., "Salt River Hydraulic Design, Grade Control No. 4 to McClintock Drive Bridge," prepared for City of Tempe, Draft Final Report, April, 1990.

5. Simons, Li and Associates, Inc., "East Papago and Hohokam Freeways, Location Study and Preliminary Design", Technical Series, Technical Memo No. 4, River Mechanics, June, 1987.

6. Simons, Li and Associates, Inc., "Design Manual for Engineering Analysis of Fluvial Systems," prepared for the Arizona Department of Water Resources, March, 1985.

7. Simons, Li and Associates, Inc., "Quasi-Dynamic Sediment Routing Model (QUASED), Users Manual," June, 1981.

8. Simons, Li and Associates, Inc., "Concept Hydraulic Design, Salt River Channelization, East Papago Freeway," May, 1988.

9. Simons, Li and Associates, Inc., "Project Report: Hydraulic Model Study of Local Scour Downstream of Project Grade Control Structures," February, 1986.

10. Federal Highway Administration, "Highways in the River Environment," February, 1990.

11. Rozovskii, I.L., Flow of Water in Bends of Open Channels, Israel Program for Scientific Translation, Jerusalem, Israel, 1961.

12. Simons, Li and Associates, Inc., "Effects of In-Stream Mining on Channel Stability," prepared for the Arizona Department of Transportation, June, 1989.

APPENDIX A

SCOUR EQUATIONS

APPENDIX A: SCOUR EQUATIONS

ARMORING POTENTIAL:

$$D_c = \frac{\tau}{0.047\ (\gamma_2 - \gamma)} \qquad (A.1)$$

Where:

D_c = Diameter of sediment particle for conditions of incipient motion (ft)

τ = Boundary shear stress (lb/ft^2)

γ_s = Specific weight of sediment (lb/ft^3)

γ = Specific weight of water (lb/ft^3)

and

$$\Delta Z_a = y_a\ [(1/P_{c)} - 1] \qquad (A.2)$$

Where:

ΔZ_a = Depth to formation of armor layer (ft)

Y_a = Thickness of armor layer (ft)

P_c = Decimal fraction of material coarser than armor layer (ft)

BED FORM-SCOUR COMPONENT:

FOR ANTIDUNES: **FOR DUNES:**

$$Y_s = (V_{avg}/8.55)2 \qquad Y_s = Y_{max}/6 \qquad (A.3)$$

Where:

V_{avg} = Average channel velocity (fps)

Y_{max} = Maximum Depth of Flow (ft)

BEND-SCOUR COMPONENT:

$$Y_s = (0.0685\ Y\ V_{avg}^{0.8}(2.1((\mathrm{Sin}^2(A_i/2)/\mathrm{Cos}(A_i))^{0.2})-1))/(Y_h^{0.4}\ S_o^{0.3}) \qquad (A.4)$$

Where:

A_i = Impingement angle (degrees)

S_o = Energy/bed slope (ft/ft)

Y_h = Hydraulic depth (ft)

Y = Maximum flow depth (ft)

V_{avg} = Average channel velocity (fps)

LOCAL-SCOUR COMPONENT FOR BRIDGE PIERS:

$$L_s = Y\ k_p\ (b_p/Y)^{0.65}\ Fr^{0.43} \qquad (A.5)$$

Where:

Y = Maximum flow depth (ft)

Fr = Froude number

b_p = Width of obstruction (ft)

k_p = Pier shape coefficient

BRIDGE-ABUTMENT-SCOUR COMPONENT:

$$\frac{Q_o}{q_{mc} y_o} = 2.75\ \frac{y_s}{y_o}\ \left[\left(\frac{y_s}{4.1 y_o} + 1\right)^{7/6} - 1\right] \qquad (A.6)$$

Where:

q_{mc} = The unit discharge in the main channel (cfs/ft)

Q = Discharge of main channel (cfs)

W = Width of the main channel (ft)

Q_o = Overbank flow discharge (cfs)

y_o = Overbank flow depth (ft)

LOCAL-SCOUR COMPONENT FOR SUBMERGED GRADE-CONTROL STRUCTURE:

$$L_{sg} = 0.581\ q^{0.667}\ (d_h/Y)^{0.411}\ (1-(d_h/Y))^{-0.118} \qquad (A.7)$$

Where:

Y = Maximum flow depth (ft)

d_h = Drop height (ft)

q = Unit discharge (cfs/ft)

DOWNSTREAM EXTENT OF BEND-SCOUR COMPONENT:

$$x = (0.6/n)/Y^{1.17} \qquad (A.8)$$

Where:

x = Distance from the downstream tangency point to the location where secondary currents have dissipated (ft)

Y = Maximum flow depth (ft)

n = Manning's roughness coefficient

SCOUR-WIDTH CHANGE:

$$W_s = ((0.088\ Q\ (\mathrm{Sin}^2(A_i/2)/\mathrm{Cos}(A_i))^{0.25})/(Y_h^{1.5}\ S_o^{0.38}))\text{-}TW \qquad (A.9)$$

Where:

A_i = Impingement angle in degrees (degrees)

S_o = Bed slope (ft/ft)

Y_h = Hydraulic depth (ft)

TW = Top width of flow (ft)

Q = Design discharge (cfs)

APPENDIX B

INPUT/OUTPUT LISTINGS FOR THE HEC-2 ANALYSES

THIS RUN EXECUTED 4/26/91 9:19: 0

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*****************************************
 HEC2 RELEASE DATED SEP 88 UPDATED SEPT 1989


 ERROR CORR -  01,02,03
 MODIFICATION -
*****************************************


T1      SIMONS, LI & ASSOCIATES, INC.
T2      19TH AVENUE ENVIRONMENTAL CLEANUP (PAZ-CPH-02)
T3      EXIST.DAT              EXISTING 100-YR FLOODPLAIN ANALYSIS

J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    Q        WSEL     FQ

      0        2        0        0     0.000       0        0        0   1044.27      0

J2  NPROF    IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW      CHNIM    ITRACE

     -1        0       -1        0        0        0       -1        0        0        0


J3  VARIABLE CODES FOR SUMMARY PRINTOUT

     38        1       55       26       56       13       14       15        8        4
     53       54        0       38        1        2        3       11       12       42
      5       33       39       67       68

J6  IHLEQ    ICOPY    SUBDIV   STRTDS   RMILE

      1


NC    0.050    0.045    0.040      0.1      0.3
QT        1   195000
X1      1.0       18     1720     2650        0        0        0        0        0        0
X3                                                  3110.0
GR   1050.5   1000.0   1050.0   1430.0   1048.0   1720.0   1040.0   1730.0   1030.0   1750.0
GR   1030.0   2250.0   1030.0   2270.0   1024.0   2280.0   1022.0   2420.0   1020.0   2440.0
GR   1020.0   2535.0   1024.0   2545.0   1026.0   2610.0   1030.0   2620.0   1040.0   2650.0
GR   1040.0   2740.0   1032.0   2750.0   1032.0   3590.0

X1      2.0       20     1625     2510      400      400      400        0        0        0
X3                                                  2915.0
GR   1051.6   1000.0   1050.0   1340.0   1048.0   1615.0   1040.0   1625.0   1032.0   1650.0
GR   1030.0   1665.0   1030.0   2130.0   1032.0   2150.0   1030.0   2160.0   1022.0   2210.0
GR   1020.0   2300.0   1020.0   2360.0   1024.0   2365.0   1026.0   2420.0   1028.0   2485.0
GR   1030.0   2495.0   1040.0   2510.0   1040.0   2550.0   1032.0   2570.0   1032.0   3230.0
```

X1	3.0	18	1510	2525	400	400	400	0	0	0
X3						2710.0				
GR	1051.0	1900.0	1051.0	1400.0	1050.0	1510.0	1034.0	1530.0	1030.0	1535.0
GR	1030.0	1975.0	1034.0	2000.0	1030.0	2020.0	1022.0	2050.0	1020.0	2150.0
GR	1025.0	2235.0	1025.0	2470.0	1030.0	2485.0	1040.0	2505.0	1042.0	2525.0
GR	1040.0	2540.0	1032.0	2575.0	1032.0	3025.0				
X1	4.0	15	1580	2680	400	400	400	0	0	0
GR	1052.6	1170.0	1052.0	1255.0	1050.0	1580.0	1036.0	1600.0	1030.0	1610.0
GR	1030.0	1990.0	1036.0	2020.0	1030.0	2040.0	1024.0	2060.0	1022.0	2125.0
GR	1022.0	2170.0	1025.0	2175.0	1025.0	2600.0	1030.0	2645.0	1040.0	2680.0
X1	5.0	15	1590	2620	400	400	400	0	0	0
X3	10									
GR	1052.0	1290.0	1052.0	1560.0	1050.0	1590.0	1030.0	1630.0	1030.0	2080.0
GR	1024.0	2100.0	1024.0	2125.0	1024.0	2150.0	1026.0	2155.0	1026.0	2240.0
GR	1030.0	2275.0	1032.0	2370.0	1032.0	2575.0	1050.0	2620.0	1050.0	3080.0
X1	6.0	16	1665	2565	400	400	400	0	0	0
X3	10									
GR	1053.0	1455.0	1052.0	1575.0	1050.0	1665.0	1030.0	1690.0	1030.0	2120.0
GR	1024.0	2135.0	1024.0	2155.0	1026.0	2170.0	1028.0	2270.0	1030.0	2280.0
GR	1032.0	2310.0	1036.0	2465.0	1040.0	2520.0	1050.0	2565.0	1052.0	2575.0
GR	1052.0	3045.0								
X1	7.0	21	1715	2510	430	380	400	0	0	0
X3	10									
GR	1052.0	1620.0	1052.0	1665.0	1050.0	1715.0	1046.0	1730.0	1044.0	1780.0
GR	1040.0	1850.0	1032.0	1910.0	1030.0	1930.0	1028.0	2060.0	1026.0	2090.0
GR	1026.0	2130.0	1026.0	2190.0	1028.0	2280.0	1030.0	2360.0	1034.0	2400.0
GR	1040.0	2430.0	1050.0	2470.0	1054.0	2510.0	1054.0	2680.0	1058.0	2840.0
GR	1058.0	3000.0								
X1	8.0	16	1760	2455	410	380	400	0	0	0
X3	10									
GR	1050.0	1760.0	1048.0	1880.0	1046.0	1920.0	1040.0	1930.0	1030.0	1950.0
GR	1028.0	2000.0	1026.0	2010.0	1026.0	2060.0	1028.0	2310.0	1028.0	2420.0
GR	1030.0	2425.0	1050.0	2445.0	1054.0	2455.0	1056.0	2575.0	1058.0	2665.0
GR	1058.0	2950.0								
X1	9.0	18	1965	2555	290	290	290	0	0	0
GR	1050.0	1820.0	1050.0	1870.0	1048.0	1930.0	1046.0	1965.0	1040.0	1975.0
GR	1030.0	1995.0	1028.0	2010.0	1026.0	2060.0	1026.0	2200.0	1027.5	2260.0
GR	1028.0	2320.0	1030.0	2340.0	1032.0	2450.0	1036.0	2500.0	1040.0	2520.0
GR	1054.0	2555.0	1056.0	2660.0	1056.0	2890.0				
NC	0.050	0.045	0.040	0.3	0.5					
X1	9.1	18	1845	2840	100	145	115	0	0	0
X3	10									
GR	1060.0	1845.0	1050.0	1865.0	1048.0	1915.0	1046.0	1960.0	1040.0	1975.0
GR	1030.0	1990.0	1028.0	2010.0	1026.0	2050.0	1026.0	2170.0	1028.0	2225.0
GR	1030.0	2355.0	1032.0	2420.0	1038.0	2550.0	1040.0	2580.0	1050.0	2620.0
GR	1052.0	2640.0	1054.0	2730.0	1060.0	2840.0				

SS	1.05	1.56	2.60	0	600	60	14650	2	1028.0	1028.0
X1	9.2	16	1845	2855	80	80	80	0	0	0
X2			1	1059.2	1062.3					
X3	10									
BT	-10	1845.0	1062.3	1055.3	1965.0	1065.6	1058.6	2090.0	1068.0	1061.0
BT		2215.0	1069.5	1062.5	2340.0	1070.0	1063.0	2465.0	1069.5	1062.5
BT		2590.0	1068.1	1061.1	2715.0	1065.7	1058.4	2840.0	1062.4	1055.4
BT		2855.0	1060.0	1060.0						
GR	1060.0	1845.0	1052.0	1885.0	1050.0	1950.0	1040.0	1995.0	1030.0	2015.0
GR	1028.0	2055.0	1026.0	2120.0	1026.0	2175.0	1028.0	2305.0	1030.0	2370.0
GR	1036.0	2500.0	1040.0	2600.0	1050.0	2710.0	1052.0	2720.0	1054.0	2830.0
GR	1060.0	2855.0								
X1	9.3	17	1980	2700	100	100	100	0	0	0
GR	1052.2	1740.0	1052.0	1920.0	1050.0	1980.0	1030.0	2020.0	1028.0	2040.0
GR	1026.0	2080.0	1026.0	2270.0	1028.0	2340.0	1034.0	2410.0	1038.0	2495.0
GR	1038.0	2625.0	1040.0	2640.0	1044.0	2680.0	1048.0	2700.0	1048.0	2820.0
GR	1050.0	2850.0	1050.0	2940.0						
NC	0.050	0.040	0.040	0.1	0.3					
X1	10.0	18	1690	2250	340	240	310	0	0	0
GR	1053.0	1070.0	1053.0	1590.0	1052.0	1690.0	1050.0	1700.0	1040.0	1715.0
GR	1030.0	1745.0	1028.0	1780.0	1028.0	1860.0	1026.0	1980.0	1026.0	2135.0
GR	1036.0	2185.0	1038.0	2210.0	1040.0	2235.0	1042.0	2250.0	1042.0	2265.0
GR	1042.0	2605.0	1042.0	2750.0	1042.0	2830.0				
X1	11.0	20	1880	2515	530	320	400	0	0	0
GR	1057.0	1000.0	1056.0	1305.0	1054.0	1610.0	1052.0	1880.0	1030.0	1975.0
GR	1028.0	2020.0	1028.0	2270.0	1026.0	2330.0	1026.0	2440.0	1030.0	2465.0
GR	1040.0	2490.0	1042.0	2515.0	1042.0	2530.0	1042.0	2590.0	1042.0	2640.0
GR	1042.0	2970.0	1044.0	2985.0	1050.0	3010.0	1050.0	3250.0	1050.0	3365.0
NC	0.045	0.040	0.040	0.1	0.3					
X1	12.0	25	2320	2705	520	300	390	0	0	0
GR	1057.0	1475.0	1056.0	1550.0	1054.0	1650.0	1050.0	1690.0	1050.0	1790.0
GR	1040.0	1880.0	1036.0	1910.0	1036.0	2250.0	1034.0	2270.0	1032.0	2320.0
GR	1030.0	2340.0	1026.0	2420.0	1026.0	2570.0	1026.0	2670.0	1030.0	2680.0
GR	1042.0	2705.0	1042.0	2720.0	1040.0	2735.0	1040.0	2755.0	1042.0	2770.0
GR	1044.0	2880.0	1044.0	3050.0	1050.0	3100.0	1052.0	3510.0	1052.0	3630.0
NC	0.040	0.040	0.040	0.3	0.5					
X1	13.0	20	2410	2920	460	350	400	0	0	0
GR	1054.0	1815.0	1052.0	2030.0	1050.0	2130.0	1048.0	2195.0	1044.0	2310.0
GR	1040.0	2410.0	1036.0	2430.0	1030.0	2460.0	1026.0	2475.0	1026.0	2620.0
GR	1027.0	2755.0	1028.0	2855.0	1030.0	2870.0	1040.0	2895.0	1044.0	2920.0
GR	1048.0	3000.0	1050.0	3045.0	1050.0	3230.0	1052.0	3440.0	1053.0	3680.0
NC	0.040	0.040	0.040	0.1	0.3					
X1	14.0	22	2390	2890	400	340	400	0	0	0
GR	1054.0	1880.0	1052.0	2100.0	1050.0	2210.0	1048.0	2270.0	1042.0	2330.0
GR	1040.0	2370.0	1040.0	2390.0	1034.0	2410.0	1032.0	2430.0	1028.0	2455.0
GR	1026.0	2600.0	1026.0	2630.0	1026.5	2780.0	1028.0	2810.0	1040.0	2880.0
GR	1048.0	2890.0	1046.0	2900.0	1046.0	3090.0	1048.0	3100.0	1050.0	3220.0

GR	1050.0	3530.0	1050.0	3550.0						
XI	15.0	20	2425	2910	400	380	400	0	0	0
GR	1056.0	2000.0	1054.0	2070.0	1052.0	2200.0	1050.0	2325.0	1044.0	2405.0
GR	1040.0	2425.0	1030.0	2465.0	1028.0	2470.0	1028.0	2560.0	1026.0	2625.0
GR	1027.0	2740.0	1026.0	2835.0	1028.0	2860.0	1040.0	2895.0	1048.0	2910.0
GR	1046.0	2940.0	1046.0	3030.0	1048.0	3200.0	1050.0	3310.0	1050.0	3400.0
NC	0.045	0.040	0.040	0.1	0.3					
XI	16.0	23	2325	2845	400	380	400	0	0	0
GR	1060.0	2000.0	1056.0	2090.0	1054.0	2165.0	1052.0	2300.0	1040.0	2325.0
GR	1036.0	2345.0	1030.0	2380.0	1028.0	2390.0	1028.0	2495.0	1030.0	2505.0
GR	1030.0	2640.0	1028.0	2675.0	1027.0	2735.0	1028.0	2770.0	1030.0	2775.0
GR	1034.0	2785.0	1040.0	2845.0	1042.0	2925.0	1042.0	2970.0	1046.0	3000.0
GR	1048.0	3100.0	1050.0	3180.0	1052.0	3220.0				
NC	0.045	0.045	0.040	0.1	0.3					
XI	17.0	15	2300	3025	400	375	400	0	0	0
GR	1054.0	2110.0	1054.0	2300.0	1050.0	2325.0	1034.0	2350.0	1032.0	2370.0
GR	1032.0	2560.0	1030.0	2660.0	1032.0	2740.0	1032.0	2800.0	1034.0	2860.0
GR	1036.0	2920.0	1038.0	2950.0	1040.0	3000.0	1052.0	3025.0	1052.0	3050.0
XI	18.0	12	2310	2970	400	400	400	0	0	0
GR	1062.0	2190.0	1062.0	2275.0	1060.0	2310.0	1040.0	2345.0	1032.0	2370.0
GR	1030.5	2600.0	1032.0	2660.0	1032.0	2920.0	1040.0	2930.0	1050.0	2950.0
GR	1056.0	2970.0	1056.0	3180.0						
XI	19.0	11	2350	2990	400	400	400	0	0	0
GR	1062.0	2295.0	1062.0	2350.0	1050.0	2375.0	1034.0	2405.0	1032.5	2550.0
GR	1032.0	2610.0	1034.0	2935.0	1040.0	2955.0	1050.0	2970.0	1059.0	2990.0
GR	1059.0	3090.0								
XI	20.0	10	2415	3040	400	400	400	0	0	0
GR	1064.0	2000.0	1064.0	2415.0	1060.0	2430.0	1040.0	2460.0	1036.0	2480.0
GR	1034.0	2575.0	1036.0	2995.0	1040.0	3005.0	1060.0	3030.0	1068.0	3040.0
XI	20.5	13	2150	2860	185	185	185	0	0	0
GR	1064.0	1780.0	1064.0	2150.0	1060.0	2160.0	1040.0	2190.0	1036.0	2205.0
GR	1034.0	2290.0	1034.0	2680.0	1036.0	2780.0	1042.0	2800.0	1050.0	2830.0
GR	1062.0	2860.0	1064.0	2920.0	1064.0	3050.0				
XI	21.0	21	2350	3080	215	215	215	0	0	0
GR	1065.0	2050.0	1065.0	2350.0	1060.0	2360.0	1050.0	2380.0	1036.0	2415.0
GR	1034.0	2455.0	1036.0	2500.0	1036.0	2525.0	1036.0	2620.0	1034.0	2660.0
GR	1034.0	2760.0	1036.0	2790.0	1036.0	2860.0	1038.0	2900.0	1040.0	2975.0
GR	1040.0	3020.0	1050.0	3070.0	1060.0	3080.0	1060.0	3150.0	1070.0	3200.0
GR	1076.0	3230.0								
NC	0.045	0.045	0.040	0.2	0.4					
XI	22.0	13	2320	2880	400	400	400	0	0	0
GR	1065.0	2125.0	1065.0	2320.0	1060.0	2330.0	1050.0	2350.0	1036.0	2380.0
GR	1036.0	2585.0	1035.0	2670.0	1036.0	2800.0	1038.0	2850.0	1060.0	2880.0
GR	1060.0	3050.0	1070.0	3090.0	1074.0	3110.0				

NC	0.045	0.045	0.040	0.1	0.3					
X1	23.0	13	2190	2795	400	400	400	0	0	0
GR	1064.0	2190.0	1060.0	2205.0	1050.0	2245.0	1040.0	2290.0	1038.0	2355.0
GR	1036.0	2425.0	1036.0	2720.0	1038.0	2750.0	1040.0	2765.0	1060.0	2795.0
GR	1060.0	2970.0	1070.0	3025.0	1076.0	3080.0				
X1	24.0	11	2195	2850	480	480	480	0	0	0
GR	1070.0	2050.0	1070.0	2195.0	1060.0	2210.0	1050.0	2230.0	1040.0	2260.0
GR	1038.0	2275.0	1038.0	2730.0	1040.0	2790.0	1050.0	2810.0	1060.0	2835.0
GR	1070.0	2850.0								
X1	25.0	16	2185	2860	450	450	450	0	0	0
GR	1070.0	2045.0	1066.0	2055.0	1064.0	2185.0	1044.0	2230.0	1040.0	2255.0
GR	1038.0	2355.0	1042.0	2370.0	1042.0	2575.0	1040.0	2585.0	1038.0	2595.0
GR	1038.0	2685.0	1040.0	2780.0	1050.0	2810.0	1060.0	2840.0	1068.0	2860.0
GR	1068.0	3080.0								
X1	26.0	16	2230	2910	400	400	400	0	0	0
GR	1070.0	2190.0	1068.0	2230.0	1060.0	2245.0	1050.0	2275.0	1042.0	2320.0
GR	1042.0	2600.0	1040.0	2610.0	1040.0	2650.0	1042.0	2655.0	1042.0	2780.0
GR	1038.0	2805.0	1038.0	2830.0	1040.0	2840.0	1050.0	2870.0	1060.0	2895.0
GR	1070.0	2910.0								
X1	27.0	16	2140	2960	400	400	400	0	0	0
GR	1070.0	2140.0	1060.0	2170.0	1050.0	2200.0	1046.0	2220.0	1046.0	2400.0
GR	1044.0	2560.0	1042.0	2630.0	1042.0	2660.0	1040.0	2760.0	1038.0	2840.0
GR	1038.0	2870.0	1040.0	2875.0	1050.0	2925.0	1060.0	2940.0	1066.0	2960.0
GR	1068.0	3000.0								

SECNO	DEPTH	CWSEL	CRIWS	WSELE	EG	HV	HL	QLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1

IHLEQ = 1. THEREFORE FRICTION LOSS (HL) IS CALCULATED AS A FUNCTION OF PROFILE TYPE, WHICH CAN VARY FROM REACH TO REACH. SEE DOCUMENTATION FOR DETAILS.

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300
*SECNO 1.000
3280 CROSS SECTION 1.00 EXTENDED 12.27 FEET

3470 ENCROACHMENT STATIONS= .0 3110.0 TYPE= 1 TARGET= 3109.999

1.000	24.27	1044.27	1037.99	1044.27	1045.79	1.52	.00	.00	1048.00
195000.	0.	160486.	34514.	0.	15455.	4884.	0.	0.	1040.00
.00	.00	10.38	7.07	.000	.040	.045	.000	1020.00	1724.66
.001853	0.	0.	0.	0	19	0	.00	1385.34	3110.00

*SECNO 2.000
3280 CROSS SECTION 2.00 EXTENDED 12.98 FEET

3470 ENCROACHMENT STATIONS= .0 2915.0 TYPE= 1 TARGET= 2914.999

2.000	24.98	1044.98	1038.38	.00	1046.54	1.56	.74	.01	1040.00
195000.	31.	158923.	36046.	15.	15117.	4857.	185.	12.	1040.00
.01	1.99	10.51	7.42	.050	.040	.045	.000	1020.00	1618.78
.001839	400.	400.	400.	2	19	0	.00	1296.22	2915.00

*SECNO 3.000
3280 CROSS SECTION 3.00 EXTENDED 13.76 FEET

3470 ENCROACHMENT STATIONS= .0 2710.0 TYPE= 1 TARGET= 2709.999

3.000	25.76	1045.76	1037.71	.00	1047.21	1.45	.66	.01	1050.00
195000.	0.	179921.	15079.	0.	18219.	2271.	371.	24.	1042.00
.02	.00	9.88	6.64	.000	.040	.045	.000	1020.00	1515.30
.001514	400.	400.	400.	2	19	0	.00	1194.70	2710.00

SECNO	DEPTH	QWSEL	QRIWS	WSELE	EG	HV	HL	QLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 4.000
3280 CROSS SECTION 4.00 EXTENDED 6.38 FEET

4.000	24.38	1046.38	1037.34	.00	1047.78	1.40	.56	.01	1050.00
195000.	0.	195000.	0.	0.	20563.	0.	559.	34.	1040.00
.03	.00	9.48	.00	.000	.040	.000	.000	1022.00	1585.16
.001321	400.	400.	400.	2	14	0	.00	1094.84	2680.00

*SECNO 5.000

3301 HV CHANGED MORE THAN HVINS

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA= 1050.00 ELREA= 1050.00

5.000	22.61	1046.61	1040.52	.00	1048.77	2.16	.76	.23	1050.00
195000.	0.	195000.	0.	0.	16526.	0.	730.	44.	1050.00
.04	.00	11.80	.00	.000	.040	.000	.000	1024.00	1596.79
.002470	400.	400.	400.	2	19	0	.00	1014.73	2611.52

*SECNO 6.000

3301 HV CHANGED MORE THAN HVINS

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA= 1050.00 ELREA= 1050.00

6.000	23.21	1047.21	1042.50	.00	1050.20	2.99	1.18	.25	1050.00
195000.	0.	195000.	0.	0.	14045.	0.	870.	53.	1050.00
.05	.00	13.88	.00	.000	.040	.000	.000	1024.00	1668.49
.003542	400.	400.	400.	2	15	0	.00	883.95	2552.44

*SECNO 7.000

3301 HV CHANGED MORE THAN HVINS

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA= 1050.00 ELREA= 1054.00

7.000	21.94	1047.94	1045.13	.00	1052.48	4.54	1.82	.46	1050.00
195000.	0.	195000.	0.	0.	11404.	0.	987.	60.	1054.00
.06	.00	17.10	.00	.000	.040	.000	.000	1026.00	1722.71
.005544	430.	400.	380.	2	15	0	.00	739.06	2461.77

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SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        QLOSS     BANK ELEV
Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA     LEFT/RIGHT
TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTH       ELMIN       SSTA
SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST


*SECNO 8.000
3280 CROSS SECTION      8.00 EXTENDED       .24 FEET


3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA=      1050.00 ELREA=      1054.00

    8.000    24.24  1050.24  1044.56      .00  1054.53     4.29     2.03      .02  1050.00
  195000.       0.  195000.       0.       0.   11728.       0.    1093.      67.   1054.00
      .07      .00    16.63      .00     .000     .040     .000     .000  1026.00  1760.00
  .004662     410.     400.     380.        3       12        0      .00   685.59  2445.59


*SECNO 9.000
3280 CROSS SECTION      9.00 EXTENDED      2.12 FEET


3301 HV CHANGED MORE THAN HVINS

    9.000    26.12  1052.12  1044.94      .00  1055.61     3.49     1.00      .08  1046.00
  195000.     1707.  195293.       0.     472.   12835.       0.    1177.      71.   1054.00
      .07     3.61    15.06      .00     .050     .040     .000     .000  1026.00  1820.00
  .002721     290.     290.     290.        2       15        0      .00   730.30  2550.30


CCHV=     .300 CEHV=     .500
*SECNO 9.100

3301 HV CHANGED MORE THAN HVINS


3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA=      1060.00 ELREA=      1060.00

    9.100    27.71  1053.71  1045.10      .00  1056.21     2.50      .30      .30  1060.00
  195000.       0.  195000.       0.       0.   15383.       0.    1214.      73.   1060.00
      .07      .00    12.68      .00     .000     .040     .000     .000  1026.00  1857.57
  .002514     100.     115.     145.        3       15        0      .00   859.53  2717.10
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SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	QLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

SPECIAL BRIDGE

SB	XK	XKOR	COFQ	RDLEN	BWC	BWP	BAREA	SS	ELCHU	ELCHD
	1.05	1.56	2.60	.00	600.00	60.00	14650.00	2.00	1028.00	1028.00

*SECNO 9.200
CLASS A LOW FLOW

3420 BRIDGE W.S.= 1053.10 BRIDGE VELOCITY= 13.16 CALCULATED CHANNEL AREA= 14815.

EGPRS	EGLWC	H3	QWEIR	QLOW	BAREA	TRAPEZOID AREA	ELLC	ELTRD	WEIRLN
.00	1056.64	.69	0.	195000.	14650.	18795.	1059.20	1062.30	0.

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA= 1060.00 ELREA= 1060.00

9.200	28.41	1054.41	.00	.00	1056.64	2.23	.43	.00	1060.00
195000.	0.	195000.	0.	0.	16270.	0.	1243.	75.	1060.00
.07	.00	11.99	.00	.000	.040	.000	.000	1026.00	1872.96
.002402	80.	80.	80.	0	0	0	.00	958.74	2831.70

*SECNO 9.300
3280 CROSS SECTION 9.30 EXTENDED 4.86 FEET

9.300	28.86	1054.86	1045.53	.00	1056.89	2.03	.19	.06	1050.00
195000.	1819.	186933.	6248.	729.	16056.	1437.	1283.	78.	1048.00
.08	2.50	11.64	4.35	.050	.040	.045	.000	1026.00	1740.00
.001582	100.	100.	100.	2	20	0	.00	1200.00	2940.00

CCHV= .100 CEHV= .300
*SECNO 10.000
3280 CROSS SECTION 10.00 EXTENDED 14.14 FEET

3301 HV CHANGED MORE THAN HVINS

10.000	30.13	1056.13	1046.28	.00	1057.31	1.18	.34	.09	1052.00
195000.	3796.	139530.	51674.	1994.	14611.	8199.	1429.	88.	1042.00
.09	1.90	9.55	6.30	.050	.040	.040	.000	1026.00	1070.00
.000866	340.	310.	240.	2	19	0	.00	1760.00	2830.00

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SECNO    DEPTH    QWSEL    QRIWS    WSELK    EG       HV       HL       ALOSS    BANK ELEV
Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA    LEFT/RIGHT
TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTH      ELMIN      SSTA
SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    COBAR    TOPWID     ENDST


*SECNO 11.000
3280 CROSS SECTION     11.00 EXTENDED      6.68 FEET

  11.000    30.68  1056.68  1045.34      .00  1057.63      .94      .29      .02  1052.00
 195000.     2438.  143273.   49289.    1578.   16713.    9499.    1660.     107.  1042.00
     .10     1.55     8.57     5.19     .050     .040     .040     .000  1026.00  1097.10
 .000687     530.     400.     320.        2       17        0      .00  2267.90  3365.00


CCHV=     .100 CEHV=     .300
*SECNO 12.000
3280 CROSS SECTION     12.00 EXTENDED      5.16 FEET

  12.000    31.16  1057.16  1045.28      .00  1057.89      .73      .24      .02  1032.00
 195000.   63707.   95523.   35770.   11702.   11466.    8502.    1927.     127.  1042.00
     .12     5.44     8.33     4.21     .045     .040     .040     .000  1026.00  1475.00
 .000552     520.     390.     300.        2       14        0      .00  2155.00  3630.00


CCHV=     .300 CEHV=     .500
*SECNO 13.000
3280 CROSS SECTION     13.00 EXTENDED      4.13 FEET


3301 HV CHANGED MORE THAN HVINS

  13.000    31.13  1057.13  1045.79      .00  1058.49     1.36      .29      .31  1040.00
 195000.   24640.  150089.   20270.    4823.   14510.    4975.    2188.     146.  1044.00
     .13     5.11    10.34     4.07     .040     .040     .040     .000  1026.00  1815.00
 .000902     460.     400.     350.        2       14        0      .00  1865.00  3680.00


CCHV=     .100 CEHV=     .300
*SECNO 14.000
3280 CROSS SECTION     14.00 EXTENDED      7.53 FEET

  14.000    31.53  1057.53  1046.17      .00  1058.84     1.31      .35      .00  1040.00
 195000.   19819.  146740.   28441.    3989.   14344.    5908.    2403.     161.  1048.00
     .14     4.97    10.23     4.81     .040     .040     .040     .000  1026.00  1880.00
 .000875     400.     400.     340.        2       14        0      .00  1670.00  3550.00
```

SECNO	DEPTH	QWSEL	QRIWS	WSELK	EG	HV	HL	QLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTH	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

```
*SECNO 15.000
3280 CROSS SECTION     15.00 EXTENDED      7.70 FEET

   15.000    31.70  1057.70  1045.93      .00  1059.30     1.59      .37      .08  1040.00
  195000.    13140.  155425.   26435.    2809.   14076.    4845.    2612.     175.   1048.00
      .15     4.68    11.04     5.46     .040     .040     .040     .000  1026.00  2000.00
 .001006     400.     400.     380.        2       14        0      .00  1400.00  3400.00


CCHV=     .100 CEHV=     .300
*SECNO 16.000
3280 CROSS SECTION     16.00 EXTENDED      6.07 FEET

   16.000    31.06  1058.06  1047.08      .00  1059.73     1.67      .41      .02  1040.00
  195000.     4354.  159445.   31201.    1264.   14397.    4625.    2803.     187.   1040.00
      .16     3.45    11.07     6.75     .045     .040     .040     .000  1027.00  2043.50
 .001068     400.     400.     380.        1       14        0      .00  1176.50  3220.00


CCHV=     .100 CEHV=     .300
*SECNO 17.000
3280 CROSS SECTION     17.00 EXTENDED      6.41 FEET

   17.000    28.41  1058.41  1046.89      .00  1060.25     1.85      .47      .05  1054.00
  195000.     2612.  191828.     559.     837.   17464.     160.    2979.     196.   1052.00
      .17     3.12    10.98     3.49     .045     .040     .045     .000  1030.00  2110.00
 .001275     400.     400.     375.        2       11        0      .00   940.00  3050.00


*SECNO 18.000
3280 CROSS SECTION     18.00 EXTENDED      2.73 FEET

   18.000    28.23  1058.73  1047.04      .00  1060.88     2.15      .54      .09  1060.00
  195000.        0.  193617.    1383.       0.   16413.     574.    3142.     205.   1056.00
      .18      .00    11.80     2.41     .000     .040     .045     .000  1030.50  2312.22
 .001417     400.     400.     400.        2       11        0      .00   867.78  3180.00


*SECNO 19.000
3280 CROSS SECTION     19.00 EXTENDED       .08 FEET

   19.000    27.08  1059.08  1048.71      .00  1061.64     2.56      .64      .13  1062.00
  195000.        0.  194998.       2.       0.   15174.       8.    3290.     212.   1059.00
      .19      .00    12.85      .26     .000     .040     .045     .000  1032.00  2356.08
 .001778     400.     400.     400.        2       14        0      .00   733.92  3090.00
```

SECNO	DEPTH	CWSEL	CRIWS	WSELB	EG	HV	HL	GLOSS	BANK ELEV
Q	WLOB	WCH	WROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 20.000

3301 HV CHANGED MORE THAN HVINS

20.000	25.51	1059.51	1050.92	.00	1062.62	3.10	.81	.16	1064.00
195000.	0.	195000.	0.	0.	13793.	0.	3423.	218.	1068.00
.20	.00	14.14	.00	.000	.040	.000	.000	1034.00	2430.73
.002277	400.	400.	400.	2	14	0	.00	598.66	3029.39

*SECNO 20.500

3301 HV CHANGED MORE THAN HVINS

20.500	27.01	1061.01	1049.26	.00	1063.04	2.03	.32	.11	1064.00
195000.	0.	195000.	0.	0.	17073.	0.	3488.	221.	1062.00
.20	.00	11.42	.00	.000	.040	.000	.000	1034.00	2157.44
.001364	185.	185.	185.	2	14	0	.00	700.11	2857.56

*SECNO 21.000

21.000	27.29	1061.29	1050.61	.00	1063.36	2.07	.31	.01	1065.00
195000.	0.	194861.	139.	0.	16853.	94.	3572.	224.	1060.00
.21	.00	11.56	1.48	.000	.040	.045	.000	1034.00	2357.43
.001482	215.	215.	215.	2	14	0	.00	799.00	3156.43

CCHV= .200 CEHV= .400
*SECNO 22.000

3301 HV CHANGED MORE THAN HVINS

22.000	26.23	1061.23	1052.99	.00	1064.73	3.50	.80	.57	1065.00
195000.	0.	194598.	402.	0.	12957.	213.	3710.	231.	1060.00
.22	.00	15.02	1.89	.000	.040	.045	.000	1035.00	2327.53
.002511	400.	400.	400.	2	14	0	.00	727.40	3054.93

CCHV= .100 CEHV= .300
*SECNO 23.000

23.000	26.70	1062.70	1053.76	.00	1065.71	3.01	.94	.05	1064.00
195000.	0.	193538.	1462.	0.	13845.	494.	3837.	238.	1060.00
.23	.00	15.98	2.96	.000	.040	.045	.000	1036.00	2194.85
.002199	400.	400.	400.	2	14	0	.00	790.03	2984.88

SECNO	DEPTH	CWSEL	CRIWS	WSELR	EG	HV	HI	WLMST	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

```
*SECNO 24.000
   24.000    26.14  1064.14  1053.96      .00  1066.70     2.56      .95      .04  1070.00
  195000.       0.  195000.       0.       0.   15174.       0.    3999.     246.   1070.00
      .24      .00    12.85      .00     .000     .040     .000     .000  1038.00  2203.79
 .001787     480.     480.     480.        2       14        0      .00   637.42  2841.21


*SECNO 25.000
   25.000    26.95  1064.95  1055.57      .00  1067.55     2.60      .84      .01  1064.00
  195000.      26.  194974.       0.      29.   15059.       0.    4156.     253.   1068.00
      .25      .89    12.95      .00     .045     .040     .000     .000  1038.00  2123.12
 .001942     450.     450.     450.        2       14        0      .00   729.26  2852.38


*SECNO 26.000
   26.000    27.68  1065.68  1056.93      .00  1068.40     2.72      .81      .04  1068.00
  195000.       0.  195000.       0.       0.   14735.       0.    4293.     260.   1070.00
      .25      .00    13.23      .00     .000     .040     .000     .000  1038.00  2234.36
 .002097     400.     400.     400.        2       19        0      .00   669.16  2903.52


*SECNO 27.000

3301 HV CHANGED MORE THAN HVINS

   27.000    29.34  1067.34  1056.51      .00  1069.15     1.82      .66      .09  1070.00
  195000.       0.  194983.      17.       0.   18030.      18.    4443.     267.   1066.00
      .26      .00    10.81      .94     .000     .040     .045     .000  1038.00  2147.98
 .001377     400.     400.     400.        2       19        0      .00   838.83  2986.81
```

THIS RUN EXECUTED 4/26/91 9:19:28

****
HEC2 RELEASE DATED SEP 88 UPDATED SEPT 1989

ERROR CORR - 01,02,03
MODIFICATION -
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

EXIST.DAT

SUMMARY PRINTOUT

SECNO	CWSEL	VLOB	VCH	VROB	QLOB	QCH	QROB	DEPTH	TOPWID	SSTA	ENDST
1.000	1044.27	.00	10.38	7.07	.00	160485.90	34514.10	24.27	1385.34	1724.66	3110.00
2.000	1044.98	1.99	10.51	7.42	30.77	158923.50	36045.79	24.98	1296.22	1618.78	2915.00
3.000	1045.76	.00	9.88	6.64	.00	179920.60	15079.40	25.76	1194.70	1515.30	2710.00
4.000	1046.38	.00	9.48	.00	.00	195000.00	.00	24.38	1094.84	1585.16	2680.00
5.000	1046.61	.00	11.80	.00	.00	195000.00	.00	22.61	1014.73	1596.79	2611.52
6.000	1047.21	.00	13.88	.00	.00	195000.00	.00	23.21	883.95	1668.49	2552.44
7.000	1047.94	.00	17.10	.00	.00	195000.00	.00	21.94	739.06	1722.71	2461.77
8.000	1050.24	.00	16.63	.00	.00	195000.00	.00	24.24	685.59	1760.00	2445.59
9.000	1052.12	3.61	15.06	.00	1706.93	193293.10	.00	26.12	730.30	1820.00	2550.30
9.100	1053.71	.00	12.68	.00	.00	195000.00	.00	27.71	859.53	1857.57	2717.10
9.200	1054.41	.00	11.99	.00	.00	195000.00	.00	28.41	958.74	1872.96	2831.70
9.300	1054.86	2.50	11.64	4.35	1819.49	186932.70	6247.82	28.86	1200.00	1740.00	2940.00
10.000	1056.13	1.90	9.55	6.30	3796.15	139530.10	51673.77	30.13	1760.00	1070.00	2830.00
11.000	1056.68	1.55	8.57	5.19	2438.30	143272.90	49288.82	30.68	2267.90	1097.10	3365.00
12.000	1057.16	5.44	8.33	4.21	63707.13	95523.10	35769.77	31.16	2155.00	1475.00	3630.00
13.000	1057.13	5.11	10.34	4.07	24640.46	150089.10	20270.46	31.13	1865.00	1815.00	3680.00
14.000	1057.53	4.97	10.23	4.81	19819.09	146740.30	28440.59	31.53	1670.00	1880.00	3550.00

SECNO	CWSEL	VLOB	VCH	VROB	QLOB	QCH	QROB	DEPTH	TOPWID	SSIA	ENDST
15.000	1057.70	4.68	11.04	5.46	13140.08	155424.70	26435.25	31.70	1400.00	2000.00	3400.00
16.000	1058.06	3.45	11.07	6.75	4353.69	159444.90	31201.44	31.06	1176.50	2043.50	3220.00
17.000	1058.41	3.12	10.98	3.49	2612.43	191828.10	559.43	28.41	940.00	2110.00	3050.00
18.000	1058.73	.00	11.80	2.41	.00	193617.10	1382.89	28.23	867.78	2312.22	3180.00
19.000	1059.08	.00	12.85	.26	.00	194998.00	2.05	27.08	733.92	2356.08	3090.00
20.000	1059.51	.00	14.14	.00	.00	195000.00	.00	25.51	598.66	2430.73	3029.39
20.500	1061.01	.00	11.42	.00	.00	195000.00	.00	27.01	700.11	2157.44	2857.56
21.000	1061.29	.00	11.56	1.48	.00	194860.80	139.24	27.29	799.00	2357.43	3156.43
22.000	1061.23	.00	15.02	1.89	.00	194597.60	402.39	26.23	727.40	2327.53	3054.93
23.000	1062.70	.00	13.98	2.96	.00	193538.10	1461.87	26.70	790.03	2194.85	2984.88
24.000	1064.14	.00	12.85	.00	.00	195000.00	.00	26.14	637.42	2203.79	2841.21
25.000	1064.95	.89	12.95	.00	26.13	194973.90	.00	26.95	729.26	2123.12	2852.38
26.000	1065.68	.00	13.23	.00	.00	195000.00	.00	27.68	669.16	2234.36	2903.52
27.000	1067.34	.00	10.81	.94	.00	194983.20	16.85	29.34	838.83	2147.98	2986.81

EXIST.DAT

SUMMARY PRINTOUT

SECNO	CWSEL	CRIWS	EG	HL	OLOSS	ELMIN	10*KS	K*CHSL	XLCH	SHEAR	FRCH
1.000	1044.27	1037.99	1045.79	.00	.00	1020.00	18.53	.00	.00	1.93	.45
2.000	1044.98	1038.38	1046.54	.74	.01	1020.00	18.39	.00	400.00	1.96	.45
3.000	1045.76	1037.71	1047.21	.66	.01	1020.00	15.14	.00	400.00	1.70	.41
4.000	1046.38	1037.34	1047.78	.56	.01	1022.00	13.21	5.00	400.00	1.55	.39
5.000	1046.61	1040.52	1048.77	.76	.23	1024.00	24.70	5.00	400.00	2.51	.52
6.000	1047.21	1042.50	1050.20	1.18	.25	1024.00	35.42	.00	400.00	3.51	.61
7.000	1047.94	1045.13	1052.48	1.82	.46	1026.00	55.44	5.00	400.00	5.34	.77
8.000	1050.24	1044.56	1054.53	2.03	.02	1026.00	46.62	.00	400.00	4.98	.71
9.000	1052.12	1044.94	1055.61	1.00	.08	1026.00	27.21	.00	290.00	3.72	.57
9.100	1053.71	1045.10	1056.21	.30	.30	1026.00	25.14	.00	115.00	2.81	.53
9.200	1054.41	.00	1056.64	.43	.00	1026.00	24.02	.00	80.00	2.54	.51
9.300	1054.86	1045.53	1056.89	.19	.06	1026.00	15.82	.00	100.00	2.20	.43
10.000	1056.13	1046.28	1057.31	.34	.09	1026.00	8.66	.00	310.00	1.41	.33
11.000	1056.68	1045.34	1057.63	.29	.02	1026.00	6.87	.00	400.00	1.13	.29
12.000	1057.16	1045.28	1057.89	.24	.02	1026.00	5.52	.00	390.00	1.03	.27
13.000	1057.13	1045.79	1058.49	.29	.31	1026.00	9.02	.00	400.00	1.60	.34
14.000	1057.53	1046.17	1058.84	.35	.00	1026.00	8.75	.00	400.00	1.57	.34
15.000	1057.70	1045.93	1059.30	.37	.08	1026.00	10.06	.00	400.00	1.82	.36
16.000	1058.06	1047.08	1059.73	.41	.02	1027.00	10.68	2.50	400.00	1.85	.37
17.000	1058.41	1046.89	1060.25	.47	.05	1030.00	12.75	7.50	400.00	1.92	.39
18.000	1058.73	1047.04	1060.88	.54	.09	1030.50	14.17	1.25	400.00	2.21	.42
19.000	1059.08	1048.71	1061.64	.64	.13	1032.00	17.78	3.75	400.00	2.66	.46
20.000	1059.51	1050.92	1062.62	.81	.16	1034.00	22.77	5.00	400.00	3.27	.52
20.500	1061.01	1049.26	1063.04	.32	.11	1034.00	13.64	.00	185.00	2.08	.41

SECNO	CWSEL	CRTWS	FS	HI	CLOSS	ELMIN	TOTLS	MXCHSL	FLOW	SHEAR	FRCH
21.000	1061.29	1050.61	1063.36	.31	.01	1034.00	14.82	.00	215.00	2.16	.42
22.000	1061.23	1052.99	1064.73	.80	.57	1035.00	25.11	2.50	400.00	3.67	.55
23.000	1062.70	1053.76	1065.71	.94	.05	1036.00	21.99	2.50	400.00	3.16	.51
24.000	1064.14	1053.96	1066.70	.95	.04	1038.00	17.87	4.17	480.00	2.65	.46
25.000	1064.95	1055.57	1067.55	.84	.01	1038.00	19.42	.00	450.00	2.73	.48
26.000	1065.68	1056.93	1068.40	.81	.04	1038.00	20.37	.00	400.00	2.88	.50
27.000	1067.34	1056.51	1069.15	.66	.09	1038.00	13.77	.00	400.00	1.91	.40

THIS RUN EXECUTED 4/26/91 9:48:24

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*************************************************
 HEC2 RELEASE DATED SEP 88 UPDATED SEPT 1989


 ERROR CORR -  01,02,03
 MODIFICATION -
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T1      SIMONS, LI & ASSOCIATES, INC.
T2      19TH AVENUE ENVIRONMENTAL CLEANUP (PAZ-CPH-02)
T3      DGN-PHX.DAT            ALTERNATIVE A ANALYSIS

J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    Q        WSEL     FQ

    -10        2        0        0     0.000       0        0        0   1044.27      0

J2  NPROF    IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW      CHNIM    ITRACE

    -1         0       -1        0        0        0       -1        0        0        0


J3  VARIABLE CODES FOR SUMMARY PRINTOUT

     38        1       55       26       56       13       14       15        8        1
     53       54        0       38        1        2        3       11       12       42
      5       33       39       67       68

J6  IHLEQ    ICOPY    SUBDIV   STRTDS   RMILE

     1
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SECNO	DEPTH	CWSEL	CRIWS	WSELR	EG	HV	HL	GLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1

THLEQ = 1. THEREFORE FRICTION LOSS (HL) IS CALCULATED AS A FUNCTION OF PROFILE TYPE, WHICH CAN VARY FROM REACH TO REACH. SEE DOCUMENTATION FOR DETAILS.

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300
*SECNO 1.000
3280 CROSS SECTION 1.00 EXTENDED 12.27 FEET

3470 ENCROACHMENT STATIONS= .0 3110.0 TYPE= 1 TARGET= 3109.999

1.000	24.27	1044.27	1037.99	1044.27	1045.79	1.52	.00	.00	1048.00
195000.	0.	160486.	34514.	0.	15455.	4884.	0.	0.	1040.00
.00	.00	10.38	7.07	.000	.040	.045	.000	1020.00	1724.66
.001853	0.	0.	0.	0	19	0	.00	1385.34	3110.00

*SECNO 2.000
3280 CROSS SECTION 2.00 EXTENDED 12.98 FEET

3470 ENCROACHMENT STATIONS= .0 2915.0 TYPE= 1 TARGET= 2914.999

2.000	24.98	1044.98	1038.38	.00	1046.54	1.56	.74	.01	1040.00
195000.	31.	158923.	36046.	15.	15117.	4857.	185.	12.	1040.00
.01	1.99	10.51	7.42	.050	.040	.045	.000	1020.00	1618.78
.001839	400.	400.	400.	2	19	0	.00	1296.22	2915.00

*SECNO 3.000
3280 CROSS SECTION 3.00 EXTENDED 13.76 FEET

3470 ENCROACHMENT STATIONS= .0 2710.0 TYPE= 1 TARGET= 2709.999

3.000	25.76	1045.76	1037.71	.00	1047.21	1.45	.66	.01	1050.00
195000.	0.	179921.	15079.	0.	18219.	2271.	371.	24.	1042.00
.02	.00	9.88	6.64	.000	.040	.045	.000	1020.00	1515.30
.001514	400.	400.	400.	2	19	0	.00	1194.70	2710.00

```
SECNO     DEPTH     CWSEL     CRTWS     WSELR     EG        HV        HL        HLOSS     BANK ELEV
Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA     (LEFT/RIGHT
TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IBC       ICONT     CORAR     TOPWID      ENDST


*SECNO 4.000
3280 CROSS SECTION      4.00 EXTENDED      6.38 FEET

   4.000    24.38  1046.38  1037.34      .00  1047.78     1.40      .56      .01  1050.00
 195000.       0.  195000.       0.       0.   20563.       0.     559.      34.   1040.00
     .03      .00     9.48      .00     .000     .040     .000     .000  1022.00  1585.16
 .001321     400.     400.     400.        2       14        0      .00  1094.84  2680.00


*SECNO 5.000

3301 HV CHANGED MORE THAN HVINS


3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA=      1050.00 ELREA=      1050.00

   5.000    22.61  1046.61  1040.52      .00  1048.77     2.16      .76      .23  1050.00
 195000.       0.  195000.       0.       0.   16526.       0.     730.      44.   1050.00
     .04      .00    11.80      .00     .000     .040     .000     .000  1024.00  1596.79
 .002470     400.     400.     400.        2       19        0      .00  1014.73  2611.52


*SECNO 6.000

3301 HV CHANGED MORE THAN HVINS


3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA=      1050.00 ELREA=      1050.00

   6.000    23.21  1047.21  1042.50      .00  1050.20     2.99     1.18      .25  1050.00
 195000.       0.  195000.       0.       0.   14045.       0.     870.      53.   1050.00
     .05      .00    13.08      .00     .000     .040     .000     .000  1024.00  1668.49
 .003542     400.     400.     400.        2       15        0      .00   883.95  2552.44


*SECNO 7.000

3301 HV CHANGED MORE THAN HVINS


3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA=      1050.00 ELREA=      1054.00

   7.000    21.94  1047.94  1045.13      .00  1052.48     4.54     1.82      .46  1050.00
 195000.       0.  195000.       0.       0.   11404.       0.     987.      60.   1054.00
     .06      .00    17.10      .00     .000     .040     .000     .000  1026.00  1722.71
 .005544     430.     400.     380.        2       15        0      .00   739.06  2461.77
```

```
SECNO    DEPTH    CWSEL    CRIWS    WSELK    FG       HV       HL       GLOSS    BANK ELEV
Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA    LEFT/RIGHT
TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN      SSTA
SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID     ENDST


*SECNO 8.000
3280 CROSS SECTION      8.00 EXTENDED       .24 FEET


3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA=      1050.00 ELREA=      1054.00

   8.000    24.24  1050.24  1044.56      .00  1054.53     4.29     2.03      .02  1050.00
 195000.       0.  195000.       0.       0.  11728.       0.    1093.      67.   1054.00
     .07      .00    16.63      .00     .000     .040     .000     .000  1026.00  1760.00
 .004662     410.     400.     380.        3       12        0      .00   685.59  2445.59


*SECNO 9.000
CHIMP CLSTA=    2260.00 CELCH=    1027.00 BW=     525.00 STCHL=    1948.00 STCHR=    2572.00
EXCAVATION DATA
AEX=   18958.5SQ-FT     VEXR=        .0K*CU-YD     VEXT=        .0K*CU-YD


3301 HV CHANGED MORE THAN HVINS


3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  1.74

   9.000    25.48  1052.48  1042.94      .00  1055.35     2.87      .67      .14  1060.00
 195000.       0.  195000.       0.       0.  14355.       0.    1180.      71.   1060.00
     .07      .00    13.58      .00     .000     .035     .000     .000  1027.00  1959.27
 .001541     290.     290.     290.        2       14        0      .00   601.46  2560.73


*SECNO 9.100
CHIMP CLSTA=    2265.00 CELCH=    1027.15 BW=     525.00 STCHL=    1845.00 STCHR=    2840.00
EXCAVATION DATA
AEX=   18864.9SQ-FT     VEXR=      80.5K*CU-YD     VEXT=      80.5K*CU-YD


3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA=      1060.00 ELREA=      1060.00

   9.100    25.52  1052.67  1043.08      .00  1055.52     2.86      .18      .00  1060.00
 195000.       0.  195000.       0.       0.  14373.       0.    1218.      73.   1060.00
     .07      .00    13.57      .00     .000     .035     .000     .000  1027.15  1964.22
 .001534     100.     115.     145.        2       14        0      .00   601.55  2565.78
```

SECNO	DEPTH	CWSEL	CRIWS	WSELV	EG	HV	HL	QLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

SPECIAL BRIDGE

SB	XK	XKOR	COFQ	RDLEN	BWC	BWP	BAREA	SS	ELCHU	ELCHD
	1.05	1.56	2.60	.00	525.00	50.00	16020.00	1.50	1027.26	1027.15

*SECNO 9.200
CHIMP CLSTA= 2265.00 CELCH= 1027.26 BW= 525.00 STCHL= 1953.39 STCHR= 2576.61
EXCAVATION DATA
AEX= 18796.4SQ-FT VEXR= 55.8K*CU-YD VEXT= 136.3K*CU-YD

CLASS A LOW FLOW

3420 BRIDGE W.S.= 1051.85 BRIDGE VELOCITY= 15.45 CALCULATED CHANNEL AREA= 12589.

EGPRS	EGLWC	H3	QWEIR	QLOW	BAREA	TRAPEZOID AREA	ELLC	ELTRD	WEIRLN
.00	1056.20	.85	0.	195000.	16020.	16019.	1058.00	1062.30	0.

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA= 1060.00 ELREA= 1060.00

9.200	26.25	1053.51	.00	.00	1056.20	2.69	.68	.00	1060.00
195000.	0.	195000.	0.	0.	14816.	0.	1245.	74.	1060.00
.08	.00	13.16	.00	.000	.035	.000	.000	1027.26	1963.12
.001395	80.	80.	80.	0	0	0	.00	603.76	2566.88

CCHV= .300 CEHV= .500
*SECNO 9.300
3280 CROSS SECTION 9.30 EXTENDED 1.39 FEET

9.300	26.19	1053.59	1043.66	.00	1056.41	2.81	.14	.06	1050.00
195000.	729.	194271.	0.	424.	14403.	0.	1279.	75.	1060.40
.08	1.72	13.49	.00	.050	.035	.000	.000	1027.40	1740.00
.001459	100.	100.	100.	2	14	0	.00	826.79	2566.79

*SECNO 10.000
3280 CROSS SECTION 10.00 EXTENDED 1.36 FEET

10.000	26.56	1054.36	1043.78	.00	1056.92	2.55	.43	.08	1052.00
195000.	1245.	193755.	0.	896.	15064.	0.	1389.	83.	1060.80
.08	1.39	12.86	.00	.050	.035	.000	.000	1027.80	1070.00
.001321	340.	310.	240.	2	14	0	.00	1232.35	2302.35

```
  SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       GROSS   BANK ELEV
  Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA   LEFT/RIGHT
  TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN     -SSTA
  SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID     ENDST


*SECNO 11.000
   11.000    27.12  1055.42  1043.86      .00  1057.53     2.11      .48      .13  1052.00
  195000.    1270.  193730.       0.     807.   16574.       0.    1544.      96.   1061.33
      .09     1.57    11.69      .00     .050     .035     .000     .000  1028.30  1393.55
  .001081     530.     400.     320.        2       11        0      .00  1159.58  2553.13


*SECNO 12.000
3280 CROSS SECTION     12.00 EXTENDED     16.69 FEET


3301 HV CHANGED MORE THAN HVINS

   12.000    27.88  1056.68  1043.85      .00  1058.08     1.40      .34      .21  1036.00
  195000.   33368.  161632.       0.    5259.   16135.       0.    1727.     106.   1061.80
      .11     6.35    10.02      .00     .045     .035     .000     .000  1028.80  1850.00
  .000712     520.     390.     300.        2       11        0      .00   864.33  2714.33


*SECNO 13.000
CHIMP CLSTA=    2590.00 CELCH=    1029.37 BW=     525.00 STCHL=    2281.55 STCHR=    2920.00
EXCAVATION DATA
AEX=   17488.1SQ-FT     VEXR=     268.8K*CU-YD     VEXT=      405.1K*CU-YD


3301 HV CHANGED MORE THAN HVINS

   13.000    27.16  1056.53  1045.34      .00  1059.03     2.50      .40      .55  1060.00
  195000.       0.  195000.       0.       0.   15366.       0.    1899.     113.   1060.00
      .11      .00    12.69      .00     .000     .035     .000     .000  1029.37  2286.76
  .001244     460.     400.     350.        2       11        0      .00   606.48  2893.24


CCHV=     .100 CEHV=     .300
*SECNO 14.000
CHIMP CLSTA=    2580.00 CELCH=    1029.90 BW=     525.00 STCHL=    2272.35 STCHR=    2890.00
EXCAVATION DATA
AEX=   17161.5SQ-FT     VEXR=     256.7K*CU-YD     VEXT=      661.8K*CU-YD

   14.000    27.12  1057.02  1045.89      .00  1059.53     2.51      .50      .00  1060.00
  195000.       0.  195000.       0.       0.   15343.       0.    2040.     118.   1060.00
      .12      .00    12.71      .00     .000     .035     .000     .000  1029.90  2276.82
  .001250     400.     400.     340.        2       11        0      .00   606.37  2883.18
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SECNO    DEPTH    QWSEL    QBIWS    WSELE    FG       HV       HL       QLOSS    BANK ELEV
Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA    LEFT/RIGHT
TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTH      ELMIN      SSTA
SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID     ENDST


*SECNO 15.000
CHIMP CLSTA=    2605.00 CELCH=    1030.43 BW=     525.00 STCHL=    2298.15 STCHR=    2911.85
EXCAVATION DATA
AEX=   16835.8SQ-FT     VEXR=     251.8K*CU-YD     VEXT=      913.6K*CU-YD

   15.000    27.09  1057.52  1046.42      .00  1060.04     2.52      .50      .00  1060.00
  195000.       0.  195000.       0.       0.   15319.       0.    2181.     124.   1060.00
      .13      .00    12.73      .00     .000     .035     .000     .000  1030.43  2301.87
 .001256     400.     400.     380.        0       11        0      .00   606.25  2908.13


*SECNO 16.000
CHIMP CLSTA=    2555.00 CELCH=    1030.95 BW=     525.00 STCHL=    2248.92 STCHR=    2861.08
EXCAVATION DATA
AEX=   16517.1SQ-FT     VEXR=     247.1K*CU-YD     VEXT=     1160.7K*CU-YD

   16.000    27.07  1058.02  1046.94      .00  1060.54     2.52      .50      .00  1060.00
  195000.       0.  195000.       0.       0.   15306.       0.    2322.     129.   1060.00
      .14      .00    12.74      .00     .000     .035     .000     .000  1030.95  2251.91
 .001259     400.     400.     380.        0       11        0      .00   606.19  2858.09


*SECNO 17.000
CHIMP CLSTA=    2620.00 CELCH=    1031.48 BW=     565.00 STCHL=    2294.72 STCHR=    3025.00
EXCAVATION DATA
AEX=   17333.9SQ-FT     VEXR=     250.7K*CU-YD     VEXT=     1411.4K*CU-YD

   17.000    27.42  1058.90  1046.71      .00  1061.03     2.14      .46      .04  1060.00
  195000.       0.  195000.       0.       0.   16618.       0.    2468.     135.   1060.00
      .15      .00    11.73      .00     .000     .035     .000     .000  1031.48  2296.38
 .001043     400.     400.     375.        2       11        0      .00   647.25  2943.63


*SECNO 18.000
   18.000    27.39  1059.39  1046.98      .00  1061.45     2.06      .41      .01  1060.00
  195000.       0.  195000.       0.       0.   16926.       0.    2622.     141.   1060.00
      .16      .00    11.52      .00     .000     .035     .000     .000  1032.00  2310.61
 .001007     400.     400.     400.        2       11        0      .00   658.17  2968.78


CCHV=     .100 CEHV=     .300
*SECNO 19.000
   19.000    27.63  1059.63  1048.71      .00  1062.09     2.45      .52      .12  1062.00
  195000.       0.  195000.       0.       0.   15514.       0.    2771.     147.   1060.00
      .17      .00    12.57      .00     .000     .040     .000     .000  1032.00  2354.93
 .001654     400.     400.     400.        2       14        0      .00   634.33  2989.26
```

SECNO	DEPTH	CWSEL	CRTWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WIN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IBC	ICONT	CORAR	TOPWID	ENDST

*SECNO 20.000

3301 HV CHANGED MORE THAN HVINS

20.000	26.03	1060.03	1050.92	.00	1063.00	2.97	.76	.15	1064.00
195000.	0.	195000.	0.	0.	14101.	0.	2907.	153.	1068.00
.18	.00	13.83	.00	.000	.040	.000	.000	1034.00	2429.90
.002124	400.	400.	400.	2	14	0	.00	600.13	3030.03

*SECNO 20.500

3301 HV CHANGED MORE THAN HVINS

20.500	27.44	1061.44	1049.32	.00	1063.39	1.96	.30	.10	1064.00
195000.	0.	195000.	0.	0.	17369.	0.	2974.	155.	1062.00
.18	.00	11.23	.00	.000	.040	.000	.000	1034.00	2156.39
.001294	185.	185.	185.	2	11	0	.00	702.22	2858.61

*SECNO 21.000

21.000	27.70	1061.70	1050.61	.00	1063.70	2.00	.29	.01	1065.00
195000.	0.	194756.	244.	0.	17150.	126.	3060.	159.	1060.00
.19	.00	11.36	1.93	.000	.040	.040	.000	1034.00	2356.61
.001399	215.	215.	215.	2	14	0	.00	801.88	3158.48

CCHV= .200 CEHV= .400
*SECNO 22.000

3301 HV CHANGED MORE THAN HVINS

22.000	26.63	1061.63	1052.98	.00	1065.00	3.37	.75	.55	1065.00
195000.	0.	194375.	625.	0.	13177.	283.	3201.	166.	1060.00
.19	.00	14.75	2.21	.000	.040	.045	.000	1035.00	2326.74
.002373	400.	400.	400.	2	14	0	.00	729.79	3056.52

CCHV= .100 CEHV= .300
*SECNO 23.000

23.000	27.01	1063.01	1053.76	.00	1065.93	2.92	.89	.04	1064.00
195000.	0.	193280.	1720.	0.	14033.	553.	3330.	173.	1060.00
.20	.00	13.77	3.11	.000	.040	.045	.000	1036.00	2193.68
.002102	400.	400.	400.	2	14	0	.00	792.92	2986.60

SECNO	DEPTH	QWSEL	QRIMS	WSELY	EG	HV	HL	QLOSS	BANK ELEV
Q	WLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*SECNO 24.000

24.000	26.37	1064.37	1054.83	.00	1066.89	2.52	.91	.04	1070.00
195000.	0.	195000.	0.	0.	15322.	0.	3494.	181.	1070.00
.21	.00	12.73	.00	.000	.040	.000	.000	1038.00	2203.44
.001733	480.	480.	480.	2	11	0	.00	638.12	2841.56

*SECNO 25.000

25.000	27.16	1065.16	1055.57	.00	1067.71	2.56	.81	.01	1064.00
195000.	43.	194957.	0.	44.	15196.	0.	3652.	188.	1068.00
.22	1.00	12.83	.00	.045	.040	.000	.000	1038.00	2109.76
.001885	450.	450.	450.	2	14	0	.00	743.14	2852.89

*SECNO 26.000

26.000	27.86	1065.86	1056.93	.00	1068.53	2.68	.79	.04	1068.00
195000.	0.	195000.	0.	0.	14856.	0.	3790.	195.	1070.00
.23	.00	13.13	.00	.000	.040	.000	.000	1038.00	2234.01
.002044	400.	400.	400.	2	19	0	.00	669.77	2903.79

*SECNO 27.000

3301 HV CHANGED MORE THAN HVINS

27.000	29.48	1067.48	1056.56	.00	1069.27	1.79	.65	.09	1070.00
195000.	0.	194978.	22.	0.	18146.	22.	3942.	202.	1066.00
.24	.00	10.74	.99	.000	.040	.045	.000	1038.00	2147.55
.001349	400.	400.	400.	2	14	0	.00	842.12	2989.67

THIS RUN EXECUTED 4/26/91 9:48:44

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*************************************************
 HEC2 RELEASE DATED SEP 88 UPDATED SEPT 1989

 ERROR CORR -  01,02,03
 MODIFICATION -
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NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

DGN-PHX.DAT

SUMMARY PRINTOUT

	SECNO	CWSEL	VLOB	VCH	VROB	QLOB	QCH	QROB	DEPTH	TOPWID	SSTA	ENDST
	1.000	1044.27	.00	10.38	7.07	.00	160485.90	34514.10	24.27	1385.34	1724.66	3110.00
	2.000	1044.98	1.99	10.51	7.42	30.77	158923.50	36045.79	24.98	1296.22	1618.78	2915.00
	3.000	1045.76	.00	9.88	6.64	.00	179920.60	15079.40	25.76	1194.70	1515.30	2710.00
	4.000	1046.38	.00	9.48	.00	.00	195000.00	.00	24.38	1094.84	1585.16	2680.00
	5.000	1046.61	.00	11.80	.00	.00	195000.00	.00	22.61	1014.73	1596.79	2611.52
	6.000	1047.21	.00	13.88	.00	.00	195000.00	.00	23.21	883.95	1668.49	2552.44
	7.000	1047.94	.00	17.10	.00	.00	195000.00	.00	21.94	739.06	1722.71	2461.77
	8.000	1050.24	.00	16.63	.00	.00	195000.00	.00	24.24	685.59	1760.00	2445.59
*	9.000	1052.48	.00	13.58	.00	.00	195000.00	.00	25.48	601.46	1959.27	2560.73
	9.100	1052.67	.00	13.57	.00	.00	195000.00	.00	25.52	601.55	1964.22	2565.78
	9.200	1053.51	.00	13.16	.00	.00	195000.00	.00	26.25	603.76	1963.12	2566.88
	9.300	1053.59	1.72	13.49	.00	729.36	194270.60	.00	26.19	826.79	1740.00	2566.79
	10.000	1054.36	1.39	12.86	.00	1245.34	193754.70	.00	26.56	1232.35	1070.00	2302.35
	11.000	1055.42	1.57	11.69	.00	1269.92	193730.10	.00	27.12	1159.58	1393.55	2553.13
	12.000	1056.68	6.35	10.02	.00	33367.96	161632.00	.00	27.88	864.33	1850.00	2714.33
	13.000	1056.53	.00	12.69	.00	.00	195000.00	.00	27.16	606.48	2286.76	2893.24
	14.000	1057.02	.00	12.71	.00	.00	195000.00	.00	27.12	606.37	2276.82	2883.18

SECND	CMSEC	WLOS	WCH	VROS	QLOS	QCH	QROS	DEPTH	TOPWID	SSIA	ENDST
15.000	1057.52	.00	12.33	.00	.00	195000.00	.00	27.09	606.25	2301.87	2908.13
16.000	1058.02	.00	12.74	.00	.00	195000.00	.00	27.07	606.19	2251.91	2858.09
17.000	1058.90	.00	11.73	.00	.00	195000.00	.00	27.42	647.25	2296.38	2943.63
18.000	1059.39	.00	11.52	.00	.00	195000.00	.00	27.39	658.17	2310.61	2968.78
19.000	1059.63	.00	12.57	.00	.00	195000.00	.00	27.63	634.33	2354.93	2989.26
20.000	1060.03	.00	13.83	.00	.00	195000.00	.00	26.03	600.13	2429.90	3030.03
20.500	1061.44	.00	11.23	.00	.00	195000.00	.00	27.44	702.22	2156.39	2858.61
21.000	1061.70	.00	11.36	1.93	.00	194756.30	243.67	27.70	801.88	2356.61	3158.48
22.000	1061.63	.00	14.75	2.21	.00	194374.60	625.42	26.63	729.79	2326.74	3056.52
23.000	1063.01	.00	13.77	3.11	.00	193280.10	1719.88	27.01	792.92	2193.68	2986.60
24.000	1064.37	.00	12.73	.00	.00	195000.00	.00	26.37	638.12	2203.44	2841.56
25.000	1065.16	1.00	12.83	.00	43.37	194956.60	.00	27.16	743.14	2109.76	2852.89
26.000	1065.86	.00	13.13	.00	.00	195000.00	.00	27.86	669.77	2234.01	2903.79
27.000	1067.48	.00	10.74	.99	.00	194978.20	21.85	29.48	842.12	2147.55	2989.67

BGN-PHX.DAT

SUMMARY PRINTOUT

SECNO	CWSEL	CRIWS	EG	HL	OLOSS	ELMIN	104KS	K*CHSL	XLCH	SHEAR	FRCH
1.000	1044.27	1037.99	1045.79	.00	.00	1020.00	18.53	.00	.00	1.93	.45
2.000	1044.98	1038.38	1046.54	.74	.01	1020.00	18.39	.00	400.00	1.96	.45
3.000	1045.76	1037.71	1047.21	.66	.01	1020.00	15.14	.00	400.00	1.70	.41
4.000	1046.38	1037.34	1047.78	.56	.01	1022.00	13.21	5.00	400.00	1.55	.39
5.000	1046.61	1040.52	1048.77	.76	.23	1024.00	24.70	5.00	400.00	2.51	.52
6.000	1047.21	1042.50	1050.20	1.18	.25	1024.00	35.42	.00	400.00	3.51	.61
7.000	1047.94	1045.13	1052.48	1.82	.46	1026.00	55.44	5.00	400.00	5.34	.77
8.000	1050.24	1044.56	1054.53	2.03	.02	1026.00	46.62	.00	400.00	4.98	.71
* 9.000	1052.48	1042.94	1055.35	.67	.14	1027.00	15.41	3.45	290.00	2.29	.49
9.100	1052.67	1043.08	1055.52	.18	.00	1027.15	15.34	1.30	115.00	2.29	.49
9.200	1053.51	.00	1056.20	.68	.00	1027.26	13.95	1.37	80.00	2.14	.47
9.300	1053.59	1043.66	1056.41	.14	.06	1027.40	14.59	1.40	100.00	2.24	.48
10.000	1054.36	1043.78	1056.92	.43	.08	1027.80	13.21	1.29	310.00	2.03	.46
11.000	1055.42	1043.86	1057.53	.48	.13	1028.30	10.81	1.25	400.00	1.66	.42
12.000	1056.68	1043.85	1058.08	.34	.21	1028.80	7.12	1.28	390.00	1.19	.34
13.000	1056.53	1045.34	1059.03	.40	.55	1029.37	12.44	1.42	400.00	1.97	.44
14.000	1057.02	1045.89	1059.53	.50	.00	1029.90	12.50	1.33	400.00	1.97	.45
15.000	1057.52	1046.42	1060.04	.50	.00	1030.43	12.56	1.33	400.00	1.98	.45
16.000	1058.02	1046.94	1060.54	.50	.00	1030.95	12.59	1.30	400.00	1.98	.45
17.000	1058.90	1046.71	1061.03	.46	.04	1031.48	10.43	1.33	400.00	1.67	.41
18.000	1059.39	1046.98	1061.45	.41	.01	1032.00	10.07	1.30	400.00	1.62	.40
19.000	1059.63	1048.71	1062.09	.52	.12	1032.00	16.54	.00	400.00	2.52	.45
20.000	1060.03	1050.92	1063.00	.76	.15	1034.00	21.24	5.00	400.00	3.11	.50
20.500	1061.44	1049.32	1063.39	.30	.10	1034.00	12.94	.00	185.00	2.00	.40

SECND	CWSEL	CRTWS	SG	HL	GLOSS	ELMIN	IQHKS	MCHSL	MCH	SHEAR	FRCH
21.000	1061.70	1050.61	1063.70	.29	.01	1034.00	13.99	.00	215.00	2.07	.41
22.000	1061.63	1052.98	1065.00	.75	.55	1035.00	23.73	2.50	400.00	3.53	.53
23.000	1063.01	1053.76	1065.93	.89	.04	1036.00	21.02	2.50	400.00	3.06	.50
24.000	1064.37	1054.03	1066.89	.91	.04	1038.00	17.33	4.17	480.00	2.60	.46
25.000	1065.16	1055.57	1067.71	.81	.01	1038.00	18.85	.00	450.00	2.68	.47
26.000	1065.86	1056.93	1068.53	.79	.04	1038.00	20.44	.00	400.00	2.83	.49
27.000	1067.48	1056.56	1069.27	.65	.09	1038.00	13.49	.00	400.00	1.88	.40

THIS RUN EXECUTED 4/26/91 9:45:54

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**************************************************
 HEC2 RELEASE DATED SEP 88 UPDATED SEPT 1989


 ERROR CORR -  01,02,03
 MODIFICATION -
**************************************************


T1      SIMONS, LI & ASSOCIATES, INC.
T2      19TH AVENUE ENVIRONMENTAL CLEANUP (PAZ-CPH-02)
T3      DESIGN15.DAT            ALTERNATIVE B ANALYSIS

J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    0        WSEL     FQ

      0        2        0        0     0.000       0        0        0    1044.27     0

J2  NPROF     IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW      CHNIM    ITRACE

     -1        0       -1        0        0        0       -1        0        0        0


J3  VARIABLE CODES FOR SUMMARY PRINTOUT

     38        1        55       26       56       13       14       15       8        4
     53        54       0        38       1        2        3        11       12       42
      5        33       39       67       68

J6  IHLEQ     ICOPY    SUBDIV   STRTDS   RMILE

      1


NC    0.050    0.045    0.040     0.1      0.3
QT      1     195000
X1     1.0      18      1720     2650      0        0        0        0        0        0
X3                                                 3110.0
GR   1050.5   1000.0   1050.0   1430.0   1048.0   1720.0   1040.0   1730.0   1030.0   1750.0
GR   1030.0   2250.0   1030.0   2270.0   1024.0   2280.0   1022.0   2420.0   1020.0   2440.0
GR   1020.0   2535.0   1024.0   2545.0   1026.0   2610.0   1030.0   2620.0   1040.0   2650.0
GR   1040.0   2740.0   1032.0   2750.0   1032.0   3590.0

X1     2.0      20      1625     2510     400      400      400      0        0        0
X3                                                 2915.0
GR   1051.6   1000.0   1050.0   1340.0   1048.0   1615.0   1040.0   1625.0   1032.0   1650.0
GR   1030.0   1665.0   1030.0   2130.0   1032.0   2150.0   1030.0   2160.0   1022.0   2210.0
GR   1020.0   2300.0   1020.0   2360.0   1024.0   2365.0   1026.0   2420.0   1028.0   2485.0
GR   1030.0   2495.0   1040.0   2510.0   1040.0   2550.0   1032.0   2570.0   1032.0   3230.0
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X1	3.0	18	1510	2525	400	400	400	0	0	0
X3						2710.0				
GR	1051.0	1000.0	1051.0	1400.0	1050.0	1510.0	1034.0	1530.0	1030.0	1535.0
GR	1030.0	1975.0	1034.0	2000.0	1030.0	2020.0	1022.0	2050.0	1020.0	2150.0
GR	1025.0	2235.0	1025.0	2470.0	1030.0	2485.0	1040.0	2505.0	1042.0	2525.0
GR	1040.0	2540.0	1032.0	2575.0	1032.0	3025.0				
X1	4.0	15	1580	2680	400	400	400	0	0	0
GR	1052.6	1170.0	1052.0	1255.0	1050.0	1580.0	1036.0	1600.0	1030.0	1610.0
GR	1030.0	1990.0	1036.0	2020.0	1030.0	2040.0	1024.0	2060.0	1022.0	2125.0
GR	1022.0	2170.0	1025.0	2175.0	1025.0	2600.0	1030.0	2645.0	1040.0	2680.0
X1	5.0	15	1590	2620	400	400	400	0	0	0
X3	10									
GR	1052.0	1290.0	1052.0	1560.0	1050.0	1590.0	1030.0	1630.0	1030.0	2080.0
GR	1024.0	2100.0	1024.0	2125.0	1024.0	2150.0	1026.0	2155.0	1026.0	2240.0
GR	1030.0	2275.0	1032.0	2370.0	1032.0	2575.0	1050.0	2620.0	1050.0	3080.0
X1	6.0	16	1665	2565	400	400	400	0	0	0
X3	10									
GR	1053.0	1455.0	1052.0	1575.0	1050.0	1665.0	1030.0	1690.0	1030.0	2120.0
GR	1024.0	2135.0	1024.0	2155.0	1026.0	2170.0	1028.0	2270.0	1030.0	2280.0
GR	1032.0	2310.0	1036.0	2465.0	1040.0	2520.0	1050.0	2565.0	1052.0	2575.0
GR	1052.0	3045.0								
X1	7.0	21	1715	2510	430	380	400	0	0	0
X3	10									
GR	1052.0	1620.0	1052.0	1665.0	1050.0	1715.0	1046.0	1730.0	1044.0	1780.0
GR	1040.0	1850.0	1032.0	1910.0	1030.0	1930.0	1028.0	2060.0	1026.0	2090.0
GR	1026.0	2130.0	1026.0	2190.0	1028.0	2280.0	1030.0	2360.0	1034.0	2400.0
GR	1040.0	2430.0	1050.0	2470.0	1054.0	2510.0	1054.0	2680.0	1058.0	2840.0
GR	1058.0	3000.0								
X1	8.0	16	1760	2455	410	380	400	0	0	0
X3	10									
GR	1050.0	1760.0	1048.0	1880.0	1046.0	1920.0	1040.0	1930.0	1030.0	1950.0
GR	1028.0	2000.0	1026.0	2010.0	1026.0	2060.0	1028.0	2310.0	1028.0	2420.0
GR	1030.0	2425.0	1050.0	2445.0	1054.0	2455.0	1056.0	2575.0	1058.0	2665.0
GR	1058.0	2950.0								
NC			0.035							
X1	9.0	5	1965	2555	290	290	290	0	0	0
CI	2260	1027.00	0	1.5	1.5	525				
GR	1060.0	1820.0	1060.0	1965.0	1060.0	2220.0	1060.0	2555.0	1060.0	2890.0
X1	9.1	3	1845	2840	100	145	115	0	0	0
CI	2265	1027.15	0			525				
X3	10									
GR	1060.0	1845.0	1060.0	2210.0	1060.0	2840.0				

SB	1.05	1.56	2.60	0	525	50	16020	1.5	1027.26	1027.15
X1	9.2	5	1953.4	2576.6	80	80	80	0	0	0
CI	2265	1027.26	0			525				
X2			1	1058.0	1062.3					
X3	10									
BT	-10	1845.0	1062.3	1055.3	1965.0	1065.6	1058.6	2090.0	1068.0	1061.0
BT		2215.0	1069.5	1062.5	2340.0	1070.0	1063.0	2465.0	1069.5	1062.5
BT		2590.0	1068.1	1061.1	2715.0	1065.7	1058.4	2840.0	1062.4	1055.4
BT		2855.0	1060.0	1060.0						
GR	1060.0	1845.0	1060.0	1953.4	1060.0	2265.0	1060.0	2576.6	1060.0	2855.0
X1	9.3	5	1980	2700	100	100	100	0	0	0
CI	2265	1027.39	0			525				
GR	1060.0	1740.0	1060.0	1980.0	1060.0	2230.0	1060.0	2700.0	1060.0	2940.0
X1	10.0	5	1690	2250	340	240	310	0	0	0
CI	2000	1027.80	0			525				
GR	1060.0	1070.0	1060.0	1690.0	1060.0	1960.0	1060.0	2250.0	1060.0	2830.0
X1	11.0	5	1880	2515	530	320	400	0	0	0
CI	2250	1028.33	0			525				
GR	1060.0	1000.0	1060.0	1880.0	1060.0	2230.0	1060.0	2515.0	1060.0	3365.0
X1	12.0	5	2320	2705	520	300	390	0	0	0
CI	2410	1028.84	0			525				
GR	1060.0	1475.0	1060.0	2320.0	1060.0	2460.0	1060.0	2705.0	1060.0	3630.0
X1	13.0	5	2410	2920	460	350	400	0	0	0
CI	2590	1029.37	0			525				
GR	1060.0	1815.0	1060.0	2410.0	1060.0	2560.0	1060.0	2920.0	1060.0	3680.0
X1	14.0	5	2390	2890	400	340	400	0	0	0
CI	2580	1029.90	0			525				
GR	1060.0	1880.0	1060.0	2390.0	1060.0	2640.0	1060.0	2890.0	1060.0	3550.0
X1	15.0	5	2425	2910	400	380	400	0	0	0
CI	2605	1030.43	0			525				
GR	1060.0	2000.0	1060.0	2425.0	1060.0	2660.0	1060.0	2910.0	1060.0	3400.0
X1	16.0	5	2325	2845	400	380	400	0	0	0
CI	2555	1030.95	0			525				
GR	1060.0	2000.0	1060.0	2325.0	1060.0	2590.0	1060.0	2845.0	1060.0	3220.0
X1	17.0	5	2300	3025	400	375	400	0	0	0
CI	2620	1031.48	0			565				
GR	1060.0	2110.0	1060.0	2300.0	1060.0	2640.0	1060.0	3025.0	1060.0	3050.0
X1	18.0	12	2310	2970	400	400	400	0	0	0
CI						.01				
GR	1062.0	2190.0	1062.0	2275.0	1060.0	2310.0	1032.0	2338.0	1032.0	2370.0
GR	1032.0	2600.0	1032.0	2660.0	1032.0	2920.0	1040.0	2930.0	1050.0	2950.0
GR	1060.0	2970.0	1060.0	3180.0						

NC	0.045	0.040	0.040	0.1	0.3					
X1	19.0	11	2350	2990	400	400	400	0	0	0
GR	1062.0	2295.0	1062.0	2350.0	1050.0	2375.0	1034.0	2405.0	1032.5	2550.0
GR	1032.0	2610.0	1034.0	2935.0	1040.0	2955.0	1050.0	2970.0	1060.0	2990.0
GR	1060.0	3090.0								
X1	20.0	10	2415	3040	400	400	400	0	0	0
GR	1064.0	2000.0	1064.0	2415.0	1060.0	2430.0	1040.0	2460.0	1036.0	2480.0
GR	1034.0	2575.0	1036.0	2995.0	1040.0	3005.0	1060.0	3030.0	1068.0	3040.0
X1	20.5	13	2150	2860	185	185	185	0	0	0
GR	1064.0	1780.0	1064.0	2150.0	1060.0	2160.0	1040.0	2190.0	1036.0	2205.0
GR	1034.0	2290.0	1034.0	2680.0	1036.0	2780.0	1042.0	2800.0	1050.0	2830.0
GR	1062.0	2860.0	1064.0	2920.0	1064.0	3050.0				
X1	21.0	21	2350	3080	215	215	215	0	0	0
GR	1065.0	2050.0	1065.0	2350.0	1060.0	2360.0	1050.0	2380.0	1036.0	2415.0
GR	1034.0	2455.0	1036.0	2500.0	1036.0	2525.0	1036.0	2620.0	1034.0	2660.0
GR	1034.0	2760.0	1036.0	2790.0	1036.0	2860.0	1038.0	2900.0	1040.0	2975.0
GR	1040.0	3020.0	1050.0	3070.0	1060.0	3080.0	1060.0	3150.0	1070.0	3200.0
GR	1076.0	3230.0								
NC	0.045	0.045	0.040	0.2	0.4					
X1	22.0	13	2320	2880	400	400	400	0	0	0
GR	1065.0	2125.0	1065.0	2320.0	1060.0	2330.0	1050.0	2350.0	1036.0	2380.0
GR	1036.0	2585.0	1035.0	2670.0	1036.0	2800.0	1038.0	2850.0	1060.0	2880.0
GR	1060.0	3050.0	1070.0	3090.0	1074.0	3110.0				
NC	0.045	0.045	0.040	0.1	0.3					
X1	23.0	13	2190	2795	400	400	400	0	0	0
GR	1064.0	2190.0	1060.0	2205.0	1050.0	2245.0	1040.0	2290.0	1038.0	2355.0
GR	1036.0	2425.0	1036.0	2720.0	1038.0	2750.0	1040.0	2765.0	1060.0	2795.0
GR	1060.0	2970.0	1070.0	3025.0	1076.0	3080.0				
X1	24.0	11	2195	2850	480	480	480	0	0	0
GR	1070.0	2050.0	1070.0	2195.0	1060.0	2210.0	1050.0	2230.0	1040.0	2260.0
GR	1038.0	2275.0	1038.0	2730.0	1040.0	2790.0	1050.0	2810.0	1060.0	2835.0
GR	1070.0	2850.0								
X1	25.0	16	2185	2860	450	450	450	0	0	0
GR	1070.0	2045.0	1066.0	2055.0	1064.0	2185.0	1044.0	2230.0	1040.0	2255.0
GR	1038.0	2355.0	1042.0	2370.0	1042.0	2575.0	1040.0	2585.0	1038.0	2595.0
GR	1038.0	2685.0	1040.0	2780.0	1050.0	2810.0	1060.0	2840.0	1068.0	2860.0
GR	1068.0	3080.0								
X1	26.0	16	2230	2910	400	400	400	0	0	0
GR	1070.0	2190.0	1068.0	2230.0	1060.0	2245.0	1050.0	2275.0	1042.0	2320.0
GR	1042.0	2600.0	1040.0	2610.0	1040.0	2650.0	1042.0	2655.0	1042.0	2780.0
GR	1038.0	2805.0	1038.0	2830.0	1040.0	2840.0	1050.0	2870.0	1060.0	2895.0
GR	1070.0	2910.0								

XI	27.0	16	2140	2960	400	400	400	0	0	0
GR	1070.0	2140.0	1060.0	2170.0	1050.0	2200.0	1046.0	2220.0	1046.0	2400.0
GR	1044.0	2560.0	1042.0	2630.0	1042.0	2660.0	1040.0	2760.0	1038.0	2840.0
GR	1038.0	2870.0	1040.0	2875.0	1050.0	2925.0	1060.0	2940.0	1066.0	2960.0
GR	1068.0	3000.0								

SECNO	DEPTH	CWSEL	CRIWS	WSELR	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 1

IHLEQ = 1. THEREFORE FRICTION LOSS (HL) IS CALCULATED AS A FUNCTION OF PROFILE TYPE, WHICH CAN VARY FROM REACH TO REACH. SEE DOCUMENTATION FOR DETAILS.

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

CCHV= .100 CEHV= .300
*SECNO 1.000
3280 CROSS SECTION 1.00 EXTENDED 12.27 FEET

3470 ENCROACHMENT STATIONS= .0 3110.0 TYPE= 1 TARGET= 3109.999

1.000	24.27	1044.27	1037.99	1044.27	1045.79	1.52	.00	.00	1048.00
195000.	0.	160486.	34514.	0.	15455.	4884.	0.	0.	1040.00
.00	.00	10.38	7.07	.000	.040	.045	.000	1020.00	1724.66
.001853	0.	0.	0.	0	19	0	.00	1385.34	3110.00

*SECNO 2.000
3280 CROSS SECTION 2.00 EXTENDED 12.98 FEET

3470 ENCROACHMENT STATIONS= .0 2915.0 TYPE= 1 TARGET= 2914.999

2.000	24.98	1044.98	1038.38	.00	1046.54	1.56	.74	.01	1040.00
195000.	31.	158923.	36046.	15.	15117.	4857.	185.	12.	1040.00
.01	1.99	10.51	7.42	.050	.040	.045	.000	1020.00	1618.78
.001839	400.	400.	400.	2	19	0	.00	1296.22	2915.00

*SECNO 3.000
3280 CROSS SECTION 3.00 EXTENDED 13.76 FEET

3470 ENCROACHMENT STATIONS= .0 2710.0 TYPE= 1 TARGET= 2709.999

3.000	25.76	1045.76	1037.71	.00	1047.21	1.45	.66	.01	1050.00
195000.	0.	179921.	15079.	0.	18219.	2271.	371.	24.	1042.00
.02	.00	9.88	6.64	.000	.040	.045	.000	1020.00	1515.30
.001514	400.	400.	400.	2	19	0	.00	1194.70	2710.00

```
SECNO    DEPTH    QWSEL    CEINC    WSELK    EG       HV       HL       QLOSS    BANK ELEV
Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA    LEFT/RIGHT
TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN       SSTA
SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IBC      ICONT    CORAR    TOPWID      ENDST


*SECNO 4.000
3280 CROSS SECTION      4.00 EXTENDED      6.38 FEET

   4.000    24.38  1046.38  1037.34      .00  1047.78     1.40      .56      .01  1050.00
 195000.       0.  195000.       0.       0.   20563.       0.     559.      34.   1040.00
     .03      .00     9.48      .00     .000     .040     .000     .000  1022.00  1585.16
 .001321     400.     400.     400.        2       14        0      .00  1094.84  2680.00


*SECNO 5.000

3301 HV CHANGED MORE THAN HVINS


3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA=      1050.00 ELREA=      1050.00

   5.000    22.61  1046.61  1040.52      .00  1048.77     2.16      .76      .23  1050.00
 195000.       0.  195000.       0.       0.   16526.       0.     730.      44.   1050.00
     .04      .00    11.80      .00     .000     .040     .000     .000  1024.00  1596.79
 .002470     400.     400.     400.        2       19        0      .00  1014.73  2611.52


*SECNO 6.000

3301 HV CHANGED MORE THAN HVINS


3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA=      1050.00 ELREA=      1050.00

   6.000    23.21  1047.21  1042.50      .00  1050.20     2.99     1.18      .25  1050.00
 195000.       0.  195000.       0.       0.   14045.       0.     870.      53.   1050.00
     .05      .00    13.88      .00     .000     .040     .000     .000  1024.00  1668.49
 .003542     400.     400.     400.        2       15        0      .00   883.95  2552.44


*SECNO 7.000

3301 HV CHANGED MORE THAN HVINS


3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA=      1050.00 ELREA=      1054.00

   7.000    21.94  1047.94  1045.13      .00  1052.48     4.54     1.82      .46  1050.00
 195000.       0.  195000.       0.       0.   11404.       0.     987.      60.   1054.00
     .06      .00    17.10      .00     .000     .040     .000     .000  1026.00  1722.71
 .005544     430.     400.     380.        2       15        0      .00   739.06  2461.77
```

```
SECNO    DEPTH    QHSEL    QRIWS    WSELK    LG       HV       HL       QLOSS   BANK ELEV
Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA   LEFT/RIGHT
TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN      SSTA
SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID     ENDST


*SECNO 8.000
3280 CROSS SECTION      8.00 EXTENDED       .24 FEET


3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA=      1050.00 ELREA=      1054.00

   8.000    24.24  1050.24  1044.56      .00  1054.53     4.29     2.03      .02  1050.00
 195000.       0.  195000.       0.       0.   11728.       0.    1093.      67.   1054.00
     .07      .00    16.63      .00     .000     .040     .000     .000  1026.00  1760.00
 .004662     410.     400.     380.        3       12        0      .00   685.59  2445.59


*SECNO 9.000
CHIMP CLSTA=    2260.00 CELCH=    1027.00 BW=     525.00 STCHL=    1948.00 STCHR=    2572.00
EXCAVATION DATA
AEX=   18958.5SQ-FT     VEXR=        .0K*CU-YD     VEXT=        .0K*CU-YD


3301 HV CHANGED MORE THAN HVINS


3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  1.74

   9.000    25.48  1052.48  1042.94      .00  1055.35     2.87      .67      .14  1060.00
 195000.       0.  195000.       0.       0.   14355.       0.    1180.      71.   1060.00
     .07      .00    13.58      .00     .000     .035     .000     .000  1027.00  1959.27
 .001541     290.     290.     290.        2       14        0      .00   601.46  2560.73


*SECNO 9.100
CHIMP CLSTA=    2265.00 CELCH=    1027.15 BW=     525.00 STCHL=    1845.00 STCHR=    2840.00
EXCAVATION DATA
AEX=   18864.9SQ-FT     VEXR=      80.5K*CU-YD     VEXT=      80.5K*CU-YD


3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA=      1060.00 ELREA=      1060.00

   9.100    25.52  1052.67  1043.08      .00  1055.52     2.86      .18      .00  1060.00
 195000.       0.  195000.       0.       0.   14373.       0.    1218.      73.   1060.00
     .07      .00    13.57      .00     .000     .035     .000     .000  1027.15  1964.22
 .001534     100.     115.     145.        2       14        0      .00   601.55  2565.78
```

SECNO	DEPTH	CWSEL	CRINS	WSELX	EG	HV	HL	QLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

SPECIAL BRIDGE

SB	XK	XKOR	COFQ	RDLEN	BWC	BWP	BAREA	SS	ELCHU	ELCHD
	1.05	1.56	2.60	.00	525.00	50.00	16020.00	1.50	1027.26	1027.15

*SECNO 9.200
CHIMP CLSTA= 2265.00 CELCH= 1027.26 BW= 525.00 STCHL= 1953.39 STCHR= 2576.61
EXCAVATION DATA
AEX= 18796.4SQ-FT VEXR= 55.8K*CU-YD VEXT= 136.3K*CU-YD

CLASS A LOW FLOW

3420 BRIDGE W.S.= 1051.85 BRIDGE VELOCITY= 15.45 CALCULATED CHANNEL AREA= 12589.

EGPRS	EGLWC	H3	QWEIR	QLOW	BAREA	TRAPEZOID AREA	ELLC	ELTRD	WEIRLN
.00	1056.20	.85	0.	195000.	16020.	16019.	1058.00	1062.30	0.

3495 OVERBANK AREA ASSUMED NON-EFFECTIVE, ELLEA= 1060.00 ELREA= 1060.00

9.200	26.25	1053.51	.00	.00	1056.20	2.69	.68	.00	1060.00
195000.	0.	195000.	0.	0.	14816.	0.	1245.	74.	1060.00
.08	.00	13.16	.00	.000	.035	.000	.000	1027.26	1963.12
.001395	80.	80.	80.	0	0	0	.00	603.76	2566.88

*SECNO 9.300
CHIMP CLSTA= 2265.00 CELCH= 1027.39 BW= 525.00 STCHL= 1953.59 STCHR= 2700.00
EXCAVATION DATA
AEX= 18715.4SQ-FT VEXR= 69.5K*CU-YD VEXT= 205.8K*CU-YD

9.300	26.27	1053.66	1043.32	.00	1056.34	2.69	.14	.00	1060.00
195000.	0.	195000.	0.	0.	14826.	0.	1279.	75.	1060.00
.08	.00	13.15	.00	.000	.035	.000	.000	1027.39	1963.10
.001392	100.	100.	100.	0	14	0	.00	603.81	2566.90

*SECNO 10.000
CHIMP CLSTA= 2000.00 CELCH= 1027.80 BW= 525.00 STCHL= 1689.20 STCHR= 2310.80
EXCAVATION DATA
AEX= 18460.2SQ-FT VEXR= 213.4K*CU-YD VEXT= 419.2K*CU-YD

```
SECNO     DEPTH    CWSEL    CRIWS    WSELK    FS       HV       HL       QLOSS    BANK ELEV
Q         QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA    LEFT/RIGHT
TIME      VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN      SSTA
SLOPE     XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID     ENDST


 10.000    26.29  1054.09  1043.73      .00  1056.77     2.68      .43      .00  1060.00
195000.       0.  195000.       0.       0.   14840.       0.    1384.      79.   1060.00
    .08      .00    13.14      .00     .000     .035     .000     .000  1027.80  1698.06
.001388     340.     310.     240.        2       14        0      .00   603.88  2301.94


*SECNO 11.000
CHIMP CLSTA=    2250.00 CELCH=    1028.33 BW=     525.00 STCHL=    1880.00 STCHR=    2560.01
EXCAVATION DATA
AEX=   18131.3SQ-FT     VEXR=     271.0K*CU-YD     VEXT=     690.3K*CU-YD

 11.000    26.33  1054.66  1044.26      .00  1057.33     2.67      .55      .00  1060.00
195000.       0.  195000.       0.       0.   14865.       0.    1521.      85.   1060.00
    .09      .00    13.12      .00     .000     .035     .000     .000  1028.33  1948.00
.001380     530.     400.     320.        1       14        0      .00   604.00  2552.00


*SECNO 12.000
CHIMP CLSTA=    2410.00 CELCH=    1028.84 BW=     525.00 STCHL=    2100.76 STCHR=    2719.24
EXCAVATION DATA
AEX=   17815.4SQ-FT     VEXR=     259.6K*CU-YD     VEXT=     949.9K*CU-YD

 12.000    26.36  1055.20  1044.77      .00  1057.87     2.66      .54      .00  1060.00
195000.       0.  195000.       0.       0.   14886.       0.    1654.      90.   1060.00
    .10      .00    13.10      .00     .000     .035     .000     .000  1028.84  2107.95
.001374     520.     390.     300.        1       14        0      .00   604.10  2712.05


*SECNO 13.000
CHIMP CLSTA=    2590.00 CELCH=    1029.37 BW=     525.00 STCHL=    2281.55 STCHR=    2920.00
EXCAVATION DATA
AEX=   17488.1SQ-FT     VEXR=     261.5K*CU-YD     VEXT=    1211.4K*CU-YD

 13.000    26.38  1055.75  1045.30      .00  1058.41     2.66      .55      .00  1060.00
195000.       0.  195000.       0.       0.   14897.       0.    1791.      96.   1060.00
    .11      .00    13.09      .00     .000     .035     .000     .000  1029.37  2287.92
.001371     460.     400.     350.        0       14        0      .00   604.16  2892.08


*SECNO 14.000
CHIMP CLSTA=    2580.00 CELCH=    1029.90 BW=     525.00 STCHL=    2272.35 STCHR=    2890.00
```

SECNO	DEPTH	CWSEL	CRTWS	WSELK	EG	HV	HL	QLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

EXCAVATION DATA
AEX= 17161.5SQ-FT VEXR= 256.7K*CU-YD VEXT= 1468.1K*CU-YD

14.000	26.41	1056.31	1045.83	.00	1058.96	2.66	.55	.00	1060.00
195000.	0.	195000.	0.	0.	14909.	0.	1927.	101.	1060.00
.12	.00	13.08	.00	.000	.035	.000	.000	1029.90	2277.89
.001368	400.	400.	340.	2	14	0	.00	604.22	2882.11

*SECNO 15.000
CHIMP CLSTA= 2605.00 CELCH= 1030.43 BW= 525.00 STCHL= 2298.15 STCHR= 2911.85
EXCAVATION DATA
AEX= 16835.8SQ-FT VEXR= 251.8K*CU-YD VEXT= 1719.9K*CU-YD

15.000	26.43	1056.86	1046.36	.00	1059.51	2.65	.55	.00	1060.00
195000.	0.	195000.	0.	0.	14918.	0.	2064.	107.	1060.00
.13	.00	13.07	.00	.000	.035	.000	.000	1030.43	2302.87
.001365	400.	400.	380.	1	14	0	.00	604.26	2907.13

*SECNO 16.000
CHIMP CLSTA= 2555.00 CELCH= 1030.95 BW= 525.00 STCHL= 2248.92 STCHR= 2861.08
EXCAVATION DATA
AEX= 16517.1SQ-FT VEXR= 247.1K*CU-YD VEXT= 1967.0K*CU-YD

16.000	26.46	1057.41	1046.88	.00	1060.06	2.65	.55	.00	1060.00
195000.	0.	195000.	0.	0.	14936.	0.	2202.	112.	1060.00
.13	.00	13.06	.00	.000	.035	.000	.000	1030.95	2252.82
.001360	400.	400.	380.	1	14	0	.00	604.35	2857.18

*SECNO 17.000
CHIMP CLSTA= 2620.00 CELCH= 1031.48 BW= 565.00 STCHL= 2294.72 STCHR= 3025.00
EXCAVATION DATA
AEX= 17333.9SQ-FT VEXR= 250.7K*CU-YD VEXT= 2217.7K*CU-YD

17.000	26.88	1058.36	1046.72	.00	1060.59	2.23	.49	.04	1060.00
195000.	0.	195000.	0.	0.	16269.	0.	2345.	118.	1060.00
.14	.00	11.99	.00	.000	.035	.000	.000	1031.48	2297.18
.001115	400.	400.	375.	2	11	0	.00	645.63	2942.82

```
  SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       QLOSS   BANK ELEV
  Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA     LEFT/RIGHT
  TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN      SSTA
  SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID     ENDST


*SECNO 18.000
   18.000    26.89  1058.89  1046.99      .00  1061.03     2.14      .44      .01  1060.00
  195000.       0.  195000.       0.       0.   16597.       0.    2496.     124.   1060.00
      .15      .00    11.75      .00     .000     .035     .000     .000  1032.00  2311.11
  .001071     400.     400.     400.        2       11        0      .00   656.67  2967.78


CCHV=     .100 CEHV=     .300
*SECNO 19.000
   19.000    27.15  1059.15  1048.71      .00  1061.70     2.55      .55      .12  1062.00
  195000.       0.  195000.       0.       0.   15210.       0.    2642.     130.   1060.00
      .16      .00    12.82      .00     .000     .040     .000     .000  1032.00  2355.93
  .001759     400.     400.     400.        2       14        0      .00   632.37  2988.30


*SECNO 20.000

3301 HV CHANGED MORE THAN HVINS

   20.000    25.58  1059.58  1050.92      .00  1062.67     3.08      .80      .16  1064.00
  195000.       0.  195000.       0.       0.   13835.       0.    2775.     136.   1068.00
      .17      .00    14.10      .00     .000     .040     .000     .000  1034.00  2430.63
  .002256     400.     400.     400.        2       14        0      .00   598.85  3029.48


*SECNO 20.500

3301 HV CHANGED MORE THAN HVINS

   20.500    27.07  1061.07  1049.26      .00  1063.09     2.02      .31      .11  1064.00
  195000.       0.  195000.       0.       0.   17113.       0.    2841.     139.   1062.00
      .17      .00    11.40      .00     .000     .040     .000     .000  1034.00  2157.30
  .001354     185.     185.     185.        2       14        0      .00   700.39  2857.70


*SECNO 21.000
   21.000    27.34  1061.34  1050.61      .00  1063.41     2.06      .30      .01  1065.00
  195000.       0.  194833.     167.       0.   16892.      98.    2925.     142.   1060.00
      .18      .00    11.53     1.70     .000     .040     .040     .000  1034.00  2357.32
  .001471     215.     215.     215.        2       14        0      .00   799.39  3156.71
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SECNO     DEPTH     QWSEL     CRIWS     WSELK     EG        HV        HL        QLOSS    BANK ELEV
Q         VLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA    LEFT/RIGHT
TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN       SSTA
SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID      ENDST


CCHV=     .200 CEHV=     .400
*SECNO 22.000

3301 HV CHANGED MORE THAN HVINS

  22.000    26.29  1061.29  1052.98      .00  1064.76      3.48       .79       .57  1065.00
 195000.       0.  194570.     430.       0.   12987.      222.     3064.      149.   1060.00
     .19      .00    14.98     1.94     .000      .040      .045      .000   1035.00  2327.43
 .002492     400.     400.     400.        2        14         0       .00    727.72  3055.14


CCHV=     .100 CEHV=     .300
*SECNO 23.000
  23.000    26.74  1062.74  1053.76      .00  1065.74      3.00       .93       .05  1064.00
 195000.       0.  193505.    1495.       0.   13870.      502.     3190.      156.   1060.00
     .19      .00    13.95     2.98     .000      .040      .045      .000   1036.00  2194.70
 .002186     400.     400.     400.        2        14         0       .00    790.41  2985.11


*SECNO 24.000
  24.000    26.17  1064.17  1053.97      .00  1066.73      2.56       .94       .04  1070.00
 195000.       0.  195000.       0.       0.   15193.        0.     3353.      164.   1070.00
     .21      .00    12.83       .00     .000      .040      .000      .000   1038.00  2203.74
 .001780     480.     480.     480.        2        14         0       .00    637.51  2841.26


*SECNO 25.000
  25.000    26.98  1064.98  1055.57      .00  1067.57      2.60       .83       .01  1064.00
 195000.      28.  194972.       0.      31.   15077.        0.     3510.      171.   1068.00
     .21      .90    12.93       .00     .045      .040      .000      .000   1038.00  2121.38
 .001934     450.     450.     450.        2        14         0       .00    731.07  2852.45


*SECNO 26.000
  26.000    27.70  1065.70  1056.93      .00  1068.41      2.71       .80       .04  1068.00
 195000.       0.  195000.       0.       0.   14750.        0.     3647.      178.   1070.00
     .22      .00    13.22       .00     .000      .040      .000      .000   1038.00  2234.31
 .002090     400.     400.     400.        2        19         0       .00    669.24  2903.55


*SECNO 27.000
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SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTH	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

3301 HV CHANGED MORE THAN HVINS

27.000	29.35	1067.35	1056.56	.00	1069.17	1.81	.66	.99	1070.00
195000.	0.	194983.	17.	0.	18045.	18.	3797.	184.	1066.00
.23	.00	10.81	.94	.000	.040	.045	.000	1038.00	2147.92
.001373	400.	400.	400.	2	14	0	.00	839.26	2987.18

THIS RUN EXECUTED 4/26/91 9:46:15

****
HEC2 RELEASE DATED SEP 88 UPDATED SEPT 1989

ERROR CORR - 01,02,03
MODIFICATION -
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

DESIGN15.DAT

SUMMARY PRINTOUT

	SECNO	CWSEL	VLOB	VCH	VROB	QLOB	QCH	QROB	DEPTH	TOPWID	SSTA	ENDST
	1.000	1044.27	.00	10.38	7.07	.00	160485.90	34514.10	24.27	1385.34	1724.66	3110.00
	2.000	1044.98	1.99	10.51	7.42	30.77	158923.50	36045.79	24.98	1296.22	1618.78	2915.00
	3.000	1045.76	.00	9.88	6.64	.00	179920.60	15079.40	25.76	1194.70	1515.30	2710.00
	4.000	1046.38	.00	9.48	.00	.00	195000.00	.00	24.38	1094.84	1585.16	2680.00
	5.000	1046.61	.00	11.80	.00	.00	195000.00	.00	22.61	1014.73	1596.79	2611.52
	6.000	1047.21	.00	13.88	.00	.00	195000.00	.00	23.21	883.95	1668.49	2552.44
	7.000	1047.94	.00	17.10	.00	.00	195000.00	.00	21.94	739.06	1722.71	2461.77
	8.000	1050.24	.00	16.63	.00	.00	195000.00	.00	24.24	685.59	1760.00	2445.59
*	9.000	1052.48	.00	13.58	.00	.00	195000.00	.00	25.48	601.46	1959.27	2560.73
	9.100	1052.67	.00	13.57	.00	.00	195000.00	.00	25.52	601.55	1964.22	2565.78
	9.200	1053.51	.00	13.16	.00	.00	195000.00	.00	26.25	603.76	1963.12	2566.88
	9.300	1053.66	.00	13.15	.00	.00	195000.00	.00	26.27	603.81	1963.10	2566.90
	10.000	1054.09	.00	13.14	.00	.00	195000.00	.00	26.29	603.88	1698.06	2301.94
	11.000	1054.66	.00	13.12	.00	.00	195000.00	.00	26.33	604.00	1948.00	2552.00
	12.000	1055.20	.00	13.10	.00	.00	195000.00	.00	26.36	604.10	2107.95	2712.05
	13.000	1055.75	.00	13.09	.00	.00	195000.00	.00	26.38	604.16	2287.92	2892.08
	14.000	1056.31	.00	13.08	.00	.00	195000.00	.00	26.41	604.22	2277.89	2882.11

SECNO	CWSEL	VLOB	VCH	VROB	WLOB	WCH	QROB	DEPTH	TOPWID	SSTA	ENDST
15.000	1056.86	.00	13.07	.00	.00	195000.00	.00	26.43	604.26	2302.87	2907.13
16.000	1057.41	.00	13.06	.00	.00	195000.00	.00	26.46	604.35	2252.82	2857.18
17.000	1058.36	.00	11.99	.00	.00	195000.00	.00	26.88	645.63	2297.18	2942.82
18.000	1058.89	.00	11.75	.00	.00	195000.00	.00	26.89	656.67	2311.11	2967.78
19.000	1059.15	.00	12.82	.00	.00	195000.00	.00	27.15	632.37	2355.93	2988.30
20.000	1059.58	.00	14.10	.00	.00	195000.00	.00	25.58	598.85	2430.63	3029.48
20.500	1061.07	.00	11.40	.00	.00	195000.00	.00	27.07	700.39	2157.30	2857.70
21.000	1061.34	.00	11.53	1.70	.00	194832.50	167.49	27.34	799.39	2357.32	3156.71
22.000	1061.29	.00	14.98	1.94	.00	194569.80	430.22	26.29	727.72	2327.43	3055.14
23.000	1062.74	.00	13.95	2.98	.00	193504.80	1495.24	26.74	790.41	2194.70	2985.11
24.000	1064.17	.00	12.83	.00	.00	195000.00	.00	26.17	637.51	2203.74	2841.26
25.000	1064.98	.90	12.93	.00	28.08	194971.90	.00	26.98	731.07	2121.38	2852.45
26.000	1065.70	.00	13.22	.00	.00	195000.00	.00	27.70	669.24	2234.31	2903.55
27.000	1067.35	.00	10.81	.94	.00	194982.60	17.45	29.35	839.26	2147.92	2987.18

DESIGN15.DAT

SUMMARY PRINTOUT

SECNO	CWSEL	CRIWS	EG	HL	OLOSS	ELMIN	10*KS	K*CHSL	XLCH	SHEAR	FRCH
1.000	1044.27	1037.99	1045.79	.00	.00	1020.00	18.53	.00	.00	1.93	.45
2.000	1044.98	1038.38	1046.54	.74	.01	1020.00	18.39	.00	400.00	1.96	.45
3.000	1045.76	1037.71	1047.21	.66	.01	1020.00	15.14	.00	400.00	1.70	.41
4.000	1046.38	1037.34	1047.78	.56	.01	1022.00	13.21	5.00	400.00	1.55	.39
5.000	1046.61	1040.52	1048.77	.76	.23	1024.00	24.70	5.00	400.00	2.51	.52
6.000	1047.21	1042.50	1050.20	1.18	.25	1024.00	35.42	.00	400.00	3.51	.61
7.000	1047.94	1045.13	1052.48	1.82	.46	1026.00	55.44	5.00	400.00	5.34	.77
8.000	1050.24	1044.56	1054.53	2.03	.02	1026.00	46.62	.00	400.00	4.98	.71
9.000	1052.48	1042.94	1055.35	.67	.14	1027.00	15.41	3.45	290.00	2.29	.49
9.100	1052.67	1043.08	1055.52	.18	.00	1027.15	15.34	1.30	115.00	2.29	.49
9.200	1053.51	.00	1056.20	.68	.00	1027.26	13.95	1.37	80.00	2.14	.47
9.300	1053.66	1043.32	1056.34	.14	.00	1027.39	13.92	1.30	100.00	2.13	.47
10.000	1054.09	1043.73	1056.77	.43	.00	1027.80	13.88	1.32	310.00	2.13	.47
11.000	1054.66	1044.26	1057.33	.55	.00	1028.33	13.80	1.32	400.00	2.12	.47
12.000	1055.20	1044.77	1057.87	.54	.00	1028.84	13.74	1.31	390.00	2.11	.47
13.000	1055.75	1045.30	1058.41	.55	.00	1029.37	13.71	1.33	400.00	2.11	.46
14.000	1056.31	1045.83	1058.96	.55	.00	1029.90	13.68	1.33	400.00	2.11	.46
15.000	1056.86	1046.36	1059.51	.55	.00	1030.43	13.65	1.33	400.00	2.10	.46
16.000	1057.41	1046.88	1060.06	.55	.00	1030.95	13.60	1.30	400.00	2.10	.46
17.000	1058.36	1046.72	1060.59	.49	.04	1031.48	11.15	1.33	400.00	1.75	.42
18.000	1058.89	1046.99	1061.03	.44	.01	1032.00	10.71	1.30	400.00	1.69	.41
19.000	1059.15	1048.71	1061.70	.55	.12	1032.00	17.59	.00	400.00	2.64	.46
20.000	1059.58	1050.92	1062.67	.80	.16	1034.00	22.56	5.00	400.00	3.25	.52
20.500	1061.07	1049.26	1063.09	.31	.11	1034.00	13.54	.00	185.00	2.06	.41

SECNO	CWSEL	CRIWS	EG	HL	HLOSS	ELMIN	TOTKS	KACHSL	XLCH	SHEAR	FRCH
21.000	1061.34	1050.61	1063.41	.30	.01	1034.00	14.71	.00	215.00	2.15	.42
22.000	1061.29	1052.98	1064.76	.79	.57	1035.00	24.92	2.50	400.00	3.65	.54
23.000	1062.74	1053.76	1065.74	.93	.05	1036.00	21.86	2.50	400.00	3.15	.51
24.000	1064.17	1053.97	1066.73	.94	.04	1038.00	17.80	4.17	480.00	2.65	.46
25.000	1064.98	1055.57	1067.57	.83	.01	1038.00	19.34	.00	450.00	2.73	.48
26.000	1065.70	1056.93	1068.41	.80	.04	1038.00	20.90	.00	400.00	2.87	.50
27.000	1067.35	1056.56	1069.17	.66	.09	1038.00	15.73	.00	400.00	1.90	.40

APPENDIX C

COST OPTIMIZATION MEASURES FOR SOIL CEMENT

APPENDIX C: COST-OPTIMIZATION TECHNIQUES FOR SOIL CEMENT

Soil-cement construction costs are primarily a function of the following items:

1. The strength of the mix (i.e., cement/flyash content);

2. The total volume of soil cement required; and

3. The earthwork requirements.

Although there are other items which may, when added together, contribute a significant amount to the total cost of a typical bank-protection project, they are individually of secondary importance. For this particular project, the most significant secondary expense will be the relocation of refuse and/or hazardous wastes. Since it is likely that this item will not be considered as a separate pay item, it will probably be reflected in the unit earthwork costs.

With respect to the three primary items, the following cost-reduction measures should be taken into consideration

1. Mix strength:

    a. Determine the minimum-allowable strength and specify this strength.

    b. Do not include specification provisions that call for adjustments in the amount of cement required solely for the purpose of increasing durability. The thickness of the typical soil-cement unit alone provides for durability.

    c. Allow for the use of flyash under specific limitations to reduce the cost of the mix.

    d. Write the specifications in a manner that will eliminate the need to pay a contractor for any additional flyash or cement he independently uses to create a mix of higher than required strength.

2. Volume requirements:

    a. Provide toe-down depths that are based on sound engineering judgment, and ensure that the depths fluctuate in accordance with the erosion hazard.

b. Examine the possibility of reducing the typical eight-foot width, if engineering analyses support that reduction.

c. Minimize or eliminate access ramps, bicycle accessibility, and other nonessential uses of soil cement, unless the requesting agency is willing to pay for both the design and construction of these features.

3. Earthwork requirements:

a. Minimize or eliminate intrusion into known or suspected areas containing hazardous materials.

b. Adjust the alignment to minimize both cut and fill requirements.

c. If borrow material is needed, specify that it is to be removed from the channel or adjacent areas in a manner that will provide secondary benefits to the project.

d. Do not require that fill material be placed against the soil cement for strictly aesthetic reasons.