JAMES M. MONTGOMERY, CONSULTING ENGINEERS, INC.
30 Corporate Park, Suite 310, Irvine, California 92714 / (714) 261-7210

file COE
~~Admin files~~
overflow Analysis

May 9, 1988

RECEIVED
MAY 11 1988
REGIONAL
FLOOD CONTROL DIST.

Mr. Glenn Mashburn
U.S. Army Corps of Engineers
Hydraulics Section
300 No. Los Angeles Street, Room 6042
Los Angeles, California 90012

Dear Glenn:

Attached herewith please find the following:

- 2 copies of final report and final watercourse reports
- 2 copies of overflow maps for all watercourses
- 2 copies of profiles for all watercourses
- 1 set of calculations and responses to COE comments for portions of Las Vegas Wash, Flamingo Wash and Tropicana Wash
- 1 set of supporting HEC-2 runs for changes made to Las Vegas Wash, Flamingo Wash, Tropicana Wash, Range Wash and Las Vegas Creek based on COE comments
- 1 photo log.

Changes to Flamingo Wash were made to incorporate the hydraulic analysis performed by Bob Schaetzel for the area between Koval Lane and the Union Pacific Railroad. Modifications to the flow divisions at this location resulted in modifications to all downstream flow divisions, boundaries and profiles. It is noted that we made these modifications even though we received Bob's comments after we submitted what we thought was the "final" analysis for Flamingo Wash. In addition, we question whether this new approach is any more "accurate" given the inherent uncertainty in the hydrologic data and in the available topography for the casino area and I-15 interchange. Nonetheless, the COE changes were incorporated into the final study products directly.

On Tropicana Wash, the breakout analysis for the flowpath which enters the Flamingo Wash floodplain was extended from Koval Lane to the confluence between Tropicana Wash and Flamingo Wash. Below the confluence, Flamingo Wash flows control.

At your request, HEC-2 runs supporting the Range Wash nondamaging flow analysis are transmitted for your files.

The Las Vegas Creek HEC-2 run was mistakenly omitted from a previous submittal.

For Las Vegas Wash, you will notice that all of the changes requested in the COE comments have not been incorporated into the final product. In most cases, this refers to comments dealing with cross section orientation, GR point definition, and floodplain encroachment using ET cards. This decision has been made for several reasons. First, as indicated in notes in the attached package, we found that results were remarkably insensitive to small changes in cross section orientation or to the number of GR points in broad overbank portions of cross sections. Analysis of several cross sections confirms this conclusion, and shows that the study results would not be improved by making the recommended modifications. Second, we consider our limitation of floodplain expansion using ET cards at ridges to be reasonable and correct. Although small amounts of flow could overtop the "confining" ridges, the available topography is not accurate enough to warrant modifications to analyses on the basis of possible differences of on the order of 0.1 feet. Finally, the level of "accuracy" called for in some of the comments is simply not consistent with the inherent uncertainty in both the hydrology (± 20% at best) and the topography (± 2 feet for 4-ft contours). We do not consider it to be a valid expenditure of Montgomery's resources to make these changes when there is no assurance that the final product will be any more accurate. Despite the above limitations, all of Las Vegas Wash has been re-analyzed to incorporate the appropriate COE comments, and new HEC-2 runs are submitted as back-up.

As I discussed with you last week, we are willing to provide the COE with a tape containing all of our HEC-2 data and output files, in the event that the COE would like to make any modifications to the hydraulic analysis. If you would like such a tape, please let me know so we can have our respective computer departments work out the details. Although this deliverable is not called out in our contract, we are well aware of the difficulties caused by the delays and technical challenges on this project, and would like to do what we can to assist the COE in obtaining the product it believes it needs.

Very truly yours,

JAMES M. MONTGOMERY,
CONSULTING ENGINEERS, INC.

Chip Paulson

Chip Paulson
Project Manager
/ncy

Attachments

cc: Mike Bagstad, JMM Las Vegas
Virginia Valentine, CCRFCD

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT, CORPS OF ENGINEERS
P.O. BOX 2711
LOS ANGELES, CALIFORNIA 90053-2325

4 March 1988

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REPLY TO
ATTENTION OF

Office of the Chief
Water Resources Branch

Mr. Kenneth G. Ferguson
James M. Montgomery,
Consulting Engineers, Inc.
250 North Madison Avenue
P.O. Box 7009
Pasadena, California 91109-7009

Dear Mr. Ferguson:

The purpose of this letter is to express our concern over the progress of the analytical studies which your firm is conducting under contract to the Clark County Regional Flood District (CCRFCD). This analysis is a critical element in the Corps' Las Vegas Wash and Tributaries Feasibility Study. As a result of repeated delays in receiving the analysis, our study completion date has slipped approximately nine months.

As you know, on February 4, 1988, our Executive Management Committee met in Los Angeles to review progress of the Las Vegas Study. The following schedule was verbally agreed upon:

Date	Item
February 5, 1988	All draft overflows
March 2, 1988	All draft profiles and non-damaging frequencies
March 28, 1988	Preliminary final report
April 29, 1988	Final overflows, profiles, and text in report form

We appreciate the support of the James M. Montgomery executive staff, and hope that this will continue throughout the remainder of the Las Vegas overflow contract and in dealings which we may have in the future.

Sincerely,

Tadahiko Ono
Colonel, Corps of Engineers
District Engineer

CF:
Ms. Viringia Bax-Valentine
Clark County Regional Flood Control District
P.O. Box 396
Las Vegas, Nevada 89125

Overflow Study

CCRFCD/COE LAS VEGAS VALLEY OVERFLOW STUDY

IN-PROGRESS MEETING #1

MINUTES

Date: May 4, 1987
Time: 9:00 A.M.
Location: JMM Pasadena Office

Attendance: COE - Don Gross, Glenn Mashburn, Bob Schaetzel
JMM - Chip Paulson, Doug Hahn, Arsalan Dadkhah

Meeting topics included discussion of several general items, modeling of C-1 Channel, modeling of Pittman Wash, and modeling of Las Vegas Creek.

General Topics

1. JMM's approach to conducting the debris analysis was reviewed. Maps were presented indicating assumed debris loading at each structure in the study area; a brief report will be distributed within a few days to document study methods and results. The JMM analysis was based on historical information provided by local agencies, and COE debris loading criteria. The COE approved of JMM's approach to the debris analysis. Results indicate that about 80% of structures will be modeled with a 2-ft. obstruction for piers and abutments. It was noted that JMM omitted the channel-to-box conduit transition for Las Vegas Creek below Las Vegas Blvd.; this will be modeled with a 2-ft. debris obstruction.

2. Sediment loading at structures was based entirely on historical evidence, and was only assumed to affect the HEC-2 modeling of peak discharges in 3 or 4 locations. The COE accepted this assumption.

3. JMM presented its approach to n value evaluation. Channel and overbank n values for typical cross sections on each watercourse will be checked for consistency between the FIS HEC-2 models and results from Cowan's method and the urban floodplain adjustment. The COE approved of this procedure. It was noted that strict application of Cowan's method can sometimes lead to high results, and that its main benefit is as a checking tool and a training aid. Initial results show the FIS values for the channels are consistant with Cowan's method, but that urban floodplain values may in some cases be too low.

4. The COE would like to assure consistency in the selection of urban n values between this study and recently completed work in the Phoenix area. They will send information in the next few days to assist JMM in urban n value estimation. JMM's preliminary approach of assigning n values to typical types of urban development was approved, assuming it is consistent with the Phoenix-area data.

5. JMM should receive a letter early this week presenting final flows for use in the study. There are minor changes compared to the preliminary flows being used at this time.

6. Existing land use conditions in floodplain areas will be modeled (for hydraulics) unless construction is in progress or a specific building permit has been issued for a development.

7. In general, JMM should model through structures at the upstream study limits of each watercourse. This is necessary to estimate potential upstream overflows and transportation system impacts.

8. For future reference, Flamingo Wash at the UPRR and I-15 is expected by the COE to be a problem and require special hydraulic modeling treatment. This will be an item of discussion of future meetings.

C-1 Channel

1. JMM's assumption that the retaining wall will hold in the reach where it is elevated above grade is acceptable as long as JMM is confident of the structural design calculations. The 3-ft. freeboard criterion will not apply in this case.

2. JMM should do a supercritical HEC-2 run if flows look supercritical. This is mainly to allow for an evaluation of the channel construction in the case of highly erosive flows. Channel capacity will probably be based on critical depth or greater; JMM should cehck with the COE on this assumption when more modeling data is available.

3. If the unlined portion of the study reach is supercritical flow, the channel cross sections may have to be modified to account for erosion. JMM will call the COE if this is the case to obtain technical guidance.

Pittman Wash

1. JMM discussed the problem of the flow division below the UPRR bridge. The COE hydrology presently shows a 50-50 split of flows between a northern (in to Duck Creek) and an eastern flow path. To be conservative, JMM will model full 100-year flows down both flow paths.

2. JMM discussed the problem of the large gravel pit on the eastern flow path which has significant storage volume, and could greatly affect downstream flows. This issue will be referred to the COE Hydrology group, which will respond to JMM as soon as possible.

Las Vegas Creek

1. JMM raised a question regarding which of the two tributaries at Valley View is included in our study. One is a box culvert and one is an open channel. Also, there is a question about which one of the tributaries is associated with the flows in the COE hydrology table. This matter will be referred to COE Hydrology, which will respond to JMM as soon as possible.

2. The buried conduit portions of Las Vegas Creek will not be modeled hydraulically. Capacities will be determined at the upstream inlet, and the remaining flow will be assumed to be overflow. Overflows will then be modeled separately.

Schedule

1. JMM is still planning to meet its initial due date for draft report submission (C-1 Channel, May 14).

2. The next in-progress meeting was scheduled for Monday, May 18th, in the JMM Pasadena Office.

Submitted By: Chip Paulson
Chip Paulson, Project Engineer

Distribution:
Virginia Valentine
Don Gross
Glenn Mashburn
Steve Ainsworth

CCRFCD/COE LAS VEGAS VALLEY OVERFLOW STUDY

IN-PROGRESS MEETING #2

MINUTES (Rev. 6-4-87)

Date: May 18, 1987
Time: 9:00 A.M.
Location: JMM Padadena Office

Attendance: COE - Glenn Mashburn, Bob Schaetzel
JMM - Chip Paulson, Doug Hahn, Arsalan Dadkhah

The meeting topics included several general topics, and specific discussion of technical issues related to C-1 Channel, Pittman Wash, and Las Vegas Creek.

General Topics

1. The format for meeting minutes used for the first in-progress meeting is acceptable to the COE.

2. The COE has only had a chance to do a preliminary review of the debris analysis report. At this time the content appears to be reasonable, and is consistant with what was discussed at the previous meeting. However, a detailed review of the report has not yet been conducted. In the meantime, JMM will assume the report is acceptable for its ongoing modeling work unless otherwise notified.

3. The method of evaluating roughness coefficients described to Bob Schaetzel by Mike Bagstad appears reasonable and appropriate. This includes review of n values for typical cross sections from the FIS models to check consistency, as well as development of typical n values for urban development. JMM will submit the results to the COE in written form early this week, and in the meantime will assume the results to be acceptable for its ongoing modeling work. The COE noted that information regarding consistency with previous COE studies in the Phoenix area, as discussed at the previous in-progress meeting, may not be forthcoming soon due to problems of internal review. JMM will move ahead with its roughness values; any subsequent changes based on COE information will be the responsibility of the COE.

4. In discussions with COE hydrologists, it would be helpful to have a base map on which flows and overflows can be shown. The COE has been using the CCRFCD Master Plan maps for this purpose. JMM will use the same format if possible.

5. In accordance with the project Scope of Work, a section of the final report will discuss JMM's management techniques used to assure consistency in analytical techniques and assumptions for all study areas. The COE would like to review this plan now to see that it meets their standards. JMM will submit a written management plan to the COE by May 22 for review and comment.

6. The procedures of the COE for reviewing, approving and transmitting "official" information were discussed with regard to their impact on the ability of JMM to meet a tight project schedule. It is realized that JMM can not wait 7 to 10 days for "official" answers to questions regarding technical issues, and still complete the project on time. Thus JMM will interpret information obtained in meetings, over the telephone, or in informal written correspondence, as being "official" information. It is understood that final approved information could differ from that originally transmitted on an informal project basis, resulting in extra effort on the part of JMM. If this occurs, the project budget and scope may have to be modified appropriately to reflect the additional work effort required to meet the final COE guidelines.

7. In order to facilitate timely COE response to technical problems, JMM was encouraged to raise potential problem areas at in-progress meetings before the actual modeling has been done. In this way possible solutions could be discussed beforehand, and the work could be performed in a more efficient manner.

C-1 Channel

1. Based on previous COE field inspection and discussions with JMM regarding Boulder Highway modeling, supercritical flow, and overflow modeling, it appears that JMM is proceeding in the right direction. However, the COE will review the modeling and mapping in more detail once the draft report is submitted.

2. JMM plans to submit the draft report for C-1 Channel on Friday, May 22.

Pittman Wash

1. In previous communication from the COE, JMM was instructed to model only the eastern flow path which enters the large gravel pit upstream of Boulder Highway. The method of handling the flow split in the HEC-2 model was discussed and resolved.

2. JMM prepared HEC-2 cross section data for the western flow path (which enters Duck Creek) before receiving notification from the COE that this path was not to be studied. This was done based on the discussion at the previous in-progress meeting, and resulted in 2-3 days of extra work ($1500) which will not be useful for the final study. The COE suggested that the report should state that this cross section data is available for use in future hydraulic studies.

3. JMM plans to submit the draft report for Pittman Wash on Friday, May 29.

Las Vegas Creek

1. Channel overflows will be calculated by subtracting the channel capacity (computed by HEC-2) from the total discharge. Development of detailed hydraulic rating curves is not considered necessary at this time.

2. JMM will prepare a schematic diagram of overflow locations and assumed inflow locations. This will be submitted to the COE (by mail or in person) for review and clarification by their hydrologists. Flows may have to be adjusted due to the difference in timing of inflow peaks with respect to the flow in Las Vegas Creek. This issue must be resolved quickly.

3. Mapping may be a problem in some Las Vegas Creek overflow areas. The Clark County mapping is difficult to interpret in certain urban areas due to the difficulty in distinguishing contours from planimetric features. The COE suggested checking into mapping developed by SCS for the original Las Vegas Valley flood insurance study. JMM's contract states that the best available mapping will be used, and no new mapping will be prepared for this project.

4. Overflows from Las Vegas Creek affect the Charleston underpass area. This location may also be affected by overflows from Flamingo Wash. This situation needs to be considered when preparing the maps and the report text.

5. The submittal date for Las Vegas Creek can not be determined until the hydrology issues are resolved.

Schedule

The next in-progress meeting was tentatively scheduled for Monday, June 1, 9:00 A.M., in the JMM Pasadena Office.

Submitted By: Steven Mauro
for Chip Paulson, Project Engineer

Distribution:
Virginia Valentine - CCRFCD
Don Gross - COE
Glenn Mashburn - COE
Steve Ainsworth - JMM
Mike Bagstad - JMM
Doug Hahn - JMM

CCRFCD/COE LAS VEGAS VALLEY OVERFLOW STUDY

IN-PROGRESS MEETING #3

MINUTES

Date: June 1, 1987
Time: 9:00 A.M.
Location: JMM Pasadena Office

Attendance: COE - Glenn Mashburn, Bob Schaetzel
JMM - Chip Paulson, Doug Hahn, Arsalan Dadkhah, Steve Mano

The meeting was conducted in accordance with the attached agenda. The following specific items were discussed.

General Topics

1. The COE had some minor corrrections to the minutes of in-progress meeting # 2. Revised minutes will be issued by JMM.

2. The COE approved the n value procedure described in the previously submitted report. Comments were offered on improving the clarity of the text, including making it clear that the Cowan method was used for channels whereas the Hejl method was used for urban overbanks. In addition, the COE would generally like JMM modelers to consider using NH cards to vary roughness across a cross section, rather than computing composite weighted-average n values. This is particularly important when there are both open and densly urban areas in the same cross section overbank. Use of NH cards is felt to give the COE and CCRFCD more flexibility in updating the HEC-2 models when land use changes in the future.

3. The COE approved the "Management Techniques to Maintain Technical Consistency" report submitted by JMM in response to the request at the previous in-progress meeting.

4. The "Submittals" section of the Scope of Work was reviewed to clarify certain items.

   a. JMM's initial submittal of material to the COE for review will be called a "Preliminary Draft." This will consist of two copies of maps, report, HEC-2 output and profiles transmitted to Glenn Mashburn. No copies will be distributed to other parties until after initial COE review.

   b. Profiles do not have to be drafted on vellum. The JMM 11" x 17" printed sheets are acceptable as long as they reproduce legibly.

   c. Drafting of workmaps can be done in ink if JMM desires, although dark pencil is allowed.

d. COE needs to review JMM's original workmaps to see all the model development information (cross section tick marks, extended sections, ineffective flow areas, etc.). These would be submitted for review with the preliminary draft material. However, the "presentation maps" for the draft and final reports should not have all the model development data on them so the results will be more clearly visible.

C-1 Channel

The COE had not had an opportunity to review the C-1 Channel material previously submitted by JMM. This could be discussed at the next in-progress meeting.

Pittman Wash

1. JMM has essentially completed the text, profiles and maps, workmaps, computer output, profiles and report will be picked up by Bob Schaetzel today for preliminary review.

2. Drafting of Pittman Wash workmaps should be completed on Wednesday, June 3.

Las Vegas Creek

1. The COE delivered new flows for Las Vegas Creek based on the rating curves previously submitted by JMM. These curves were adjusted by Bob Schaetzel to account for channel surcharge capacity. The COE will provide JMM with backup for these adjustments if they are to be described in the report.

2. Overflows continue to be a major problem for the Las Vegas Creek analysis. It is estimated that the study of this flooding source will require another two weeks to complete.

Range Wash

1. Questions on the COE hydrology table are currently being resolved by the Hydrology Branch.

2. A potentially complex overflow condition exists at Las Vegas Blvd., where the main Range Wash Channel could overflow into the Eastern Tributary to Ranch Wash. This is the area where JMM requested clarification on the hydrology table.

Duck Creek

Modeling is proceeding on Duck Creek. No problems were discussed.

Schedule

1. At this time JMM is approximately 2 weeks behind on the overall schedule. Although this time can not be made up in the short term (all modelers are working on streams in progress), there are opportunities to pick up time near the end of the schedule after most of the preliminary analyses have been submitted.

2. The next in-progress meeting was scheduled for Wednesday, June 17, at 9:00 A.M. in the JMM Pasadena office.

Submitted By: Steven Mauro
for Chip Paulson, Project Engineer

Distribution:
Virginia Valentine - CCRFCD
Don Gross - COE
Glenn Mashburn - COE
Steve Ainsworth - JMM, LV
Mike Bagstad - JMM, LV
Doug Hahn - JMM, Pas

CCRFCD/COE LAS VEGAS VALLEY OVERFLOW STUDY
IN-PROGRESS MEETING #3
JUNE 1, 1987, 9:00 AM
JMM PASADENA OFFICE

AGENDA

1. Review and approve Minutes from In-progress Meeting #2

2. Review draft n value report

3. Review draft Management Techniques report

4. Review "Submittals" section of the Scope of Work

5. Receive comments on the C-1 Channel preliminary submittal
   - Maps
   - Profiles
   - Report

6. Pittman Wash Modeling
   - Status
   - Problems
   - Schedule

7. Las Vegas Creek
   - Status
   - Problems
   - Schedule

8. Range Wash
   - Status
   - Problems
   - Schedule

9. Other issues from JMM or COE

10. Schedule and Budget Concerns

CCRFCD/COE LAS VEGAS VALLEY OVERFLOW STUDY

IN-PROGRESS MEETING #4

MINUTES

Date:	June 17, 1987
Time:	9:00 A.M.
Location:	JMM Pasadena

Attendance: COE - Glenn Mashburn, Bob Schaetzel
JMM - Chip Paulson, Steve Mano

The overall topics of discussion are shown on the attached meeting agenda. Specific discussion items are summarized below.

Minutes

The minutes from In-progress Meeting #3 were accepted as presented.

General

1. COE will allow JMM to submit only one copy of preliminary study material (maps, reports, profiles) rather than the two copies specified in the contract. COE has sufficient in-house reproduction capability to make its own copies for mark-up and internal review.

2. COE requested that copies of engineering notes, computer output and workmaps be submitted to Bob Schaetzel at the time the maps are turned over to drafting. This will expedite Bob's review process, and perhaps avoid potential problems prior to final drafting.

3. COE requested that map panels be consolidated when only a tiny portion of a panel has flood boundaries shown. Sheet 52 on Range Wash is an example. This will facilitate review and reduce the number of sheets to be duplicated.

4. In areas affected only by 500-year flooding, boundaries may be shown on USGS quadrangle maps rather than obtaining additional County base mapping at 1"=200'. It is recognized that this may result in use of more than one scale of mapping to show flood boundaries for some streams.

5. When plotting coincident flood boundaries, COE would like the boundary for the largest flow to take precedence. This is in contrast to the contract, which states that the "highest frequency flood" will take precedence. JMM will assess the budget implications of this change (since several maps have already been drafted) and report to Glenn.

6. There are two approaches for showing water surface elevations in areas of breakout flows. If a "main channel" and associated thalweg can be identified, and a HEC-2 run is used to compute water surface elevations, then a regular profile would be appropriate. If this is not the case, then water surface

elevations (not depths) computed for each cross section will be shown on the maps in a 4-tiered box next to each section number. The legend will indicate which slots refer to each flood frequency; The lowest box will be Q25 and the highest box will be Q500. It is assumed that the latter case will be more prevalent. Water surface elevations should be shown to the nearest tenth of a foot.

7. JMM was reminded that structure and channel photographs must still be collected and organized for all flooding sources.

8. COE asked JMM if their review comments have been presented in a useable format. JMM has no suggestions for improvement to offer at this time.

C-1 Channel

1. JMM received clarification on some of Bob's modeling and mapping assumptions.

2. JMM should review the field survey data for the unlined channel to see if it agrees with the photos from the recon. Bob's opinion is that the survey may be in error based on his own observations.

3. In the upstream sheet flow area, Bob's model encroaches the floodplain arbitrarily to result in 1-ft deep flooding for each flood. It is suggested that this method be used to model sheet flow areas where the limits of flooding are virtually undefined due to the flat topography.

4. As long as JMM finds no errors, the COE revisions to the C-1 Channel maps and HEC-2 models will be adopted for our study. The profiles and report should be modified accordingly.

5. As noted in the review comments, Breakout #2 needs to be re-evaluated in light of channel capacity estimates in different reaches of the lined section. As soon as JMM completes this analysis, results should be transmitted to COE so they have a complete set of C-1 Channel mapping.

6. No estimated time of completion for the C-1 Channel Draft Report was offered. (See "Schedule" section.)

Pittman Wash

COE delivered review comments at the meeting. These will be discussed at a later date. Bob noted that his review comments should be amended to include a request that JMM specify non-damaging flows.

Las Vegas Creek

1. JMM reported that the maps are in drafting. Previous COE guidance was followed in drawing flood boundaries. JMM will review the maps to assure that there is clarity in distinguishing between main channel and breakout overflows. Water surface elevations in the breakout area can be shown using the box notation discussed previously.

2. Map drafting should be completed on Monday, June 22.

Range Wash

1. Clarification on the hydrologic impact of the Eastern Tributary to Range Wash was transmitted from COE to JMM.

2. JMM should plot flood boundaries over I-15, but not upstream of the freeway.

3. JMM's assumptions in calculating breakout flows, overflows and sheet flows were reviewed. Based on this cursory review, COE felt the assumptions made were reasonable.

4. Because peak floods on Range Wash and Las Vegas Wash are caused by independent storms, floodplains for each source should be delineated independently. Thus two separate sets of mapping will be prepared for the confluence area.

Duck Creek

1. JMM has discussed modeling assumptions with COE previously by telephone. This guidance has been followed.

2. Maps should go to drafting early next week.

Flamingo Wash

1. JMM has discussed specific modeling questions with COE previously by telephone. Bob requested topographic maps of the UPRR area so he can more carefully review the modeling in this area.

2. Because Doug Hahn was not available this week, no target due date was established for Flamingo Wash.

Tropicana Wash

1. Modeling is just beginning for this stream. Potential problems near the upstream study limit (alluvial fan), the long conduit at Paradise Road, and the confluence with Flamingo Wash were discussed. Sheet flow on the alluvial apron will be modeled similar to upper C-1 Channel.

2. It is too early to establish a schedule for completion of Tropicana Wash.

Report Outline

The COE proposed report outline was discussed. Certain points were added by JMM, and the following items were clarified:

a. "Hydrology" refers to the peak discharges provided by COE.

b. "Flood History and Characteristics" will only incorporate text already developed for the FIS or Master Plan, unless additional material is provided by CCRFCD.

c. "Mathematical Model" refers to HEC-2, normal depth calculations, bridge calculations, etc. used in the hydraulic analysis.

d. "Cross Section Orientation" will refer to classes of sections (e.g. main flow path, breakout areas, sheet flow, etc.), not individual cross sections.

A revised report format is attached based on the above discussion.

Schedule

1. JMM has limited drafting capability to process both new stream mapping and revisions to material reviewed by COE. If priorities must be asigned, COE would prefer that new mapping be completed first, before changes to previously submitted material are made.

2. JMM remains approximately 2 weeks behind the overall project schedule.

3. The next In-progress Meeting was tentatively scheduled for Wednesday, July 1, 1987 at 9:00 A.M. in the JMM Pasadena office.

Submitted By: Chip Paulson
Chip Paulson, Project Engineer

Distribution:
Virginia Bax-Valentine - CCRFCD
Don Gross - COE
Glenn Mashburn - COE
Steve Ainsworth - JMM
Mike Bagstad - JMM
Doug Hahn - JMM
Steve Mano - JMM

CCRFCD/COE LAS VEGAS VALLEY OVERFLOW STUDY

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IN-PROGRESS MEETING #5

MINUTES

Date: July 1, 1987
Time: 9:00 am
Location: JMM Pasadena Office

Attendance: COE - Glenn Mashburn, Bob Schaetzel
JMM - Chip Paulson, Doug Hahn, Arsalan Dadkhah, Steve Mano

The general topics of discussion are shown on the attached meeting agenda. Specific discussion items are summarized below.

Minutes

Minutes from In-progress Meeting #4 were reviewed. COE expressed concern over the wording of item 4 under "General" and item 1 under "Las Vegas Creek". JMM will revise these sections and redistribute the amended minutes.

CCRFCD Meeting

JMM reviewed the input received during its June 25, 1987 meeting with Virginia Valentine. In particular, CCRFCD would like to assure that there is opportunity for local input to study results at some point in the process. This could possibly occur after preparation of draft material by JMM. It was noted that the schedule and budget currently do not provide for this situation.

Las Vegas Creek

1. Discussion centered on modeling strategies and assumptions in light of preliminary COE review comments and the meeting on June 29, 1987 between Bob Shaetzel, Doug Hahn and Arsalan Dadkhah.

2. The COE idea of the "economic development boundary" to be used at the upstream study limit was explained. In general, this consists of plotting flood boundaries in shallow sheet flow areas based on flood widths which yield a depth of approximately 1.0 foot at the encroachment limits. Boundaries would be determined by trial-and-error, using identifiable ridge lines for encroachments as much as possible. This is the approach taken by Bob for analyzing the upstream reach of C-1 Channel.

3. Bob is working on an analysis of the complex hydraulic situation for sheet flow between I-15 and Washington Avenue Channel. He will forward this to JMM for review and discussion when it is complete.

4. JMM will produce a supercritical HEC-2 model of the upper, lined portion of Las Vegas Creek to develop a better estimate of the channel capacity.

5. JMM delivered to Bob all of its workmaps for the Las Vegas Creek area so he can make copies for use in his analysis and review.

Flamingo Wash

1. COE delivered a new hydrology table providing additional flows for Flamingo Wash.

2. Final modeling for the reach downstream of the Tropicana Wash confluence must wait completion of the preliminary analysis for Tropicana Wash in case extensive breakouts affect the Flamingo Wash hydrology.

3. Flamingo Wash and Tropicana Wash floodplains will be modeled independently at the confluence.

Tropicana Wash

1. See Item 3 for Flamingo Wash.

2. South Branch Tropicana Wash will not be studied west of UPRR due to lack of existing development. JMM will map the North Branch and Central Branch, even though mileage for only one branch is included in the contract, because there is a possibility that both branches will flow together.

3. Problems of accurately modeling the deep channels in the upstream reach were discussed. It is recognized that there may have to be some inconsistencies between the maps and the HEC-2 runs in these areas.

4. Skewed bridges can be modeled by explicitly modifying the bridge dimensions on the SB card if desired, rather than using the skew factor in HEC-2.

5. JMM expects to deliver preliminary Tropicana Wash material in about two weeks.

Range Wash

1. The problem of modeling breakout flows of different recurrence intervals in the downstream left overbank (south of Charleston) was discussed and resolved.

2. Preliminary maps (original workmaps), profiles, report, HEC-2 runs and engineering notes were delivered to COE for review.

Duck Creek

1. JMM reported that Duck Creek modeling is complete, but mapping has not been completed for the channel area. Estimated completion time is Wednesday, July 8.

2. COE will be in Las Vegas next week to conduct field reconnaissance. They will tentatively stop by the JMM office at 3:00 to discuss Duck Creek and pick up preliminary submittal material.

C-1 Channel, Pittman Wash

1. JMM reported that work on corrections to these streams is on hold until preliminary work has been completed on the other stream currently in progress.

2. COE reminded JMM that information on Breakout #2 on C-1 Channel is desired as soon as possible.

Hydrology

JMM noted that it had received a letter from FEMA stating that the FIS discharges for Clark County will not be changed as a result of the recent master plan hydrologic analysis. A copy of this letter will be forwarded to Glenn.

Budget

JMM reviewed its concerns regarding the project budget, as per the attachment to the meeting agenda. COE will raise this issue at the next Study Management Committee meeting.

General

1. COE does not need profiles as part of JMM's preliminary submittal, as they do not assist Bob in his technical review at this stage.

2. COE reproduction and use of JMM original (pencil) workmaps will be facilitated if JMM:

   a) assures colored pencil lines are as dark as possible

   b) adopts a line-type legend as well as a color code to distinguish between flood boundaries.

   JMM will attempt to accomodate this request in the future.

3. JMM should state in the reports that "non-damaging channel capacity" refers to the potential hydraulic capacity of the channel, regardless of whether that amount of flow could ever enter the channel.

Schedule

The next In-Progress Meeting was tentatively scheduled for Wednesday, July 15, 1987 in the JMM Pasadena Office.

Submitted By: Chip Paulson
Chip Paulson, Project Engineer

Distribution:

Don Gross - COE
Glenn Mashburn - COE
Virginia Bax-Valentine - CCRFCD
Steve Ainsworth - JMM
Mike Bagstad - JMM
Doug Hahn - JMM
Arsalan Dadkhah - JMM
Steve Mano - JMM

CCRFCD/COE LAS VEGAS VALLEY OVERFLOW STUDY
IN-PROGRESS MEETING #5
JULY 1, 1987
JMM PASADENA OFFICE

AGENDA

1. Approval of Minutes from In-Progress Meeting #4

2. Review of June 26, 1987 Meeting with CCRFCD
   Request for formal period of local input to study results

3. Las Vegas Creek
   Discussion of COE review comments
   Schedule

4. Flamingo Wash
   Problems
   Schedule

5. Tropicana Wash
   Problems
   Schedule

6. Range Wash
   Delivery of preliminary submittal maps, profiles, report
   Discussion of problem areas
   Schedule

7. Duck Creek
   Problems
   Schedule

8. C-1 Channel and Pittman Wash corrections on hold

9. Budget Problems
   Summary of present problems (attached)
   Discussion of possible resolutions

10. COE Hydrology vs FEMA Hydrology

11. COE Items

12. Schedule Next Meeting

SUMMARY OF JMM BUDGET CONCERNS FOR LAS VEGAS VALLEY OVERFLOW STUDY (JULY 1, 1987)

Description	Hours	Cost
A. Greater Overall Level of Effort		
1. Modifications to FIS models to adapt them to high COE flows exceeds original estimate (10 hr/mi) by 8 hr/mi for 50 mi	400	$24,000
2. Length of breakouts (overflows) to be analyzed exceeds budget estimate (20 mi) by 30 mi, and analyses are significantly more complex due to high flows (actual time = 8 hr/mi, budgeted time = 4 hr/mi)	240	$14,400
3. Extensive inundation areas and breakouts required numerous requests for County topographic mapping and production of base maps	60	$3,000
TOTAL =		$41,400
B. Requests for Work Out of Project Scope		
1. COE change in flow path to be analyzed for Pittman Wash after modeling had begun	24	$1,500
2. C-1 Channel drafting and report corrections due to COE change in upsteam reach modeling strategy	16	$900
3. COE change in priority of plotting flood boundaries ("highest frequency" vs "highest flow")	8	$400
4. Remodeling of Duck Creek due to incomplete structure information	4	$250
5. COE issuance of report outline after 3 draft reports were written.	20	$1,000
6. Anticipate need for 2 additional in-progress meetings for adequate technical review of remaining streams	24	$1,500
TOTAL =		$5,500

CCRFCD/COE LAS VEGAS VALLEY OVERFLOW STUDY

IN-PROGRESS MEETING #6

RECEIVED

JUL 23 1987

R.T.C.

MINUTES

Date: July 15, 1987
Time: 9:00 A.M.
Location: JMM Pasadena Office

Attendance: COE - Glenn Mashburn, Bob Schaetzel
JMM - Chip Paulson, Doug Hahn, Arsalan Dadkhah

A copy of the meeting agenda is attached. Specific discussion items are summarized below.

Minutes

Due to an oversight by JMM, minutes from In-Progress Meeting #5 had not been distributed. Minutes from this meeting, as well as revised minutes from In-Progress Meeting #4, were handed out. COE will call JMM with review comments tomorrow.

(Note: On July 16 COE called JMM to approve the minutes from Meeting #5.)

Study Management Committee Meeting

1. COE reported that due to fiscal constraints on this project, JMM's request for additional funds to cover the greater-than-expected level of effort can not be met.

2. CCRFCD would still like to involve local agencies in review of the study results at some point. The most likely time for this will be after production of draft material.

Las Vegas Creek

1. A general discussion was held regarding cross section locations and orientations, and flow distributions. There is still some disagreement between COE and JMM as to how this area will behave in a flood event.

2. Bob and Arsalan will meet tomorrow to conduct a detailed review of Las Vegas Creek modeling strategies by both groups. At this time a final decision will be made regarding assumptions to be used in completing the Las Vegas Creek Study.

3. JMM does not have to perform supercritical runs for the upper channel reach. Non-damaging capacity will be estimated using critical depths from the subcritical HEC-2 run.

4. A completion schedule can not be determined until after tomorrow's meeting.

Flamingo Wash

1. The upper reach is still in COE review.

2. Although portions of the lower reach may go to supercritical flow in the channel, capacities can be based on critical depths in the subcritical HEC-2 run.

3. It can be assumed that for reaches with high channel velocities, all of the weir flow over a bridge deck will return to the channel immediately downstream of the bridge.

4. The Flamingo Wash analysis will assume that there will not be significant affects on hydrology due to breakouts from Tropicana Wash.

5. JMM estimates that Flamingo Wash preliminary submittal materials will be completed by the end of next week.

Tropicana Wash

No problem areas were discussed. It is estimated that preliminary submittal materials will be completed by the end of next week.

Range Wash

1. COE had some preliminary review comments on the upstream reach. In general, review had been complicated by the use of repeated cross sections in the FIS model and by the failure to show bridge cross sections on the workmaps.

2. COE will summarize all comments after review is completed. Specific comments made at the meeting will be passed on to Steve Mano.

Duck Creek

JMM delivered preliminary submittal material for COE review on July 8.

COE Field Reconnaissance

COE briefly described their field reconnaissance trip last week. Recon areas included Las Vegas Creek and Range Wash.

Schedule

1. JMM remains 2 weeks behind the overall schedule. Difficulties in completing the Las Vegas Creek study have prevented making up time.

2. The next In-Progress Meeting is scheduled for July 29, 1987 at 9:00 at the JMM Pasadena Office.

Submitted by: Chip Paulson

Chip Paulson, Project Engineer

Distribution

Don Gross - COE
Glenn Mashburn - COE
Virginia Bax-Valentine - CCRFCD
Steve Ainsworth - JMM
Mike Bagstad - JMM
Doug Hahn - JMM
Arsalan Dadkhah - JMM
Steve Mano - JMM

CCRFCD/COE LAS VEGAS VALLEY OVERFLOW STUDY
IN-PROGRESS MEETING #6
JULY 15, 1987
JMM PASADENA OFFICE

AGENDA

1. Review (and approval?) of Minutes from In-Progress Meeting #5. Minutes to be distributed at meeting.

2. COE report on last Study Management Meeting

3. Las Vegas Creek
   Discussion of shallow flooding analyses by JMM and COE
   Resolution of remaining differences
   Status and schedule

4. Flamingo Wash
   Status
   Schedule

5. Tropicana Wash
   Status
   Schedule

6. Range Wash
   COE preliminary review comments

7. Duck Creek
   In COE review

8. Report on COE field reconnaissance

9. Other COE items

10. Schedule next meeting

CCRFCD/COE LAS VEGAS VALLEY OVERFLOW STUDY

IN-PROGRESS MEETING #7

MINUTES

Date: July 29, 1987
Time: 9:00 A.M.
Location: JMM Pasadena Office

Attendance: COE - Glenn Mashburn, Bob Schaetzel
JMM - Chip Paulson, Doug Hahn, Arsalan Dadkhah, Steve Mano

A copy of the meeting agenda is attached. Specific discussion items are summarized below.

Minutes

Minutes from In-Progress Meeting #6 were approved as submitted.

Las Vegas Creek

1. COE delivered new routed flows for the area below the railroad and freeway. Considerable discussion followed over how these flows compared with those previously agreed upon at the July 16 meeting. COE will check flows for agreement. This is the last set of flows JMM will model.

2. JMM has revised the hydraulic models based on the previous meeting with COE, but has not run the new flows.

3. JMM anticipates delivery of draft material on August 7.

Flamingo Wash

1. JMM reviewed technical criteria for flow divisions discussed previously with COE.

2. Bob's review comments on the reach from Jones Blvd. to Rainbow Blvd. were discussed in detail, particularly with regard to use of the normal bridge routine versus the special bridge routine.

3. Doug will make revisions to his model from Jones to Rainbow to incorporate Bob's suggestions, and will submit the results to Bob for review. After this review, work will continue on the lower reach of Flamingo Wash.

4. JMM anticipates delivery of Flamingo Wash preliminary submittal material by August 10.

Range Wash

1. JMM is in the process of incorporating COE review comments on the upper reach received at a special review meeting on July 22. This will affect breakout flows, requiring potential modifications to the full model.

2. COE review on the lower reaches is awaiting JMM's new results.

3. JMM expects new models and mapping to be completed by August 7.

Duck Creek

COE is now beginning review of the Duck Creek preliminary submittal, and should be completed by early next week.

Tropicana Wash

1. No major problems were discussed for Tropicana Wash.

2. Preliminary submittal material will be delivered by August 7.

Duck Creek

COE is now beginning review of the Duck Creek preliminary submittal, and should be completed by early next week.

Tropicana Wash

1. No major problems were discussed for Tropicana Wash.

2. Preliminary submittal material will be delivered by August 7.

General

1. Extensive discussion revolved around use of normal and special bridge routines. Bob pointed out potential problems with special bridge weir flow calculations for high flows where much of the flow is out of the channel. Guidelines were considered for selecting between the two modeling methods, and for making each accurately reflect the true flow conditions. It was decided that the method most appropriate for modeling the 100-year flood for each structure will be used, since JMM has neither the time or budget available to model different discharges with different methods. In general, normal bridge routine should be considered where there is substantial flow out of the channel and where bridge sections are depressed below the surrounding grade (i.e., where true weir flow does not occur). Possible impacts of this selection should be discussed in the reports for each stream.

2. The difference between FEMA and COE hydrology remains an issue for COE. It will not impact the JMM overflow study.

Schedule

1. Drafting is beginning on C-1 Channel revisions for preparation of the draft material. Pittman Wash corrections must await completion of the preliminary Flamingo Wash submittal due to personnel assignments (Doug is responsible for both streams).

2. Work on Las Vegas Wash will be temporarily delayed until corrections have been completed for Range Wash.

3. The complete set of draft reports should be delivered in the third week of August. The final reports will be completed by the second week of September, pending review by COE and perhaps others as well.

4. The last In-Progress meeting was tentatively scheduled for Tuesday, August 18. The date could be changed in order to maximize the effectiveness of this last meeting relative to the status of work on the various streams.

Submitted by: Chip Paulson

Chip Paulson, Project Engineer

Distribution:

Don Gross - COE
Glenn Mashburn - COE
L ~~Virginia~~ Bax-Valentine -CCRFCD
Steve Ainsworth - JMM
Mike Bagstad - JMM
Doug Hahn - JMM
Arsalan Dadkhah - JMM
Steve Mano - JMM

LAS VEGAS WASH AND TRIBUTARIES

OVERFLOW STUDY

CLARK COUNTY, NEVADA

Prepared for

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

and

CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT

September 1988

JAMES M. MONTGOMERY, CONSULTING ENGINEERS, INC.

LAS VEGAS WASH AND TRIBUTARIES

OVERFLOW STUDY

CLARK COUNTY, NEVADA

Prepared for

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

and

CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT

by

James M. Montgomery, Consulting Engineers, Inc.
2915 West Charleston Blvd., Suite 12
Las Vegas, Nevada 89102

September 1988

TABLE OF CONTENTS

LAS VEGAS WASH AND TRIBUTARIES OVERFLOW STUDY

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this overflow study is to determine the extent and depth of flooding in Las Vegas Valley, Clark County, Nevada. Flood boundaries and water-surface elevations are required by the Hydraulics Section of the U.S. Army Corps of Engineers (COE) as part of the Las Vegas Wash and Tributaries Feasibility Study. The Overflow Study includes all major flooding sources in the Las Vegas Valley (Las Vegas Wash, Range Wash, Las Vegas Creek, Flamingo Wash, Tropicana Wash, Duck Creek, Pittman Wash, and C-1 Channel), and delineates flood hazards for main channels and all significant breakout flows.

1.2 AUTHORIZATION

This study was performed by James M. Montgomery, Consulting Engineers, Inc. (JMM), under contract to the Clark County Regional Flood Control District dated April 9, 1987. The Scope of Work for the study was prepared by the Los Angeles District of the COE, which also provided extensive technical and administrative review throughout the project.

1.3 COORDINATION WITH OTHER AGENCIES

Technical criteria and review were provided by the Hydraulics Section of the COE, with input during the negotiation process from Clark County Regional Flood Control District (CCRFCD). Supplemental bridge survey data were obtained from the CCRFCD.

1.4 REPORT ORGANIZATION

This main body of the report presents an overview to the entire overflow study for Las Vegas Wash and Tributaries. It describes general study area characteristics, analytical methods, and results in a summary fashion.

The main text is followed by eight appendices, each of which is a flood analysis report for an individual stream. These reports describe study data, methods and results in sufficient detail to allow another engineer to interpret and understand the analysis that was performed. It is intended that the individual watercourse reports be stand-alone documents which, when combined with the overflow maps, profiles and hydraulic calculations, provide a complete explanation of the overflow analysis for that watercourse.

The products of the overflow study consist of:

- HEC-2 Computer Program Data Tape
- Study Report
- Overflow Maps for 25-, 50-, 100- and 500-year Floods
- Water Surface Profiles for 25-, 50-, 100- and 500-year Floods
- Engineering Backup Data

This material is on file with the Los Angeles District of the U.S. Army COE and Clark County Regional Flood Control District.

2.0 DESCRIPTION OF STUDY

2.1 LOCATION AND EXTENT

Las Vegas Valley is located in central Clark County, which in turn is located in the southern tip of the State of Nevada. Las Vegas Valley includes essentially all of the Las Vegas Wash drainage area upstream of Lake Mead. This encompasses all of the incorporated areas of the City of Las Vegas, the City of North Las Vegas, and the City of Henderson, as well as a large unincorporated portion of the County. The study area is shown in Figure 1.

Hydraulic analyses for the overflow study were limited to reaches in presently urbanized areas, or where breakouts could impact existing development. Study reaches are defined below.

a. Las Vegas Wash - from Interstate 15 to the AWT Plant
b. Las Vegas Creek - from Valley View Blvd. to Las Vegas Wash
c. Las Vegas Range Wash - from Interstate 15 to Las Vegas Wash
d. Flamingo Wash - from Rainbow Blvd. to Las Vegas Wash
e. Tropicana Wash - from Rainbow Blvd. to Flamingo Wash
f. Duck Creek - from Maryland Parkway to Las Vegas Wash
g. Pittman Wash - from Union Pacific Railroad to Las Vegas Wash
h. Henderson Area - C-1 Channel from Boulder Highway to Lake Mead Drive.

2.2 TOPOGRAPHIC AND STREAM CHARACTERISTICS

Las Vegas Valley is a large bowl formed by the Sheep Mountains on the north, the Spring Mountains on the west, the McCullough Range on the south, and the French Mountains on the east. All runoff in the Valley drains to Las Vegas Wash, which flows in a southeasterly direction, and exits the Valley in the southeast corner about 4 miles upstream of Lake Mead.

The remote portions of the Las Vegas Wash watershed are very steep, mountainous areas of rugged desert terrain. The lower valley portions are very flat, and are dominated by urban development of all types. The transition between the mountain and valley watershed areas is comprised of a nearly continuous series of alluvial fans. The alluvial

JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC.	LOCATION MAP	FIGURE 1

apron is most pronounced on the west and north sides of the Valley, where the largest watershed areas empty onto the Valley floor.

All of the study reaches in this analysis are dry washes (ephemeral streams). They convey runoff only in direct response to storm events. Most channels have flat bottoms and steep side slopes characteristic of alluvial channels. More detailed descriptions of each stream of study are contained in the Appendices.

A schematic diagram showing the relationship among the various watercourses is presented in Figure 2.

2.3 FLOOD HISTORY AND CHARACTERISTICS

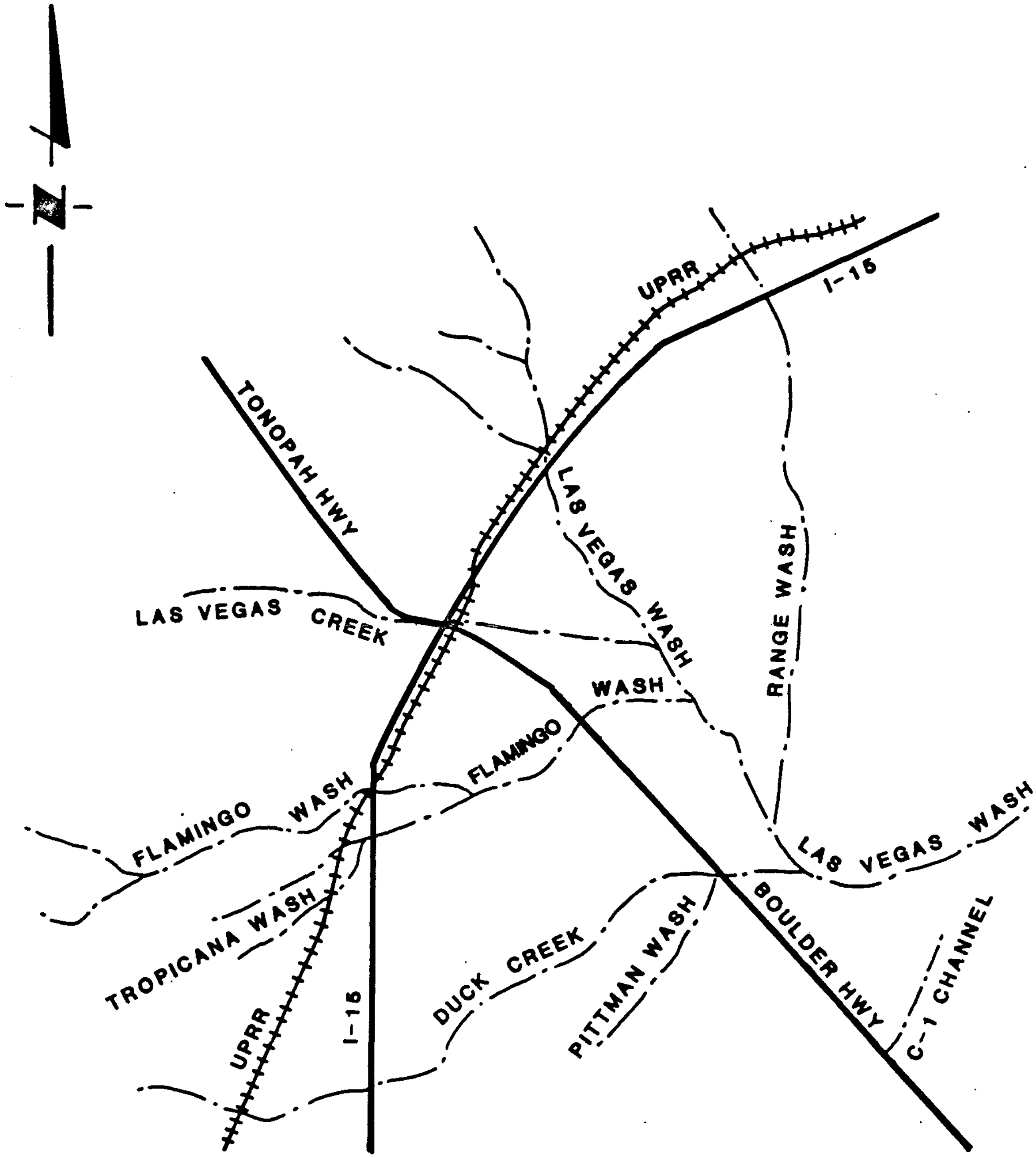
A number of severe storms have occurred in Clark County which have been fairly well documented. These storms are briefly described below. In general, storm events which result in significant runoff rates are summer thunderstorms of short duration and high intensity, most of which occur in July or August. These storms are the result of tropical depressions which approach Clark County from the south or the southeast. General storms, either in summer or winter, are rare, and have not contributed to significant flood flows in the past.

July 23, 1923

In a 1-hour period, 1.98 inches of precipitation was registered but it was estimated that the measurement was 50 percent greater than the storm amount due to high winds. The storm was local and centered in Las Vegas. Water flowed through most every building in the city including those along Fremont Avenue. An estimate of damage was $25,000.

October 12, 1947

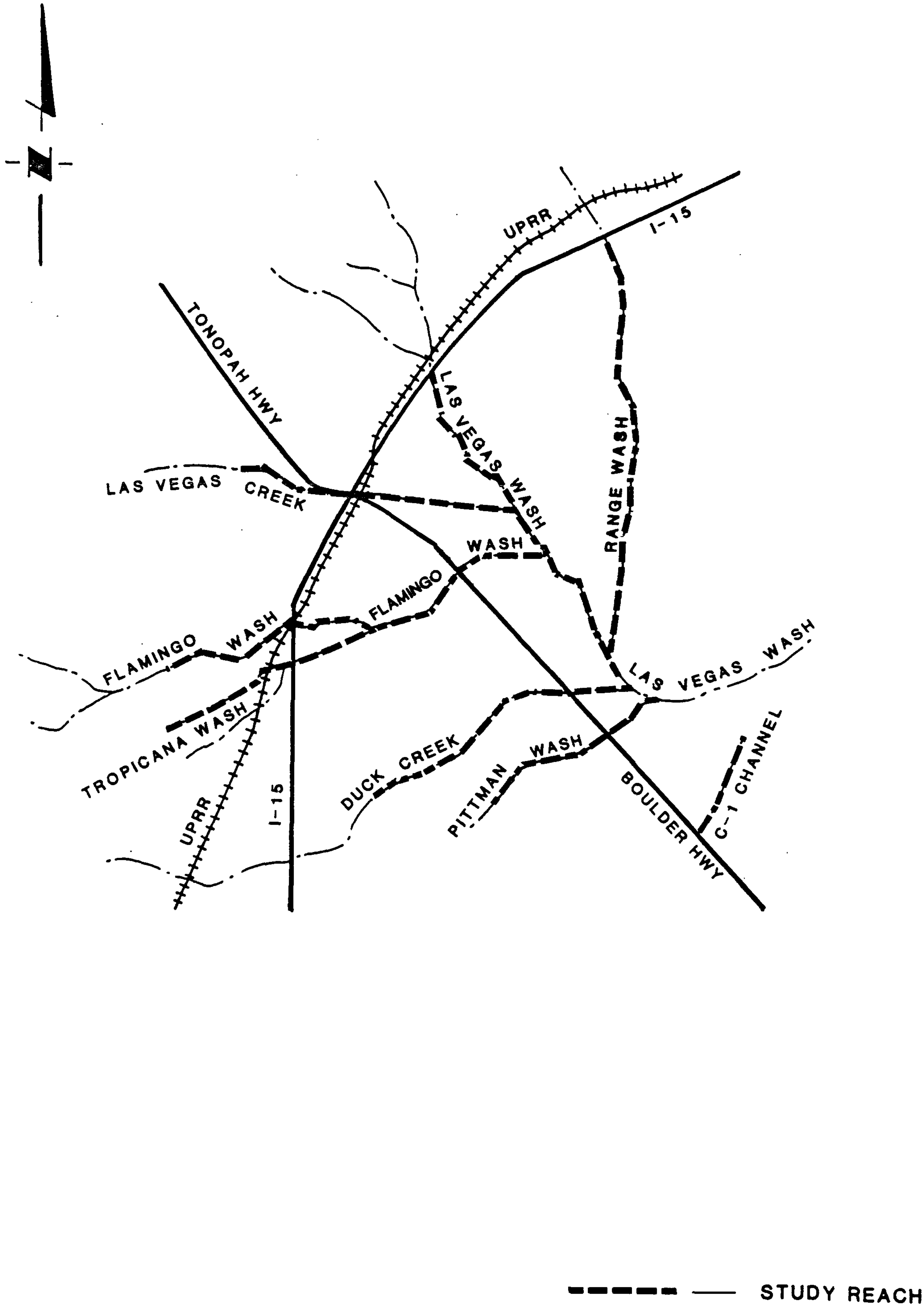
Damages from fallen trees, wind and a heavy rainfall of 1.04 inches were reported. Approximately $100,000 of damage occurred in the



JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.

WATERCOURSE LOCATION MAP

FIGURE 2



JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC.	WATERCOURSE LOCATION MAP	FIGURE 2

Mayfair Trail immediately south of Fremont Avenue near 17th Street. Water flowed down Fremont Street and Charleston Blvd.

June 13, 1955

Precipitation of nearly 3 inches was reported for this large storm covering nearly 500 square miles. The official raingage at McCarran Field only recorded .39 inches. The COE prepared a special report on this storm and estimated damages at $1.5 million. Other sources indicate damages from $2,375,000 to $3,000,000 to buildings, contents of buildings, public utilities, streets and alleys, the Union Pacific Railroad, automobiles and personal property. The sewage disposal plant for Las Vegas was flooded and clogged by silt and mud. An estimated $83,000 in damages occurred to the sewer plant and its connecting lines. The COE estimated a peak discharge of 6,000 cfs along the west side of the Union Pacific Railroad track about 200 feet north of San Francisco Street (now known as Sahara Avenue).

August 21, 1957

The Las Vegas Valley was drenched by 2.57 inches of rain damaging city streets estimated at $50,000. This storm gave a discharge of 1,400 cfs at the U.S. Geological Survey (USGS) stream gaging station on Las Vegas Wash near Henderson.

September 13, 1969

Heavy rains pushed by Pacific Coast tropical storms hit the Las Vegas Valley. The only rainfall that was measured was .48 inches at Little Red Rock west of Las Vegas. Conservative damage estimates from this storm were in excess of a quarter of a million dollars. More than a dozen automobiles were swept from Caesars Palace parking lot under the bridge crossing Las Vegas Blvd. (the Strip) where they jammed up, causing a crude dam that forced the water still higher. The USGS recorded a peak discharge of 1,500 cfs on Flamingo Wash at Maryland Parkway. It is noted that this site is downstream of culverts which were partially obstructed with debris.

July 3-4, 1975

This storm occurred generally between 12:00 noon and 6:00 p.m. on July 3, 1975. The heaviest cumulative rainfall was about 1 inch per hour, with the total storm precipitation exceeding 3 inches in some areas. Most of the precipitation occurred during a 3-hour period. The storm was located primarily over the mountains and alluvial fans south, west and north of metropolitan Las Vegas. The storm track was in the typical south-to-north direction, with runoff being generated from approximately 350 square miles throughout the duration of the event. Peak flows on Tropicana Wash, Flamingo Wash and Las Vegas Creek were the highest recorded at that time. Heaviest damage occurred on Flamingo Wash, particularly in the vicinity of Caesars Palace. Floodwaters also ponded in several areas in the downtown business district. Problems associated with sediment erosion and deposition occurred throughout the study area. Lateral erosion appeared most prominent in most channels. Flooding caused the loss of two lives, and total damage was estimated by Clark County Flood Control District at $4-5 million.

August 10, 1983

On the afternoon of August 10, 1983, an intense flash-flood thunderstorm occurred over the upper portion of Flamingo Wash. The storm moved from south to north and produced 1 inch of rain or more over 100-150 square miles. The maximum total storm depth at any location was estimated to be 4 inches occurring over a total of about 3 hours. A 4.5 square mile area of the Flamingo Wash watershed produced 2,300 cfs. The storm produced the peak flow of record for Flamingo Wash. Flood damage included erosion of channel banks, flooding along Winnick Avenue, and damage to several road crossings.

July-August 1984

In July and August 1984, a series of thunderstorms swept through southern Nevada causing flooding in Las Vegas Valley, Moapa Valley, and Boulder City. Detailed information from this event has not been published. The most intense rainfall recorded at Boulder City (by two private raingages) was 1.75 inches in one hour, followed by another 1.5 inches in 1.5 hours, for a total storm depth of about 3.25 inches in 2.5 hours. Significant damage occurred in southern Las Vegas Valley and the City of Henderson.

Other recent severe thunderstorms in Eldorado Canyon in 1974 and Moapa Valley in 1981 and 1984 support the tendency toward flash-flood types of events in Clark County.

In most recent floods, flooding has been characterized by sheet flow conditions, with scour and deposition problems occurring in many of the channels. A primary source of damage is the deposition of sediment on roadways and in other floodplain areas. In addition, debris obstruction of certain bridges and culverts has been a problem in the urban areas.

2.4 PRESENT AND FUTURE URBANIZATION

The floodplain areas along the watercourse reaches analyzed in this study exhibit a variety of levels and types of urbanization. This ranges from downtown areas along Las Vegas Creek, to casino complexes over Flamingo Wash, to ranch estates in the upper reaches of Tropicana Wash. There remain large parcels of undeveloped land within the study area. These will eventually infill in a manner assumed to be consistent with the surrounding development. With regard to the hydraulic analysis, baseline conditions for land use and flood control facilities were set at conditions as of July 1, 1987.

Urban development will eventually extend well beyond the present urban area. In establishing the study limits for this project, it was assumed that future urbanization beyond the present development limits would be adequately protected from flooding as a result of implementing the CCRFCD Flood Control Master Plan(1).

Specific floodplain conditions for each of the streams of study are discussed in the individual watercourse reports in the Appendices.

3.0 HYDRAULIC ANALYSIS

3.1 DATA SOURCES

3.1.1 Maps

The best available mapping was utilized for this study. This consisted of:

- o Rectified photo topographic maps prepared for the unpublished Clark County Flood Insurance Study(2) (Scale: 1"=400', Contour Interval: 4 ft., Date: September 1984)
- o Rectified photo topographic maps prepared for the City of North Las Vegas (Scale: 1"=200', Contour Interval: 2 ft., Date: September 1981)
- o Clark County planimetric base mapping (Scale: 1"=200', Contour Interval: 5 ft., Date: 1974)
- o USGS Quadrangles (Scale: 1"=2,000', Contour Interval: 10 ft., Date: 1973)

No new topographic mapping was developed for this project.

3.1.2 Hydrology

Peak discharges for 25-, 50-, 100- and 500-year floods were based on "future conditions without project" hydrology provided by the COE, adjusted for hydraulic constraints and breakout flows. Peak flows for each watercourse and study reach are contained in the Appendices. Representative discharges are listed in Table 1.

TABLE 1

Peak Discharges w/o Project
1987 Conditions
(in c.f.s.)

Location	25-Year Fut.	50-Year Fut.	100-Year Fut.	500-Year Fut.
Las Vegas Wash at Vegas Valley Drive RM 2.29	7,800	14,000	24,000	84,000
Las Vegas Wash at I-15 RM 10.7	6,200	12,500	23,000	82,000
Las Vegas Creek at confluence with Las Vegas Wash RM 0.00	6,000	9,500	15,000	36,000
Las Vegas Creek at upstream limit of study RM 6.40	910	1,150	9,200	33,000
Range Wash upstream of Vegas Valley Drive RM 0.5	4,600	7,500	12,500	35,000
Range Wash at Interstate Highway 15 RM 9.49	3,500	6,000	10,000	28,000
Flamingo Wash at Nellis Blvd. RM 0.9	6,400	9,400	14,000	39,000
Flamingo Wash at Spanish Trails Golf Course RM 12.5	3,700	6,000	9,400	34,000
Tropicana Wash at Flamingo Wash RM 0.00	2,800	4,700	7,500	22,000
Tropicana Wash at UPRR RM 3.5	1,900	3,200	5,500	19,000
Duck Creek at Las Vegas Wash RM 0.00	5,400	10,000	18,500	60,000
Duck Creek Downstream of Las Vegas Blvd. RM 8.75	5,100	9,400	16,500	51,000

TABLE 1

Peak Discharges w/o Project
1987 Conditions
(in c.f.s.)

Location	25-Year Fut.	50-Year Fut.	100-Year Fut.	500-Year Fut.
Pittman Wash at upstream study limit RM 5.28	5,300	8,900	14,500	39,000
Pittman Wash at Las Vegas Wash (before Weisner Channel diversion) RM 1.17	400	1,300	3,700	9,500
C-1 Channel at Apache Place RM 0.54	4,600	7,600	12,500	33,000
C-1 Channel downstream of Boulder Highway RM 3.00	2,950	4,900	7,900	21,000

3.1.3 Hydraulic Structures

Surveys of hydraulic structures obtained for the unpublished Clark County Flood Insurance study were utilized for most of the bridges and culverts included in this analysis. This information was supplemented with field checks and/or as-built plans of new structures supplied by CCRFCD. All structures completed by July 1, 1987 have been included in this analysis.

3.1.4 Cross Sections

Where available, digitized cross sections developed for the unpublished Clark County Flood Insurance Study(2) were used for the riverine analysis. Digitized sections were entered into HEC-2 files directly from magnetic tapes supplied by the aerial surveyor. Cross sections were extended or supplemented using the topographic data (contours and spot elevations) from the best available mapping of the study reaches. This supplemental data was entered into HEC-2 manually. Bank stations were selected manually by inspection of the cross section data. In general, the cross sections will oriented perpendicular to the direction of flow. No new cross sections were surveyed.

3.1.5 Mathematical Models

The COE HEC-2 Water Surface Profiles computer program(3) was used to determine water-surface elevations. In reaches which had been modeled for the unpublished Clark County FIS(2) (Las Vegas Wash, Range Wash, Flamingo Wash, Tropicana Wash, Duck Creek, and portions of Las Vegas Creek), the FIS models were used as a foundation for the overflow modeling. The FIS models were prepared in 1985 and 1986 under the guidelines of the Federal Emergency Management Agency. Many modifications to the FIS models were made in order to implement the study criteria specified by the Corps of Engineers for this overflow study. These included modifications to bridge models, n values, sedimentation, and split and divided flow analyses. In reaches not analyzed previously for the FIS (including breakout areas), new HEC-2 models were developed, incorporating COE study criteria. In some breakout areas HEC-2 was applied to individual cross sections with a normal depth assumption.

3.2 METHODOLOGY

3.2.1 Assumptions and Limitations

The accuracy of the overflow analysis is based in part on the accuracy of the topographic data with which the cross sections and flood boundaries were defined. This data was not field checked.

In sheet flow areas, computed floodplain boundaries are very sensitive to cross section orientation. Sections in these areas were drawn to be generally parallel to the contour lines.

In breakout areas, overflows were analyzed until it was determined that the boundary depth was less than 1.0 foot and the velocity was less than 3 feet/sec. At this point, the analysis was terminated due to the limited damage potential associated with this level of flooding. Thus, in these areas, the boundaries reflect an "economic value boundary" rather than the actual limit of inundation.

Small islands in floodplains which are due to local topographic variations have not been delineated on the overflow maps. However, these high ground areas are contained in the cross section data.

Hydraulic analyses for each stream were performed independent of backwater effects from downstream watercourses. This is consistent with the assumption that the critical discharges are generated by storms centered over individual watersheds, rather than straddling portions of multiple watersheds. The starting water surface elevations for the tributaries to Las Vegas Wash were determined using the slope-area method. This may lead to inaccuracies in water-surface elevations for the tributary washes in the first several hundred feet of the confluence with Las Vegas Wash, but this condition will be masked by the water-surface elevations on the main stream.

Due to the uncertainty of their foundations and the variation of their construction methods, block walls were assumed to fail at ground level. Therefore, the effects of block walls on channel breakouts and overflow paths and depths have not been considered in this analysis.

The hydraulic analysis was conducted using HEC-2 in the subcritical mode only. This implies the assumption of steady state uniform flow conditions with no transitions to supercritical flow. In addition, HEC-2 is a fixed bed model, and hence the fluvial processes of sediment transport, erosion, sedimentation, and channel migration have not been simulated.

Bridges were modeled using either the normal or special bridge routine. If the 100-year discharge was primarily contained in the channel, the special bridge routine was selected; if the 100-year discharge was primarily overbank flow, the normal bridge routine was used. The same routine was used for all four floods of study. Bridges and culverts modeled in the HEC-2 simulation were assumed to remain intact throughout the flood event. Impacts of bridge failure were not investigated.

3.2.2 Roughness Factor Determinations

Two methods were utilized for making n value determinations. For open or natural areas, "Supplement B Hydraulics," a supplement to the SCS Engineering Handbook, developed by Woody L. Cowan was used[4]. For urban developed areas, "A Method for Adjustment of Manning's Roughness Coefficient for Flooded Urban Areas", written by Hejl and Kaus was used[5]. The Appendix contains a detailed description of the background data used to estimate n values. A summary of this description follows.

The Cowan method begins with a base n value for the earthen material in the channel. Adjustments are made to the base value on the basis of protruding surface irregularities, variation of cross section shape along the stream, the amount and type of vegetation and degree of meandering. Calculated n values using the Cowan Method for channel and overbanks in open land ranged from 0.040 to 0.080.

The urban n value method begins with a base n value between the houses or buildings. Adjustments are made on the basis of longitudinal and transverse spacing of the buildings along the flow path. The procedure used in setting urban n value criteria was to calculate n values for a variety of typical development types throughout the Las Vegas Valley. Urban n values range from a low of 0.045 for sparsely populated rural areas to a high of 0.180 for high density multifamily areas. Following is a summary of results for the Las Vegas valley:

Development Type	Description	N Value
Rural	Sparse development	.045
	Fully developed	.060
Residential		
Custom lots	Curved streets and lots of room between houses	.060
Custom lots	Large houses on large lots but arranged perpendicular to flow	.120
Single family	Open space around houses or curved streets	.130
Single family	Close packed with rows of houses perpendicular to flow path	.160
Multifamily Units	Space provided between buildings	.140
	A minimum of low space between the buildings	.180
Commercial or Industrial	Only half of the flow path blocked	.060
	A majority of the flow path is blocked	.170

3.2.3 Debris Evaluation

The potential for debris loading impacts on hydraulic structures in Las Vegas Valley was investigated. A full discussion of this investigation is contained in the Appendix. A summary of the debris analysis follows.

The approach for conducting the Las Vegas Valley debris analysis consisted of three steps.

1. Investigation of areas where debris and sedimentation problems have historically occurred, and local conditions which typically lead to debris obstruction problems. Due to the subjectivity of much of the debris evaluation, this historical information is particularly valuable.

2. Development of debris criteria specific to the Las Vegas Valley study area, consistent with the Los Angeles District of the COE approach to debris analyses.

3. Assignment of a debris obstruction factor to each bridge and culvert structure on the streams of study.

The first step was carried out by contacting public works agencies in the Las Vegas Valley. The following individuals were contacted:

Virginia Valentine - Clark County Regional Flood Control District
Gus Cederburg - Clark County Department of Public Works
Steve Jackson - City of Las Vegas
John Murchie - City of North Las Vegas
Saeed Ahmad - City of Henderson
Kent Mayer - Nevada Department of Transportation

Based on these local agency contacts, the following important facts were gathered.

- Problems with debris in channels are valley-wide, and are primarily associated with trash and vegetation from urban areas.

- Locations where nuisance flows are present and where there is extensive public access are particularly susceptible to debris problems.

- Virtually all multiple barrel box culverts have potential debris problems. Although debris may catch on the supports of span bridges, their larger capacities minimize the problem.

- o The following structures were specifically mentioned as having debris or sedimentation problems: Vegas Valley Drive on Las Vegas Wash; Swenson Road on Flamingo Wash; UPRR bridge and Boulder Highway on Duck Creek; lower Pittman Wash and Whitney Wash; Vandenburg Channel in North Las Vegas; Lake Mead Blvd. on Las Vegas Wash; 18th Street and 21st Street on Washington Avenue Channel; Lamb Blvd. on Flamingo Wash; Charleston Blvd. on Las Vegas Wash; Lake Mead Blvd. on the C-1 Channel.

- o Flamingo Wash has continuous flow in the largely unlined reach between Cambridge Road and Las Vegas Wash.

- o Most sediment load is generated from eroding channel banks in unimproved reaches rather than sheet erosion from the upland watersheds. This is verified by the relatively small amounts of sediment collected in the local detention basins.

In consideration of the above local information and the Los Angeles District's standard procedures for modeling debris obstructions, five criteria were developed for analyzing each stream reach and structure.

1. Structures with a significant debris potential were modeled with an assumed 2-foot debris obstruction on both sides of each pier. For clear span bridges, the 2-foot obstruction was applied to each abutment, unless the abutments are wingwalls, in which case no obstruction was applied.

2. For structures located in reaches with significant debris potential, but which are only a short distance downstream of another structure with debris problems, a 1-foot obstruction was applied to each pier or abutment.

3. Unlined stream reaches in urban areas were assumed to have significant debris potential, particularly those with continuous flow.

4. Unfenced stream reaches in urban areas were assumed to have significant debris potential.

5. Sediment deposition was assumed to occur in structures which have experienced severe sedimentation problems in past floods. Depths of assumed sedimentation with blockage at the time of peak discharge were either 1 or 2 feet, depending on the severity of reported historical deposition.

Based on the above criteria, each bridge and culvert structure in the study reaches was evaluated with regard to its debris potential. An obstruction factor equal to the required assumed blockage on each side of the piers was then assigned to each structure. This blockage was applied to both sides of all piers, as well as to the abutments if no wingwalls are present.

3.2.4 Channel Capacities

Nondamaging discharges were established for each watercourse of study. Based on guidance from the COE, the nondamaging discharge was defined to be the bank-to-bank channel capacity with no freeboard. Channel capacities were estimated using rating curves developed from the multiple profile HEC-2 runs.

Each watercourse was divided into several reaches for establishing nondamaging discharges, each reach having reasonably uniform hydraulic characteristics.

Nondamaging discharges for each stream of study are presented in the Appendices. These values have been established for economic evaluation purposes, and should not necessarily be used for floodplain management applications.

3.3 SUMMARY OF RESULTS

Floodplain maps have been prepared to identify 25-, 50-, 100- and 500-year flood boundaries throughout the study area. Flood profiles have been plotted showing water-surface elevations for the four floods along all of the channel reaches and in some of the major breakout areas. Where profiles have not been prepared, water-surface elevations are shown on the maps.

Specific discussions of the results for individual stream courses are contained in the Appendices. In general, the 25-year flood has relatively little damage potential, whereas the 100-year and 500-year floods inundate extensive areas. Results for the 50-year flood are more site-specific.

Floodplains delineated in this Overflow Study are significantly more extensive than those developed for the unpublished Clark County FIS. This is attributed to three factors, in order of decreasing importance:

1. The discharges used in the Overflow Study are considerably larger than those used in the unpublished FIS.

2. Debris loading of bridges and culverts in the Overflow Study greatly reduces their capacities as compared to the FIS analysis in which all structures were considered to be unobstructed.

3. The Overflow Study n values are higher than FIS values in areas of dense urban development.

4.0 MANAGEMENT TECHNIQUES TO MAINTAIN TECHNICAL CONSISTENCY

The Las Vegas Valley Overflow Study included coincident analysis of eight independent but interrelated stream courses with a parallel approach. Resources from three different offices were utilized. An engineer was assigned responsibility for a specific stream, from initial data gathering to completion of the report. Staffing the project in this decentralized manner increased the potential for inconsistency in modeling methods and application of hydraulic judgment. Several specific management techniques were applied to assure consistent quality control of technical judgments and of hydraulic data interpretations between water courses. These methods are outlined below.

Initial Mobilization Meetings

The project manager held initial mobilization meetings with all of the hydraulic modeling staff to assure that all engineers clearly understood their responsibilities as well as the overall project scope of work. The project engineer was present at all of the negotiation sessions, and so was in a position to interpret the intent of the scope of work to the rest of the staff. At this time project goals and milestones were established.

In-Progress Meeting Minutes

Most significant project decisions of a technical or policy nature were discussed at regular in-progress review meetings held throughout the project period. These meetings were held bi-weekly during the initial phase of the study.

These meetings were attended by the JMM project manager, and by other staff engineers on an as-needed basis. In order to keep the entire engineering staff aware of the progress and direction of the project, the project manager prepared detailed meeting minutes for distribution to the technical staff, the COE and CCRFCD. These minutes allowed engineers to apply principles discussed early in the project to all streams.

Centralized Project Tasks

Several project tasks were centralized in order to avoid different interpretations among the various engineers. These tasks were those which affected all of the modeling areas. The most significant examples were the debris analysis and the roughness coefficient evaluation. For both of these tasks, analyses for all watercourses were conducted by one engineer, who then distributed the results to the rest of the modeling staff in the form of an interim technical report. This assured uniform application of the recommended study methods, and also improved the efficiency of completing the work. These interim technical reports were also circulated to the COE and CCRFCD for review and comment in draft form, in order to obtain input prior to production of the draft report.

Computer Mail

JMM has an internal electronic mail system which links all of the offices through an in-house VAX computer network. Computer mail was used to transfer written communications regarding technical questions, policy issues, meeting results, telephone conversations, etc. throughout the course of the project. This was used in instances when a written record of the communication was desired, or when accuracy was of importance and the potential for verbal misinterpretation existed.

Project Review

The ultimate responsibility for maintaining consistency in technical analysis between the study areas rested with the project manager. He was actively involved in the day-to-day progress of modeling each watercourse to assure that decisions were made in accordance with the overall project guidelines and objectives. Although the project manager was the key point of contact between the JMM staff and the COE staff, individual modelers were encouraged to contact the COE staff directly with technical questions so as to expedite the work effort. In these instances, the project manager was informed of the contact immediately (usually in writing or by computer mail) so important information could be passed on to the rest of the staff if necessary.

5.0 CONCLUSIONS

The report, flood maps, profiles and HEC-2 hydraulic computer models will provide the COE with the basic floodplain information necessary to evaluate the benefits and damages associated with proposed flood control projects in Las Vegas Valley. Hydraulic analyses were performed in accordance with the criteria outlined by the COE, and results were carefully reviewed by COE staff. Study results will also be useful to CCRFCD and other local agencies in floodplain management and flood control planning.

Major flood problems have been identified for all of the watercourses studied. These are primarily associated with:

- Undersized bridges and culverts
- General lack of major channel improvements in urban areas
- Sheet flows from upstream alluvial fans.

Numerous major transportation arteries are shown to be inundated by the floods of study, and could experience severe flood damage. These arteries include Interstate 15, U.S. 95, the Union Pacific Railroad, Boulder Highway, and Las Vegas Blvd. There is significant potential for extensive flood damage to occur to critical roadways, pipelines, and other infrastructure components. In addition, prominent commercial/industrial areas are shown to be flooded, particularly along Las Vegas Creek and Flamingo Wash.

This study has confined attention to primary flood sources in the presently developed portions of Las Vegas Valley. As urbanization spreads and infill continues, new properties and structures will become subject to flooding unless remedial measures are undertaken.

Much of the flood-prone area in Las Vegas Valley is affected by large breakouts from the main watercourses. Such breakouts occur on Las Vegas Creek, Flamingo Wash, Tropicana Wash, Duck Creek, C-1 Channel, and Range Wash. These breakouts subject large areas to sheetflow flooding conditions, with relatively low depths (less than 3 feet) and velocities. Much of the area affected by sheetflow flooding is currently in various densities of residential development.

This analysis has not addressed problems associated with erosion, deposition, channel migration, or headcutting. Hazards associated with these processes could be significant at several locations in the study area.

6.0 REFERENCES

1. Clark County Regional Flood Control District, Flood Control Master Plan, 1986.

2. Federal Emergency Management Agency, Draft Flood Insurance Study, Unincorporated Areas of Clark County, Nevada, 1987 (unpublished).

3. Hydrologic Engineering Center, U.S. Army Corps of Engineers, HEC-2 Water Surface Profiles, Users Manual, September 1982.

4. Cowan, Woody L., Guide for Selecting Roughness Coefficient n Values for Channels, Soil Conservation Service, December 1963. Also Soil Conservation Service, Engineering Handbook, Hydraulic Section 4.4 Supplement B, August 1956.

5. Hejl, H.R., Jr., Method for Adjusting Values of Manning's Roughness Coefficient for Flooded Urban Areas, Journal Record U.S. Geological Survey, Vol. 5, No. 5, September-October 1977.

APPENDICES

LAS VEGAS WASH

LAS VEGAS WASH

CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT

OVERFLOW ANALYSES

by:

James M. Montgomery, Consulting Engineers, Inc.
2915 West Charleston Blvd., Suite 12
Las Vegas, Nevada 89102

September 1988

LAS VEGAS WASH AND TRIBUTARIES OVERFLOW STUDY

LAS VEGAS WASH

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LAS VEGAS WASH

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this overflow study is to determine the extent and depth of flooding in the Las Vegas Wash floodplain. Flood boundaries and water-surface elevations are required by the Hydraulics Section of the U.S. Army Corps of engineers (COE) as part of the Las Vegas Valley Feasibility Study. The overall overflow study included all major flooding sources in the Las Vegas Valley (Las Vegas Wash, Range Wash, Las Vegas Creek, Flamingo Wash, Tropicana Wash, Duck Creek, Pittman Wash, and C-1 Channel), and mapped flood hazards for main channels and all significant breakout flows.

1.2 AUTHORIZATION

This study was performed by James M. Montgomery, Consulting Engineers, Inc. (JMM), under contract to the Clark County Regional Flood Control District dated April 9, 1987. The Scope of Work for the study was prepared by the Los Angeles District of the COE, which also provided extensive technical and administrative review throughout the project.

1.3 COORDINATION WITH OTHER AGENCIES

Technical criteria and review were provided by the Hydraulics Section of the COE, with input during the negotiation process from Clark County Regional Flood Control District (CCRFCD). Supplemental bridge survey data were obtained from the CCRFCD.

2.0 GENERAL DESCRIPTION OF STUDY AREA

2.1 LOCATION AND EXTENT

Las Vegas Wash is the main streamcourse flowing through the Las Vegas Valley, with a drainage area of approximately 1,300 square miles at the downstream study limit. Las Vegas Wash was studied for approximately 10.7 miles, from the Advanced Wastewater Treatment (AWT) Plant upstream to Interstate Highway 15. In this reach, Las Vegas Wash flows though the City of North Las Vegas, the City of Las Vegas, and unincorporated Clark County. The confluence with Range Wash is at River Mile (RM) 2.6; the confluence with Flamingo Wash is at RM 3.0; the confluence with Las Vegas Creek (Washington Avenue Channel) is at RM 6.4; and the confluence with "N" Channel in North Las Vegas is at RM 9.6. Upstream of the confluence with "N" Channel, Las Vegas Wash is also known locally as "A" Channel. Only "A" Channel, the main Las Vegas Wash channel has been analyzed in this study. Duck Creek, Pittman Wash, and C-1 Channel join Las Vegas Wash downstream of the study reach.

2.2 TOPOGRAPHIC AND STREAM CHARACTERISTICS

From the downstream study limit upstream to Vegas Valley Drive, Las Vegas Wash flows through a broad, flat floodplain and is not very well defined. The average slope is approximately 0.0037 (20 feet/mile).

Upstream of Vegas Valley Drive, the Las Vegas Wash channel is well-defined for the remainder of the study reach. The average slope from Vegas Valley Drive upstream to the confluence with "N" Channel is approximately 0.0040 (21 feet/mile). Upstream of the confluence with "N" Channel, Las Vegas Wash becomes steeper, with an average slope of approximately 0.0062 (33 feet/mile).

2.3 CHANNEL IMPROVEMENTS

Several sections of Las Vegas Wash are improved:

- from the confluence with Flamingo Wash to Winterwood Golf Course Bridge #2, the channel is trapezoidal with earth bottom and concrete side slopes,
- from Winterwood Golf Course Bridge #2 to Stewart Avenue, the channel has various widths and is unlined,
- from Stewart Avenue to Bonanza Avenue, the channel is 85′ wide, 18′ deep and is unlined,
- from Bonanza Avenue to the confluence with Las Vegas Creek, the channel has various widths, is 10′ deep, and unlined,
- from the confluence with Las Vegas Creek to Lamb Boulevard, the channel has various widths, is 12′ deep, and unlined,
- from Lamb Boulevard to Pecos Street/Lake Mead Boulevard, the channels has various widths, is 8′ deep, and unlined.
- from Pecos Street/Lake Mead Boulevard to Carey Avenue, the channel has various widths, is 10′deep, and unlined,
- from Carey Avenue to Cheyenne Avenue, the channel is 80′ wide, 10′ deep, and unlined, and
- from Civic Center Drive to I-15, the channel is 88′ wide, 9′ deep, and is unlined.

The only other improvements to the Las Vegas Wash channel are the numerous bridges and culverts which span the channel and road crossings.

2.4 FLOOD HISTORY AND CHARACTERISTICS

A number of severe storms have occurred in Southern Nevada in the past decade which have been fairly well documented, and which provide an indication of the nature of the typical flood-producing storm in Las Vegas Valley. In general, storm events which result in significant runoff rates are summer thunderstorms of short duration and high intensity. These storms are the result of tropical depressions which approach Clark County from the south or the southeast. General storms, either in summer or winter, are rare and have not contributed to significant discharges in the past.

A heavy thunderstorm occurred generally between 12:00 and 6:00 p.m. on July 3, 1975, with the heaviest cumulative rainfall of approximately 1 inch per hour and the total storm precipitation exceeding 3 inches in some areas. The storm was located primarily over the mountains and alluvial fans to the south, west, and north of metropolitan Las Vegas. The storm track was the typical south-to-north direction, with runoff being generated from approximately 350 square miles throughout the duration of the event. Peak flows on Las Vegas Wash were the highest recorded at that time, with an estimated return period of 111 years (References 1 and 2).

2.5 PRESENT AND FUTURE URBANIZATION

In the reach from the wastewater treatment plant (the downstream study limit) to the confluence with Flamingo Wash, the area adjacent to Las Vegas Wash is mostly undeveloped and used primarily for agricultural purposes.

In the reach from the confluence with Flamingo Wash upstream to Cheyenne Avenue, the development in both overbanks is primarily medium density housing.

In the reach from Cheyenne Avenue upstream to I-15 (the upstream study limit), the area adjacent to Las Vegas Wash is basically undeveloped, although there is some new development in the right overbank, downstream of I-15.

3.0 HYDRAULIC ANALYSIS

3.1 DATA SOURCES

3.1.1 MAPS

The analysis of flooding along Las Vegas Wash was based on mapping from three sources:

Rectified photo topographic maps prepared for James M. Montgomery, Consulting Engineers, Inc., by Cooper Aerial of Nevada, Inc., for the Clark County Flood Insurance Study (FIS) (Reference 3). Scale 1:4,800, Contour interval: 4 feet. Photo date: September 14, 1984.

Rectified photo topographic maps prepared for James M. Montgomery, Consulting Engineers, Inc., by Aero-Graphics, Inc., for the City of North Las Vegas Flood Insurance Study Appeal (Reference 4). Scale 1:2,400, Contour interval: 2 feet. Photo date: September 1981.

U.S. Geological Survey 7.5-Minute Topographic Map, Las Vegas NE, Nevada. Scale 1:24,000, Contour interval: 20 feet. 1967 (Photo Revised 1984).

3.1.2 HYDROLOGY

Peak discharges were based on "future conditions without project" hydrology provided by the COE. Table 1 summarizes the discharges used in the analysis of flooding along Las Vegas Wash.

TABLE 1

Peak Discharges w/o Project
1987 Conditions
(in c.f.s.)

Concentration Point	Main Channel 25-Year Fut.	Main Channel 50-Year Fut.	Main Channel 100-Year Fut.	Main Channel 500-Year Fut.	Breakout Flow 25-Year Fut.	Breakout Flow 50-Year Fut.	Breakout Flow 100-year Fut.	Breakout Flow 500-Year Fut.
Las Vegas Wash at Vegas Valley Drive CP-3 RM 2.29 DA = 1100.0 mi^2	7,800	14,000	24,000	84,000	0	0	0	0
Las Vegas Wash at Harris Avenue and Marion Avenue CP-9 RM 6.10 DA = 768.0 mi^2	6,800	13,000	24,000	84,000	0	0	0	0
Las Vegas Wash Upstream of North Las Vegas Boulevard CP-7 RM 9.4 DA = 735.0 mi^2	6,400	13,000	24,000	84,000	0	0	0	0
Las Vegas Wash at I-15 CP-6 RM 10.7 DA = 733.0 mi^2	6,200	12,500	23,000	82,000	0	0	0	0

3.1.3 HYDRAULIC STRUCTURES

Surveys of hydraulic structures obtained for the Clark County Flood Insurance Study (Reference 3) were utilized in this analysis. This information was supplemented with field checks for new structures supplied by the CCRFCD. All structures completed by July 1, 1987, have been included in this analysis. No future flood control projects have been included in this study. The hydraulic structures included in this analysis are listed in Table 2.

TABLE 2

Bridge Structures

Las Vegas Wash - Advanced Wastewater Treatment Plant to I-15

Stream Miles	Location	Structure - Type, Size
2.29	Vegas Valley Drive	Box Culvert 14'W x 5.5'D (Ten)
3.27	Winterwood Golf Course Bridge #1	Bridge 150'W x 4'D, supported
3.50	Winterwood Golf Course Bridge #2	Bridge 100'W x 4'D, supported
4.45	Nellis Boulevard	Bridge 90'W x 12'D, supported
4.70	Charleston Boulevard	Bridge 140'W x 7'D, supported
5.21	Stewart Avenue	Bridge 100'W x 16'D, supported
5.80	Bonanza Avenue	Bridge 105'W x 16'D, supported
6.76	Lamb Boulevard	Bridge 106'W x 10.5'D, supported
7.61	Owens Avenue (Vegas Drive)	Bridge 105'W x 8.5'D, supported
8.29	Pecos Street/ Lake Mead Boulevard	Box Culverts 12'W x 8'D (Three) + 8'W x 8'D (Four)
8.91	Carey Avenue	CMP Arch Culvert 7.5' x 15' (Five)
9.12	Las Vegas Boulevard	Box Culvert 12'W x 8'D (Five)
10.01	Cheyenne Avenue	CMP Arch Culvert 15'W x 7.5'D (Five)
10.55	Civic Center Drive	Bridge 88'W x 12.5'D, supported
10.70	I-15	Bridge 70'W x 13.5'D, supported

3.1.4 STREAM BED CROSS SECTIONS

Cross sections digitized from the aerial mapping for the FIS (Reference 3) were utilized for the riverine analysis. These cross sections were extended using topography from the 1:4,800 scale mapping. For the breakout analyses, cross sections were developed from topography from the 1:4,800, 1:2,400, and 1:24,000 mapping.

3.1.5 MATHEMATICAL MODELS

For the riverine analysis, the U.S. Army Corps of Engineers' HEC-2 step backwater computer program (Reference 5) was used to determine water-surface elevations. The hydraulic analysis for Las Vegas Wash has been divided into six main channel study reaches: 1. from the downstream study limit upstream to Vegas Valley Drive, 2. from Vegas Valley Drive upstream to Nellis Boulevard, 3. from Nellis Boulevard upstream to Lamb Boulevard, 4. from Lamb Boulevard upstream to Las Vegas Boulevard, 5. from Las Vegas Boulevard upstream to RM 10.34, and 6. from RM 10.34 upstream to I-15.

Where necessary, the models were linked using known water-surface elevations from downstream HEC-2 runs. Additionally in some areas, the various recurrence intervals were modeled separately so that X3 and ET cards could be applied independently. The foundation of the main channel HEC-2 runs was the HEC-2 modeling developed by JMM for the Clark County Flood Insurance Study (Reference 3). These models were originally prepared in 1985 and 1986 under the guidelines of the Federal Emergency Management Agency (FEMA). Extensive modifications to the FIS models were made in order to implement the study criteria for the Corps Feasibility Study.

Cross section labels (SECNO) for the riverine analysis reflect actual centerline distances, in miles, upstream from the Advanced Wastewater Treatment Plant. The AWT Plant is located 9.5 miles upstream of the confluence with Lake Mead.

3.2 METHODOLOGY

3.2.1 ASSUMPTIONS AND LIMITATIONS

The accuracy of the overflow analysis is based in part on the accuracy of the topographic data with which cross sections and flood boundaries were defined. In general, this data was not field checked. Where there are minor discrepancies between contour elevations and digitized cross section elevations, it was assumed in preparing the HEC-2 models that the digitized cross sections represented the more accurate data.

Where discrepancies occur at digitized cross sections between the computed HEC-2 flood boundary and the contour information, the boundary on the map has been plotted based on the contours. This improved consistency in plotting boundaries between cross sections and yields a more "regular" floodplain geometry.

In sheet flow areas, floodplain widths are very sensitive to the cross section orientation. Sections in these areas were drawn to be generally parallel to the contour lines.

In some areas of shallow flooding, small islands may occur as the result of minor local topographic variations. These islands have not been shown on the maps due to limitations of topographic definition and accuracy.

In some cases, bridges were modeled using the normal bridge routine and in other cases the special bridge routine was used. In general, when most of the 100-year flow at the bridge was contained in the channel either as low flow, pressure flow, or weir flow over the bridge deck, the special bridge routine was used. When most of the 100-year flow was in the overbanks at the bridge location, the normal bridge routine was used. Because the 100-year flood was used as the benchmark, the adopted bridge routines may not represent the best approaches to modeling the other recurrence intervals. Nonetheless, the same routine was used to model all four floods at a particular structure.

3.2.2 ROUGHNESS COEFFICIENT ASSESSMENT

Manning's "n" roughness coefficients used in the FIS analysis were verified as outlined in a JMM project memorandum (Reference 6). For the riverine analysis of Las Vegas Wash, the FIS roughness values were used as a basis, and were adjusted as necessary to reflect Corps of Engineers criteria. In particular, "n" values in areas of dense urban development were generally increased over the values used in the FIS. NH cards were utilized where cross sections were extended through multiple land use types.

Table 3 presents representative channel and overbank "n" values used in the analyses. Cross sections for which NH cards were used have data presented for the 100-year floodplain and are footnoted.

Table 3

"n" Values

Cross Section	Left Overbank	Right Overbank	Channel
0.00	0.070	0.050	0.070
1.65	0.100	0.060	0.060
2.78	0.060	0.050	0.030
3.256	0.045	0.045	0.050
3.69*	0.045	0.110	0.023
4.75*	0.118	0.100	0.035
5.46*	0.130	0.130	0.035
6.16*	0.053	0.040	0.032
6.92	0.070	0.080	0.030
7.68*	0.060	0.160	0.025
8.31	0.055	0.140	0.015
8.60*	0.100	0.160	0.025
9.06*	0.160	0.145	0.025
9.75*	0.046	0.035	0.035
10.26	0.042	0.037	0.035
10.71	0.037	0.037	0.035

* Weighted based on the 100-year floodplain

3.2.3 DEBRIS LOADING EVALUATION

The analysis of debris loading of hydraulic structures was described in a JMM project memorandum (Reference 7). The amount of debris loading at each hydraulic structure on Las Vegas Wash is summarized Table 4. Debris loading of the specified width was applied to all piers, and to the bridge abutments if no wingwalls were present.

Table 4

Debris Load

Structure	Debris Load (ft)	Sediment Load (ft)
Vegas Valley Drive	2	0
Winterwood Golf Course Bridge #1	2	0
Winterwood Golf Course Bridge #2	2	0
Nellis Boulevard	1	0
Charleston Boulevard	2	0
Stewart Avenue	2	0
Bonanza Avenue	2	0
Lamb Boulevard	2	0
Owens Avenue (Vegas Drive)	2	0
Pecos Street/Lake Mead Boulevard	2	0
Carey Avenue	2	0
Las Vegas Boulevard	2	0
Cheyenne Avenue	2	0
Civic Center Drive	1	0
I-15	2	0

3.2.4 CROSS SECTION ORIENTATION

For the riverine analysis, cross sections used in the HEC-2 model were oriented perpendicular to the direction of flow. The extensive overbank flows for the 100- and 500-year events required the overbank portions of the cross sections to be oriented independent of the channel portions.

3.2.5 CHANNEL CAPACITIES

The channel capacities along Las Vegas Wash represent nondamaging discharges. These were estimated based on the HEC-2 computer analyses for the various recurrence interval floods and represent a bank-to-bank capacity for the economic analysis and not for floodplain management purposes. For the purposes of identifying nondamaging discharges, the stream was broken into reaches with similar hydraulic characteristics. The nondamaging discharges for these reaches, based on a cross section with limiting capacity, are summarized in Table 5. The channel capacity of the majority of Las Vegas Wash is much greater than the values shown at the selected cross sections. These limiting cross sections represent very localized conditions.

Table 5

Nondamaging Flows

Reach	Cross Section	Nondamaging Flow (cfs)
1. AWT Plant to Vegas Valley Drive	1.82	2,000
2. Vegas Valley Drive to Nellis Boulevard	3.51	2,600
3. Nellis Boulevard to Lamb Boulevard	6.40	5,900
4. Lamb Boulevard to Las Vegas Boulevard	9.43	3,900
5. Las Vegas Boulevard to I-15	10.46	1,000

3.2.6 BREAKOUTS AND BRANCHED FLOWS

A breakout of the 50-year flood in the right overbank near Nellis Boulevard was analyzed using the split flow routine in HEC-2 and resulted in depths of less than one foot. The breakout was not modeled independently, but discharges for the main channel were adjusted to account for the reduction in flow at Nellis Boulevard.

Several breakouts were analyzed on Las Vegas Wash in the reach between Lamb Boulevard and Las Vegas Boulevard. The left overbank in this reach is separated from the main channel portion of the floodplain by high ground along the east side of Pecos Road, and by several minor ridges running parallel to the direction of flow. Flow is forced into the left overbank by Las Vegas Boulevard, and additional flows spill over Pecos Road to enter the breakout area. Breakout flows were determined using the split flow routine in HEC-2 to estimate normal depth flow over the Pecos Road ridge and weir flow over Las Vegas Boulevard. The split flow run was performed for Q_{50} and Q_{100} only; Q_{25} was found to be contained by Pecos Road or confined to the channel (with the exception of minor, unstudied sheet flow over Las Vegas Boulevard), and Q_{500} was modeled as a single continuous floodplain. The sketch in Figure 1 shows the breakout locations and discharges between Lamb Boulevard and Las Vegas Boulevard.

The left overbank breakout area was modeled using a separate HEC-2 run based on truncated cross sections from the full main channel model. The 50-year breakout was found to have an average depth of less than one foot, and thus has not been delineated on the overflow maps. The combined breakout flows rejoin the main channel at cross section 6.92.

Several 25- and 50-year overflows between Carey Avenue and Owens Avenue were identified using the split flow option of HEC-2. They were all determined to result in breakout depths of less than one foot and have not been modeled separately. However, the main channel flows have been adjusted to account for these unmodeled breakouts. The breakouts flows all rejoined the main channel upstream of Lamb Boulevard.

Three breakouts were analyzed in the reach from Cheyenne Avenue to I-15. A 25-year breakout in the left overbank at Cheyenne Avenue and another in the left overbank downstream of Civic Center Drive both resulted in depths less than one foot. Although these breakouts were not

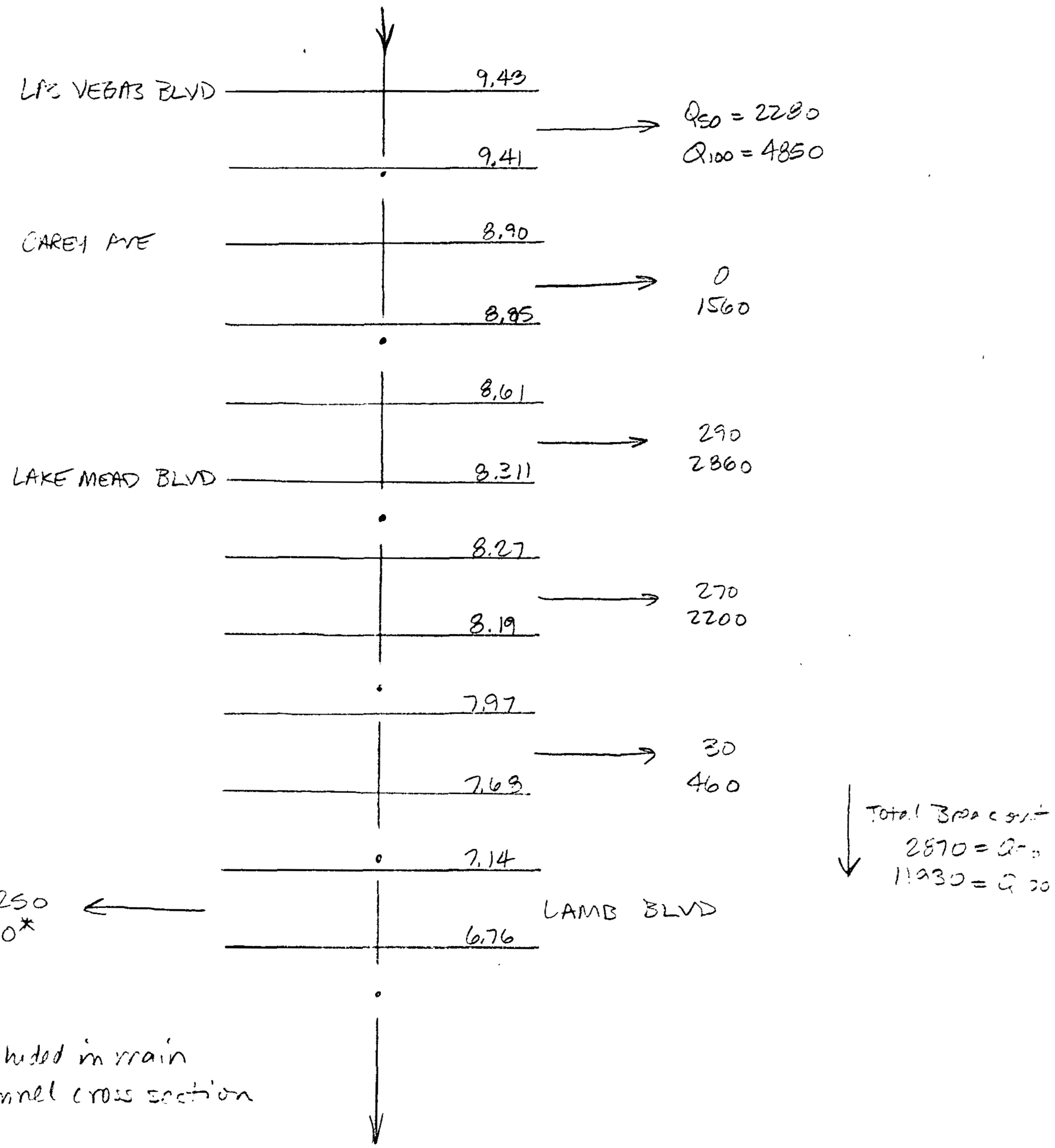
DATE

CLIENT | JOB NO. | CALC. BY

DESCRIPTION | CHECKED BY

FIGURE 1

BREAKOUT FLOWS ON LAS VEGAS WASH
BETWEEN LAMB BLVD AND LAS VEGAS BLVD



* Included in main channel cross section

modeled separately, flows for the main channel have been adjusted. A combined 500-year breakout in the left overbank just downstream of I-15 consisted of a flow division at I-15 and a split flow along a ridge in the left overbank, both determined using HEC-2. A total breakout flow of 4,000 cfs was modeled using HEC-2 with a normal depth assumption. The 500-year breakout flow returns to the main channel floodplain by way of the "N" Channel, near the intersection of Barr Avenue and Belmont Street.

3.2.7 OTHER MODELING ASSUMPTIONS

The starting water-surface elevations for Las Vegas Wash were determined using the slope-area method based on the slope of the channel invert at the downstream study limit. Flood elevations for Las Vegas Wash are equal to or greater than those determined for the downstream-most portion of Range Wash, Flamingo Wash, and Las Vegas Creek Tributaries were analyzed separately because peak discharges are caused by local storms centered over individual watersheds. Thus, Las Vegas Wash backwater was not incorporated into the tributary analyses.

3.3 SUMMARY OF RESULTS

Floodplain maps have been prepared to identify 25-, 50-, 100-, and 500-year flood boundaries. Flood profiles have been plotted showing water-surface elevations for the four floods along the entire channel study area.

The following is a description of the results of the analyses. This discussion focuses on the 100-year floodplain and begins at the upstream limit of study, at Interstate Highway 15:

Las Vegas Wash

The 100-year flood inundates approximately one-half mile of I-15, primarily in the left overbank. Downstream of I-15 the 100-year floodplain follows Gowan Road in the left overbank and parallels the channel in the right overbank. The left overbank inundates the "N" Channel south of Gowan Road and spreads into Clark County Community College while the right overbank continues to parallel the channel downstream toward the confluence with "N" Channel.

The 100-year floodplain follows Pecos Street in the left overbank as it crosses Las Vegas Boulevard. At Las Vegas Boulevard the floodplain spreads out in the right overbank. Downstream of Las Vegas Boulevard, the floodplain follows Pecos Street in the left overbank and continues to widen in the right overbank. Upstream of Pecos Street/Lake Mead Boulevard, there is a 100-year breakout in the left overbank. Combining with this 100-year breakout are two others between Pecos/Lake Mead and Owens Avenue. This combined left overbank breakout rejoins the main channel floodplain upstream of Lamb Boulevard. The right overbank follows Owens Avenue toward the channel.

Downstream of Lamb Boulevard, the 100-year floodplain remains very wide in the left overbank and follows Las Vegas Creek in the right overbank. Downstream of the confluence with Las Vegas Creek, the floodplain parallels the channel in the right overbank and inundates the broad, flat area between Las Vegas Wash and Range Wash (Sloan Channel). The left overbank floodplain inundates Range Wash downstream of Stewart Avenue. At Charleston Boulevard, the floodplain spreads into the right overbank, toward the south. The left overbank follows southerly along Range Wash. The right overbank inundates the downstream end of Flamingo Wash. The broad floodplain is "funneled" back toward the Las Vegas Wash main channel by Range Wash on the left and Flamingo Wash on the right.

Downstream of the Range Wash confluence, the 100-year floodplain remains relatively narrow through the Vegas Valley Drive crossing. At Desert Inn Road the channel has become very undefined, causing the floodplain to widen, particularly in the right overbank. Continuing downstream, the left overbank follows the base of a steep slope, while the right overbank remains very wide, narrowing somewhat as a result of berms near the AWT Plant, the downstream study limit.

The 100-year computed water-surface elevation on Las Vegas Wash at the confluence with Range Wash is approximately equal to the elevation computed for the tributary. The 100-year computed water-surface elevation for Las Vegas Wash is approximately 3 feet higher than that for Flamingo Wash and 5.5 feet higher than that for Las Vegas Creek.

4.0 CONCLUSIONS

The flood maps, profiles, and HEC-2 hydraulic computer models will provide the Corps of Engineers with the basic floodplain information necessary to evaluate the benefits and damages associated with proposed flood control projects on Las Vegas Wash. Hydraulic analyses were performed in accordance with the criteria outlines by the COE, and results were carefully reviewed by COE staff. Study results will also be useful to CCRFCD and other local agencies in floodplain management and flood control planning.

Major flood problems have been identified for Las Vegas Wash in the reaches of study. These are primarily associated with:

- undersized culverts
- inadequate channel capacities
- several major breakouts

The Las Vegas Wash floodplain is very broad, covering areas exceeding one mile in width for several stream miles. Extensive residential areas are affected by flooding from all four events studied; in contrast, there is relatively little commercial/industrial development in the existing floodplain. The Advanced Wastewater Treatment Plant is in the 500-year floodplain, but not the 100-year floodplain.

Virtually every road crossing of Las Vegas Wash would be inundated during a 100-year flood. This includes major transportation arteries such as Interstate Highway 15 and Las Vegas Boulevard. This would essentially isolate the eastern portion of Las Vegas Valley during a major flood event. Damage to numerous bridge structures could result in serious transportation problems for the community.

In most cases, breakouts and overflows are associated primarily with restrictions at bridges and culverts, particularly when debris obstruction is considered. Improvements to these limiting structures could significantly increase the overall hydraulic capacity of the Las Vegas Wash system.

5.0 REFERENCES

1. Clark County Regional Flood Control District, Flood Control Master Plan, 1986

2. U.S. Department of Agriculture, Soil Conservation Service, in cooperation with Clark County agencies, Flood Hazard Study, Las Vegas Wash and Tributaries, Clark County, Nevada, February 1979

3. Federal Emergency Management Agency, Draft Flood Insurance Study, Unincorporated Areas of Clark County, Nevada, 1987, (unpublished)

4. James M. Montgomery, Consulting Engineers, Inc., Flood Insurance Study Appeal, City of North Las Vegas, Nevada, 1982

5. U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, Computer Program 723-X6-L202A, HEC-2 Water Surface Profiles, September 1982

6. James M. Montgomery, Consulting Engineers, Inc., Memorandum to Files, Overflow Study n Values, in Corps of Engineers files, May 1987

7. James M. Montgomery, Consulting Engineers, Inc., Memorandum to Files, Debris Analysis for Las Vegas Valley Overflow Study, in Corps of Engineers files, April 1987

LAS VEGAS CREEK

LAS VEGAS CREEK

CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT

OVERFLOW ANALYSES

by:

James M. Montgomery, Consulting Engineers, Inc.
2915 West Charleston Blvd., Suite 12
Las Vegas, Nevada 89102

September 1988

LAS VEGAS WASH FEASIBILITY OVERFLOW STUDY

LAS VEGAS CREEK

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LAS VEGAS CREEK

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this overflow study is to determine the extent and depth of flooding in the Las Vegas Creek floodplain. Flood boundaries and water-surface elevations are required by the Hydraulic Section of the U.S. Army Corps of Engineers (COE) as part of the Las Vegas Valley Feasibility Study. The overall overflow study included all major flooding sources in the Las Vegas Valley (Las Vegas Wash, Range Wash, Las Vegas Creek, Flamingo Wash, Tropicana Wash, Duck Creek, Pittman Wash, and C-1 Channel), and mapped flood hazards for main channels and all significant breakout flows.

1.2 AUTHORIZATION

This study was performed by James M. Montgomery, Consulting Engineers, Inc., under contract to the Clark County Regional Flood Control District (CCRFCD) dated April 9, 1987. The Scope of Work for the study was prepared by the Los Angeles District of the COE, which also provided extensive technical and administrative review throughout the project.

1.3 COORDINATION WITH OTHER AGENCIES

Technical criteria and review were provided by the Hydraulics Section of COE, with input during the negotiation process from the CCRFCD. Supplemental bridge survey data were obtained from the CCRFCD.

2.0 GENERAL DESCRIPTION OF THE STUDY AREA

2.1 LOCATION AND EXTENT

Las Vegas Creek is a tributary to Las Vegas Wash. Las Vegas Creek was studied for approximately 6.4 miles, from its confluence with the Las Vegas Wash upstream to approximately Valley View Boulevard. The Las Vegas Creek streamcourse flows generally west to east with a jog to the north near the downtown area.

2.2 TOPOGRAPHIC AND STREAM CHARACTERISTICS

From the confluence with Las Vegas Wash upstream to the Cashman Field Sports Complex, the streamcourse is well-defined, with an average slope of approximately 0.0067. The channel flows due east through this reach and is in varying states of improvement. From the Cashman Field Sports Complex to the UPRR crossing, the streamcourse passes through several culverts with an approximate capacity of 1,000 cfs. The Las Vegas Creek streamcourse is in a formal channel from the UPRR crossing to Valley View Boulevard. This reach has an average slope of approximately 0.0057.

2.3 CHANNEL IMPROVEMENTS

Almost all of the Las Vegas Creek covered in the study area has been improved to some degree:

- from RM 0.00 to 0.35, the channel is trapezoidal and unimproved.
- from RM 0.35 to 0.85, the channel is trapezoidal and concrete-lined.
- from 0.85 to 2.85, the channel is trapezoidal and in varying states of disrepair. This reach was originally concrete-lined, but in most places the concrete is broken and has resulted in a rough surface.
- from RM 2.85 to 2.95, the channel is trapezoidal and concrete-lined.
- from RM 2.95 to 4.18, the channel passes through box sections and channel sections and has a capacity of approximately 1,000 cfs.

- from RM 4.18 to 6.40, the channel is trapezoidal and concrete-lined with box structures at the road crossings.

2.4 FLOOD HISTORY AND CHARACTERISTICS

At the present time, Las Vegas Creek serves as the major drainage way for much of the west and east side of the City of Las Vegas. Flooding along the lower reach of Las Vegas Creek even during small events is very common. This reach along Washington Avenue is one of the most visible flood-prone areas in the Las Vegas Valley. Frequently, flood waters break out of the channel after exiting the downtown box structure and overflow Washington Avenue.

2.5 PRESENT AND FUTURE URBANIZATION

In the reach from the confluence with Las Vegas Wash to the Cashman Field Sports Complex, the development is primarily medium and low density housing along both sides of the channel.

The reach between the Cashman Field Sports Complex and the UPRR crossing is comprised mainly of commercial and public development.

There is an isolated reach upstream of the UPRR crossing where, with the exception of the Freeway and the railroad yard, no development has taken place. However, future conditions may include mostly commercial development.

The reach from I-15 upstream to Valley View Boulevard is comprised mainly of low density development south of the streamcourse with the Oran K. Gragson Expressway lying north of the streamcourse.

3.0 HYDRAULIC ANALYSIS

3.1 DATA SOURCES

Four sources of mapping were used in the analysis of flooding along Las Vegas Creek:

1. Rectified photo topographic maps prepared for James M. Montgomery, Consulting Engineers, Inc. by Cooper Aerial of Nevada, Inc. for the Clark County Flood Insurance Study. The scale is 1:4,800. Contour interval: 4 feet. Photo date: September 4, 1984.

2. Rectified photo topographic maps prepared for James M. Montgomery, Consulting Engineers, Inc. by Cooper Aerial of Nevada, Inc. for the Clark County Flood Insurance Study. The scale is 1:2,400. Contour interval: 2 feet. Photo date: July 1984.

3. Planimetric topographic maps prepared for the Clark County Regional Planning Council by American Aerial Surveys, Inc. for the Clark County Regional Aerial Mapping Project. The scale is 1:2,400. Contour interval: 5 feet. Photo date: February 1974.

4. United States Geological Survey 7.5 minute Quadrangle maps (Las Vegas N.E. and Las Vegas N.W.) The scale is 1:24,000. Contour interval: 20 feet. 1967 (photo revised 1984).

3.1.2 HYDROLOGY

Peak discharges were based on "future conditions without project" hydrology provided by the COE, adjusted for hydraulic constraints and breakout flows. The following table summarizes the discharges used in the analysis of flooding along Las Vegas Creek:

Las Vegas Creek

Table 1
Las Vegas Feasibility Study
Peak Discharges w/o Project

River Mile	Location	Discharges (cfs)			
	MAIN CHANNEL	25-Yr.	50-Yr.	100-Yr.	500-Yr.
6.40-6.02	Upstream limit of study	910	1150	2500	4550
6.02-4.87	Rancho Drive to I-15	1400	2000	2025	2025
4.87-4.18	I-15 to box structure	1600	2800	6300	18050
2.95-1.41	Box structure to Mojave Rd.	1400	1650	2000	2000
1.41-1.10	Mojave Rd. to Pecos Rd.	1400	1650	1870	1870
1.10-0.00	Pecos Rd. to limit of study	1200	1300	1400	2700
	BREAKOUT SECTIONS				
	1			6700	28450
	2			7375	31975
	3			7375	31975
	4			2500	7300
	7			1500	12000
	8	700	1000	3200	9500
	9	500	1200	3300	12500
	10	500	1200	3300	13500
	11	400	800	2900	9500
	12			1500	12000
	13	7200	10000	12500	17000
	14			1000	7500
	15			1000	7500
	16	6200	9000	11500	16000
	17	4300	6500	9500	14500
	18			750	5500
	19			1000	7500
	20			1000	7500
	21			1500	12000

3.1.3 HYDRAULIC STRUCTURES

Surveys of hydraulic structures obtained for the Clark County Flood Insurance Study (FIS) were utilized in this analysis. This information was supplemented with field checks for new structures supplied by the CCRFCD. All structures completed by July 1, 1987, have been included in this analysis. No future flood control projects have been included in this study.

3.1.4 STREAM BED CROSS SECTIONS

Cross sections digitized from the aerial mapping for the FIS were utilized for the riverine analysis. These cross sections were extended using topography from the 1:4,800 and the 1:2,400 scale mapping. For the breakout analyses, cross sections were developed from topography from the 1:4,800 and the 1:2,400 scale mapping.

3.1.5 MATHEMATICAL MODELS

For the riverine analysis, the U.S. Army Corps of Engineers' HEC-2 step backwater computer program was used to determine water-surface elevations. The hydraulic analysis for the Las Vegas Creek has been divided into two main channel models, one upstream of the downtown box section and one downstream of the box section. This section of Las Vegas Creek including a few boxes and channel sections has a 1,000 cfs capacity according to the CCRFCD Master Plan and was not modeled. Individual models were used for all breakout cross sections.

Cross section labels (SECNO) for the riverine analysis reflect actual centerline distances, in miles, upstream from the confluence with Las Vegas Wash.

3.2 METHODOLOGY

3.2.1 ASSUMPTIONS AND LIMITATIONS

The accuracy of the overflow analysis is based in part on the accuracy of the topographic data with which cross sections and flood boundaries were defined. In general, this data was not field checked.

Where discrepancies occur at digitized cross sections between the computed HEC-2 flood boundary and the contour information, the boundary on the map has been plotted based on the contours. This improved consistency in plotting boundaries between cross sections and yields a more "regular" floodplain geometry.

In sheet flow areas, floodplain widths are very sensitive to the cross section orientation. Sections in these areas were drawn to be generally parallel to the contour lines.

In breakout areas, overflows were analyzed until it was determined that the average depth was less than 1.0 foot and the velocity was less than 3 ft/sec. At this point, the analysis was terminated.

In some areas of shallow flooding, small islands may occur as the result of minor local topographic variations. These islands have not been shown on the maps due to limitations of topographic definition and accuracy.

3.2.2 ROUGHNESS COEFFICIENT ASSESSMENT

Manning's "n" roughness coefficients used in the FIS analysis were verified as outlined in a memorandum from Mike Bagstad and Chip Paulson dated May 18, 1987. For the riverine analysis of Las Vegas Creek, the FIS roughness values were used. NH cards were utilized where cross sections were extended through multiple land use types. For analysis of breakout flows from Las Vegas Creek, values suggested in the May 18, 1987 memo were used. The following are representative of the channel and overbank "n" values used in the analyses:

Table 2
"n" Values

Cross Section	Left Overbank	Channel	Right Overbank
0.010	0.090	0.045	0.159
0.140	0.045	0.045	0.159
0.320	0.030	0.045	0.035
0.380	0.177	0.022	0.177
0.620	0.040	0.022	0.177
0.860	0.090	0.022	0.040
1.100	0.177	0.040	0.143
1.410	0.177	0.040	0.040
1.850	0.177	0.040	0.150
2.340	0.177	0.040	0.177
2.600	0.177	0.035	0.177
2.840	0.177	0.018	0.177
2.870	0.177	0.045	0.177
4.180	0.040	0.022	0.050
5.331	0.040	0.022	0.164
5.490	0.040	0.022	0.169
5.790	0.040	0.022	0.062
6.030	0.040	0.022	0.123

3.2.3 DEBRIS LOADING EVALUATION

The analysis of debris loading of hydraulic structures was described in a memorandum from Mike Bagstad and Chip Paulson dated April 7, 1987. The amount of debris loading at each hydraulic structure on Las Vegas Creek is summarized in the following table:

Table 3

Bridge Structures

Las Vegas Creek - Valley View Boulevard to Las Vegas Wash

River Mile	Location	Structure - Type, Size
5.97	Rancho	Box culvert 8'W x 7'H (two)
5.331	Highland Onramp	Box culvert 10'W x 10'H (two)
5.24	Highland	Box culvert 10'W x 7'H (two)
4.33	F Street	Box culvert 10'W x 7'H (two)
4.18	UPRR	Box culvert 12'W x 8'H
2.85	Bruce Street	Box culvert 12'W x 5'H (two)
2.77	18th Street	Box culvert 10'W x 3'H (two)
2.60	21st Street	Box culvert 10'W x 3.5'H (two)
2.34	Eastern Ave.	Box culvert 9'W x 4'H (two)
1.85	Mojave Road	Box culvert 10'W x 4'H (two)
1.34	Pecos Road	Bridge 18'W x 7.3'H
0.34	Lamb Blvd.	Box culvert 8'W x 6'H

Table 4

Debris Load

River Mile	Structure	Debris Loading (ft)
5.97	Rancho Bridge	2
5.331	Highland onramp	2
5.24	Highland bridge	1
4.33	F Street bridge	2
4.18	UPRR crossing	0
2.85	Bruce Street bridge	1
2.77	18th Street bridge	2
2.60	21st Street bridge	2
2.34	Eastern Ave. bridge	2
1.85	Mojave Road bridge	2
1.34	Pecos Road bridge	0
0.34	Lamb Blvd. bridge	2

3.2.4 CROSS SECTION ORIENTATION

For the riverine analysis, cross sections used in the HEC-2 model were oriented perpendicular to the direction of flow. For the breakout analysis, the cross sections were oriented parallel to the contours.

3.2.5 CHANNEL CAPACITIES

The channel capacities along Las Vegas Creek represent nondamaging discharges. These were estimated based on the HEC-2 computer analyses for the various recurrence interval floods. For the purpose of identifying nondamaging discharges, the stream was broken into reaches with similar hydraulic characteristics. The nondamaging discharges for these reaches, based on a cross secton with limiting capacity, are summarized in the following table:

Las Vegas Creek

Table 5
Nondamaging Flows by Reach

Reach No.	Cross Section	Nondamaging Flow (cfs)
1	0.01	4,000
2	0.14	1,500
3	0.32 0.34 0.36 0.38	300
4	0.62	1,800
5	0.86 1.10 1.31 1.34 1.36	100
6	1.41 1.81	800
7	1.85 1.86 1.90 2.08 2.30 2.34 2.36	100
8	2.41 2.56 2.60 2.61 2.65 2.76 2.77	700
9	2.78	300
10	2.80 2.84 2.85 2.86 2.87 2.95	1,000

Las Vegas Creek

Nondamaging Flows by Reach (continued)

Reach No.	Cross Section	Nondamaging Flow (cfs)
11	4.18	1,200
	4.23	
12	4.32	1,800
	4.33	
	4.34	
	4.35	
	4.44	
	4.54	
13	4.61	2,800
	4.71	
14	4.83	8,000
15	4.87	5,300
16	4.99	200
	5.04	
17	5.11	1,800
18	5.19	7,200
19	5.22	4,300
	5.24	
	5.25	
20	5.285	500
	5.30	
	5.326	
	5.331	
	5.41	
21	5.49	2,000
22	5.58	900
	5.68	
23	5.79	3,500
	5.89	

Las Vegas Creek

Nondamaging Flows by Reach (continued)

Reach No.	Cross Section	Nondamaging Flow (cfs)
24	5.96 5.97 6.02 6.03	800
25	6.11 6.22	2,700
26	6.32 6.40	1,200

3.2.6 BREAKOUTS AND BRANCHED FLOWS

Three main breakouts were analyzed on Las Vegas Creek. At the very upstream end of the study area, the 100-year and 500-year ROB flows start as breakout flows and remain out of the channel until their confluence with Las Vegas Wash. This breakout splits into two main branches, one which flows to the east along Alta Drive and combines with other overflows from Las Vegas Creek downstream of I-15.

The Alta Drive branch splits around the UPRR tracks and some of the flow joins the overflow from the main channel while the rest flows southeast to Charleston Boulevard and then east. At the main channel's junction with the long box structure under the downtown area, all analyzed recurrence interval flows break out of the main channel and join the intersecting flows from Alta Drive. The LOB breakout roughly parallels the channel's alignment until its confluence with Las Vegas Wash. The ROB breakout flows east from the channel and forms an island around the Las Vegas City Hall area before rejoining the main channel breakout flows near the Cashman Field Sports Complex. This flow then roughly parallels the main channel until it reaches Pecos Road where the flow turns to the southeast and joins the Charleston Boulevard overflow branch.

Las Vegas Creek

The second main branch flows south along the west embankment of I-15 to Oakey Avenue where it turns east, crosses under I-15 and then flows north to Charleston Boulevard where it intersects with the Alta Drive flows heading to the southeast. After combining with this flow, this overflow route continues generally along Charleston Boulevard until its confluence with Las Vegas Wash.

Nineteen breakout cross sections were used to track the various breakout flows.

3.2.7 OTHER MODELING ASSUMPTIONS

The starting water-surface elevations for Las Vegas Creek were determined using the slope-area method based on the slope of the channel invert at the downstream study limit.

There is a 2.5 foot median barrier in the center of the Oran K. Gragson Expressway effectively limiting any breakout to the north along this reach.

Where possible, the most recent topographic material (1984) was used for modeling and mapping. However, this source did not cover all areas studied so the older topographic material (1974) was used in these areas. In certain areas of overlap of these two sources, elevation inconsistencies surfaced. Specifically, in the reach between SECNO 2.36 and 2.95, the difference in elevation for the same location on the two maps ("delta h") ranged in value from negligible to 1.7 feet with the 1984 topo being higher in elevation in most cases. The digitized cross sections for the channel were taken from the 1984 topo while breakout cross sections were taken from the 1974 topo because of the lack of adequate 1984 material. This fact accounts for different water surface elevations and other inconsistencies in this region.

Las Vegas Creek

Straight line interpolation was used to compute water surface elevation between cross sections. In an urban area, this can sometimes lead to inaccuracy, however, this method does conform to contract.

3.3 SUMMARY OF RESULTS

Flood plain maps have been prepared to identify 25-, 50-, 100-, and 500-year flood boundaries. Flood profiles have been plotted showing water-surface elevations for the four floods along the entire channel study area. Water-surface elevations in breakout areas are shown on the maps at each cross section.

The following is a description of the results of both the riverine and breakout analyses. This discussion focuses on the 100-year floodplain and begins at the upstream limit of study, just east of Valley View Boulevard.

Riverine Analyses. At the upstream limit of study, the 100-year flood uses the Oran K. Gragson Expressway as its LOB boundary and flows generally east paralleling the main channel until its junction with the long box structure under the downtown area. According to the CCRFCD Master Plan, this box structure has a capacity of 1,000 cfs and was not modeled in this analyses. The 100-year flood widens its path and flows north and then east roughly parallel with the main channel alignment until its confluence with Las Vegas Wash. The 25- and 50-year floods are pretty much contained in the main channel from the upstream limit of study to the box structure downtown where they break out and remain out of the channel proper until their confluence with Las Vegas Wash.

Breakout Analyses. Three main breakouts were analyzed on Las Vegas Creek. At the very upstream end of the study area, the 100-year and 500-year ROB flows start as breakout flows and remain out of the channel until their confluence with Las Vegas Wash. This breakout splits into two main branches, one which flows to the east along Alta Drive and combines with other overflows from Las Vegas Creek near the downtown box structure.

Las Vegas Creek

The Alta Drive branch splits around the UPRR tracks and some of the flow joins the overflow from the main channel while the rest flows southeast to Charleston Boulevard and then east. At the main channel's junction with the long box structure under the downtown area, all analyzed recurrence interval flows break out of the main channel and join the intersecting flows from Alta Drive. The LOB breakout roughly parallels the channel's alignment until its confluence with Las Vegas Wash. The ROB breakout flows east from the channel and forms an island around the Las Vegas City Hall area before rejoining the main channel breakout flows near the Cashman Field Sports Complex. This flow then roughly parallels the main channel until it reaches Pecos Road where the flow turns to the southeast and joins the Charleston Boulevard overflow branch.

The second main branch flows south along the west embankment of I-15 to Oakey Avenue where it turns east, crosses under I-15 and then flows north to Charleston Boulevard where it intersects with the Alta Drive flows heading to the southeast. After combining with this flow, this overflow route continues generally along Charleston Boulevard until its confluence with Las Vegas Wash.

4.0 CONCLUSIONS

The Las Vegas Creek channels have capacities much smaller than the anticipated flood. Flow expands into the right overbank in almost every reach along Las Vegas Creek. The major reaches causing overflow are:

1. The reach upstream of Rancho Drive.
   The overflow from this reach passes Rancho Drive and inundates both sides of the drive.

2. The area immediately upstream of the Highland Avenue onramp.
   Overflow from this reach combines with the upstream overflow and ponds at the west side of I-15, where it forms three branches of flow (channel flow and two overflows).

3. The reach upstream of the Union Pacific Railroad.
   LOB overflow from this reach flows north and then east to inundate the area just north of the Washington Avenue Channel. ROB overflow from this reach combines with flow in Alta Drive and flows east and then north to inundate the area south of the Washington Avenue Channel.

4. The downstream reach of Washington Avenue Channel.
   Overflow from this reach combines with Alta Drive flows and inundates the area between Washington Avenue and Charleston Boulevard.

5.0 REFERENCES

1. Federal Emergency Management Agency, Draft Flood Insurance Study, Unincorporated Areas of Clark County, Nevada, 1987, (unpublished)

2. U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, Computer Program 723-X6-L202A, HEC-2 Water Surface Profiles, September 1982

3. James M. Montgomery, Consulting Engineers, Inc., Memorandum to Files, Overflow Study n Values, in Corps of Engineers files, May 1987

4. James M. Montgomery, Consulting Engineers, Inc., Memorandum to Files, Debris Analysis for Las Vegas Valley Overflow Study, in Corps of Engineers files, April 1987

RANGE WASH

RANGE WASH

CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT

OVERFLOW ANALYSES

by:

James M. Montgomery, Consulting Engineers, Inc.
2915 West Charleston Blvd., Suite 12
Las Vegas, Nevada 89102

September 1988

LAS VEGAS WASH AND TRIBUTARIES OVERFLOW STUDY

RANGE WASH

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LAS VEGAS WASH AND TRIBUTARIES OVERFLOW STUDY

RANGE WASH

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this overflow study is to determine the extent and depth of flooding in the Range Wash floodplain. Flood boundaries and water-surface elevations are required by the Hydraulics Section of the U.S. Army Corps of engineers (COE) as part of the Las Vegas Valley Feasibility Study. The overall overflow study included all major flooding sources in the Las Vegas Valley (Las Vegas Wash, Range Wash, Las Vegas Creek, Flamingo Wash, Tropicana Wash, Duck Creek, Pittman Wash, and C-1 Channel), and mapped flood hazards for main channels and all significant breakout flows.

1.2 AUTHORIZATION

This study was performed by James M. Montgomery, Consulting Engineers, Inc. (JMM), under contract to the Clark County Regional Flood Control District dated April 9, 1987. The Scope of Work for the study was prepared by the Los Angeles District of the COE, which also provided extensive technical and administrative review throughout the project.

1.3 COORDINATION WITH OTHER AGENCIES

Technical criteria and review were provided by the Hydraulics Section of the COE, with input during the negotiation process from Clark County Regional Flood Control District (CCRFCD). Supplemental bridge survey data were obtained from the CCRFCD.

2.0 GENERAL DESCRIPTION OF STUDY AREA

2.1 LOCATION AND EXTENT

Range Wash is a tributary to Las Vegas Wash, with a drainage area of approximately 160 square miles at its mouth. Range Wash was studied for approximately 9.5 miles, from its confluence with Las Vegas Wash upstream to Interstate Highway 15. The confluence with East Tributary Range Wash is at River Mile (RM) 4.5 and the confluence with West Tributary Range Wash is at RM 7.0. South of Las Vegas Boulevard, Range Wash is also known locally as Sloan Channel.

2.2 TOPOGRAPHIC AND STREAM CHARACTERISTICS

From the confluence with Las Vegas Wash upstream to the confluence with East Tributary Range Wash, the streamcourse is well-defined, with an average slope of approximately 0.0044 (23 feet/mile). The channel flows due south through this reach.

From the confluence with East Tributary Range Wash upstream to Nellis Boulevard, the stream is a very narrow, well-defined, linear channel with several 90° bends. The average slope through this reach is approximately 0.0030 (16 feet/mile).

From Nellis Boulevard upstream to Las Vegas Boulevard, Range Wash is a linear, narrow channel, with very limited capacity upstream of the confluence with West Tributary Range Wash. The average slope through this reach is approximately 0.0040 (21 feet/mile).

From Las Vegas Boulevard upstream to Interstate Highway 15, Range Wash becomes steeper and less well-defined. The average slope through this reach is approximately 0.0070 (37 feet/mile).

2.3 CHANNEL IMPROVEMENTS

Several sections of Range Wash are improved:

- from RM 5.19 to 5.69, the channel is trapezoidal and soil cemented,

- from RM 7.08 to 7.59, the channel is trapezoidal and concrete-lined, and

- between Lamb Boulevard and Lone Mountain Road, the channel is trapezoidal and concrete-lined.

The only other improvements to the Range Wash channel are the numerous bridges and culverts which span the channel and road crossings.

2.4 FLOOD HISTORY AND CHARACTERISTICS

A number of severe storms have occurred in Southern Nevada in the past decade which provide an indication of the nature of the typical flood-producing storm in Las Vegas Valley. In general, storm events which result in significant runoff rates are summer thunderstorms of short duration and high intensity. These storms are the result of tropical depressions which approach Clark County from the south or the southeast. General storms, either in summer or winter, are rare and have not contributed to significant discharges in the past. (References 1 and 2).

2.5 PRESENT AND FUTURE URBANIZATION

In the reach from the confluence with Las Vegas Wash to the confluence with East Tributary Range Wash, the area adjacent to the stream is undeveloped below Charleston Boulevard; the development upstream of Charleston Boulevard is medium density housing. The density of the development upstream of Charleston Boulevard increases near the confluence with East Tributary Range Wash.

The reach from the confluence with East Tributary Range Wash to Nellis Boulevard follows the southwest border of the Nellis Air Force Base and is basically undeveloped. There is some development in the left overbank of the reach between Nellis Boulevard and Las Vegas Boulevard. This development is primarily mobile homes.

The reach between Las Vegas Boulevard and Interstate Highway 15 is undeveloped except for the area immediately upstream of Las Vegas Boulevard, where there is some medium density housing.

3.0 HYDRAULIC ANALYSIS

3.1 DATA SOURCES

3.1.1 MAPS

The analysis of flooding along Range Wash was based on mapping from three sources:

Rectified photo topographic maps prepared for James M. Montgomery, Consulting Engineers, Inc., by Cooper Aerial of Nevada, Inc., for the Clark County Flood Insurance Study (FIS) (Reference 3). Scale 1:4,800, Contour interval: 4 feet. Photo date: September 14, 1984.

Planimeteric topographic maps prepared for Clark County Regional Planning Council by American Aerial Surveys, Inc., for the Clark County Regional Aerial Mapping

Project. Scale 1:2,400, Contour interval: 5 feet. Photo date: February 3, 1974.

U.S. Geological Survey 7.5-Minute Topographic Map, Las Vegas NE, Nevada. Scale 1:24,000, Contour interval: 20 feet. 1967 (Photo Revised 1984).

3.1.2 HYDROLOGY

Peak discharges were based on "future conditions without project" hydrology provided by the COE, adjusted for hydraulic constraints and breakout flows. Table 1 summarizes the discharges used in the analysis of flooding along Range Wash.

TABLE 1

Peak Discharges w/o Project
1987 Conditions
(in c.f.s.)

Concentration Point	Main Channel 25-Year Fut.	Main Channel 50-Year Fut.	Main Channel 100-Year Fut.	Main Channel 500-Year Fut.	Breakout Flow 25-Year Fut.	Breakout Flow 50-Year Fut.	Breakout Flow 100-year Fut.	Breakout Flow 500-Year Fut.
Range Wash at Interstate Highway 15 CP-8 RM 9.49 DA = N/A	3,500	6,000	10,000	28,000	0	0	0	0
Range Wash at Las Vegas Boulevard CP-12 RM 7.62 DA = 78.56 mi^2	4,100	7,000	11,500	30,000	0	0	0	0
Range Wash upstream of Confluence with East Tributary Range Wash CP-14 RM 5.0 DA = 82.18 mi^2	1,900	3,200	5,500	14,600	2,200	3,800	6,000	15,400
Range Wash downstream of Confluence with East Tributary Range Wash CP-9 RM 3.5 DA = 144.30 mi^2	1,200	1,600	2,300	3,000	3,200	5,900	10,200	32,000
Range Wash upstream of Vegas Valley Drive CP-1 RM 0.5 DA = 156.35 mi^2	2,800	4,000	10,000	35,000	1,800	3,500	2,500	0
Breakout from RM 6.35	N/A	N/A	N/A	N/A	2,200	3,800	6,000	15,400
Breakout from RM 4.47	N/A	N/A	N/A	N/A	1,000	2,100	4,200	14,100
Breakout from RM 4.33	N/A	N/A	N/A	N/A	0	0	0	2,500
Breakout downstream of Charleston Boulevard	N/A	N/A	N/A	N/A	1,600	3,500	5,800	0

3.1.3 HYDRAULIC STRUCTURES

Surveys of hydraulic structures obtained for the Clark County Flood Insurance Study (Reference 3) were utilized in this analysis. This information was supplemented with field checks for new structures supplied by the CCRFCD. All structures completed by July 1, 1987, have been included in this analysis. No future flood control projects have been included in this study. The hydraulic structures included in this analysis are listed in Table 2.

TABLE 2

Bridge Structures

Range Wash - I-15 to Las Vegas Wash

Stream Miles	Location	Structure - Type, Size
9.49	Interstate Highway 15	Box Culvert 15'W x 10'D (Three)
9.19	Lone Mountain Road	Box Culvert 10'W x 3'D (Two)
9.06	Bridge #3	Box Culvert 10'W x 3'D (Two)
8.86	Bridge #2	Box Culvert 10'W x 3'D (Two)
8.76	Bridge #1	Box Culvert 10'W x 4'D (Two)
8.69	Craig Road	Box Culvert 10'W x 4'D (Two)
8.25	Lamb Boulevard	Box Culvert 10'W x 4'D (Two)
7.93	Alexander Road	Box Culvert 13'W x 7'D (Four)
7.62	Las Vegas Boulevard	Box Culvert 13'W x 7'D (Seven)
7.33	Marion Drive/Gowan Road	Box Culvert 10'W x 8'D (Three)
6.83	Nellis Boulevard	Box Culvert 10'W x 7'D (Three)
6.73	Gowan Road	Box Culvert 10'W x 8'D (Three)
4.20	Judson Avenue	Box Culvert 12'W x 6'D (Four)
3.95	Lake Mead Boulevard	Box Culvert 12'W x 5'D (Five)
3.45	Owens Avenue	Box Culvert 7'W x 5'D (Six)
2.94	Washington Avenue	Bridge
2.44	Bonanza Road	Box Culvert 10'W x 5'D (Five)
1.96	Stewart Avenue	Box Culvert 10'W x 3.5'D (Eight)
1.41	Charleston Boulevard	Bridge

3.1.4 STREAM BED CROSS SECTIONS

Cross sections digitized from the aerial mapping for the FIS (Reference 3) were utilized for the riverine analysis. These cross sections were extended using topography from the 1:4,800 scale mapping. For the breakout analyses, cross sections were developed from topography from the 1:4,800, 1:2,400, and 1:24,000 mapping.

3.1.5 MATHEMATICAL MODELS

For the riverine analysis, the U.S. Army Corps of Engineers' HEC-2 step backwater computer program (Reference 4) was used to determine water-surface elevations. The hydraulic analysis for Range Wash has been divided into four main channel study reaches: 1) confluence with Las Vegas Wash to confluence with East Tributary Range Wash; 2) confluence with East Tributary Range Wash to RM 6.03; 3) RM 6.35 to Las Vegas Boulevard; and 4) Las Vegas Boulevard to Interstate Highway 15. Where necessary, the models were linked using known water-surface elevations from downstream HEC-2 runs. Additionally, the 25- and 50-year recurrence intervals were modeled separately from the 100- and 500-year so that X3 and ET cards could be applied independently. The foundation of the main channel HEC-2 runs was the HEC-2 modeling developed by JMM for the Clark County Flood Insurance Study (Reference 3). These models were originally prepared in 1985 and 1986 under the guidelines of the Federal Emergency Management Agency (FEMA). Many modifications to the FIS models were made in order to implement the study criteria for the Corps Feasibility Study. HEC-2 was also used to determine elevations for the breakout analysis, but was only applied to individual cross sections with a normal depth assumption.

Cross section labels (SECNO) for the riverine analysis reflect actual centerline distances, in miles, upstream from the confluence with Las Vegas Wash. Cross section labels for the breakout analysis reflect distances upstream from Stewart Avenue.

3.2 METHODOLOGY

3.2.1 ASSUMPTIONS AND LIMITATIONS

The accuracy of the overflow analysis is based in part on the accuracy of the topographic data with which cross sections and flood boundaries were defined. In general, this data was not field checked. Where there are minor discrepancies between contour elevations and digitized cross section elevations, it was assumed in preparing the HEC-2 models that the digitized cross sections represented the more reliable data.

Where discrepancies occur at digitized cross sections between the computed HEC-2 flood boundary and the contour information, the boundary on the map has been plotted based on the contours. This improved consistency in plotting boundaries between cross sections and yields a more "regular" floodplain geometry.

In sheet flow areas, floodplain widths are very sensitive to the cross section orientation. Sections in these areas were drawn to be generally parallel to the contour lines.

In breakout areas, overflows were analyzed until it was determined that the average depth was less than 1.0 foot and the velocity was less than 3 ft/sec. At this point, the analysis was terminated.

In some areas of shallow flooding, small islands may occur as the result of minor local topographic variations. These islands have not been shown on the maps due to limitations of topographic definition and accuracy.

In some cases, bridges were modeled using the normal bridge routine and in other cases the special bridge routine was used. In general, when most of the 100-year flow at the bridge was contained in the channel either as low flow, pressure flow, or weir flow over the bridge deck, the special bridge routine was used. When most of the 100-year flow was in the overbanks at the bridge location, the normal bridge routine was used. Because the 100-year flood was used as the benchmark, the adopted bridge routines may not represent the best approaches to modeling the other recurrence intervals. Nonetheless, the same routine was used to model all four floods at a particular structure.

3.2.2 ROUGHNESS COEFFICIENT ASSESSMENT

Manning's "n" roughness coefficients used in the FIS analysis were verified as outlined in a JMM project memorandum (Reference 5). For the riverine analysis of Range Wash, the FIS roughness values were used as a basis, and were adjusted as necessary to reflect Corps of Engineers criteria. In particular, "n" values in areas of dense urban development were generally increased over the values used in the FIS. NH cards were utilized where cross sections were extended through multiple land use types. For the analysis of breakout flows from Range Wash, values suggested in the project memorandum were used.

Table 3 presents representative channel and overbank "n" values used in the analyses. Cross sections for which NH cards were used have data presented for the 100-year floodplain and are footnoted.

Table 3

"n" Values

Cross Section	Left Overbank	Right Overbank	Channel
0.32	0.050	0.050	0.045
1.18*	0.045	0.045	0.035
1.76	0.065	0.100	0.040
2.41	0.040	0.045	0.030
2.79	0.045	0.030	0.035
3.57	0.050	0.100	0.018
4.99	0.040	0.040	0.025
5.92	0.040	0.040	0.025
6.69	0.040	0.045	0.015
7.20*	0.064	0.085	0.018
7.70	0.060	0.060	0.045
7.89*	0.030	0.130	0.030
8.49	0.070	0.070	0.040
9.03	0.040	0.040	0.020
9.28	0.060	0.060	0.040
10.59	0.130	0.130	0.130
11.77	0.080	0.080	0.080
13.26	0.050	0.050	0.050

* Weighted based on the 100-year floodplain

3.2.3 DEBRIS LOADING EVALUATION

The analysis of debris loading of hydraulic structures was described in a JMM project memorandum (Reference 6). The amount of debris loading at each hydraulic structure on Range Wash is summarized Table 4. Debris loading of the specified width was applied to all piers, and to the bridge abutments if no wingwalls were present.

Table 4

Debris Load

Structure	Debris Load (ft)	Sediment Load (ft)
Lone Mountain Road	2	0
Bridge #3	1	0
Bridge #2	1	0
Bridge #1	1	0
Craig Road	2	0
Lamb Boulevard	2	0
Alexander Road	2	0
Las Vegas Boulevard	2	0
Marion Drive/Gowan Road	1	0
Nellis Boulevard	1	0
Gowan Road	1	0
Judson Avenue	2	0
Lake Mead Boulevard	1	0
Owens Avenue	1	0
Washington Avenue	2	0
Bonanza Road	2	0
Stewart Avenue	2	0
Charleston Boulevard	2	0

3.2.4 CROSS SECTION ORIENTATION

For the riverine analysis, cross sections used in the HEC-2 model were oriented perpendicular to the direction of flow. For the breakout analysis, the cross sections were oriented parallel to contours.

3.2.5 CHANNEL CAPACITIES

The channel capacities along Range Wash represent nondamaging discharges. These were estimated based on the HEC-2 computer analyses for the various recurrence interval floods. For the purposes of identifying nondamaging discharges, the stream was broken into six reaches with similar hydraulic characteristics. The nondamaging discharges for these reaches, based on a cross section with limiting capacity, are summarized in Table 5.

Range Wash

Table 5

Nondamaging Flows

	Reach	Cross Section	Nondamaging Flow (cfs)
1.	Confluence to Charleston Boulevard	0.93	2,200
2.	Charleston Blvd. to Washington Avenue	1.59	850
3.	Washington Ave. to Confl. w/ E. Trib.	3,41, 3.57	2,300
4.	Confl. w/ E. Trib. to Nellis Blvd.	5.55	2,200
5.	Nellis Blvd. to Las Vegas Blvd.	7.45	1,000
6.	Las Vegas Blvd. to Interstate Hwy 15	9.03	300

3.2.6 BREAKOUTS AND BRANCHED FLOWS

Four breakouts were analyzed on Range Wash. The first of these is located downstream of the Gowan Road crossing. An analysis was made of the reach between cross sections 6.03 and Las Vegas Boulevard. Due to a ridge in the right overbank, it was assumed that all the flow to the right of this ridge at cross section 6.35 will flow south (i.e., will NOT remain in the main channel). Flow in the left overbank, channel, and to the left of this ridge will stay in the "channel".

The total flows at this point (including inflow from West Tributary Range Wash) are:

Recurrence Interval (yr)	Q total (cfs)
25	4,100
50	7,000
100	11,500
500	30,000

Based on a HEC-2 run for this reach, the following flow divisions were determined in the channel and overflow at cross section 6.35:

Recurrence Interval (yr)	Q CH (cfs)	Q O'Flow (cfs)
25	1,900	2,200
50	3,200	3,800
100	5,500	6,000
500	14,600	15,400

In addition to the first breakout at cross section 6.35, a second breakout was analyzed at cross section 4.47. The total flows at this point (including inflow from East Tributary Range Wash) are:

Recurrence Interval (yr)	Q total (cfs)
25	2,200
50	3,700
100	6,500
500	19,600

It was assumed that the flows in the left overbank and channel would remain in the "channel" and the flows in the right overbank will breakout and join the flows from the major breakout at cross section 6.35 (described above). This breakout flow joins the major overflow path near Lake Mead Boulevard. The flow divisions at cross section 4.47 are:

Recurrence Interval (yr)	Q LOB+CH (cfs)	Q O'flow (cfs)
25	1,200	1,000
50	1,600	2,100
100	2,300	4,200
500	5,500	14,100

A third breakout was analyzed at cross section 4.33. A HEC-2 model was prepared for the reach between cross sections 4.17 and 4.75 to determine the capacity at this cross section. It was assumed that all flows in excess of the bank-full condition at cross section 4.33 overtopped into the right overbank and joined the breakout flow from cross section 4.47 (described above). At cross section

4.33, the bank-full condition was determined to be approximately 3,000 cfs. Therefore, only the 500-year discharge was affected. The amount of the 500-year breakout flow is 2,500 cfs. This breakout flow joins the overflow path from cross section 4.47.

The extent of flooding from these three breakouts was determined using single cross section, normal depth HEC-2 runs. Sources of cross sectional data for these analyses were described in Section 3.1, Data Sources. The resulting computed water-surface elevations for the four recurrence intervals are presented on the maps in lieu of a profile.

In the reach of Range Wash between the upstream breakout and the point where the flows return, a set of reduced flows was modeled in the main channel. The breakout and main channel flood plains were rejoined between RM 2.11 and 2.63. This rejoining was modeled independently for each recurrence interval and was based on a channel capacity analysis and the computed water-surface elevations in the breakout floodplain. It was necessary to contact the COE to have the hydrology table revised at one of the concentration points (see Section 3.1.2, Hydrology).

A fourth breakout was analyzed at Charleston Boulevard, where the 25-, 50-, and 100-year flows overtop the roadway in the left overbank and become a "shallow flooding" zone downstream of the road. Since a ridge separates the channel from the left overbank downstream of Charleston Boulevard, the left overbank is hydraulically separated from the channel for these recurrence intervals. Based on a flow distribution at Charleston Boulevard (at cross section 1.42), it was determined that approximately 1,600 cfs of the 25-year and 3,500 cfs of the 50-year will break away from the main channel. Average depths were computed for the left overbank using normal depth calculations. These average depths were less than one foot for both the 25- and 50-year breakouts; therefore, no floodplain delineations or flood profiles are presented on the maps. Based on a flow distribution downstream of Charleston Boulevard (at cross section 0.93) and a channel capacity analysis of cross sections 0.72 to 0.13, it was determined that between 1,500 to 5,800 cfs of the 100-year discharge breaks out into the left overbank. A HEC-2 model was developed to analyze the 100-year left overbank floodplain and separate 100-year flood elevations are presented on the maps.

3.2.7 OTHER MODELING ASSUMPTIONS

The starting water-surface elevations for Range Wash were determined using the slope-area method based on the slope of the channel invert at the downstream study limit. The analysis of flooding on Range Wash was assumed to be independent of flooding from Las Vegas Wash. It is likely that flood elevations for Las Vegas Wash will be greater than those determined for the downstream-most portion of Range Wash.

The inflow from East Tributary Range Wash was assumed to be represented by the difference in discharges between Concentration Points 9 and 14. The inflow was added to the discharges upstream of East Tributary Range Wash to determine flows downstream of the confluence. This was coordinated with the COE.

Due to the configuration of the 500-year floodplain, the discharge was increased downstream of Lamb Boulevard to include the inflow from West Tributary Range Wash. The 25-, 50-, and 100-year discharges were not increased until further downstream at Las Vegas Boulevard (Concentration Point 12).

A comparison was made of the computed water-surface elevations to the ground elevations at Interstate Highway 15. It was determined that the full flows will cross the highway and will not spread west, upstream of the highway and thus will not overflow into the Las Vegas Wash drainage area.

3.3 SUMMARY OF RESULTS

Floodplain maps have been prepared to identify 25-, 50-, 100-, and 500-year flood boundaries. Flood profiles have been plotted showing water-surface elevations for the four floods along the entire channel study area. In areas where the lower recurrence interval floods are contained to the channel and the higher recurrence interval floods are spread into the overbanks (e.g., upstream of Las Vegas Boulevard), the profiles have been allowed to cross one another. Water-surface elevations in breakout areas are shown on the maps at each cross section.

The following is a description of the results of both the riverine and breakout analyses. This discussion focuses on the 100-year floodplain and begins at the upstream limit of study, at Interstate Highway 15:

Riverine Analysis

At the upstream limit of study, the 100-year flood overtops approximately 1,100 feet of Interstate Highway 15. Downstream from the highway, the floodplain spreads out in the left overbank. The floodplain remains wide across Lone Mountain Road. As backwater, the 100-year flood elevations partially inundate a tributary valley in the right overbank upstream of Craig Road (near an industrial park). The intersection of Lamb

Boulevard and Nellis Boulevard is inundated by the 100-year floodplain. Downstream from this point, the floodplain is contained by Lamb Boulevard in the left overbank and a ridge in the right overbank. Downstream of Lamb Boulevard, the right overbank becomes wide and inundates a subdivision downstream of Alexander Street. Just upstream of Las Vegas Boulevard, the 100-year flood breaks out in the left overbank and partially inundates a drive-in theater. Approximately 4,100 feet of Las Vegas Boulevard is inundated by the 100-year floodplain. Downstream of Las Vegas Boulevard (at cross section 6.35), all of the 100-year flow in excess 5,500 cfs is lost to a breakout in the right overbank. Between this breakout and the confluence with East Tributary Range Wash, the 100-year floodplain is contained in the channel and right overbank. Immediately downstream of the confluence, another breakout in the right overbank leaves approximately 2,300 cfs in the "channel". Downstream of this breakout, the floodplains are basically contained within the channel downstream to Stewart Avenue, where the breakout flows return to Range Wash. At this point, the 100-year floodplain spreads out in both overbanks due to the increase in discharge. The floodplain is approximately 2,500 feet wide downstream of Stewart Avenue. Downstream of Charleston Boulevard, a portion of the 100-year floodplain breaks away from the main channel into the left overbank. All of the road crossings of Range Wash except Bonanza Avenue, Lake Mead Boulevard, Washington Avenue, and Marion/Gowan Road are overtopped by the 100-year floodplain.

Breakout Analysis

Flows to the right of a ridge in the right overbank at cross section 6.35 break away from the main channel and flow south. As these flows head in a southeasterly direction, the intersections of Carey Avenue and Nellis Boulevard and Lake Mead Boulevard and Nellis Boulevard are inundated. Downstream of Washington Avenue, the breakout floodplain inundates the majority of the area between Range Wash in the left overbank and Nellis Boulevard in the right overbank. The breakout flows return to the main channel of Range Wash at Stewart Avenue.

4.0 CONCLUSIONS

The flood maps, profiles, and HEC-2 hydraulic computer models will provide the Corps of Engineers with the basic floodplain information necessary to evaluate the benefits and damages associated with proposed flood control projects on Range Wash. Hydraulic analyses were performed in accordance with the criteria outlines by the COE, and results were carefully reviewed by COE staff. Study results will also be useful to CCRFCD and other local agencies in floodplain management and flood control planning.

Major flood problems have been identified for Range Wash in the reaches of study. These are primarily associated with:

- o undersized culverts
- o inadequate channel capacities
- o major breakouts downstream of Gowan Road and downstream of the confluence with East Tributary Range Wash

5.0 REFERENCES

1. Clark County Regional Flood Control District, Flood Control Master Plan, Clark County Regional Flood Control District, 1986

2. U.S. Department of Agriculture, Soil Conservation Service, in cooperation with Clark County agencies, Flood Hazard Study, Las Vegas Wash and Tributaries, Clark County, Nevada, February 1979

3. Federal Emergency Management Agency, Draft Flood Insurance Study, Unincorporated Areas of Clark County, Nevada, 1987, (unpublished)

4. U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, Computer Program 723-X6-L202A, HEC-2 Water Surface Profiles, September 1982

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FLAMINGO WASH

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CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT

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James M. Montgomery, Consulting Engineers, Inc.
2915 West Charleston Blvd., Suite 12
Las Vegas, Nevada 89102

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FLAMINGO WASH

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FLAMINGO WASH

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this overflow study is to determine the extent and depth of flooding in the Flamingo Wash floodplain. Flood boundaries and water-surface elevations are required by the Hydraulics Section of the U.S. Army Corps of engineers (COE) as part of the Las Vegas Wash and Tributaries Feasibility Study. The overall overflow study included all major flooding sources in the Las Vegas Valley (Las Vegas Wash, Range Wash, Las Vegas Creek, Flamingo Wash, Tropicana Wash, Duck Creek, Pittman Wash, and C-1 Channel), and mapped flood hazards for main channels and all significant breakout flows.

1.2 AUTHORIZATION

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1.3 COORDINATION WITH OTHER AGENCIES

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2.0 GENERAL DESCRIPTION OF STUDY AREA

2.1 LOCATION AND EXTENT

Flamingo Wash is a tributary to Las Vegas Wash, and has a drainage area of approximately 135 square miles at its mouth. During severe runoff events, it is possible for about 40 percent of the Blue Diamond Wash watershed to contribute flows to lower Flamingo Wash via Tropicana Wash. This is due to the highly unstable nature of the Blue Diamond Wash channel on the alluvial fan. In this case, the effective drainage area of Flamingo Wash at the mouth is about 192 square miles. Flamingo Wash was studied for approximately 12.6 miles, from its confluence with Las Vegas Wash upstream to Rainbow Blvd.

2.2 TOPOGRAPHIC AND STREAM CHARACTERISTICS

Flamingo Wash flows in a generally easterly direction, draining a portion of the alluvial apron on the west side of Las Vegas Valley. Its western-most portions are fairly steep and poorly defined on the undeveloped alluvial fan, whereas its eastern-most portions are surrounded by intense urban development. All of the study reach floodplain is in various stages of urban development.

The reach from Las Vegas Wash to Boulder Highway has been graded and straightened, and the channel is well defined throughout. The average channel slope is 0.0072 (38 ft/mile).

The reach from Boulder Highway to Pecos/McLeod Rd contains several sharp bends, which in the past were subject to erosion damage. Portions of this reach have been improved, as described below. The channel is moderately deep and very well defined throughout this reach. The average slope is 0.0101 (53 ft/mile).

Flamingo Wash

From Pecos/McLeod to the confluence with Tropicana Wash, the channel is similar in cross section to the downstream reach, but is it generally straighter. The slope is this section is 0.011 (59 ft/mile). Evidence of past channel erosion can be seen in the floodplain between Pecos/McLeod and Eastern Ave.

Between the Tropicana Wash confluence and Koval Lane, the channel becomes more poorly defined, particularly upsteam of Paradise Rd where the channel is little more than a broad swale. The slope in this reach is 0.0153 (81 ft/mile).

From Koval Lane to the Union Pacific Railroad tracks (UPRR), the Flamingo Wash channel is very complex. Downstream of the UPRR bridge the channel drops into a 4000-ft long culvert (or buried channel) which passes under Interstate 15, under Caesars Palace casino parking lot, under the Imperial Palace casino, and empties onto Winnick Ave. Winnick Ave between Imperial Palace and Koval Lane is an inverted crown street which serves as the Flamingo Wash channel. The average slope for this entire reach is 0.0084 (44 ft/mile).

The reach from UPRR to Decatur Blvd is partially straightened and graded, and partially natural. The slope is 0.0122 (65 ft/mile).

Upstream of Decatur Blvd is a large natural ponding area which is on a site of a future County park. The rest of the reach from Decatur Blvd to Rainbow Blvd has been graded and straighened but is unlined. At the upstream study limit the channel flows through the Spanish Trails Country Club golf course. The slope in this upper reach is 0.0177 (93 ft/mile).

2.3 CHANNEL IMPROVEMENTS

Flamingo Wash has several sections of excavated earthen channel, but only one short reach where major channel improvements have been made (30-ft wide, 7-ft deep lined channel from Desert Inn Rd to Mojave Ave). The following reaches are graded but unlined:

- o Nellis Blvd to US-95 (Expressway)
- o Upstream of Boulder Highway to McLeod, with the exception of the lined reach specified above
- o Spencer Ave to Swenson Rd
- o Jones Blvd to Rainbow Blvd

As mentioned in a previous section, Flamingo Wash passes under the Caesars Palace and Imperial Palace casinos in a large box culvert (twin 24-ft wide, 7-ft deep). It empties onto Winnick Ave, which is about 60 feet wide and has an inverted crown of 3-4 feet deep.

The only other improvements to the Flamingo Wash channel are the numerous bridges and culverts which span the channel at road crossings.

2.4 FLOOD HISTORY AND CHARACTERISTICS

Flamingo Wash has experienced several significant flooding events in recent years. Flood flows have most commonly been generated by short-duration, high-intensity summer thunderstorms occurring in the mountainous portions of the watershed.

- On July 3, 1975, Flamingo Wash experienced flooding from a large storm which affected areas west and north of metropolitan Las Vegas. The storm track was in a typical south-to-north direction, and covered a total of 350 square miles. The total storm depth exceeded 3 inches over 6 hours in some areas, with most of th rainfall occurring during a 3-hour period. The storm generated the largest peak flow recorded to that time on Flamingo Wash (3,910 cfs at I-15; 2,750 cfs at Maryland Parkway). This contributed to flooding in the vicinity of Caesars Palace.

- On the afternoon of August 10, 1983, an intense flash-flood occurred over the upper portion of the Flamingo Wash watershed. The maximum storm depth was estimated to be about 4 inches occurring over a total of about 3 hours. A 4.5 square mile area in the upper Flamingo Wash watershed produced 2,300 cfs. The peak flow of record was produced for Flamingo Wash at Maryland Parkway (4,700 cfs). Flood damage included erosion of channel banks, damage to several road crossings, and flooding at Caesars Palace and along Winnick Avenue.

In the past, damage along Flamingo Wash has been associated with a combination of erosion, sedimentation, inundation, and debris.

2.5 PRESENT AND FUTURE URBANIZATION

The Flamingo Wash floodplain in the study area currently includes a wide variety of urbanization and land uses, from hotel/casino properties to small parcels of natural desert. From Las Vegas Wash to Boulder Highway, floodplain development consists primarily of low to high density residential land, with some significant industrial areas and commercial development along Boulder Highway. The newly constructed US-95 crosses the channel between Boulder Highway and Lamb Blvd.

From Boulder Highway to McLeod, development is primarily medium and high density residential, with very few open parcels left.

From McLeod to the Flamingo Wash confluence, development remains predominantly medium and high density residential, but there is more existing open space than in the downstream reach. This section also contains the Desert Inn Country Club, between Eastern Ave and Spencer Ave.

From the Tropicana Wash confluence to Paradise Rd, land use is a mix of residential and commercial developments. Upstream of Paradise Rd there is a large open parcel which is scheduled for intense development in the near future.

Along Winnick Ave, development consists of high density residential properties. Between Winnick Ave and the UPRR, the floodplain contains the structures and parking facilities associated with the Caesars Palace and Imperial Palace hotel/casinos.

Between the UPRR and Decatur Blvd, land use is primarily industrial, with a number of large open parcels remaining. The County park site is immediately upstream of Decatur Blvd; this is also the site of a major detention basin recommended in the CCRFCD Flood Control Master Plan. From Jones Blvd to Rainbow Blvd, development is low to medium density residential tracts. At the upstream study limit the floodplain constitutes the Spanish Trails Country Club.

Future development in the floodplain will consist of infill following the same basin trends as the existing land use. In the reach downstream of Koval Lane, varying density residential developments will continue to be built along with a mix of commercial and industrial projects. There are only a few major development areas remaining in this lower section. In the area between the UPRR and Decatur, industrial properties will infill in the available lots. Above Decatur Blvd, residential land uses will prevail.

3.0 HYDRAULIC ANALYSIS

3.1 DATA SOURCES

3.1.1 MAPS

The analysis of flooding along Flamingo Wash was based primarily on rectified photo topographic maps prepared for James M. Montgomery, Consulting Engineers, Inc., by Cooper Aerial of Nevada, Inc., for the Clark County Flood Insurance Study (FIS) (Reference 1). Scale 1:4,800, Contour interval: 4 feet. Photo date: September 14, 1984.

These maps were supplemented where necessary with the Clark County base mapping (Scale 1:2,400; Contour Interval: 5 feet; 1974) and with USGS quadrangles (Scale 1:24,000; Contour Interval: 10 feet; 1973).

3.1.2 HYDROLOGY

Peak discharges were based on "future conditions without project" hydrology provided by the COE, adjusted for hydraulic constraints and breakout flows. Table 1 summarizes the discharges used in the analysis of flooding along Flamingo Wash.

TABLE 1

Peak Discharges w/o Project
1987 Conditions
(in c.f.s.)

Concentration Point	Main Channel 25-Year Fut.	Main Channel 50-Year Fut.	Main Channel 100-Year Fut.	Main Channel 500-Year Fut.	Breakout Flow 25-Year Fut.	Breakout Flow 50-Year Fut.	Breakout Flow 100-year Fut.	Breakout Flow 500-Year Fut.
Flamingo Wash at Spanish Trails Golf Course CP-26 RM 12.5 DA = 91.86 mi^2	3,700	6,000	9,400	34,000	0	0	0	0
Flamingo Wash Upstream of Decatur Blvd. CP-12 RM 10.3 DA = 96.54 mi^2	4,100	7,000	10,500	35,000	0	0	0	0
Flamingo Wash at UPRR CP-13 RM 8.8 DA = 97.55 mi^2	4,100	7,000	10,500	35,600	0	0	0	0
Flamingo Wash at I-15 CP-16 RM 8.4 DA = 98.07 mi^2	4,100	5,340	5,880	20,200	0	1,660	4,620	14,800
Flamingo Wash at Koval Lane CP N/A RM 7.4 DA = N/A	4,100	5,340	5,880	16,600	0	1,660	4,620	18,400
Flamingo Wash at Spencer Street CP-35 RM 6.1 DA = 183.92 mi^2 *	6,000	7,340	9,470	23,600	0	1,660	4,030	14,400
Flamingo Wash at Mojave Avenue CP N/A RM 3.5 DA = N/A	6,000	7,340	10,700	34,100	0	1,660	2,800	3,900
Flamingo Wash at Boulder Highway CP-40 RM 2.7 DA = 191.59 mi^2 *	6,400	7,740	11,200	35,100	0	1,660	2,800	3,900

TABLE 1 (Cont'd)

Peak Discharges w/o Project
1987 Conditions
(in c.f.s.)

Concentration Point	Main Channel				Breakout Flow			
	25-Year Fut.	50-Year Fut.	100-Year Fut.	500-Year Fut.	25-Year Fut.	50-Year Fut.	100-year Fut.	500-Year Fut.
Flamingo Wash at Lamb Blvd. CP N/A RM 1.9 DA = N/A	3,400	4,710	5,500	12,400	3,000	4,690	8,440	26,600
Flamingo Wash at Nellis Blvd. CP N/A RM 0.9 DA = N/A	3,250	3,880	5,260	8,080	3,150	5,520	8,740	30,920
Breakout along Spring Mtn. Rd at Las Vegas Blvd. RM N/A	N/A	N/A	N/A	N/A	0	140	1,830	14,500
Breakout (North) split at Mall on Maryland Parkway RM N/A North Branch	N/A	N/A	N/A	N/A	0	0	1,240	10,500
South Branch	N/A	N/A	N/A	N/A	0	0	590	4,000
Breakout at I-515 RM 2.4	N/A	N/A	N/A	N/A	3,150	3,860	5,840	19,700
Breakout Upstream of Lamb Blvd. RM 1.9	N/A	N/A	N/A	N/A	0	0	0	5,700
Breakout Upstream of Nellis Blvd. RM 0.9	N/A	N/A	N/A	N/A	0	70	300	4,320

* Drainage areas include Blue Diamond Wash. Up to 40% of Blue Diamond Wash is diverted into Flamingo Wash

3.1.3 HYDRAULIC STRUCTURES

Surveys of hydraulic structures obtained for the Clark County Flood Insurance Study were utilized in this analysis. This information was supplemented with field checks for new structures supplied by the CCRFCD. All structures completed by July 1, 1987, have been included in this analysis. No future flood control projects have been included in this study. The hydraulic structures included in this analysis are listed in Table 2.

TABLE 2

Bridge Structures

Flamingo Wash - Rainbow Boulevard to Las Vegas Wash

Stream Miles	Location	Structure - Type, Size
12.49	Rainbow Blvd	Bridge 80'W x 11'D, 1 support
12.16	Tropicana Ave	Bridge 136'W x 11'D, 3 supports
11.83	Torrey Pines Rd	Bridge 40'W x 8'D, 3 supports
11.32	Jones Blvd	Bridge 40'W x 8'D, 3 supports
10.33	Decatur Blvd	Bridge 36'W x 10'D, 2 supports
8.66	UPRR	Bridge 84'W x 6'D, 6 supports
8.36	I-15	Box culvert 60'W x 8'D, 5 supports
7.38	Koval Lane	Grated drop structure (assumed plugged)
6.83	Paradise Rd	Dip Crossing
6.36	Swenson Rd	Bridge 28'W x 5'D, 2 supports
6.11	Cambridge Ave	Bridge 36'W x 7'D, 2 supports
5.86	Maryland Blvd	Bridge 36'W x 10'D, 2 supports
5.29	Spencer St	Bridge 48'W x 5'D, 3 supports
4.83	Tioga Rd	Corrugated metal arch pipes 3-7'H
4.70	Eastern Ave	Bridge 30'W x 8'D, 2 supports
4.06	McLeod Ave	Bridge 114'W x 16'D, clear span
3.78	Desert Inn Rd	Bridge 50'W x 8'D, 4 supports
3.56	Mojave Ave	Bridge 50'W x 8'D, 4 supports
2.70	Boulder Highway	Bridge 32'W x 8'D, 3 supports
2.38	US-95	Bridge 150'W x 12'D, clear span
1.91	Lamb Blvd	Bridge 98'W x 6'D, 8 supports
0.92	Nellis Blvd	Bridge 114'W x 5'D, 2 supports

3.1.4 STREAM BED CROSS SECTIONS

Cross sections digitized from the aerial mapping for the FIS were utilized for the riverine analysis. These cross sections were extended and supplemented using topography from the 1:4,800 scale mapping. For the breakout analyses, cross sections were developed from topography from the 1:4,800, 1:2,400, or 1:24,000 mapping.

3.1.5 MATHEMATICAL MODELS

For the riverine analysis, the U.S. Army Corps of Engineers' HEC-2 step backwater computer program was used to determine water-surface elevations. The hydraulic analysis for Flamingo Wash has been divided into six main channel study reaches: 1) confluence with Las Vegas Wash to Boulder Highway; 2) Boulder Highway to Algonquin Rd; 3) Algonquin Rd to Koval Lane; 4) Koval Lane to Union Pacific Railroad; 5) UPRR to Decatur Blvd; and 6) Decatur Blvd to Rainbow Blvd. Separate HEC-2 models were prepared for each reach to improve the efficiency of the modeling process in making multiple debugging runs. Where necessary, the models were linked using known water-surface elevations from the downstream HEC-2 runs.

The reach from Koval Lane to UPRR was the subject of a special detailed analysis by the Hydraulics Section of the Los Angeles District of the COE. This analysis produced a rating curve for the closed conduit, and separate HEC-2 runs for the main channel overflow and the overbank breakout areas. The COE models were adopted by JMM for this study.

The foundation of the main channel HEC-2 runs was the HEC-2 modeling developed by JMM for the Clark County Flood Insurance Study. These models were originally prepared in 1985 and 1986 under the guidelines of the Federal Emergency Management Agency (FEMA). Many modifications to the FIS models were made in order to implement the study criteria for the Corps Feasibility Study.

Cross section labels (SECNO) for the riverine analysis reflect actual centerline distances, in miles, upstream from the confluence with Flamingo Wash.

Separate HEC-2 models were prepared for the following breakout reaches:

- Overflow along the UPRR from Flamingo Wash channel to Spring Mountain Rd (cross sections numbered consistent with centerline stationing for use in split flow analysis)

- Overflow along US-95 north of the channel (51.XX series cross sections)

Other breakouts were modeled using single normal depth cross sections in HEC-2.

3.2 METHODOLOGY

3.2.1 ASSUMPTIONS AND LIMITATIONS

The accuracy of the overflow analysis is based in part on the accuracy of the topographic data with which cross sections and flood boundaries were defined. In general, this data was not field checked. Where there are minor discrepancies between contour elevations and digitized cross section elevations, it was assumed in preparing the HEC-2 models that the digitized cross sections represented the more reliable data.

Where discrepancies occur at digitized cross sections between the computed HEC-2 flood boundary and the contour information, the boundary on the map has been plotted based on the contours. This improved consistency in plotting boundaries between cross sections and yields a more "regular" floodplain geometry.

In sheet flow areas, floodplain widths are very sensitive to the cross section orientation. Sections in these areas were drawn to be generally parallel to the contour lines.

In breakout areas, overflows were analyzed until it was determined that the average depth was less than 1.0 foot and the velocity was less than 3 ft/sec. At this point, the analysis was terminated.

In some areas of overbank and shallow flooding, small islands may occur as the result of minor local topographic variations. These islands have not been shown on the maps due to limitations of topographic definition and accuracy.

In some cases bridges were modeled using the normal bridge routine and in other cases the special bridge routine was used. In general, when most of the 100-year flow at the bridge was contained in the channel either as low flow, pressure flow or weir flow over the bridge deck, the special bridge routine was used. When most of the 100-year flow was in the overbanks at the bridge location, the normal bridge routine was used. Because the 100-year flood was used as the benchmark, the adopted bridge routines may not represent the best approaches to modeling the other recurrence intervals. Nonetheless, the same routine was used to model all four floods at a particular structure.

3.2.2 ROUGHNESS COEFFICIENT ASSESSMENT

Manning's "n" roughness coefficients were selected as outlined in a JMM project memorandum (Reference 2). The FIS values were used as a basis, and were adjusted as necessary to reflect Corps of Engineers criteria. In particular, "n" values in areas of dense urban development were generally increased over the values used in the FIS. NH cards were utilized where cross sections were extended through multiple land use types.

Table 3 presents representative channel and overbank "n" values used in the analyses:

Table 3

"n" Values

Cross Section	Left Overbank	Right Overbank	Channel
1.27	0.070	0.050	0.035
2.06	0.180	0.180	0.035
3.37	0.140	0.140	0.035
4.41	0.060	0.050	0.035
5.04	0.120/0.045	0.045/0.120	0.035
7.16	0.045	0.045	0.045
7.47	0.120	0.120	0.025
9.18	0.170	0.170	0.040
10.49	0.045	0.045	0.050
11.45	0.140	0.160	0.035

3.2.3 DEBRIS LOADING EVALUATION

The analysis of debris loading of hydraulic structures was described in a JMM project memorandum (Reference 3). The amount of debris loading at each hydraulic structure on Flamingo Wash is summarized in Table 4. Debris loading of the specified width was applied to all piers, and to the bridge abutments if no wingwalls were present.

Table 4

Debris Load

Structure	Debris Loading (ft)	Sediment Load (ft)
Rainbow Blvd	2	0
Tropicana Ave	1	0
Torrey Pines Rd	1	0
Jones Blvd	1	0
Decatur Blvd	2	0
UPRR	2	0
I-15	1	0
Koval Lane	2	0
Paradise Rd	2	0
Swenson Rd	2	0
Cambridge Ave	1	0
Maryland Blvd	1	0
Spencer St	2	0
Desert Inn Golf Course Footbridges	0	0
Tioga Rd	2	0
Eastern Ave	1	0
McLeod Ave	0	0
Desert Inn Rd	2	0
Mojave Ave	1	0
Boulder Highway	2	0
US-95	0	0
Lamb Blvd	2	0
Nellis Blvd	1	0

3.2.4 CROSS SECTION ORIENTATION

For the riverine analysis, cross sections used in the HEC-2 model were oriented perpendicular to the direction of flow. For the breakout analysis, the cross sections were oriented parallel to contours.

3.2.5 CHANNEL CAPACITIES

The channel capacities along Flamingo Wash represent nondamaging discharges. These were estimated based on the HEC-2 computer analyses for the various recurrence interval floods, and simulation of additional flows as necessary to develop rating curves. For the purposes of identifying nondamaging discharges, the study area was broken into five reaches with reasonably similar hydraulic characteristics. The nondamaging discharges for these reaches, based on a cross section with limiting capacity, are summarized in Table 5.

Table 5

Nondamaging Flows

Reach	Cross Section	Nondamaging Flow (cfs)
1. Decatur Blvd to Rainbow Blvd	11.84	6,100
2. UPRR to Decatur Blvd	9.62	3,200
3. Algonquin Road to Winnick Avenue	6.60	780
4. McLeod Road to Algonquin Road	5.32	5,400
5. Boulder Highway to McLeod Road	2.79	4,300
6. Confluence to Boulder Highway	1.27	2,700

3.2.6 BREAKOUTS AND BRANCHED FLOWS

There are several major breakouts from the Flamingo Wash channel in the study reach. These are discussed in an upstream-to-downstream direction.

The first major breakout occurs when the flow hits the UPRR grade. The 500-year flow begins weiring over the tracks as far upstream as cross section 9.62, although the first major overflow occurs between sections 8.74

and 8.94. A significant portion of the discharge for the two higher floods is diverted north along the tracks at the Flamingo Wash UPRR structure. Some of this diverted flow weirs over the UPRR tracks and flows back into the main channel, while some continues north as far as Spring Mountain Rd.

This UPRR breakout was analyzed by creating a split flow HEC-2 model, with the "main channel" running along I-15 from Spring Mountain Rd to the UPRR underpass, then along the UPRR to cross section 9.62. Flow over the tracks was modeled as a weir overflow, and flow through the UPRR and Spring Mountain Rd underpasses was modeled as normal depth flow. Flow through the UPRR culvert for Flamingo Wash (the main channel) in the split flow analysis was determined using a rating curve provided by the COE, which took into account downstream hydraulic constraints. A summary of flows produced by the split flow analysis is shown in Figure 1.

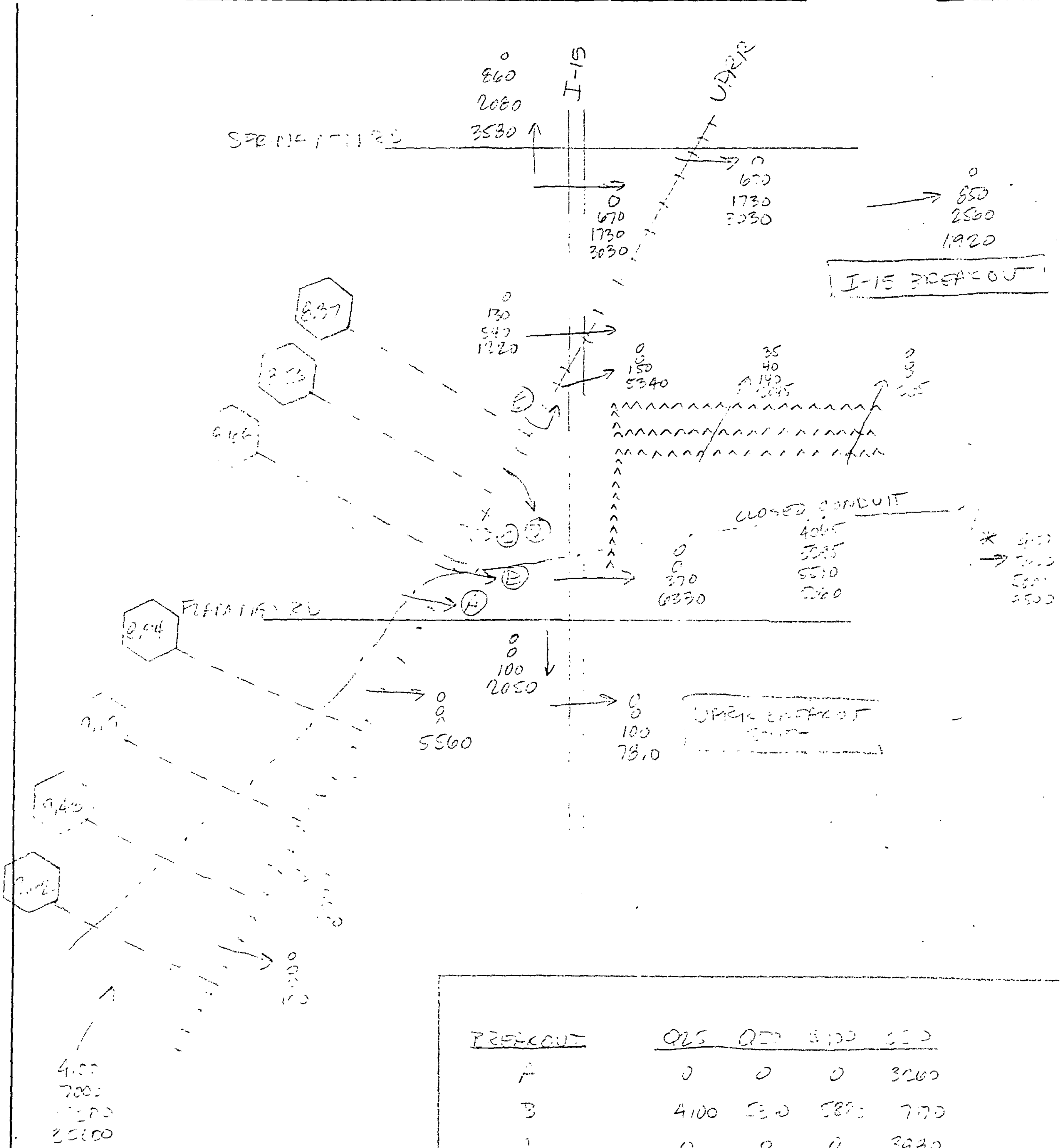
Flow which follows the course of the main channel, either as channel flow or as weir flow over the UPRR grade, enters the I-15 culvert up to the capacity of the overall culvert from I-15 to Winnick Ave (approximately 5,500 cfs). The remaining flow crosses I-15 and enters the Caesars Palace casino property. Concrete blocks (3-ft high, 8-ft long) have been placed around the perimeter of the property to divert sheet flows. These force most of the breakout flow to go south and run along the alignment of Flamingo Rd; however, a portion of the breakout flow at the I-15 culvert does flow north to join with the breakout at Spring Mountain Rd.

Flow which weirs over the UPRR tracks south of the Flamingo Rd overpass for I-15 crosses the highway and flows through the Emerald Country Club. It then co-

DATE

CLIENT JOB NO. CALC. BY

DESCRIPTION FIGURE 1 - UPRR / I-15 BREAKOUT FLOWS CHECKED BY



BREAKOUT	Q25	Q50	Q100	Q500
A	0	0	0	3260
B	4100	[illegible]	[illegible]	[illegible]
C	0	0	0	3980
D	0	0	0	[illegible]
E	0	0	265	3510

* Adjusted and rounded to yield correct total outflows from the area, i.e., to agree with inflow at X-9.62

N-3A

JAMES M. MONTGOMERY, CONSULTING ENGINEERS, INC. SHEET ___ OF ___ mingles with the I-15 breakout sheet flow, prior to joining the main channel flow at Winnick Ave. This is referred to as UPRR Breakout South.

The split flow at Spring Mountain Rd shows that some of the discharge continues north across the road, from which point it can not return to the Flamingo Wash floodplain. This discharge is not mapped in this study.

The breakout which includes the Spring Mountain Rd component and the portion of the overflow at I-15 that could not pass through the freeway/casino culvert is referred to as the I-15 Breakout. This flows as sheet flow to the east, and eventually reaches the large commercial center at Twain Ave and Maryland Parkway. This shopping center is in the middle of the flowpath, and causes the I-15 breakout to split into north and south branches. The split was determined based on a flow distribution at a normal depth cross section through the site. The south branch returns to the Flamingo Wash channel upstream of Eastern Ave; the north branch does not return until downstream of Desert Inn Rd.

There is a series of interrelated breakouts downstream of Boulder Highway associated with the major road crossings. Figure 2 summarizes the breakout discharges, which are discussed below.

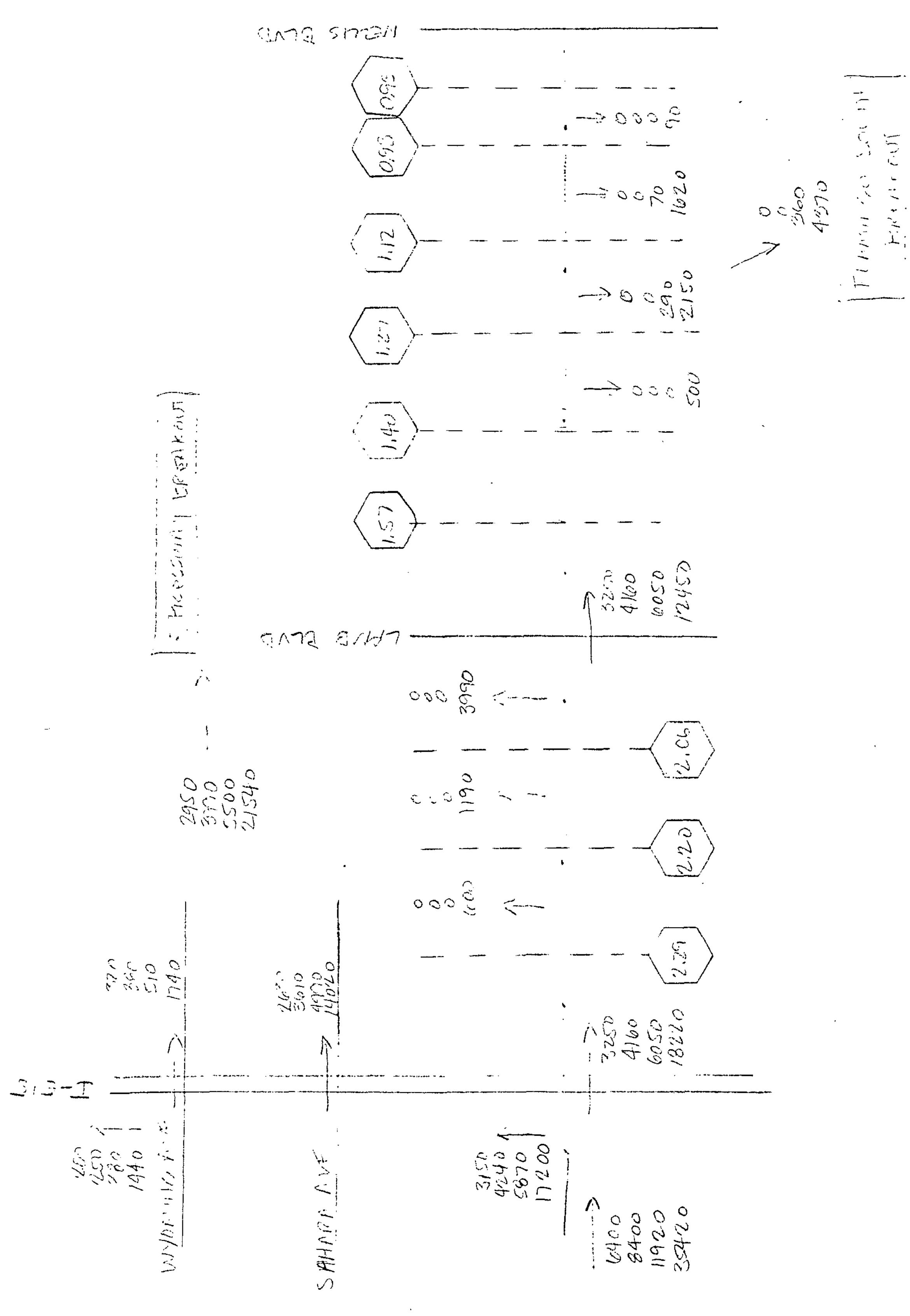
The new US-95 Expressway structure forces flows to break out of the Flamingo Wash channel and go north along the roadway embankment. This breakout was analyzed using the split flow option of HEC-2. Another split flow model was prepared to distribute the flow to the underpasses at Sahara Ave and Wyoming Ave (cross sections 51.XX and 52.XX). Flow which continued north across Wyoming Ave was minor, and was not mapped.

DATE

CLIENT ____ JOB NO. ____ CALC. BY ____

DESCRIPTION FIGURE 2 - BREAKOUT FLOWS FROM ____ CHECKED BY ____

LV WASH TO I-515



Between US-95 and Lamb Blvd, a breakout occurs over the north (left) bank into what appears to be an old channel remnant. Breakouts in this reach were determined with a split flow model using normal depth breakout cross sections which accounted for the obstruction due to the large industrial buildings adjacent to the channel. These breakout flows travel north and join with the flows which passed through the Sahara Ave and Wyoming Ave underpasses. Together these flows are referred to as the Expressway Breakout, and they run eastward until joining Las Vegas Wash upstream of Sahara Ave. See cross sections 31 and 32.

Between Nellis Blvd and Lamb Blvd a breakout occurs over the south bank due to the limited channel capacity. Again, this breakout was analyzed using the split flow option of HEC-2. Breakout flows in this reach are only significant for the 500-year flood. This breakout is referred to as the South Flamingo Breakout, and flows southeasterly until merging with the Las Vegas Wash floodplain south of the wastewater treatment plant. See cross sections 41, 42, 43 and 44.

3.2.7 OTHER MODELING ASSUMPTIONS

The starting water-surface elevations for Flamingo Wash were determined using the slope-area method based on the slope of the results of the FIS hydraulic analysis. The analysis of flooding on Flamingo Wash was assumed to be independent of flooding from Tropicana and Las Vegas Washes.

Portions of cross sections with ineffective flow due to rapid floodplain expansions were isolated using ET cards. Flood boundaries at these sections were plotted based on the contour elevations and the HEC-2 water surface elevations, not on the start or end stations.

3.3 SUMMARY OF RESULTS

Floodplain maps have been prepared to identify 25-, 50-, 100-, and 500-year flood boundaries. Flood profiles have been plotted showing water-surface elevations for the four floods along the entire channel study area, and in the major breakout areas.

The following is a description of the results of both the riverine and breakout analyses. This discussion focuses on the 100-year floodplain and begins at the upstream limit of study.

There is considerable overbank flooding for Q_{100} even at the upstream study limit, with residential areas between Jones Blvd and Torrey Pines Rd subject to flooding.

From Decatur Blvd to the UPRR, there is significant flooding of industrial properties in the right (east) overbank. This occurs for Q_{50} and above. Flooding of industrial sites contines all along the upsstream side of the UPRR and I-15 grades from Flamingo Rd to Spring Mountain Rd.

The major breakouts over the UPRR and I-15 cause sheet flow conditions at several of the major hotel/casinos along Las Vegas Blvd. The I-15 Breakout (north flowpath) contributes to sheet flow flooding in residential and commercial areas along a 3-mile flowpath from I-15 to Mojave Ave.

The 100-year flood causes overbank flooding in residential areas from Winnick Ave to Swenson Rd. From this point the 100-

year discharge is largely contained in the channel until the reach just upstream of Boulder Highway. Boulder Highway is overtopped for a length of about 1000 feet.

The US-95 breakout and the breakout upstream of Lamb Blvd cause sheet flow over a broad area of low density residential land use between US-95 and Las Vegas Wash for the 100-year flood. The southerly breakout at Nellis Blvd is only significant for the 500-year flood.

With only a couple of exceptions (McLeod Ave and US-95) virtually every road crossing of the Flamingo Wash channel is overtopped for at least one of the floods of study.

4.0 CONCLUSIONS

The flood maps, profiles, and HEC-2 hydraulic computer models will provide the Corps of Engineers with the basic floodplain information necessary to evaluate the benefits and damages associated with proposed flood control projects on Flamingo Wash. Hydraulic analyses were performed in accordance with the criteria outlined by the COE, and results were carefully reviewed by COE staff. Study results will also be useful to CCRFCD and other local agencies in floodplain management and flood control planning.

Major flood problems have been identified for Flamingo Wash in the reaches of study. These are primarily associated with:

- undersized bridges and culverts throughout the study reach
- general lack of major channel improvements
- a major breakout at the UPRR grade
- insufficient capacity in the long culvert under Caesars Palace and Imperial Palace
- a major breakout at US-95 and Lamb Blvd

5.0 REFERENCES

1. Federal Emergency Management Agency, Draft Flood Insurance Study, Unincorporated Areas of Clark County, Nevada, 1987, (unpublished)

2. James M. Montgomery, Consulting Engineers, Inc., Memorandum to Files, Overflow Study n Values, in Corps of Engineers files, May 1987

3. James M. Montgomery, Consulting Engineers, Inc., Memorandum to Files, Debris Analysis for Las Vegas Valley Overflow Study, in Corps of Engineers files, April 1987

TROPICANA WASH

TROPICANA WASH

CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT

OVERFLOW ANALYSES

by:

James M. Montgomery, Consulting Engineers, Inc.
2915 West Charleston Blvd., Suite 12
Las Vegas, Nevada 89102

September 1988

LAS VEGAS WASH AND TRIBUTARIES OVERFLOW STUDY

TROPICANA WASH

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LAS VEGAS WASH AND TRIBUTARIES OVERFLOW STUDY

TROPICANA WASH

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this overflow study is to determine the extent and depth of flooding in the Tropicana Wash floodplain. Flood boundaries and water-surface elevations are required by the Hydraulics Section of the U.S. Army Corps of engineers (COE) as part of the Las Vegas Wash and Tributaries Feasibility Study. The overall overflow study included all major flooding sources in the Las Vegas Valley (Las Vegas Wash, Range Wash, Las Vegas Creek, Flamingo Wash, Tropicana Wash, Duck Creek, Pittman Wash, and C-1 Channel), and mapped flood hazards for main channels and all significant breakout flows.

1.2 AUTHORIZATION

This study was performed by James M. Montgomery, Consulting Engineers, Inc. (JMM), under contract to the Clark County Regional Flood Control District dated April 9, 1987. The Scope of Work for the study was prepared by the Los Angeles District of the COE, which also provided extensive technical and administrative review throughout the project.

1.3 COORDINATION WITH OTHER AGENCIES

Technical criteria and review were provided by the Hydraulics Section of the COE, with input during the negotiation process from Clark County Regional Flood Control District (CCRFCD). Supplemental bridge survey data were obtained from the CCRFCD.

2.0 GENERAL DESCRIPTION OF STUDY AREA

2.1 LOCATION AND EXTENT

Tropicana Wash is a tributary to Flamingo Wash, which in turn is a tributary to Las Vegas Wash. Tropicana Wash has a drainage area of approximately 76 square miles at its mouth. This includes approximately 40 percent of the Blue Diamond Wash drainage area, which contributes flow to lower Tropicana Wash due to breakouts and shifting channels on the Blue Diamond alluvial fan. Tropicana Wash was studied for approximately 6.8 miles, from its confluence with Flamingo Wash upstream to Rainbow Blvd.

2.2 TOPOGRAPHIC AND STREAM CHARACTERISTICS

Tropicana Wash flows in a generally northeast direction, draining a portion of the alluvial apron on the west side of Las Vegas Valley. Its western-most portions are fairly steep and poorly defined on the undeveloped alluvial fan, whereas its eastern-most portions are surrounded by intense urban development.

From the confluence with Flamingo Wash to Koval Lane, the Tropicana Wash channel is generally well defined, with the exception of a broad flat reach in the undeveloped area west of Paradise Road. The average slope in this reach is 0.0088 (46 feet/mile). The channel passes through a long continuous culvert under a parking lot east of Paradise Road.

From Koval Lane to Las Vegas Blvd, Tropicana Wash is a swale through the golf course of the Tropicana Country Club. From Las Vegas Blvd to Interstate Highway 15 the channel has variable geometry and capacity. The average slope in this reach is 0.0102 (54 feet/mile). At the upstream face of I-15, the South Branch of Tropicana Wash joins the main stem.

Between I-15 and the Union Pacific Railroad (UPRR) tracks, the channel is small and poorly defined as it meanders through an industrial area. The average slope in this reach is 0.0154 (81 feet/mile).

Upstream of the UPRR, Tropicana Wash has three main branches which are associated with the primary erosion channels on the Tropicana Wash alluvial fan. Only the North and Central Branches have been analyzed in this study. The South Branch, which picks up a portion of the flow from the upper Blue Diamond Wash watershed due to assumed breakouts on the alluvial fan, was not analyzed in this study because of the general lack of existing development in its floodplain.

The Central and North Branches join just upstream of the UPRR. The North Branch channel is almost indistinguishable for about 3000 feet upstream of the UPRR. However, the remainder of the reach up to Rainbow Blvd is deeply entrenched (up to 20 feet) due to headcutting and channel erosion in the coarse alluvial material. The average slope for the North Branch is 0.0130 (69 feet/mile). In contrast, the Central Branch has a small but well defined low flow channel up to Decatur, but above that point most of the floodplain is comprised of small erosion channels with limited capacity. The average slope of the Central Branch is 0.0129 (68 feet/mile).

2.3 CHANNEL IMPROVEMENTS

Tropicana Wash has a few sections of graded channel, but no reaches where major channel improvements (e.g., concrete lining) have been made. The following reaches are graded but unlined:

- Swenson Road to the culvert at Paradise Road
- A short reach 1200 feet upstream of I-15 (RM 2.70 to RM 2.93)

- o The low flow channel for Central Branch upstream of the UPRR (RM 3.88 to RM 4.41)

The only other improvements to the Tropicana Wash channel are the numerous bridges and culverts which span the channel at road crossings.

2.4 FLOOD HISTORY AND CHARACTERISTICS

Flooding on Tropicana Wash has been associated with short-duration, high-intensity thunderstorms common to Las Vegas Valley. Although Flamingo Wash has produced several flood flows over the past 15 years, storms have not occurred as frequently in the Tropicana Wash watershed. When peak flows do occur, they are generated by storms occurring in the upland portions of the watershed (mountains and alluvial fans).

The storm of July 3, 1975, produced the peak flow of record for Tropicana Wash (1,700 cfs at I-15). Limited culvert capacities at I-15 and UPRR prevented significant damage to the downstream urbanized areas.

2.5 PRESENT AND FUTURE URBANIZATION

The Tropicana Wash floodplain in the study area currently includes a wide variety of urbanization and land uses, from hotel/casino properties to broad expanses of natural desert. From the Flamingo Wash confluence to Koval Lane, the Tropicana Wash floodplain supports a significant number of high density residential developments, although there are still many open parcels. In particular, there is a large open area which straddles the channel to the west of Paradise Road.

The reach from Koval Lane to Las Vegas Blvd includes a mixture of golf course land and hotel/casinos. Between Las Vegas Blvd and the UPRR the primary land use is industrial, although many of the available parcels have not yet been developed.

Upstream of the UPRR to Decatur, there is very light industrial development. Above Decatur, most land is open desert, although there are sparsely placed ranch estates throughout the area.

Future development in the floodplain will consist of infill following the same basin trends as the existing land use. In the lower reach downstream of Las Vegas Blvd, high density residential developments will continue to be built. In the areas between I-15 and Decatur, industrial properties will infill in the available lots. Above Decatur Blvd, low density residential land uses will prevail.

3.0 HYDRAULIC ANALYSIS

3.1 DATA SOURCES

3.1.1 MAPS

The analysis of flooding along Tropicana Wash was based on rectified photo topographic maps prepared for James M. Montgomery, Consulting Engineers, Inc., by Cooper Aerial of Nevada, Inc., for the Clark County Flood Insurance Study (FIS) (Reference 1). Scale 1:4,800, Contour interval: 4 feet. Photo date: September 14, 1984.

3.1.2 HYDROLOGY

Peak discharges were based on "future conditions without project" hydrology provided by the COE, adjusted for hydraulic constraints and breakout flows. Table 1 summarizes the discharges used in the analysis of flooding along Tropicana Wash.

TABLE 1

Peak Discharges w/o Project
1987 Conditions
(in c.f.s.)

Concentration Point	Main Channel 25-Year Fut.	Main Channel 50-Year Fut.	Main Channel 100-Year Fut.	Main Channel 500-Year Fut.	Breakout Flow 25-Year Fut.	Breakout Flow 50-Year Fut.	Breakout Flow 100-year Fut.	Breakout Flow 500-Year Fut.
North Tropicana Wash at UPRR CP-8 RM 4.3 DA = 2.55 mi^2	820	1,500	2,600	9,500	0	0	0	0
Central Tropicana Wash at UPRR CP-6 RM 4.3 DA = 5.52 mi^2	1,300	2,200	3,800	17,000	0	0	0	0
Tropicana Wash at UPRR CP-7 + 8 RM 3.5 DA = 8.07 mi^2	1,900	3,200	5,500	19,000	0	0	0	0
Tropicana Wash downstream of UPRR CP-9 RM 3.4 DA = 8.07 mi^2	1,010	1,120	1,330	3,100	890	2,080	4,170	15,900
Tropicana Wash at I-15 CP-10 RM 2.7 DA = 67.92 mi^2 *	1,810	2,520	3,330	6,100	890	2,080	4,170	15,900
Tropicana Wash at Koval Lane CP-29 RM 1.5 DA = 69.01 mi^2 *	1,910	2,620	3,330	6,100	890	2,080	4,170	15,900
Tropicana Wash at Paradise Road CP N/A RM 0.7 DA = N/A	1,910	2,620	3,330	8,400	890	2,080	4,170	13,600
Tropicana Wash at Flamingo Wash CP-30 RM 0.0 DA = 75.92 mi^2 *	1,910	2,620	3,330	8,400	890	2,080	4,170	13,600

TABLE 1 (Cont'd)

Peak Discharges w/o Project
1987 Conditions
(in c.f.s.)

Concentration Point	Main Channel 25-Year Fut.	Main Channel 50-Year Fut.	Main Channel 100-Year Fut.	Main Channel 500-Year Fut.	Breakout Flow 25-Year Fut.	Breakout Flow 50-Year Fut.	Breakout Flow 100-year Fut.	Breakout Flow 500-Year Fut.
Breakout at UPRR RM 3.5	N/A	N/A	N/A	N/A	890	2,080	4,170	15,900
Weir Flow Over UPRR south of Tropicana Aveneue RM 3.5	N/A	N/A	N/A	N/A	0	0	20	3,000
Breakout north of Tropicana Avenue at UPRR RM 3.5	N/A	N/A	N/A	N/A	0	0	0	1,000

* Drainage areas include Blue Diamond Wash. Up to 40% of Blue Diamond Wash is diverted into Flamingo Wash

3.1.3 HYDRAULIC STRUCTURES

Surveys of hydraulic structures obtained for the Clark County Flood Insurance Study were utilized in this analysis. This information was supplemented with field checks for new structures supplied by the CCRFCD. All structures completed by July 1, 1987, have been included in this analysis. No future flood control projects have been included in this study. The hydraulic structures included in this analysis are listed in Table 2.

TABLE 2

Bridge Structures

Tropicana Wash - Rainbow Boulevard to Flamingo Wash

Stream Miles	Location	Structure - Type, Size
3.46	Union Pacific Railroad	Corrugated metal pipe culvert 9.5′ diam.
2.62	I-15	Bridge 32′W x 7′D, 3 supports
2.39	Tropicana Avenue	Bridge 32′W x 7′D, 3 supports
2.12	Las Vegas Blvd	Bridge 40′W x 6′D, 3 supports
1.46	Koval Lane	Bridge 24′W x 7′D, 2 supports
1.15	Harmon Avenue	Bridge 60′W x 5′D, 4 supports
0.74	Paradise Road	Bridge 72′W x 4′D, 9 supports
0.30	Swenson Avenue	Bridge 72′W x 4′D, 5 supports
0.16	Flamingo Road	Corrugated metal pipe culverts 2-18"x30"

3.1.4 STREAM BED CROSS SECTIONS

Cross sections digitized from the aerial mapping for the FIS were utilized for the riverine analysis. These cross sections were extended and supplemented using topography from the 1:4,800 scale mapping. For the breakout analyses, cross sections were developed from topography from the 1:4,800 mapping.

3.1.5 MATHEMATICAL MODELS

For the riverine analysis, the U.S. Army Corps of Engineers' HEC-2 step backwater computer program was used to determine water-surface elevations. The hydraulic analysis for Tropicana Wash has been divided into five main channel study reaches: 1) confluence with Flamingo Wash to Harmon Avenue; 2) Harmon Avenue to I-15; 3) I-15 to the UPRR; 4) Central Branch from the UPRR to Rainbow Blvd; and 5) North Branch from the UPRR to Rainbow Blvd. Separate HEC-2 models were prepared for each reach to improve the efficiency of the modeling process in making multiple debugging runs. Where necessary, the models were linked using known water-surface elevations from the downstream HEC-2 runs.

The foundation of the main channel HEC-2 runs was the HEC-2 modeling developed by JMM for the Clark County Flood Insurance Study. These models were originally prepared in 1985 and 1986 under the guidelines of the Federal Emergency Management Agency (FEMA). Many modifications to the FIS models were made in order to implement the study criteria for the Corps Feasibility Study.

Cross section labels (SECNO) for the riverine analysis reflect actual centerline distances, in miles, upstream from the confluence with Flamingo Wash. In the case of the North and Central Branches, common cross sections were used to model both floodplains. Section numbering was based on channel distances measured along the Central Branch.

Separate HEC-2 models were prepared for the following breakout reaches:

- o Overflow along the UPRR from Tropicana Wash channel to Tropicana Avenue (90.XX series cross sections)

- o Overflow along Tropicana Avenue from the UPRR to I-15 (same section numbers as corresponding cross sections on main channel)

- o Overflow in right overbank from I-15 to Koval Lane (70.XX series cross sections)

Downstream of Koval Lane, the breakout overflows were modeled using cross sections from the HEC-2 analysis for Flamingo Wash. For ease of comparison, cross section numbers were retained from the Flamingo Wash analysis.

3.2 METHODOLOGY

3.2.1 ASSUMPTIONS AND LIMITATIONS

The accuracy of the overflow analysis is based in part on the accuracy of the topographic data with which cross sections and flood boundaries were defined. In general, this data was not field checked. Where there are minor discrepancies between contour elevations and digitized cross section elevations, it was assumed in preparing the HEC-2 models that the digitized cross sections represented the more reliable data.

Where discrepancies occur at digitized cross sections between the computed HEC-2 flood boundary and the contour information, the boundary on the map has been plotted based on the contours. This improved consistency in plotting boundaries between cross sections and yields a more "regular" floodplain geometry.

In sheet flow areas, floodplain widths are very sensitive to the cross section orientation. Sections in these areas were drawn to be generally parallel to the contour lines.

In breakout areas, overflows were analyzed until it was determined that the average depth was less than 1.0 foot and the velocity was less than 3 ft/sec. At this point, the analysis was terminated.

In some areas of overbank and shallow flooding, small islands may occur as the result of minor local topographic variations. These islands have not been shown on the maps due to limitations of topographic definition and accuracy.

In some cases bridges were modeled using the normal bridge routine and in other cases the special bridge routine was used. In general, when most of the 100-year flow at the bridge was contained in the channel either as low flow, pressure flow or weir flow over the bridge deck, the special bridge routine was used. When most of the 100-year flow was in the overbanks at the bridge location, the normal bridge routine was used. Because the 100-year flood was used as the benchmark, the adopted bridge routines may not represent the best approaches to modeling the other recurrence intervals. Nonetheless, the same routine was used to model all four floods at a particular structure.

3.2.2 ROUGHNESS COEFFICIENT ASSESSMENT

Manning's "n" roughness coefficients were selected as outlined in a JMM project memorandum (Reference 2). The FIS values were used as a basis, and were adjusted as necessary to reflect Corps of Engineers criteria. In particular, "n" values in areas of dense urban development were generally increased over the values used in the FIS. NH cards were utilized where cross sections were extended through multiple land use types.

Table 3 presents representative channel and overbank "n" values used in the analyses:

Table 3

"n" Values

Cross Section	Left Overbank	Right Overbank	Channel
0.09	0.040	0.040	0.060
0.48	0.040	0.180	0.032
0.81	0.050	0.050	0.045
1.14	0.170	0.180	0.055
1.77	0.042	0.042	0.046
2.23	0.080	0.050	0.050
2.91	0.070	0.050	0.040
3.38	0.040	0.045	0.040
4.09	0.055	0.056	0.055
5.80 (North)	0.045	0.060	0.045

3.2.3 DEBRIS LOADING EVALUATION

The analysis of debris loading of hydraulic structures was described in a JMM project memorandum (Reference 3). The amount of debris loading at each hydraulic structure on Tropicana Wash is summarized in Table 4. Debris loading of the specified width was applied to all piers, and to the bridge abutments if no wingwalls were present.

Table 4

Debris Load

Structure	Debris Loading (ft)	Sediment Load (ft)
Union Pacific Railroad	2	0
I-15	2	0
Tropicana Avenue	1	0
Las Vegas Blvd	1	0
Koval Lane	1	0
Harmon Avenue	2	0
Paradise Road	2	0
Swenson Avenue	1	0
Flamingo Road	1	0

3.2.4 CROSS SECTION ORIENTATION

For the riverine analysis, cross sections used in the HEC-2 model were oriented perpendicular to the direction of flow. For the breakout analysis, the cross sections were oriented parallel to contours.

3.2.5 CHANNEL CAPACITIES

The channel capacities along Tropicana Wash represent nondamaging discharges. These were estimated based on the HEC-2 computer analyses for the various recurrence interval floods, and simulation of additional flows as necessary to develop rating curves. For the purposes of identifying nondamaging discharges, the study area was broken into seven reaches with similar hydraulic characteristics. The nondamaging discharges for these reaches, based on a cross section with limiting capacity, are summarized in Table 5.

Table 5

Nondamaging Flows

Reach	Cross Section	Nondamaging Flow (cfs)
1. Confluence to Harmon Avenue	0.171	1,600
2. Harmon Avenue to Las Vegas Blvd	1.17	2,800
3. Las Vegas Blvd to I-15	2.40	1,500
4. I-15 to UPRR	2.72	600
5. UPRR to Confluence of North Branch and Central Branch	3.47	950
6. North Branch	4.09	125
7. Central Branch	4.28	2,700

3.2.6 BREAKOUTS AND BRANCHED FLOWS

The major breakout from Tropicana Wash channel occurs at the first structure it meets at the fringe of the present urban area: the UPRR culvert. This structure is undersized, and causes flow to leave the channel and flow north along the west side of the UPRR tracks. The breakout was analyzed using the HEC-2 split flow option, with section 90.24 as the breakout control section. The discharges leaving the main channel are given below.

Q_{25} = 890 cfs

Q_{50} = 2,080 cfs

Q_{100} = 4,170 cfs

Q_{500} = 15,900 cfs

The 500-year UPRR breakout is large enough to exceed the elevation of the tracks, and thus 3,000 cfs weirs back over the tracks. The weir flow component was estimated using the HEC-2 split flow option, with the "main channel" being the overflow path on the west side of the UPRR tracks. This weir flow does not rejoin the main channel, but rather flows northeast to merge with the remainder of the original breakout flow. Thus Q_{500} left overbank flooding mapped at section 3.38 is due to the UPRR weir overflow, not to overbank flooding from the main channel.

At Tropicana Avenue, most of the breakout flow turns east and enters the Tropicana Avenue underpass. Based on the flow distribution at section 90.03, it is assumed that 1,000 cfs of Q_{500} will continue north along the UPRR alignment. Normal depth calculations show that this flow is less than 1.0 foot deep, and thus it was not studied.

The breakout flow was modeled along Tropicana Avenue using HEC-2, with extensions of the main channel cross sections. The ridge south of Tropicana Avenue prevents comingling of main channel and breakout flows all the way to I-15 and the Tropicana Avenue on-ramp, even for Q_{500}.

Another split flow model was used to determine the flow distribution of weir flow over I-15 in the breakout area. In this case the "main channel" was the flow path parallel to I-15 (sections 80.XX).

A HEC-2 model was used to compute elevations for breakout flows between I-15 and Koval Lane. Judgement was used in plotting boundaries in this reach, because there were significant changes in conveyance between adjacent cross sections. An approximate 1:1 expansion limit was used in the left overbank downstream of Las Vegas Blvd. Winnick Avenue, which has an inverted crown and serves as the Flamingo Wash channel, was "filled in" in the model in order to reduce its conveyance, since most of the breakout flow can not reach this part of the floodplain.

The breakout analysis for Q_{25} and Q_{50} was terminated at Koval Lane because average flow depths drop below 1.0 foot. The Q_{100} and Q_{500} breakouts were continued down to the Flamingo Wash channel confluence. Based on the flow distribution at section 70.07 (Koval Lane), it was estimated that 2,300 cfs of the Q_{500} breakout could return to the main channel flowpath at Paradise Road; thus this flow was added back in to the main channel discharge. The lesser return period floods had no flow returning to the main channel at this location.

The Q_{100} and Q_{500} breakouts between Koval Lane and Flamingo Wash were modeled using the HEC-2 cross sections from the Flamingo Wash analysis. A "discontinuity" in flood boundaries appears between sections 70.07 and 7.16; this is because breakout flows along Flamingo Road have not been mapped as a result of depths less than 1.0 foot. To be conservative, all breakout flows were modeled in the Flamingo Wash channel area between Koval Lane and Flamingo Wash.

Between Swenson Road and Paradise Road, the elevation of Q_{500} exceeds the elevation of Flamingo Road on the left overbank. Thus some of the main channel flow weirs over the road and is captured by Flamingo Wash upstream of the main channel confluence. A split flow run was made to determine the weir flows. It was found that 2,100 cfs weirs between sections 0.74 and 0.53; 90 cfs weirs between 0.53 and 0.39; and 1,100 cfs weirs between 0.39 and 0.31.

3.2.7 OTHER MODELING ASSUMPTIONS

The starting water-surface elevations for Tropicana Wash were determined using the slope-area method based on the slope of the channel invert at the downstream study limit. The analysis of flooding on Tropicana Wash was assumed to be independent of flooding from Flamingo Wash.

Several unique assumptions were made in the modeling of the alluvial fan area upstream of Decatur Blvd. Erosion channels were generally "filled in" when coding cross sections due to the lack of lateral slope which could bring flow into these channels. Despite this assumption, channel conveyance changes rapidly in this reach from cross section to cross section. This tends to result in widely varying computed flood topwidths. Boundaries were plotted smoothly between sections to avoid unreasonable lateral flow conditions. For the North Branch, flow was not allowed to spread beyond the major erosion channel, since it has adequate capacity to convey the full model discharges. On the Central Branch, the existing topography upstream of the study area indicates that most flow would be directed into the northerly of the two channels at section 6.81 for Q_{25} through Q_{100}. However, flow was assumed to occur in both channels due to the potential for upstream erosion and shifting of channels in the alluvial material.

Although the long culvert between sections 0.53 and 0.74 does not have the same cross sectional geometry throughout, the structure was modeled with a single normal bridge routine.

In the subreaches where the North Branch and Central Branch transition into the confluence upstream of the UPRR, 1:1 expansion limits were set with ET cards to prevent rapid expansion of the floodplain. This was done at sections 3.89 to 4.28.

3.3 SUMMARY OF RESULTS

Floodplain maps have been prepared to identify 25-, 50-, 100-, and 500-year flood boundaries. Flood profiles have been plotted showing water-surface elevations for the four floods along the entire channel study area, and in the major breakout areas.

The following is a description of the results of both the riverine and breakout analyses. This discussion focuses on the 100-year floodplain and begins at the upstream limit of study.

The 100-year floodplain for the Central Branch is very wide (2,500 to 3,000 feet) due to the limited capacity of the existing erosion channels. However, overbank flooding is also very shallow. The floodplain width is so wide because of the unconcentrated flows entering the study area from the upstream alluvial fan. The same case applies to the North Branch, but the floodplain is narrower because of the ability of the large erosion channel to capture and convey flow.

Between the North/Central Branch confluence and the UPRR, the 100-year floodplain is relatively wide due to the lack of a well defined channel, particularly for flows originating in the North Branch.

The limited capacity of the UPRR culvert causes major breakouts for all floods (as discussed above), and also allows the railroad tracks to be overtopped by the 500-year flood.

Ponding occurs upstream of the I-15 grade for all floods. The 25-year flow is able to pass through the culvert structure, but the higher flows weir over the highway for a width of up to 450 feet.

Because of the significant breakout at the UPRR, there is relatively little overbank flooding downstream of I-15. Areas where local problem have been identified are: the Las Vegas Blvd culvert; the Koval Lane culvert; the Harmon Avenue culvert; the Paradise Road culvert; and the Flamingo Road culvert. It is noted that the primary problem in this reach is undersized bridges and culverts.

The UPRR breakout causes significant flooding problems. Several major hotel/casinos on Las Vegas Blvd are in the floodplain, and I-15 is overtopped essentially all the way from Tropicana Avenue to Flamingo Road. However, except for the reach along Tropicana Avenue west of I-15, flooding will consist of sheet flows with shallow depths and slow velocities.

4.0 CONCLUSIONS

The flood maps, profiles, and HEC-2 hydraulic computer models will provide the Corps of Engineers with the basic floodplain information necessary to evaluate the benefits and damages associated with proposed flood control projects on Tropicana Wash. Hydraulic analyses were performed in accordance with the criteria outlined by the COE, and results were carefully reviewed by COE staff. Study results will also be useful to CCRFCD and other local agencies in floodplain management and flood control planning.

Major flood problems have been identified for Tropicana Wash in the reaches of study. These are primarily associated with:

- undersized culverts
- lack of any major channel improvements
- sheet flows from the upstream alluvial fan
- a major breakout at the UPRR

5.0 REFERENCES

1. Federal Emergency Management Agency, Draft Flood Insurance Study, Unincorporated Areas of Clark County, Nevada, 1987, (unpublished)

2. James M. Montgomery, Consulting Engineers, Inc., Memorandum to Files, Overflow Study n Values, in Corps of Engineers files, May 1987

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DUCK CREEK

DUCK CREEK

CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT

OVERFLOW ANALYSES

by:

James M. Montgomery, Consulting Engineers, Inc.
2915 West Charleston Blvd., Suite 12
Las Vegas, Nevada 89102

September 1988

LAS VEGAS WASH FEASIBILITY OVERFLOW STUDY

DUCK CREEK

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DUCK CREEK

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this overflow study is to determine the extent and depth of flooding in Duck Creek. Flood boundaries and water-surface elevations are required by the Hydraulics Section of the U.S. Army Corps of Engineers (COE) as part of the Las Vegas Valley Feasibility Study. The overall overflow study included all major flood sources in the Las Vegas Valley (Las Vegas Wash, Range Wash, Las Vegas Creek, Flamingo Wash, Tropicana Wash, Duck Creek, Pittman Wash, and C-1 Channel), and mapped flood hazards for main channels and all significant breakout flows.

1.2 AUTHORIZATION

This study was performed by James M. Montgomery, Consulting Engineers, Inc., under contract to the Clark County Regional Flood Control District dated April 9, 1987. The Scope of Work for the study was prepared by the Los Angeles District of the COE, which also provided extensive technical and administrative review throughout the project.

1.3 COORDINATION WITH OTHER AGENCIES

Technical criteria and review were provided by the Hydaulics Section of the COE, with input during the negotiation process from Clark County Regional Flood Control District (CCRFCD). Supplemental bridge survey data were obtained from the CCRFCD.

2.0 GENERAL DESCRIPTION OF STUDY AREA

2.1 LOCATION AND EXTENT

Duck Creek extends from the south Las Vegas Valley northeast to the Las Vegas Wash. The study portion of Duck Creek begins in the south half of Section 11, Township 22 South, Range 6 East generally south of the Henderson spur of the Union Pacific Railroad (UPRR) at the natural extension south of Maryland Parkway.

Duck Creek meanders in a pronounced northeast direction until it enters the Las Vegas Wash in the south half of Section 26, Township 21 South, Range 62 East. It is crossed by the railroad and Boulder Highway.

Two major breakouts occur along Duck Creek. The first is at UPRR. Approximately 90 percent of the flow breaks out in the right overbank and runs along the railroad to a second crossing. From there it returns to Duck Creek. The second breakout occurs one mile downstream from the railroad in the left overbank. This overflow rejoins the main stream at U.S. 95, but breaks away again downstream. It rejoins the main stream at its confluence with the Las Vegas Wash. These breakout flows are discussed in more detail elsewhere in this report.

2.2 TOPOGRAPHIC AND STREAM CHARACTERISTICS

Duck Creek for the most part is a natural meandering wash which falls off to the northeast approximately 470 feet in the 8.75 mile stretch to the Las Vegas Wash. The overbanks vary from open flood plain and steep banked plateaus to sparse rural and dense residential development.

In the upstream reach between Maryland Parkway and the railroad, the left overbank consists of intermittent rural development. The right overbank also has intermittent rural development, but additionally has high ground at varying distances from the channel. The high ground falls away sharply just upstream of where the main stream crosses the railroad. Flows over and above the channel capacity follow the railroad to a second crossing. Again, there is intermittent development along the way.

In the next reach downstream between the railroad and Boulder Highway, the left overbank is for the most part residential development interspersed with parks and other open areas. The right overbank consists of the same type of land usage, and again, has high ground at varying distances from the channel and at times directly adjacent to the channel.

Downstream of Boulder Highway, development and open ground share the broad flood plain on either side of Duck Creek from Boulder Highway to Las Vegas Wash. From just upstream of Boulder Highway to the Las Vegas Wash, slopes flatten out and streambed course and banks are poorly defined.

2.3 CHANNEL IMPROVEMENTS

At a distance of 440 feet upstream from the Pecos Road alignment, the channel improvements begin. The channel section is rectangular with concrete blocks forming the walls. The invert of the channel is earthen.

Approximately 160 feet upstream of the Pecos Road alignment the channel transitions to a fully lined concrete channel. The shape is trapezoidal with a 30-foot bottom, side slopes set at 1.5H to 1.0V and an overall depth of 9 feet. The concrete section continues past Pecos to Sandhill.

From Sandhill to just past Sunset Road, the channel has an improved earthen cross section with gabion side slopes, a 36-foot bottom, 2.0H to 1.0V side slopes and an overall depth of 14 feet.

At the Russell Road bridge, the side slopes are covered with loose riprap and there is a concrete drop structure on the downstream side.

The bridge structures at Eastern Avenue and the Boulder Highway have concrete lined bottoms. The remainder of Duck Creek remains unimproved natural wash.

2.4 FLOOD HISTORY AND CHARACTERISTICS

There have been small flood events in recent flood history in 1983 and 1984. Typical effects noted were channel bank erosion between Warm Springs Road and Pecos Road. Pachuca Street, Mira Vista Street, and Tomiyasu Lane experienced severe erosion damage. The pipe culverts were plugged with sediment.

Erosion damage was also noted on the downstream side of Warm Springs Road along the flow path of the breakout flow upstream of UPRR.

Sediment deposition is evident at the bridges at Boulder Highway, and flooding up over the highway occurred during one of those events.

Large storm events have not been experienced recently on Duck Creek but topography and aerial photography indicate their general nature. While the topography was used to model the two breakout flows mentioned and estimate their magnitude and breadth, the natural foilage along their path evident in the aerial photos serve as conformation to the model scenario. The topography at the UPRR clearly indicates that historic large flows followed the flow path of the second crossing. Downstream of UPRR a dense line of foilage is evident everywhere along the second breakout flow path not obscured by development.

2.5 PRESENT AND FUTURE URBANIZATION

Upstream of the railroad, development consists of a mixture of rural and urban development. The development is active, and it can be assumed that in the future, the area surrounding Duck Creek will be fully developed with the above mentioned mixture.

Immediately downstream from the railroad the development is ranch rural estates. This area is more densely developed than the area upstream of the railroad and is still developing. In the near future, it will be fully developed.

Downstream from the custom home area, development is not possible in the right overbank area due to steep slopes and high ground. The left overbank is densely developed with residential type development. While there are pockets of open area, further development in this area is slow. Just upstream of Boulder Highway in the left overbank, development is very dense with residential and commercial areas.

Between the Boulder Highway and Las Vegas Wash residential development exists on both sides of the creek bed. While open land predominates, development is active in the area.

3.0 HYDRAULIC ANALYSIS

3.1 DATA SOURCES

3.1.1 MAPS

Two sources of mapping were used in the analysis of flooding along Range Wash:

1. Rectified photo topographic maps prepared for James M. Montgomery, Consulting Engineers, Inc., by Cooper Aerial of Nevada, Inc., for the Clark County Flood Insurance Study (FIS). Scale 1:4,800, Contour interval: 4 feet. Photo date: September 14, 1984.

2. Planimeteric topographic maps prepared for Clark County Regional Planning Council by American Aerial Surveys, Inc., for the Clark County Regional Aerial Mapping Project. Scale 1:2,400, Contour interval: 5 feet. Photo date: February 3, 1974.

3.1.2 HYDROLOGY

Peaks flows were generated with the HEC-1 model supplied by the Corps for Duck Creek. Discharges were based on "future conditions change are at the Union Pacific Railroad and at Sunset Road. Refer to the enclosed Table 1 for flow values.

3.1.3 HYDRAULIC STRUCTURES

There are 14 hydraulic structures between the upstream study limit and the Las Vegas Wash. They range in size from simple dip sections at road crossings to full span bridges. A list was supplied by Clark County Public Works (see Table 2).

Two dip section structures, one at Vista Del Sol and one at Pachuca, were added to the model. Field survey data provided by the Flood Control District was used for the model. Their locations in the model are at mile 7.135 and 6.97 respectively.

3.1.4 STREAM BED CROSS SECTIONS

The stream bed cross sections for the main channel were obtained from digitized cross sections from the 1984 topo as described under map sources. The overbanks were extended and modified using the 1984 contour maps. Cross sections for the right overbank and left overbank breakout flows were obtained directly from the investigation of the 1984 topo maps.

3.1.5 MATHEMATICAL MODELS

The Army Corps of Engineers' HEC-2 step backwater computer program was utilized to determine water surface elevations and flood plain boundaries for the 25-, 50-, 100- and 500-year flood flows for both the main channel and the breakout flows. Eleven separate HEC-2 models were used to model the flows. For each of the eleven models

TABLE 1

Peak Discharges w/o Project
1987 Conditions
(in c.f.s.)

Concentration Point	Main Channel 25 Year Fut.	Main Channel 50 Year Fut.	Main Channel 100 Year Fut.	Main Channel 500 Year Fut.	Breakout Flow 25 Year Fut.	Breakout Flow 50 Year Fut.	Breakout Flow 100 Year Fut.	Breakout Flow 500 Year Fut.
South Blue Diamond at Paradise Road CP 5 RM 8.75 DA=65.23 mi.*	1300	2150	3300	8200	0	0	0	0
North Blue Diamond at Paradise Road CP 4 RM 8.75 DA=66.76 mi.*	3300	5600	8900	23000	0	0	0	0
Duck Creek Downstream of Las Vegas Blvd. CP 10 DA=130.21 mi.*	5100	9400	16500	51000	0	0	0	0
Duck Creek at Paradise Rd. CP 12 RM 8.75 DA=137.45 mi.	5200	9600	17000	52000	0	0	0	0
Duck Creek at UPRR CP 14 RM 7.18 DA=205.77 mi.*	559	842	1371	10715	4741	8958	16629	43285
Duck Creek at Pecos St. RM 6.30	5300	9800	18000	54000	0	0	0	0
Duck Creek at Sandhill RM 5.71	4413	6690	11670	28000	987	3310	6830	27000

* Drainage areas include Blue Diamond Wash. 60% to 70% of Blue Diamond Wash is diverted into Duck Creek

TABLE 1 (continued)

Peak Discharges w/o Project
1987 Conditions
(in c.f.s.)

Concentration Point	Main Channel 25 Year Fut.	Main Channel 50 Year Fut.	Main Channel 100 Year Fut.	Main Channel 500 Year Fut.	Breakout Flow 25 Year Fut.	Breakout Flow 50 Year Fut.	Breakout Flow 100 Year Fut.	Breakout Flow 500 Year Fut.
Duck Creek at Sunset Rd. CP 57 RM 5.20 DA=214.36 mi.*	4413	6690	11670	25380	987	3310	6830	29620
Duck Creek at Russell Rd. RM 3.82	4413	6690	10420	18398	987	3310	8080	36602
Duck Creek at US 95 RM 3.44	5400	10000	18500	55000	0	0	0	0
Duck Creek at Nellis Blvd. RM 3.25	5400	10000	18433	52540	0	0	67	2460
Duck Creek downstream from Nellis Blvd. RM 2.72	5400	8908	11301	18752	0	1092	7199	36248
Duck Creek upstream from Boulder Highway RM 2.37	5313	8424	10358	15658	87	1576	8142	39342
Duck Creek Downstream of Boulder Highway CP 8 RM 1.17 DA=227.92 mi.*	733	1096	1253	2884	4667	8904	12247	52116
Duck Creek at Las Vegas Wash RM 0.94	5400	10000	18500	60000	0	0	0	0

* Drainage areas include Blue Diamond Wash. 60% to 70% of Blue Diamond Wash is diverted into Duck Creek

TABLE 2

Bridge Structures

Duck Creek - Maryland Parkway to Las Vegas Wash

Stream Miles	Location	Structure - Type, Size
7.54	Eastern	Bridge 2-7' High Corrugated Metal
7.17	UPRR	Bridge 90' W x 7' D, 2 Supports
7.135	Vista Del Sol	Dip Crossing
6.97	Pachuca St.	Dip Crossing
6.86	Mira Vista	Pipe Culverts 4-48" CMP
5.46	Sunfish Drive	Bridge 77' W x 11' D, Clear Span
5.18	Sunset Road	Bridge 104' W x 13' D, 2 Supports
3.93	Mt. Vista	Bridge 95' W x 12' D, 1 Support
3.80	Russell	Bridge 100' W x 13' D, 2 Supports
3.44	U.S. 95	Box culvert 10' W x 8' H (Four)
2.22	Stephanie	Pipe culvert 3-36" CMP
1.40	Boulder Hwy.	Bridge 84' W x 6' D, 6 Supports

the appropriate flow regime was subcritical. Additionally, four of the models utilized HEC-2's split flow capability and one used the flow distribution option for determining breakout flow quantities. For convenience, a reference name and a brief description of each file is given here.

JMU is the upper reach run from RM 8.75 to 7.426.

UPR is downstream of JMU and includes a split flow analysis at the UPRR.

DSR is the main channel model downstream of the UPRR to RM 6.67.

BBO is the right overbank breakout flow model downstream of the UPRR.

SPF combines DSR and BBO and includes the flow distribution option for determining the initial breakout flow in the left overbank.

MVU tracks the main channel between SPF and U.S. 95, RM 5.85 to 3.64. It incorporates the split flow routine.

NBU is the left overbank breakout model between SPF and U.S. 95.

MVL is the main channel model between U.S. 95 and the Boulder Highway, RM 3.44 to 2.37. The split flow option is incorporated.

BHY is the main channel model across the Boulder Highway to RM 1.34. The split flow option is incorporated at the Boulder Highway.

NBL is the left over bank breakout model from U.S. 95 to downstream of the Boulder Highway.

JML combines flows from BHY and NBL and extends to the Las Vegas Wash.

3.2 METHODOLOGY

3.2.1 ASSUMPTIONS AND LIMITATIONS

The high ground in the right overbank upstream of the UPRR falls off at river mile 7.30 and 7.35. The water is forced into the right overbank by the UPRR.

Not all of the flow is forced into the right overbank, however. A portion of the flow weirs over the UPRR. The split flow option is utilized to determine the amount flowing over.

The 25- and 50-year boundaries are shown wider at RM 6.98 on the main channel than indicated by the model. The basis was eye witness accounts during small flood events.

The left overbank breakout flow is brought back to the main channel at U.S. 95 by the combined effects of the freeway and topography. A three-foot high crash barrier (jersey rail) prevents all but the 500-year flow from going over. While the topography falls off to the southeast along the freeway, the major portion of the flow will follow the stream path in a northeasterly direction. All flow was considered to remain with the channel flows.

A second breakout occurs in the left overbank downstream of the freeway. The portion of the flow leaving the channel is determined by the split flow option. Flow leaving the main channel enters the breakout overflow in sheet flow fashion.

Both breakout flow models for the left overbank utilize the split flow option with normal depth used rather than weir flow. The slope for the normal depth calculation was 0.001.

Historically there have been sediments deposited in the Boulder Highway bridge. This is reflected in the model.

The left overbank breakout flow, the main channel of Duck Creek and the Las Vegas Wash all confluence in the same general location. It was felt appropriate to combine the breakout flow and the main channel at RM 0.94 to give the best possible representation of Duck Creek entering the Las Vegas Wash.

3.2.2 ROUGHNESS COEFFICIENT ASSESSMENT

The roughness coefficients of the HEC-2 model were verified using the methodology described elsewhere in this report. Representative "n" values are reproduced here for the convenience of the reader.

Table 3
"n" Value

Cross Section	Left Overbank	Right Overbank	Channel
0.15	.060	.060	.080
1.34	.060	.050	.070
2.00	.050	.050	.050
2.37	.060	.045	.040
2.72	.050	.050	.045
3.39	.020	.020	.020
3.64	.050	.050	.045
4.31	.060	.040	.060
4.94	.050	.050	.033
5.38	.140	.140	.030
6.67	.060	.060	.040
7.35	.050	.050	.040
7.54	.050	.020	.045
8.75	.045	.045	.040
10.80	.060	.040	.040
12.74	.130	.130	.130
13.61	.140	.140	.140
13.85	.045	.045	.045
14.19	.120	.050	.065
14.46	.050	.045	.050
15.06	.040	.050	.040
16.41	.085	.060	.060
16.83	.060	.060	.060

3.2.3 DEBRIS LOADING EVALUATION

The piers and inlet conditions for the bridges were reviewed and analyzed according to the procedure discussed elsewhere in this report.

Table 4

Debris Load

Structure	Debris Load (ft)	Sediment Load (ft)
Eastern	2	0
UPRR	2	0
Mira Vista	2	0
Pecos	0	0
Sunfish	0	0
Sunset	2	0
Mountain Vista	2	0
Russell	1	0
U.S. 95	2	0
Stephanie	2	0
Emerald	2	0
Boulder Highway	0	1
Stadium	2	0

3.2.4 CROSS SECTION ORIENTATION

Cross sections between 7.426 and 8.75, the upstream study limit are oriented typically looking downstream and perpendicular to the path of flow.

Cross sections 7.426 to 6.716 form a split flow model and are oriented to trace the breakout flows in the right overbank. The cross sections are terminated in the left overbank at the UPRR which forms the weir for the split flow model.

Cross sections 7.35 to 6.67 follow the main stream, have a typical orientation, and model the flows in the channel and a portion of the flow coming over the UPRR.

The major portion of the flow over the UPRR is located in the right overbank of the upstream model. Cross sections 16.83 to 6.45 are oriented to model this flow crossing the UPRR on its way back to the main stream.

Cross sections 6.30 to 5.85 are oriented to receive the combined flows from the main channel and the right overbank breakout flow. They also serve to delineate the location of the breakout flow in the left overbank.

Cross sections 5.91 to 2.37 follow the main channel and have typical orientations. Their left overbanks are terminated at ridge lines and they form a split flow model allowing further discharge into the left overbank breakout flow.

Cross sections 15.35 to 10.80 are oriented perpendicular to the left overbank breakout flow and follow its flow path to the Las Vegas Wash.

Cross sections 2.22 to 1.49 are oriented as typical on the main stream. The left overbanks are terminated at the Boulder Highway which serves as a weir for the split flow model. Cross sections 1.40 to 1.04 are oriented typically and trace the main channel flow to the Las Vegas Wash.

Cross section 0.94 is oriented to accept the flows from both the main channel and the left overbank breakout. Cross section 0.15 extends across the Las Vegas Wash and is oriented typically.

3.2.5 CHANNEL CAPACITIES

Nondamaging discharges were determined from a HEC-2 rating curve. Similar cross sections were grouped together. The nondamaging flow

Table 5

Nondamaging Flows

Reach No.	Cross Section	Nondamaging Flow (cfs)
1	0.15	48,000
2	0.94	18,400
3	1.04 1.17	700
4	1.34 1.36	4,500
5	1.37 1.38	2,200
6	1.40	1,200
7	1.49	3,000
8	1.66 1.77 1.90	600
9	2.0	4,800
10	2.15	1,800
11	2.22 2.23 2.25	No Flow
12	2.37	4,000
13	2.47	4,500
14	2.60	17,500
15	2.72 2.86	6,000
16	3.03 3.13	10,000

Nondamaging Flows (continued)

Reach No.	Cross Section	Nondamaging Flow (cfs)
17	3.25 3.39	15,500
18	3.44	No Flow
19	3.64	10,800
20	3.76	20,500
21	3.80	25,800
22	3.82	19,500
23	3.88 3.93 3.95 3.98 4.13	7,000
24	4.31 4.50	3,500
25	4.63	16,608
26	4.81	47,000
27	4.85	3,800
28	4.94	9,000
29	5.03	3,500
30	5.17	9,500
31	5.18	15,500
32	5.20 5.24 5.38 5.46 5.48 5.54	6,600

Nondamaging Flows (continued)

Reach No.	Cross Section	Nondamaging Flow (cfs)
33	5.60	16,500
34	5.71	5,000
35	5.85 6.01	2,100
36	6.14 6.30	4,000
37	6.67 6.83	No Flow
38	6.98 7.08 7.170 7.171 7.172	1,100
39	7.18	8,000
40	7.30	1,500
41	7.35 7.426	200
42	7.54	30,000
43	7.58 7.72	1,400
44	8.08 8.26 8.50	300
45	8.75	2,000

for the group, or reach, was that flow with the water surface elevation at the height of the lowest bank elevation listed for the reach. Some cross sections showed no flow. This was due either to backwater effects from the downstream cross section or to complete blockage of the bridge or culvert at the cross section.

3.2.6 BREAKOUTS AND BRANCHED FLOWS

There are two breakout flows on Duck Creek. The first happens at the UPRR. The UPRR forces the majority of the flow into the right overbank area along the railroad. The breakout flow spills over the railroad which acts as a weir. The split flow option is used to determine portions of flow along the railroad. Flow crossing the UPRR between sections 7.35 and 7.08 is considered to remain in the main channel. Flow crossing the UPRR between 7.08 and 6.716 is considered part of the breakout flow. The breakout flow rejoins the main channel at RM 6.45.

The second breakout flow has two components, one upstream and one downstream from U.S. 95. The freeway combines the breakout and main channel flows. The flow breaks out again immediately downstream of the freeway.

The initial flow split is determined by the flow distribution option in HEC-2. High ground becomes apparent in the left overbank at RM 6.01. The water surface elevations in the HEC-2 model indicate that the flow split for the 25-, 50-, and 100-year flows occurs between RM 5.85 and 6.01 and between 5.35 and 5.85 for the 500-year flow. A flow split model indicates that additional flow leaves the main channel for the left overbank area. Below U.S. 95, another flow split model is used to determine the amount of flow reentering the left overbank.

A third split flow model is employed at the Boulder Highway which acts as a weir for flow leaving the channel and entering the breakout flow.

3.2.7 OTHER MODELING ASSUMPTIONS

(Section not used.)

3.3 SUMMARY OF RESULTS

Floodplain maps have been prepared to identify 25-, 50-, 100-, and 500-year flood boundaries. Flood profiles have been plotted showing water-surface elevations for the four floods along the entire channel study area. Water-surface elevations in breakout areas are shown on the maps at each cross section.

The following is a description of the results of both the riverine and breakout analyses. This discussion focuses on the 100-year floodplain and begins at the upstream limit of the study.

Between the upstream study limit and the UPRR, the 100-year flood remains confined to the confines of the channel and the immediate overbank areas. At UPRR the effects of low structure capacity, back pressure from the UPRR and low ground elevations in the right overbank area all contribute to the expansion into the right overbank area along the UPRR.

Flow weirs over the UPRR the entire length between the left overbank flood boundary to a second bridge structure along the path of the breakout flow in the right overbank. Downstream of the UPRR, the flood boundary remains wide. It continues to expand in the left overbank to Tomiyasu Lane. The right overbank is pulled back to the main channel by the stream path leading from the second bridge structure.

While the flood boundaries continue to expand in the left overbank, high ground emerges adjacent to the channel and separates the flow in the left overbank from the flow in the channel. This separation initially occurs approximately one-half mile downstream from Pecos Road. Flow continues to leave the channel to the left overbank in small amounts expanding gradually to Rawhide Avenue. The flow in the right overbank remains relatively contained.

Topography and the berm of U.S. 95 bring the breakout flow in the left overbank back to the main channel. All of the flow passes through the freeway bridge structure.

Immediately downstream of the freeway, flow again breaks out into the left overbank area. The flow quickly expands to Tropicana Avenue and remains relatively confined until it reaches Boulder Highway. Again, after the initial large breakout, small amounts of flow continue to leave the channel for the left overbank area all the way to Boulder Highway across that same high ground area prevalent both upstream and downstream of the East Lake Freeway.

At Boulder Highway, the main channel bends sharply east to follow the highway. Large flows weir over the highway to join the left overbank breakout flow. A small percentage of the flow is left in the main channel, but it crosses the highway in pressure and weir flow.

Downstream from the Boulder Highway, the left overbank breakout flow expands further initially and then turns sharply returning to and combining with the main channel flow before it enters the Las Vegas Wash.

5.0 REFERENCES

1. Federal Emergency Management Agency, Draft Flood Insurance Study, Unincorporated Areas of Clark County, Nevada, 1987, (unpublished)

2. U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, Computer Program 723-X6-L202A, HEC-2 Water Surface Profiles, September 1982

3. James M. Montgomery, Consulting Engineers, Inc., Memorandum to Files, Overflow Study n Values, in Corps of Engineers files, May 1987

4. James M. Montgomery, Consulting Engineers, Inc., Memorandum to Files, Debris Analysis for Las Vegas Valley Overflow Study, in Corps of Engineers files, April 1987

PITTMAN WASH

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CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT

OVERFLOW ANALYSES

by:

James M. Montgomery, Consulting Engineers, Inc.
2915 West Charleston Blvd., Suite 12
Las Vegas, Nevada 89102

September 1988

LAS VEGAS WASH FEASIBILITY OVERFLOW STUDY

PITTMAN WASH

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LAS VEGAS WASH FEASIBILITY OVERFLOW STUDY

PITTMAN WASH

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this overflow study is to determine the extent and depth of flooding in Pittman Wash. Flood boundaries and water-surface elevations are required by the Hydraulics Section of the U.S. Army Corps of Engineers (COE) as part of the Las Vegas Valley Feasibility Study. The overall overflow study included all major flood sources in the Las Vegas Valley (Las Vegas Wash, Range Wash, Las Vegas Creek, Flamingo Wash, Tropicana Wash, Duck Creek, Pittman Wash, and C-1 Channel), and mapped flood hazards for main channels and all significant breakout flows.

1.2 AUTHORIZATION

This study was performed by James M. Montgomery, Consulting Engineers, Inc., under contract to the Clark County Regional Flood Control District dated April 9, 1987. The Scope of Work for the study was prepared by the Los Angeles District of the COE, which also provided extensive technical and administrative review throughout the project.

1.3 COORDINATION WITH OTHER AGENCIES

Technical criteria and review were provided by the Hydaulics Section of the COE, with input during the negotiation process from Clark County Regional Flood Control District (CCRFCD). Supplemental bridge survey data were obtained from the CCRFCD.

2.0 GENERAL DESCRIPTION OF STUDY AREA

2.1 LOCATION AND EXTENT

Pittman Wash is a tributary to the Las Vegas Wash drainage system. Its watershed drains portions of the Las Vegas Valley immediately south of the Duck Creek watershed. The first channel reach that is included in this study begins at the Union Pacific Railroad crossing down to the historic flow split near Stephanie Road and Warm Springs Road. At this point two branches are formed. The Western Branch of Pittman Wash basically follows Stephanie Road to the north, where it crosses Russell Road and confluences with Duck Creek.

The flow split at this location was coordinated with the U.S. Army Corps of Engineers. It was assumed that 100% of the discharges for all of the study flood events were diverted to the gravel pit to the east. The basis for this assumption is the anticipated head cutting that would progress upstream across Warm Springs and Stephanie Road and capture all of the flood flows for the gravel mine.

A flow high ground natural division ridge was drawn along the western limit of flow lines entering the pit area. Cross sections (3.84 to 4.39) were terminated at that limit.

Some discharge may enter the historic Western Branch prior to gravel mine head cutting becoming fully developed. These discharges were assumed to be non-damaging, short duration, nuisance flow, and a negligible fraction of the discharges of the Eastern Branch.

The Eastern Branch currently flows east into a major gravel excavation. It overflows this gravel pit near Sunset and Gibson Roads and travels to the northeast. The flow path crosses Boulder Highway and Weisner Road before confluencing with Las Vegas Wash near a series of water treatment ponds.

Pittman Wash

The U.S. 95 embankment crosses Pittman Wash at the intersection of Gibson Road and Sunset Road. A bridge structure on each road passes flow to the East Branch. The freeway embankment diverts the remaining flow northwest to a low point. At the low point, the flow crosses the freeway and reverts to sheet flow. It travels by overland flow and enters Duck Creek at Russell Road immediately upstream of the Boulder Highway.

2.2 TOPOGRAPHIC AND STREAM CHARACTERISTICS

The Pittman Wash channel is unimproved for the full study reach. At and to about 2,000 feet downstream of the Union Pacific Railroad crossing. The channel is well incised and has an average depth of greater than 30 feet and a channel width of 80 to 200 feet. Near the historic flow split the channel becomes alluvial in nature forming multiple braided channels (estimates of channel depth and width is inappropriate for this reach). The Eastern Branch does not have a formal channel and represents overland flow which is impacted by gravel pits, road crossings and treatment ponds.

Natural channel slopes decreased slightly as the Eastern Branch Pittman Wash approached Las Vegas Wash. The reach upstream of the major gravel pit had a representative slope of 0.017. Immediately below the gravel pit the slope was 0.013 and at the confluence with Las Vegas Wash the slope had reduced to 0.009.

2.3 CHANNEL IMPROVEMENTS

The improved channel along the west side of Weisner Road was calculated to have a capacity of 550 cfs. For the 25-year event, all 400 cfs were assumed to follow this route. For the 50-year event the 550 cfs capacity was subtracted from the primary (modeled) flow path. For the 100- and 500-year events the downstream flows were not adjusted for two reasons, 1) the diversion represented a small fraction of the total discharge, and 2) the higher discharges could damage the embankments of the channel along Weisner Road.

2.4 FLOOD HISTORY AND CHARACTERISTICS

The 100-year event is confined to the incised channel in the upstream reach of this study. This channel opens up near Section 4.83 into a series of braided channels which forms a widening floodplain. All discharges from this floodplain are collected in the large gravel excavation in the northern portion of the area bounded by Warm Springs Road, Stephanie Road, Sunset Road, and Gibson Road.

The overflow of the large gravel pit is referred to in this study as the Eastern Branch Pittman Wash. The pit overflows at its Gibson Road and Sunset Road corner. A few industrial sites near this intersection will be impacted by the 100-year event. From there the discharges flow northeast to Boulder Highway where some ponding will occur prior to and during overtopping of the highway. Also, some flow follows U.S. 95 to Duck Creek.

Between Boulder Highway and Weisner Road, the discharges pass a series of gravel pits. An improved channel has been constructed on the west side of Weisner Road which has a calculated capacity of 550 cfs. This channel will divert only a fraction of the flood flows larger than 25-year frequency due north to Las Vegas Wash; however, the primary overflow path will continue northeast to Las Vegas Wash passing water treatment ponds in the right overbank.

2.5 PRESENT AND FUTURE URBANIZATION

Sparse development has occurred along the Pittman Wash floodplain up to the present. There are a few industrial operations along Sunset Road that will be impacted by major flood events and the only other existing facilities that will be impacted include transportation routes, utility lines, treatment ponds, and quarry operations. This study has been conducted with the assumption of no future flood control projects and discharges based on future development within the watershed.

Flows along U.S. 95 were accounted for in hydraulic routing. The limit of study was established at Sunset Road because of inadequate mapping. The main stream path was tracked through U.S. 95 with the Gibson Road and Sunset Road underpasses to Las Vegas Wash.

3.0 HYDRAULIC ANALYSIS

3.1 DATA SOURCES

3.1.1 MAPS

The base topographic maps used in this study came from three sources which are listed below:

1. Rectified photo topographic maps prepared for James M. Montgomery, Consulting Engineers, Inc. by Olympus Aerial Surveys, Inc. for the City of Henderson Master Plan. Scale: 1" = 200'. Contour interval: 5 feet. Photo date: October 23, 1985.

2. Rectified photo topographic maps prepared for James M. Montgomery, Consulting Engineers, Inc. by Cooper Aerial of Nevada, Inc. for the Clark County Flood Insurance Study. Scale 1" = 400'. Contour interval: 4 feet. Photo date: September 14, 1984.

3. Planimetric topographic maps prepared for Clark County Regional Planning Council by American Aerial Surveys, Inc. for the Clark County Regional Aerial Mapping Project. Scale: 1" = 200'. Contour interval: 5 feet. Photo date: April 4, 1974.

3.1.2 HYDROLOGY

Peak flow values used in the HEC-2 hydraulic analysis were obtained from hydrology performed by C.O.E.

Table 1
Las Vegas Feasibility Study
Peak Discharges w/o Project
(in cfs)

Concentration Point	25 YR	50 YR	100 YR	500 YR
UPRR CP 23 RM 5.28 DA=86.84 sq. mi.	5400	9100	15000	40000
Upstream of Gravel Pit RM 3.84	5300	8900	14500	39000
Downstream of Gravel Pit RM 2.83	150	400	3600	9000
Breakout along U.S. 95 RM 2.83	250	900	6400	29000
Upstream of Boulder Hwy. CP 9 RM 2.07 DA=88.87 sq. mi.	400	1300	3700	9500
Upstream of Las Vegas Wash CP 10 RM 1.17 DA=89.90 sq. mi.	1	850	3700	9500
Flows diverted by channel at Weisner Way RM 1.17	399	450	0	0

3.1.3 HYDRAULIC STRUCTURES

Clark County Regional Flood Control District's field personnel supplied surveys of bridge and culvert crossings at the Union Pacific Railroad, Boulder Highway and Weisner Road. Design drawings were obtained for crossings along Sunset Road. Through field reconnaissance, crossings at Warm Springs Road, Gibson Road and Stephanie Road were found to have no culverts or bridge spans.

Additionally, the improved channel at Weisner Road is a hydraulic structure. It is an earthen lined channel with concrete lining at the bend and has a capacity of 550 cfs.

3.1.4 STREAM BED CROSS SECTIONS

Stream bed cross sections were estimated from the topographic maps.

3.1.5 MATHEMATICAL MODELS

Hydraulic calculations to determine water surface elevations and flood boundaries for the main course of Pittman Wash were performed with the HEC-2 backwater model. Flow split calculations were performed at the gravel pit and at Boulder Highway. The flow split at the gravel pit was determined by C.O.E. Hydrology Division. The flow split at the Boulder Highway was determined by balancing the flow over the highway and along the highway. Flow along the highway was assumed to be critical at the location of the diversion. The following rating curve was calculated from a cross section shown on the map perpendicular to the highway: 2,000 cfs at 1653.4 and 5,000 cfs at 1654.5.

3.2 METHODOLOGY

3.2.1 ASSUMPTIONS AND LIMITATIONS

It was assumed that 100% of the discharge from the upper reach enters the gravel pit due to head cutting action. Only minor discharges will follow the western branch prior to this head cutting.

Between the gravel pit and cross section 4.08 engineering judgement was used to limit the flow to the path to the gravel pit to simulate flooding after the head cutting is established.

The first cross section (3.84) upstream above the gravel pit was assumed to go to critical depth. The anticipated head cutting would occur at the entrance of the roughly 30-foot deep plunge pool excavation. The first cross section was also located upstream of the pit entrance and existing topography was assumed to be adequate.

While Sunset Road will divert some flow east, review of the topography indicated that most of the flow would cross to the north.

The 500-year boundary at the Boulder Highway was extended to Gibson Road. The depth of flow at the channel is approximately 0.7 feet over the highway. With a weir coefficient for a double highway of 1.9 and an average depth on the weir of 0.35 feet, the length of weir calculated is 1,650 feet.

A small improved channel at Weisner Road has a capacity of 550 cfs. It diverts the 25-year flow and a portion of the 50-year flow away from the natural flow path. It is not reflected in the larger flows because it represents only a small percentage of the flow.

3.2.2 ROUGHNESS COEFFICIENT ASSESSMENT

For a general description of the approach and methods used in defining Manning's "n" values, refer to the appropriate chapter of the final report. For specific n values used in the Pittman Wash analysis, the following table presents representative channel and overbank roughnesses for various reaches of study.

Table 2
"n" Values

Cross Section	Left Overbank	Channel	Right Overbank
UPRR to X-3.13	0.044	0.034	0.044
X-3.06 to X-2.46	0.044	0.044	0.044
X-2.38 to Pit	0.044	0.034	0.044
Eastern Branch	0.044	0.044	0.044

No "NH" or "NV" options of the HEC-2 program were used in this model. The only development that encroached onto the floodplain was sparse enough to be assumed negligible in impact to roughness values selected. It was noted in making this assumption that the scattered development had occurred at the higher elevations in the fringe region.

3.2.3 DEBRIS LOADING EVALUATION

No culverts were found at the Warm Springs Road, Stephanie Road and Gibson Road crossings. Culverts at Sunset Road and Weisner Road were found to have widths of 4 feet or less. Due to upstream conditions 2 feet of debris encroachment was assumed on each side. This assumption completely blocked these culverts. All five of these crossings were near the normal grade of the natural topography over the greater part of the floodplain. The ineffective culverts would have little or no effect on backwater calculation of the hydraulic model.

3.2.4 CROSS SECTION ORIENTATION

Cross sections between the gravel pit and the upstream study limit (3.83 to 5.28) were oriented typically across the channel and flood plain perpendicular to flow and looking downstream.

Cross section 2.83 just downstream from the gravel pit was oriented along the on and off ramps of U.S. 95 to give a distribution of flow through the two bridge openings.

Cross sections between U.S. 95 and Boulder Highway were oriented typically across the channel and floodplain perpendicular to flow and looking downstream.

Cross sections 1.890 to 1.893 located upstream and downstream of the Boulder Highway are not used to determine the 500-year boundary in the left overbank. A divided flow analysis was performed as described elsewhere in this report and weir calculations were used to locate the 500-year flood boundary at Gibson Road. A divided flow cross section is shown on the map and oriented perpendicular to the Boulder Highway and extends from the end of cross section 1.893.

Cross sections between Boulder Highway and Weisner Road were taken along controlling ridges within this gravel pit area. This was done to avoid underestimating water surface elevations. As a result, the sections are not straight and meander with the ridges involved.

Between Weisner Road and the Las Vegas Wash, cross sections are again oriented typically across the channel, perpendicular to flow and looking downstream.

3.2.5 CHANNEL CAPACITIES

The channel capacities along Pittman Wash represent nondamaging discharges. The flow was limited to the channel between the bank stations. The nondamaging flow was the flow at the water surface elevation of the lowest bank station. These were estimated based on the HEC-2 computer analyses rating curve.

The nondamaging discharges, based on a cross section with limiting capacity are summarized in the following table.

Table 3
Channel Capacities
Lower Branch

Reach Station to Station	Channel Capacity (cfs)
0.42 - 1.13	650
1.13 - 1.51	450
1.51 - 1.893	250
1.893 - 2.42	700
2.42 - 2.83	200

Upper Branch

Reach Station to Station	Channel Capacity (cfs)
3.84 - 4.08	2000
4.08 - 4.32	4500
4.32 - 4.46	3000
4.46 - 4.68	4000
4.68 - 5.28	1000

3.2.6 BREAKOUTS AND BRANCHED FLOWS

A breakout flow occurs at U.S. 95 at Sunset and Gibson Road. The flows which continue along the east branch of the Pittman Wash flow through the overpass bridge structures at Sunset and Gibson Road.

The breakout flows which follow the freeway to Duck Creek are added to the flow for that stream (see Duck Creek portion of the report). A detailed analysis of the breakout flow was not performed due to inadequate topographic information available to track the flow to Duck Creek.

The following flow split was determined in hydrology:

Table 4

Breakout Flows

Storm	Breakout Flow along Freeway	Main Channel Flow
Q25	250	150
Q50	900	400
Q100	6,400	3,600
Q500	29,000	9,000

3.2.7 OTHER MODELING ASSUMPTIONS

At cross section 4.75, the 25- and 50-year flows are restricted in the right overbank by a high ground ridge line which extends upstream.

At cross sections 4.08, 4.00, and 3.93, the 25-year flow boundaries are determined by the computed water surface elevation and a review of the topography. Ridge lines extending upstream will not allow the water to expand as indicated in the model.

Cross section 3.84 was utilized in the computer model for backwater determinations only. Water may or may not seek out the particular low spot as indicated by the model. With engineering judgement it was felt that floodplain boundaries were better determined by the upstream cross sections.

At cross section 2.57, the 25-year flow is restricted and the 50- and 100-year flows are allowed to expand in the right overbank based on the computed water surface elevation and review of the topography.

At cross section 2.24 the 50-year flow is allowed to expand in the right overbank based on the computed water surface elevation and review of the topography. The 500-year flow is restricted in the left overbank by a ridge line at Station 9380.

Pittman Wash

At cross section 2.07, the 25-year flow is restricted in the right overbank by a ridge line at Station 10,400. The 500-year flow boundary in the right overbank is determined by the computed water surface elevation. Physically, the water cannot return to the channel as the model indicates.

At cross section 1.893, the computed water surface elevations and review of the topography were the basis for expanding the 25-year flow and restricting the 100-year flow in the left overbank area.

At cross section 1.890, the 25-, 50-, and 100-year flows were extended in the left overbank based on the computed water surface elevation and a review of the topography. At cross section 1.51, the 100- and 500-year flows were limited in the left overbank area based on the computed water surface elevation and a review of the topography. High ground extending upstream will not allow the water to expand as the model indicates.

At cross section 1.30, the 25-year flow is allowed to expand in the left and right overbanks based on the computed water surface elevation and a review of the topography. The water cannot physically return to the channel as indicated by the model. The 500-year flow boundary is restricted in the left overbank. High ground extending upstream will not allow the water to expand as the model indicates.

At cross section 0.77, the 50-year flow boundary is restricted in the right overbank by a ridge line at Station 10,150. The 500-year flow is allowed to expand in the right overbank by an existing wash at Station 11,460.

3.3 SUMMARY

Pittman Wash is clearly separated into two systems, one above and one below the gravel pit at Sunset Road and Gibson Road. Above the gravel pit, the flood flows are contained within the channel and overbank areas and is part of a single flow regime. Below the gravel pit and due to the East Lake Freeway, the flow divides. Part of the flow continues northeast along the main channel to the Las Vegas Wash. The remaining flow follows the freeway to Duck Creek.

Between the gravel pit and Boulder Highway, Pittman Wash is characterized by braided stream flow paths. Flow in the overbank areas is controlled by the channel backwater to a lesser degree than is characterized by the upper reach.

Downstream from the Boulder Highway to Weisner Road, the flow path is littered with both abandoned and active gravel pits. Flood boundaries follow the irregular bank lines of the pits.

Downstream of Weisner Road, Pittman Wash returns to a braided stream and enters the Las Vegas Wash.

5.0 REFERENCES

1. Federal Emergency Management Agency, Draft Flood Insurance Study, Unincorporated Areas of Clark County, Nevada, 1987, (unpublished)

2. U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, Computer Program 723-X6-L202A, HEC-2 Water Surface Profiles, September 1982

3. James M. Montgomery, Consulting Engineers, Inc., Memorandum to Files, Overflow Study n Values, in Corps of Engineers files, May 1987

4. James M. Montgomery, Consulting Engineers, Inc., Memorandum to Files, Debris Analysis for Las Vegas Valley Overflow Study, in Corps of Engineers files, April 1987

C1 CHANNEL

C1 CHANNEL

CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT

OVERFLOW ANALYSES

by:

James M. Montgomery, Consulting Engineers, Inc.
2915 West Charleston Blvd., Suite 12
Las Vegas, Nevada 89102

September 1988

LAS VEGAS WASH FEASIBILITY OVERFLOW STUDY

C1 CHANNEL

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this overflow study is to determine the extent and depth of flooding in the C1 Channel floodplain. Flood boundaries and water-surface elevations are required by the Hydraulics Section of the U.S. Army Corps of Engineers (COE) as part of the Las Vegas Valley Feasibility Study. The overall overflow study included all major flooding sources in the Las Vegas Valley (Las Vegas Wash, Range Wash, Las Vegas Creek, Flamingo Wash, Tropicana Wash, Duck Creek, Pittman Wash, and C1 Channel), and mapped flood hazards for main channels and all significant breakout flows.

1.2 AUTHORIZATION

This study was performed by James M. Montgomery, Consulting Engineers, Inc., under contract to the Clark County Regional Flood Control District dated April 9, 1987. The Scope of Work for the study was prepared by the Los Angeles District of the COE, which also provided extensive technical and administrative review throughout the project.

1.3 COORDINATION WITH OTHER AGENCIES

Technical criteria and review were provided by the Hydraulics Section of the COE, with input during the negotiation process from Clark County Regional Flood Control District (CCRFCD). Supplemental bridge survey data were obtained from the CCRFCD.

2.0 GENERAL DESCRIPTION OF STUDY AREA

2.1 LOCATION AND EXTENT

The C1 Channel is situated in Henderson, Nevada and extends due north along the section line parallel to Pueblo Boulevard and Arrowhead Trail. This presents the without project analysis of the C1 Channel with future developed flows. The limit of study is Boulder Highway on the south and Lake Mead Drive to the north.

2.2 TOPOGRAPHIC AND STREAM CHARACTERISTICS

The channel is approximately 3.5 miles long with the lower 1.6 miles improved into a concrete lined channel with bridge structures at Warm Springs Road and Lake Mead Drive. Natural terrain slopes generally northwest at two percent. The left overbank region is substantially developed while the right overbank region is only sparsely developed.

2.3 CHANNEL IMPROVEMENTS

The lower concrete lined channel portion varies between rectangular and trapezoidal shape with an average top width of 50 feet. The invert slopes vary from 1.0 to 2.0 percent while an average depth in the channel is 9.0 feet.

The lined channel was constructed in four phases and is in good condition. Stationing in all HEC-2 models is in river miles beginning at Lake Mead Drive. The stationing shown next to the river mile conforms to City of Henderson stationing for the C1 Channel.

There are two bridge structures along the lined channel; there are two 10'W x 10'H RCB's at Lake Mead Drive and three 12'W x7'H RCB's at Warm Springs Road.

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The channel is "rough graded" from the study limit at Boulder Highway to approximately 1300 feet south of Warm Springs Road. The bottom width varies from 8 to 15 feet and the channel depth varies from 3 to 10 feet.

2.4 FLOOD HISTORY AND CHARACTERISTICS

The channel is small compared to the anticipated flows. In the upper unlined portion of the channel, flow expands into the right overbank areas immediately downstream from Boulder Highway. Land slopes generally northeast away from the channel in this area toward an unnamed wash. Flow in the right overbank migrates towards this wash.

The unnamed wash is formed at the intersection of north trending and west trending alluvial fans. Flow in the right overbank collects in this wash and is trained back to the C1 Channel in a northwesterly direction. The flow crosses the channel in the 3,400-foot stretch just upstream from the beginning of the lined portion. From this point to the downstream limit of the study, natural terrain slopes northwesterly. The flow crossing the channel at this location forms a major overflow of the C1 Channel. A model was constructed to trace this flow to Lake Mead Drive as the channel backwater has no effect. This overflow passes through predominantly residential areas on its way to Lake Mead Drive.

In August, 1984, the section of channel constructed under the "Phase IV" improvement plans, approximately RM 1.34 to RM 1.62, suffered storm water damage. This segment (approximately 1500 linear feet) sustained damage which included cracking and buckling of the concrete panels. Most of the damage was concentrated along the eastern side slope panels and bottom panels. The channel has since been repaired.

2.5 PRESENT AND FUTURE URBANIZATION

At the present time, the right overbank of the C1 channel is partially developed with residential units. The left overbank is almost completely "built up" with residential units.

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The City of Henderson Zoning Map (September 15, 1986) outlines the planned zoning for future development. Along Boulder Highway and Race Track Road the zoning is C2, "general commercial district".

The remaining area in the left overbank is zoned predominantly RR, "rural residence district".

3.0 HYDRAULIC ANALYSIS

3.1 DATA SOURCES

3.1.1 MAPS

The base topographic maps used in this study came from two sources which are listed below:

1. Planimetric topographic maps prepared for Clark County Regional Planning Council by American Aerial Surveys, Inc. for the Clark County Regional Aerial Mapping Project. Scale: 1" = 200'. Contour interval: 5 feet. Photo date: April 4, 1974.
2. USGS Quad Maps. Scale: 1" = 2000'. Contour interval: 20 feet. Photo date: 1967. Photo revised: 1984.

3.1.2 HYDROLOGY

Peak flows for the HEC-2 hydraulic analysis were obtained from hydrology performed by COE. Concentration points and flow values are outlined in Table 1.

Table 1

Las Vegas Feasibility Study
Peak Discharges w/o Project
(in cfs)

Concentration Point	25 YR	50 YR	100 YR	500 YR
Downstream of Boulder Hwy. CP 42 RM 3.00 DA=14.0 sq. mi.	2950	4900	7900	21000
Basic High School CP 40 RM 2.415 DA=21.77 sq. mi.	3350	5500	9100	25000
Major Avenue CP 27 RM 1.677 DA=29.22 sq. mi.	4000	6500	11000	28000
Apache Place CP 23 RM 0.54 DA=34.37 sq. mi.	4600	7600	12500	33000

3.1.3 HYDRAULIC STRUCTURES

Measurements for the bridges at Warm Springs Road and Lake Mead Drive were obtained from design drawings while measurements for the bridge at Boulder Highway were obtained from field reconnaissance.

While Boulder Highway is skewed to the C1 Channel, the bridge structure is not skewed and, therefore, the cross sections have not been skewed.

3.1.4 STREAM BED CROSS SECTIONS

Design drawings supplied by the City of Henderson Department of Public Works were used to obtain the cross sections in the lined portion of the channel.

For the upper unlined portion of the channel, the Clark County Regional Flood Control District's field personnel supplied surveyed cross sections. Because the 200 scale topo is dated 1974, adjustments had to be made to invert elevations and left and right overbank elevations to obtain acceptable consistency between topography and channel cross section data.

3.1.5 MATHEMATICAL MODELS

HEC-2 was used to model the unlined and lined channel sections and the overflow. Water surface elevations were derived from the results of the model.

Weir flow over Boulder Highway was calculated by hand using the weir flow equation. The weir coefficient used was 2.6. The assumed depth (head) was 6 inches.

3.2 METHODOLOGY

3.2.1 ASSUMPTIONS AND LIMITATIONS

1. Inlet Flow at Boulder Highway. Field investigations verified that the full amount of the flow will not pass through the structure at C1 Channel and Boulder Highway. The COE determined the culvert capacity of the structure at Boulder Highway is approximately 1800 cfs. Storm water runoff in excess of the culvert capacity were assumed to be weir flow over Boulder Highway. This weir flow was modeled by extending the cross section to the southeast and using a depth of 6 inches to calculate the weir length.

2. Right Overbank Unnamed Wash. A sheet flow model was built to best analyze the runoff entering the channel from the southeast. Cross sections were oriented to the contour lines and the right overbank was "encroached" to a point where the depth of flow was one foot or less. In order to have a smooth flow boundary, a small tolerance was given to this one foot depth.

Concentration points 40 and 27 flows were added to the channel on a linearly proportional basis once the unnamed wash became "active" with the channel.

3. Lined Channel Section. The lined channel has variable capacities. The section of the channel which limits the capacity is between river mile 1.16 and 1.21 where the channel slope is approximately 0.003 and the capacity is approximately 1500 cfs. Below river mile 1.16 there are two concentration points (CP) where storm water will reenter the channel.

The runoff from the 500-year storm at CP 23 (C1 at Apache Place) is 33000 cfs. At CP 27 (C1 at Major Avenue) the runoff is 28000 cfs. The channel gains 5000 cfs in a distance of 4520 feet between concentration points, or 1.1 cfs per foot on a linear basis.

When calculated in this manner, the lined channel section below river mile 1.16 was able to contain the additional runoff from CP 23 and CP 27.

3.2.2 ROUGHNESS COEFFICIENT ASSESSMENT

The hydraulic roughness coefficients were estimated using the Cowan method and "A Method for Adjusting Value of Manning's Roughness Coefficient for Flooded Urban Areas" by H.R. Hejl, Jr.

The following are representative of the channel and overbank "n" values used in the analyses:

Table 2
"n" Values

Cross Section	Left Overbank	Channel	Right Overbank
0.001	.040	.030	.040
0.002	.040	.030	.040
0.003	.040	.013	.040
0.040	.040	.013	.040
0.080	.040	.013	.040
0.085	.040	.013	.040
0.160	.040	.013	.040
0.165	.040	.013	.040
0.310	.040	.013	.040
0.315	.040	.013	.040
0.450	.040	.013	.040
0.510	.040	.013	.040
0.540	.040	.013	.040
0.570	.040	.013	.040
0.630	.040	.013	.040
0.720	.040	.013	.040
0.870	.040	.013	.040
1.150	.040	.013	.040

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Cross Section	Left Overbank	Channel	Right Overbank
1.160	.040	.013	.040
1.200	.040	.013	.040
1.210	.040	.013	.040
1.240	.040	.013	.040
1.320	.040	.013	.040
1.340	.040	.013	.040
1.360	.040	.013	.040
1.430	.040	.013	.040
1.520	.040	.013	.040
1.630	.040	.013	.040
10.582	.075	.040	.075
10.719	.075	.040	.075
10.872	.075	.040	.075
11.200	.075	.040	.075
11.346	.075	.040	.075
11.525	.075	.040	.075
1.670	.075	.040	.054
1.790	.075	.040	.054
1.933	.075	.040	.054
2.028	.075	.040	.054
2.177	.075	.040	.054
2.272	.075	.040	.054
2.356	.075	.040	.054
2.415	.075	.040	.054
2.566	.075	.040	.054
2.718	.075	.040	.054
2.822	.075	.040	.054
2.945	.075	.040	.054
3.000	.075	.040	.054
3.135	.075	.040	.054
3.261	.075	.040	.054
3.373	.054	.040	.054
3.381	.054	.040	.054
3.433	.054	.040	.054
3.471	.054	.040	.054

3.2.3 DEBRIS LOADING EVALUATION

The calculated debris load for the Warm Springs Bridge structure is one foot.

The Lake Mead bridge structure has historically had debris loading during storm water events. A debris load of two feet was used at the Lake Mead bridge.

3.2.4 CROSS SECTION ORIENTATION

For the riverine analysis, the cross sections were oriented perpendicular to flow.

For the breakout analysis, the cross sections were oriented parallel to contours.

3.2.5 CHANNEL CAPACITIES

The channel capacities along C1 Channel represent nondamaging discharges. The flow was limited to the channel between the bank stations. The nondamaging flow was the flow at the water surface elevation of the lowest bank station. These were estimated based on the HEC-2 computer analyses rating curve.

The nondamaging discharges, based on a cross section with limiting capacity are summarized in the following table.

C1 Channel

Table 3

Nondamaging Flows by Reach

Reach No.	Cross Section	Nondamaging Flow (cfs)
1	0.001	7200
	0.002	
	0.003	
	0.04	
	0.08	
	0.085	
	0.16	
	0.165	
	0.31	
	0.315	
	0.45	
	0.51	
	0.54	
	0.57	
	0.63	
2	0.72	5600
	0.87	
	1.15	
3	1.16	2800
	1.20	
	1.21	
4	1.24	4900
	1.32	
	1.34	
5	1.36	3200
	1.43	
	1.52	
	1.63	
6	1.677	900
7	1.790	2600

Nondamaging Flow by Reach (continued)

Reach No.	Cross Section	Nondamaging Flow (cfs)
8	1.933	500
	2.028	
	2.177	
	2.272	
	2.356	
	2.415	
	2.566	
	2.718	
	2.822	
	2.945	
	3.000	
	3.135	
	3.261	
	3.373	
	3.381	
	3.433	
	3.471	

3.2.6 BREAKOUTS AND BRANCHED FLOWS

Left Overbank Breakout. The main channel has one breakout flow, which begins at river mile 1.525 and extends past Lake Mead Drive (river mile 0.582). The breakout flows are identified by the addition of +10 to the river stationing.

3.2.7 OTHER MODELING ASSUMPTIONS

(Section not used.)

3.3 SUMMARY OF RESULTS

Floodplain maps have been prepared to identify 25-, 50-, 100-, and 500-year flood boundaries. The floodplain maps are entitled "Overflow Analysis of the Las Vegas Wash and Tributaries, C-1 Channel" and are comprised of 9 sheets.

4.0 CONCLUSIONS

The C1 Channel from Boulder Highway to Lake Mead Drive is approximately 3.5 miles long; the lower 1.6 miles are lined, the upstream 1.9 miles of channel have been rough graded.

The 500-year flow for this reach of channel ranges from 21,000 cfs to 33,000 cfs.

The 100-year storm runoff for this reach of channel ranges from 7900 cfs to 12,500 cfs. Similarly, the 50-year storm runoff ranges from 4900 cfs and 7600 cfs and the 25-year storm runoff from 2950 cfs to 4600 cfs.

The capacity of the unlined channel is approximately 500 cfs for the majority of the channel. However, at cross section 1.677 the capacity is approximately 900 cfs and at cross section 1.790 the capacity is approximately 2600 cfs.

The storm water runoff which cannot be conveyed in the unlined portion of the C1 Channel weir flows over Boulder Highway and creates major overflows in the right overbank.

The capacity of the lined reach of the C1 Channel ranges from 2800 cfs to 7200 cfs.

The storm water runoff in excess of the channel capacity creates a large overflow in the left overbank and will result in substantial damage to these residences.

5.0 REFERENCES

1. Federal Emergency Management Agency, Draft Flood Insurance Study, Unincorporated Areas of Clark County, Nevada, 1987, (unpublished)

2. U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, Computer Program 723-X6-L202A, HEC-2 Water Surface Profiles, September 1982

3. James M. Montgomery, Consulting Engineers, Inc., Memorandum to Files, Overflow Study n Values, in Corps of Engineers files, May 1987

4. James M. Montgomery, Consulting Engineers, Inc., Memorandum to Files, Debris Analysis for Las Vegas Valley Overflow Study, in Corps of Engineers files, April 1987

OVERFLOW STUDY N VALUES

JAMES M. MONTGOMERY, CONSULTING ENGINEERS, INC.

MEMORANDUM

TO: Distribution **DATE:** May 18, 1987

FROM: Mike Bagstad [redacted] **JOB NO.:** 1758.0090

SUBJECT: Overflow Study n Values **CLIENT:** CCRFCD

As indicated in my previous computer note, the Corps has given verbal approval of our appraoch to n value determination. This memo provides criteria for selecting new n values and adjusting FIS n values. I will try to give some general observations about the n values in the Flood Insurance Study and some specific suggestions for each stream we are to model. I am also transmitting the criteria you should use in verifying the n values in your stream model.

GENERAL OBSERVATIONS

In general, the n values in our FIS models for natural condition channel and overbanks are acceptable according to the Cowan Method technique requested for use by the Corps. I did find exceptions in some of the streams which are noted under the heading of those streams in this memo. Also from those exceptions I have deduced helpful hints we can use in adjusting our n values.

Calculated n values using the Cowan Method for channel and overbanks in open land ranged from 0.040 to 0.080. When the FIS values fell in this range, they were found to be generally acceptable. Extreme values found in the FIS study of 0.030 and 0.10 could not be substantiated with Cowan Method calculations. If the stream modeller has back up notes which substantiate the extreme values, then those should dictate as the calculated range had to depend for the most part on 400 scale mapping. If there is no basis for the extreme values, the recommendation is to reduce values of 0.10 to ~~0.750~~ 0.075 or ~~0.80~~ 0.080 and to increase values of 0.030 to 0.040.

The other inconsistency found in the FIS study was the similarity in n values in a few instances between the right and left overbanks when it seemed clear from the aerial mapping that there should be a distinct difference between the two. The recommendation here is that the modeller verify from the aerial photography that apparent differences between the overbanks are reflected in the model.

As far as urban n values, except in the few locations which will be noted later, the FIS numbers are significantly lower than those calculated with the method by Hejl and Lawrence recommended for use by the Corps. The procedure used in setting urban n value criteria was to calculate n values for a variety of typical development types throughout the Las Vegas Valley. Included in this memo are the results of those calculations and tables and figures which will be used by each modeller to modify or verify the urban n values along their stream. Urban n values range from a low of 0.045 for sparsely populated rural areas to a high of 0.180 for high density multifamily areas.

URBAN N VALUES

Urban n values were calculated for a range of development types and densities throughout the valley. The calculations are recorded in calc sheets 1 through 5 included with this memo. Calc sheets 6 and 7 show those values compared where possible to values found in the FIS study. Streams for which urban n values were not calculated were found to have development types similar to those already calculated.

To aid the modeller in adjusting n values in urban areas, Figures 1 through 9 have been included with this memo as a representative sample of calculated urban n values.

Figure 1 shows rural residential development. One calculation shows the effect of densely packed rural units while the other shows the effect of a more intermittent rural development. The corresponding calculations are shown on calc sheet 4. Note that the intermittent rural development varies only slightly from the initial n value given to the land between the houses.

Residential urban development is shown in Figures 2, 3, 4, 6, 7 and 9. Figures 2 and 3 show custom lot development with big lots and big houses. In Figure 2 the development sprawls with excess space between the houses while in Figure 3 the development is a little more closely knit with striaght streets and not as much room between the houses.

Figure 4 shows a typical residential development with curving streets and street layouts which do not align themselves either with or against the tendency of flow in the overbanks. Figure 6 shows the effect of tightly packed lots with rows of houses aligned to inhibit flow both along and laterally from the channel. Figure 7 shows a residential area with houses arranged perpendicular and with much shrubbery between the houses causing the starting n value to be high as shown on calc sheet 3. Figure 9 shows straight rows of tightly packed houses and what was felt to represent a minimum of available flow path again along and laterally from the channel.

Multi-family units can be seen in Figures 5 and 8. In Figure 5 there is space between the units and in Figure 8 the space between the units is minimal.

Figures 7 and 8 show commercial or industrial type development in which one or two large buildings occupy the entire lot. In Figure 7 the buildings block about half of the flow area in either direction and in Figure 8 the building blocks the majority of the flow path in both directions.

Where the floodplain extends across more than one type of development or includes portions of barren land, the composite n value can be a linear combination of the adjacent n values.

As a further aid to the modeller for n value adjustment or verification, the following table was developed from the figures and the calculation process.

Development Type	Description	N Value
Rural	Sparse development	.045
	Fully developed	.060
Residential		
Custom lots	Curved streets and lots of room between houses	.060
Custom lots	Large houses on large lots but arranged perpendicular to flow	.120
Single family	Open space around houses or curved streets	.130
Single family	Close packed with rows of houses perpendicular to flow path	.160
Multifamily Units	Space provided between buildings	.140
	A minimum of low space between the buildings	.180
Commercial or Industrial	Only half of the flow path blocked	.060
	A majority of the flow path is blocked	.170

UNDEVELOPED N VALUES

On an average, 2 to 3 locations were checked for n values in channels and overbanks along each stream. The locations and n value calculations are recorded on calc sheets 8 to 13. Those values are compared to the corresponding FIS values where available on sheets 14 and 15. Following are specific notes for each stream. The comments made under General Observations are also applicable.

Las Vegas Creek

It appears that an n value of 0.09 to 0.10 was used for residential areas. These should be checked and adjusted as per this memo. The one natural cross section checked did not differ significantly from the calculated values. All natural n values should, however, be checked for consistency according to the suggestions under General Observations in this memo.

Duck Creek

Natural ground n values were verified by the Cowan Method. Comments in the General Observations section are applicable.

Flamingo Wash

Three separate locations were checked. N values were found to vary from 0.030 to 0.060 by the Cowan Method. At two of the locations, the FIS values were 0.10. If there is backup data to substantiate the higher values along this stream, no adjustment is necessary. Otherwise, it is recommended that these extreme values be reduced to 0.060.

Tropicana Wash

Natural ground n values calculated by the Cowan Method do not vary significantly from those values shown in the FIS model.

Range Wash

Most of the FIS n values compare favorably to the calculated values. One out of three checked seemed high. If there is backup data to substantiate the high value, no adjustment is necessary. If no backup data exists, the high values should be reduced to 0.050 or 0.060 as appropriate.

Las Vegas Wash

Fair agreement was found between the FIS n values and the calculated values. On each cross section checked, however, one or the other of the overbank values was found to be either too high or too low. It is suggested that the right and left overbank n values be checked for consistency, and where the aerial photography indicates a discrepancy between the left and right bank land surfaces, the n values should be adjusted accordingly.

SUMMARY

While I was unable to check every n value in every model, I will be more than willing to help each modeller in interpretation and n value adjustment. My continued involvement will ensure that consistency between the models.

Also enclosed with this memo are copies of the documents we received from the Corps for the purpose of n value calculation for your information and reference.

Distribution:
- Doug Hahn
- Steve Mano
- Vicki Scharnhorst
- Arsalan Dadkhah

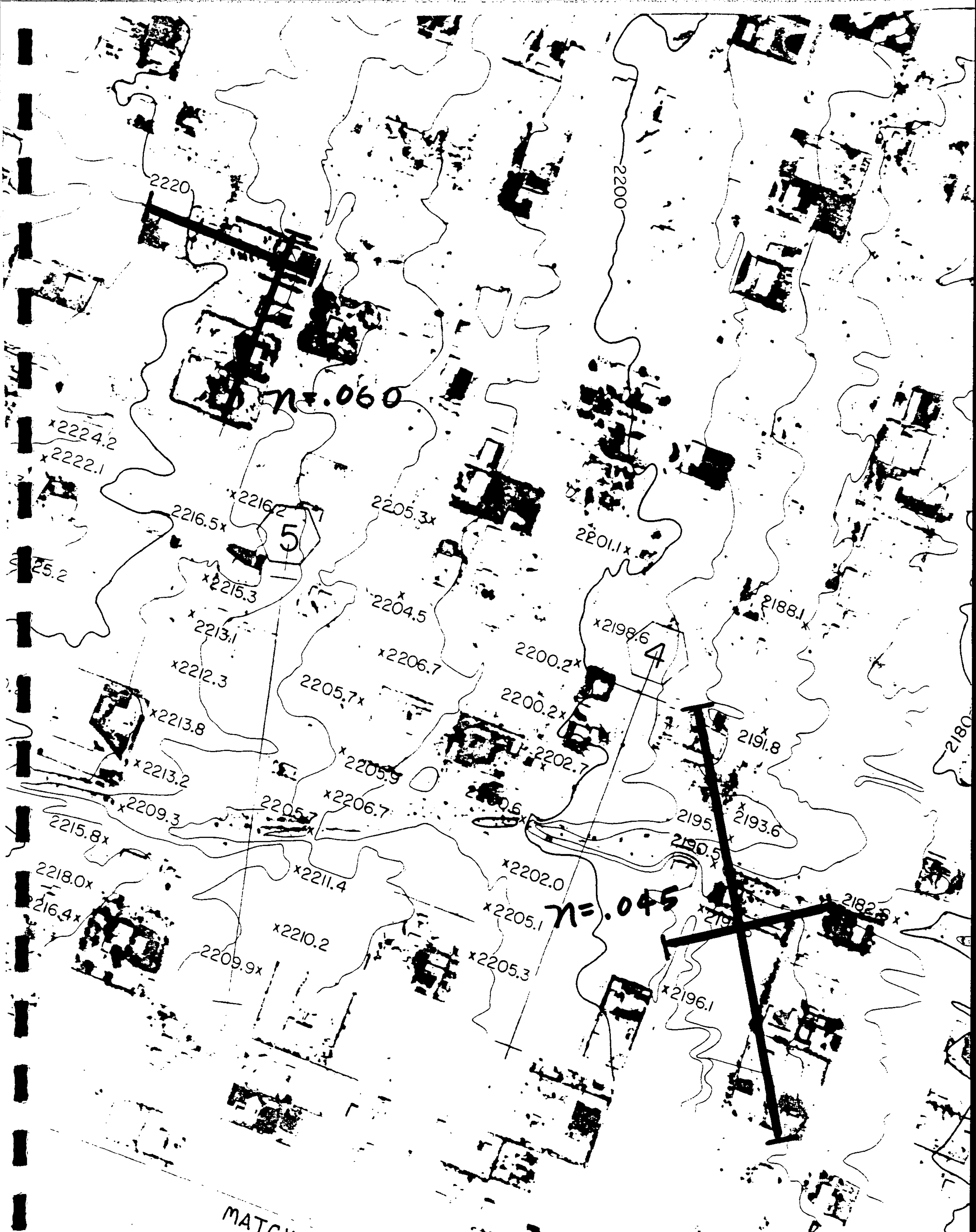

2220
2200
n=.060
2224.2
2222.1
2216.2
2216.5
5
2205.3
2201.1
25.2
2215.3
2204.5
2213.1
2198.6
2188.1
4
2206.7
2200.2
2212.3
2205.7
2200.2
2191.8
2213.8
2205.9
2202.7
2213.2
2209.3
2205.7
2206.7
2195.
2193.6
2215.8
2190.5
2211.4
2202.0
2218.0
n=.045
2182.8
2216.4
2205.1
2210.2
2209.9
2205.3
2196.1
MATCH LINE

FIG 1

FIG 2

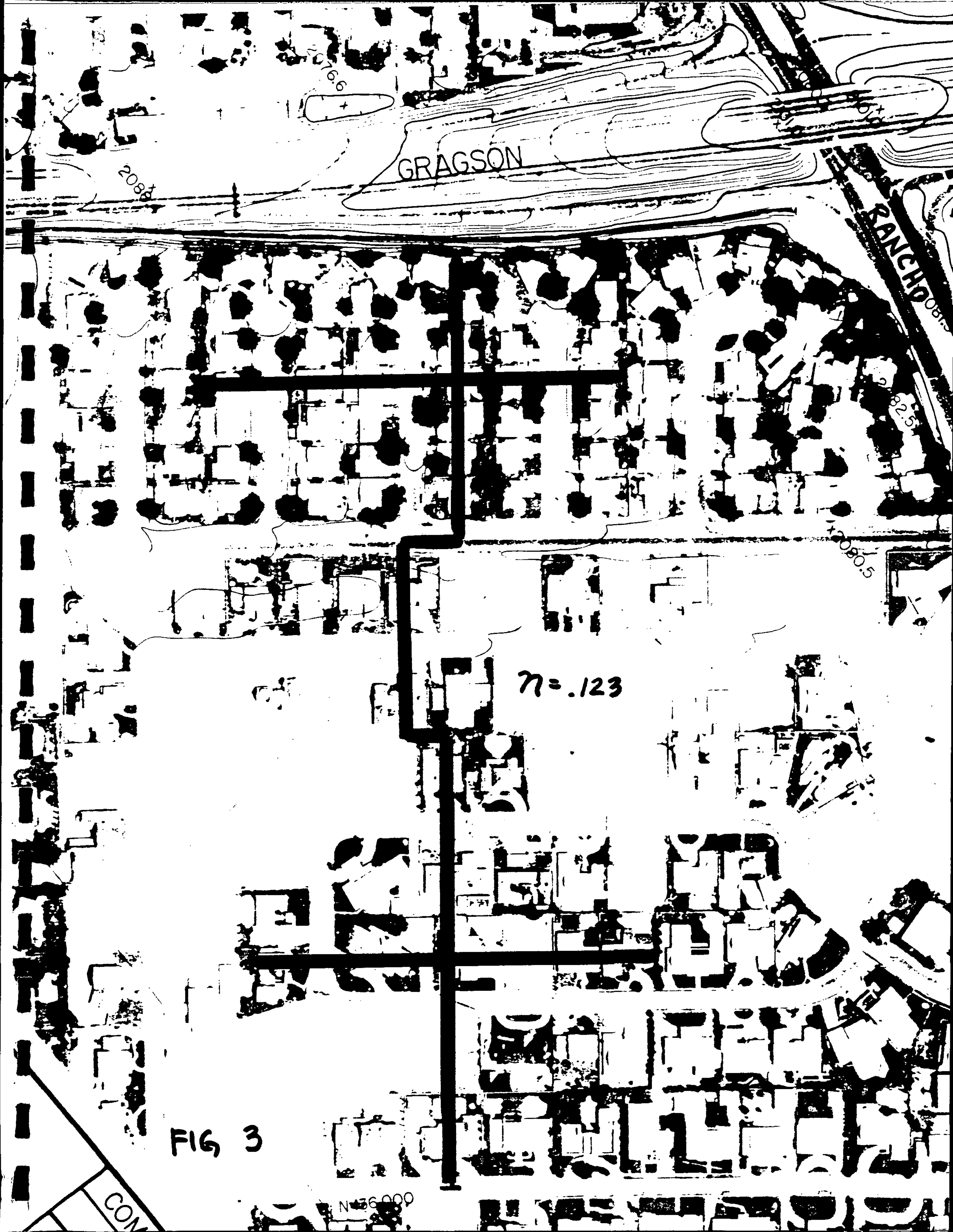


FIG 3

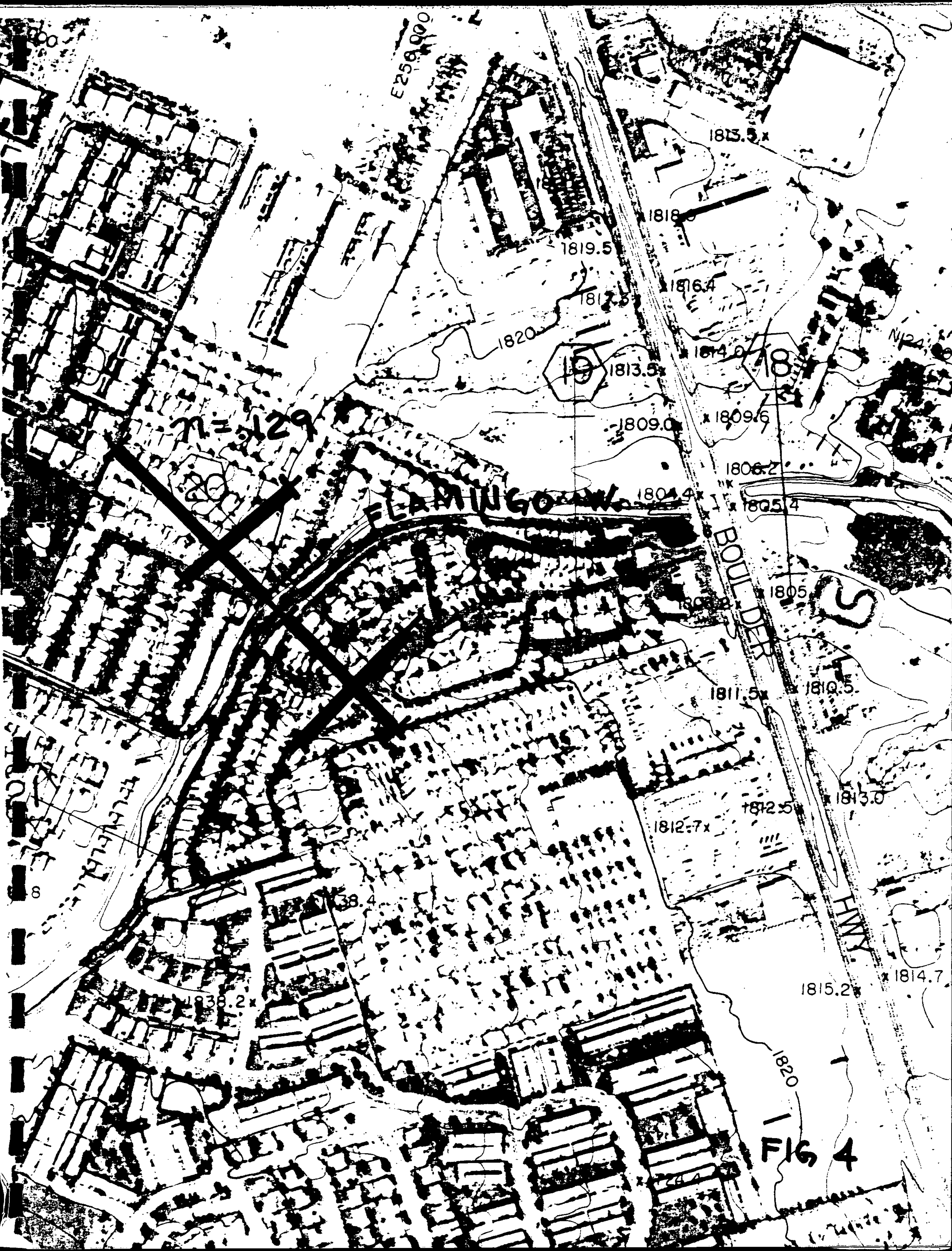
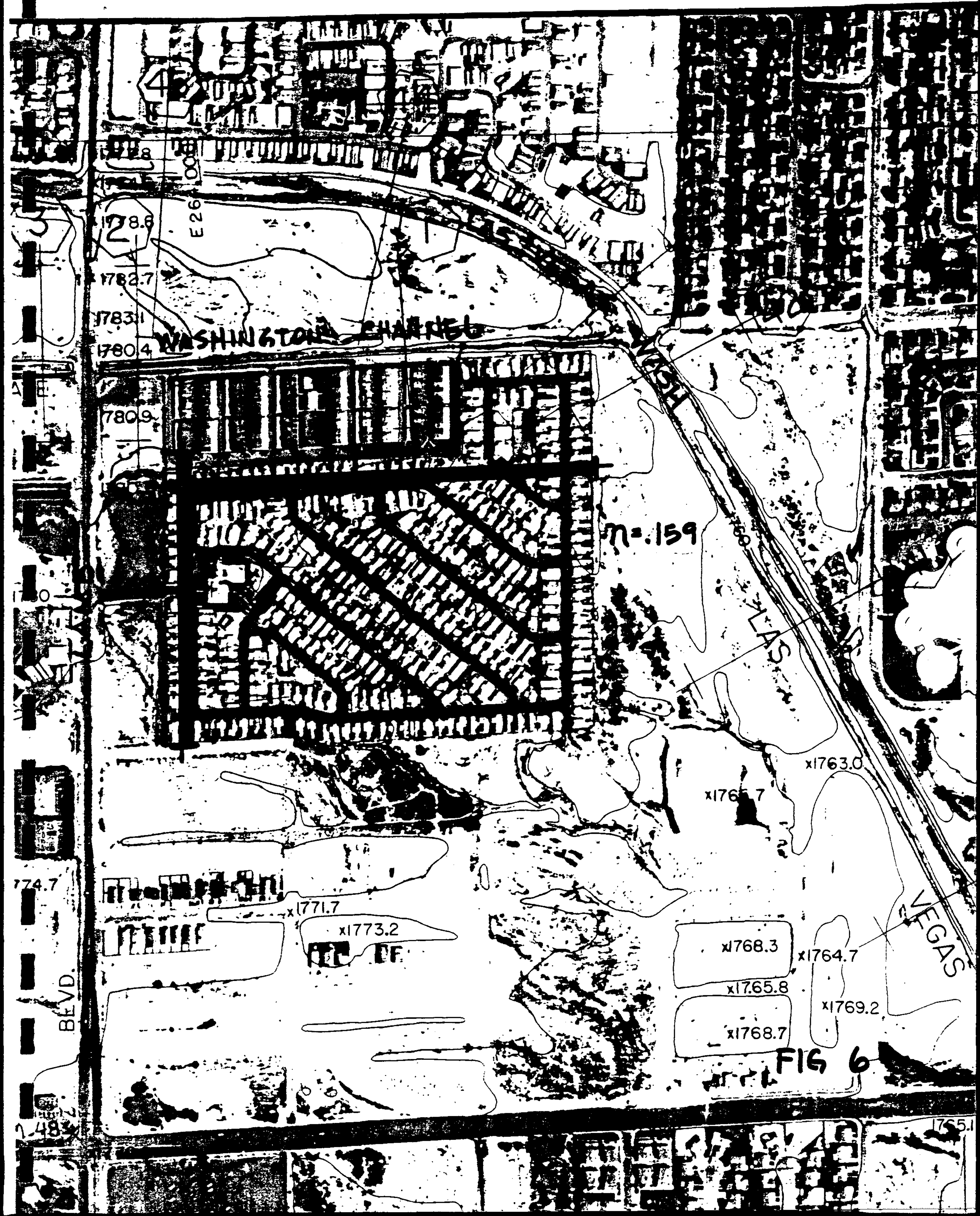

E258,000
1813.5
1818.0
1819.5
1816.4
1817.3
1820
1813.5
1814.0
N124,000
1809.0
1809.6
n=129
1806.2
1804.4
1805.4
FLAMINGO
BOULDER HWY
1805
1811.5
1810.5
1812.5
1813.0
1812.7
38.4
1814.7
1815.2
1838.2
1820

FIG 4


1804.3
WASHINGTON
1801.6
1802.8
WASHINGTON
CHANNEL
n = .143
PECOS

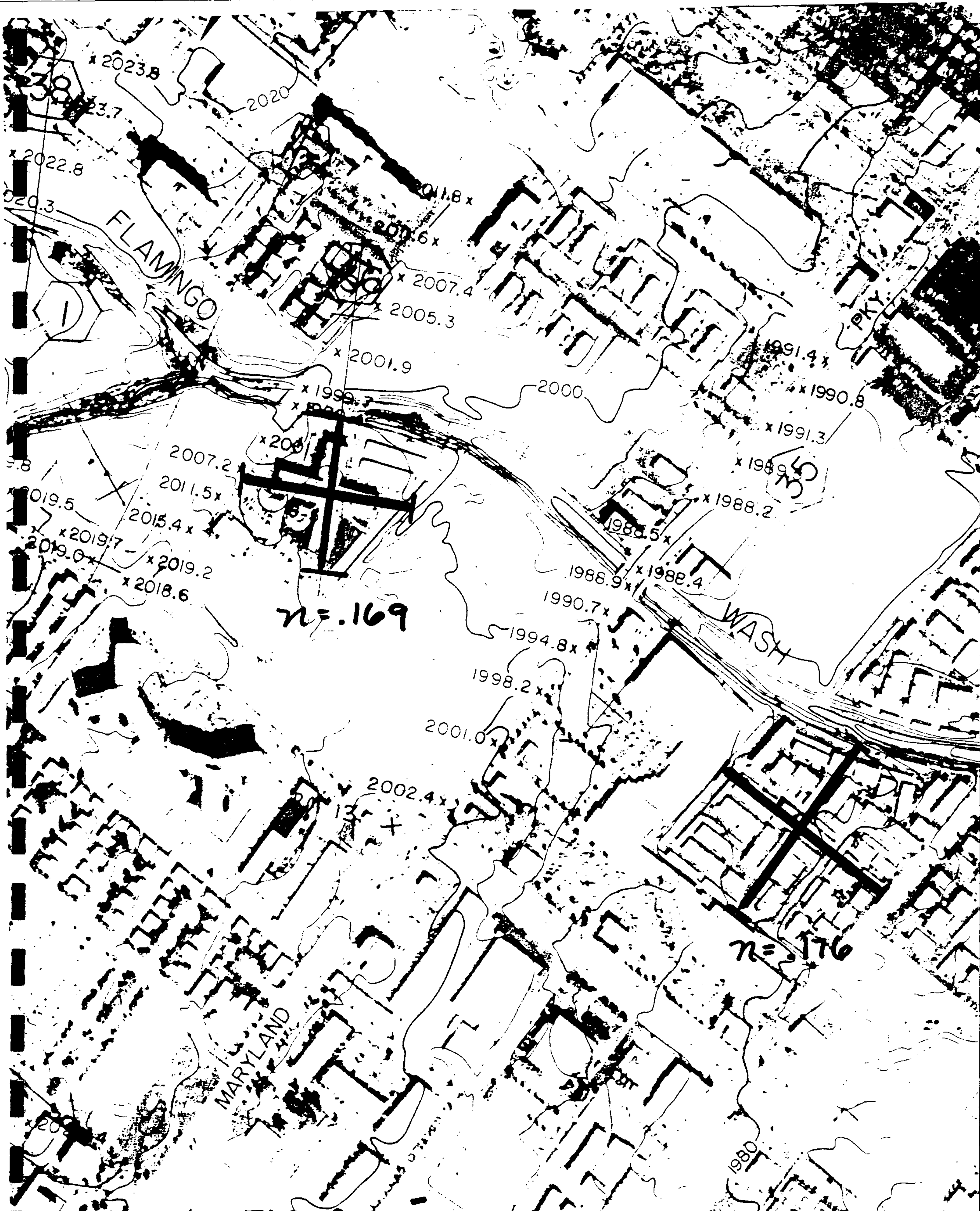
FIG 5



WASHINGTON CHANNEL
WASH
LAS VEGAS
n=.159
BLVD.
1778.6
1782.7
1783.1
1780.4
1780.9
x1763.0
x1771.7
x1773.2
x1768.3
x1764.7
x1765.8
x1769.2
x1768.7
774.7
1765.1

FIG 6

ORAN GRAGSON
HWY.
LAS
FIG 7
n=.062
n=.169
270
8-2
X 40



x 2023.8
2020
x 2022.8
FLAMINGO
2011.8 x
2007.4
2005.3
x 2001.9
2000
x 1991.4
x 1990.8
x 1991.3
PKY
2007.2
2011.5 x
2015.4 x
x 2019.5
x 2019.2
x 2018.6
x 1988.2
x 1988.4
1986.9
1990.7 x
1994.8 x
1998.2 x
2001.0 x
2002.4 x
WASH
n=.169
n=.176
MARYLAND
1980

FIG 8

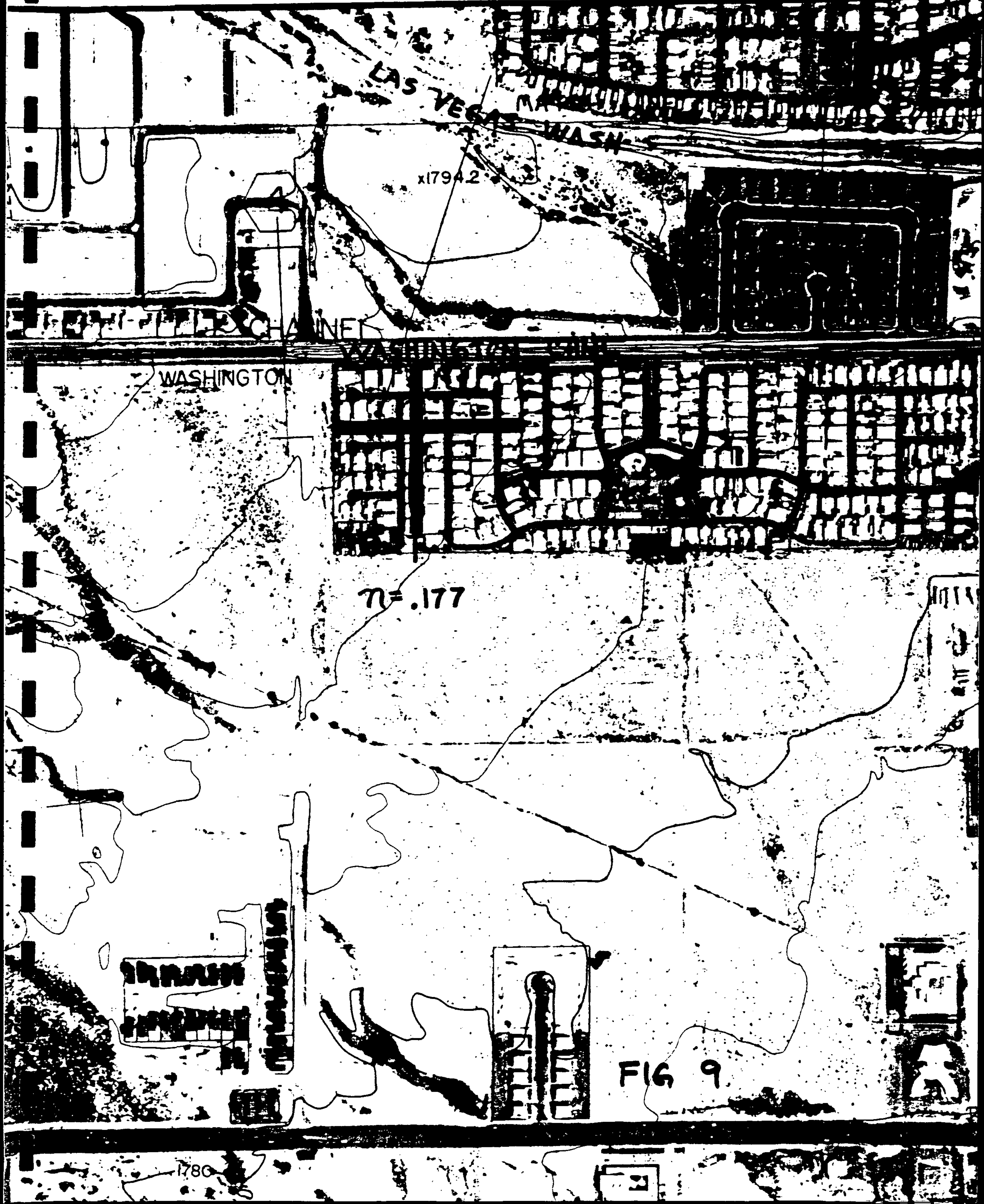


FIG 9

DATE

CLIENT JOB NO. CALC. BY

DESCRIPTION CHECKED BY

STREAM	LOCATION	N_o	L_T	L_o	W_T	W_o	N
C-1 CHANNEL							
	139+21 - 148+50 RIGHT 3800	.024	1250	540	750	505	.075
	131+56 - 139+21 2200 RIGHT	.024	1190	355	800	610	.069

DATE ______

CLIENT ______ JOB NO. ______ CALC. BY ______

DESCRIPTION ______ CHECKED BY ______

STREAM	LOCATION	N_o	L_T	L_o	W_T	W_o	N
L.V. CREEK	F.I.S. STA 16+00 U.S. FROM L.V. WASH RT OVER BANK	.04	1500	600	1000	270	.159
	STA 41+00 U.S. FROM L.V. WASH R.O.B. (DENSE)	.04	650	165	600	160	.177
	STA 64+00 U.S. FROM L.V. WASH APTS (MOD. DENSE)	.04	770	320	1030	305	.143

DATE ______

CLIENT ______ JOB NO. ______ CALC. BY ______

DESCRIPTION ______ CHECKED BY ______

STREAM	LOCATION	N_o	L_T	L_o	W_T	W_o	N
L.V. CREEK	BETWEEN RANCHO & HIGHLAND (HIGH DENSITY)	.06	750	320	1050	390	.169
	WEST OF RANCHO (MEDIUM DENSITY)	.06	740	325	1640	825	.123
	S.E. COR. RANCHO & HWY	.04	900	490	920	580	.062
	APTS WEST. OF HIGHLAND	.04	630	110	600	180	.164

DATE

CLIENT JOB NO. CALC. BY

DESCRIPTION CHECKED BY

STREAM	LOCATION	N_o	L_T	L_o	W_T	W_o	N
DUCK CREEK	RURAL - EAST OF I-15 SPARSE	.040	600	540	1500	1240	.045
	RURAL - EAST OF I-15 DEVELOPED	.040	600	490	680	400	.059
	1800' NE OF UPRR	.05	880	630	1650	1380	.058

DATE ____

CLIENT ____ JOB NO. ____ CALC. BY ____

DESCRIPTION ____ CHECKED BY ____

STREAM	LOCATION	N_o	L_T	L_o	W_T	W_o	N
FLAMINGO	1700' U.S. FROM BLDR. HWY. (DENSE SMALL LOTS)	.05	500	160	1250	535	.129
	880' D.S. FROM MARYLAND	.04	700	130	700	195	.176
	1200' U.S. FROM MARYLAND	.04	580	230	510	130	.169

EN-3A

DATE ____
CLIENT ____ JOB NO. ____ CALC. BY ____
DESCRIPTION ____ CHECKED BY ____

N - VALUES

STREAM	LOCATION	FIS LOB	FIS ROB	FIS CHNL	LOB	ROB	CHNL
L.V. CREEK	F.I.S. STA 16+00 U.S. FROM L.V. WASH	.045	.10	.045		.159	
	F.I.S. STA 41+00	.090	.040	.016		.177	
	F.I.S. STA 64+00	.090	.040	.040		.143	
DUCK	1800' NE UPRR	.070	.070	.045	.058	.058	

DATE ______

CLIENT ______ JOB NO. ______ CALC. BY ______

DESCRIPTION ______ CHECKED BY ______

N - VALUES

STREAM	LOCATION	FIS					
		LOB	ROB	CHNL	LOB	ROB	CHNL
FLAMINGO	1700' U.S. FROM BLDR. HWY	.070	.070	.040		.129	
	880' D.S. FROM MARYLAND	.080	.080	.016		.176	
	1200' U.S. FROM MARYLAND	.040	.037	.080		.169	

DATE ________

CLIENT ________ JOB NO. ________ CALC. BY ________

DESCRIPTION ________ CHECKED BY ________

STREAM	LOCATION	No	SURFACE IRREGULARITIES	X-SECTION SHAPE	OBSTRUCTIONS	VEGETATION	MEANDERS	N
C1-CHANNEL	LEFT OVERBANK 24+40 - 108+00	.024	.01	0	.015	.005	0	.054
LAS VEGAS WASH	STA 149+00							
	L.O.B.	.024	.01	.005	0	.025	0	.074
	R.O.B.	.024	.005	0	.005	0	0	.034
	CHNL	.024	.005	0	.005	.050	0	.084
	STA 343+80							
	L.O.B.	.024	.01	0	0	.005	0	.039
	R.O.B.	.024	.005	0	0	0	0	.029

DATE ____
CLIENT ____ JOB NO. ____ CALC. BY ____
DESCRIPTION ____ CHECKED BY ____

STREAM	LOCATION	No	SURFACE IRREGULARITIES	X-SECTION SHAPE	OBSTRUCTIONS	VEGETATION	MEANDERS	N
PITTMAN	CHNL UPRR TO 1300 D.S.	.024	.005	0	0	.005	0	.034
	CHNL 1300 S. TO 5300 S. OF UPRR 1000' WIDE ±	.024	.005	.005	0	.01	0	.044
	WEST TRIB 5300 S. OF UPRR TO 2000 U.S. OF RUSSELL		SIMILAR					.044
	WEST TRIB TO RUSSELL							
	OVER BANKS		SIMILAR					.044
	CHNL	.024	0	0	.005	.02	0	.049
	WEST TRIP RUSSELL TO DOCK							
	CHNL	.024	0	0	.005	.05	0	.079
	OVER BANK							.044

DATE ______

CLIENT ______ JOB NO. ______ CALC. BY ______

DESCRIPTION ______ CHECKED BY ______

STREAM	LOCATION	No	SURFACE IRREGULARITIES	X-SECTION SHAPE	OBSTRUCTIONS	VEGETATION	MEANDERS	N
PITTMAN	MAIN BRANCH FROM DIVERSION TO PIT							
	CHANNEL	.024	.005	.005	0	0	0	.034
	OVER BANK	SEE PREVIOUS						.044
LAS VEGAS CREEK	@ I-15	.024	.01	0	.01	0	0	.044
	7500 FT U.S. FROM L.V. WASH							
	L.O.B.	.024	.005	0	0	.005	0	.034
	R.O.B.	.024	.005	0	0	.01	0	.039

STREAM	LOCATION	No	SURFACE IRREGULARITIES	X-SECTION SHAPE	OBSTRUCTIONS	VEGETATION	MEANDERS	N
DUCK	800' U.S. FROM EASTERN							
	L.O.B.	.024	.01	0	.01	.005	0	.049
	R.O.B.	.024	.01	0	0	0	0	.034
	800' D.S. FROM SUNSET RD.							
	L.O.B.	.024	.005	0	0	.01	0	.039
	R.O.B.	.024	.01	.005	0	.01	0	.049
FLAMINGO	BUFFALO							
	L.O.B.	.024	.005	0	0	0	0	.029
	R.O.B.	.024	.01	.01	0	.01	0	.054
	800' U.S. FROM TROPICANA AVE.							
	L.O.B.	.024	.005	0	0	0	.005	.034
	R.O.B.	.024	.005	0	0	.005	.005	.039

DESCRIPTION
CLIENT
JOB NO.
CHECKED BY
CALC. BY
DATE

DATE

CLIENT JOB NO. CALC. BY

DESCRIPTION CHECKED BY

STREAM	LOCATION	No	SURFACE IRREGULARITIES	X-SECTION SHAPE	OBSTRUCTIONS	VEGETATION	MEANDERS	N
FLAMINGO	900' U.S. FROM DECATUR							
	L.O.B.	.024	.01	.005	0	.005	0	.044
	R.O.B.	.024	.01	.005	0	.005	0	.044
	CHNL	.024	.005	0	0	.005	0	.034
TROPICANA	S. BRANCH @ PATRICK							
	L.O.B.	.024	.005	0	0	.005	0	.034
	R.O.B.	.024	.005	0	0	.005	0	.034
	N. BRANCH 1760' EAST OF JONES							
	L.O.B.	.024	.01	.005	0	.005	0	.044
	R.O.B.	.024	.01	.01	0	.005	0	.049
	500' U.S. FROM PARADISE							
	L.O.B.	.024	.01	.01	0	.010	0	.054
	R.O.B.	.024	.01	.01	0	.010	0	.054
	CHNL	.024	.01	.005	0	.015	0	.054

DESCRIPTION ______ CLIENT ______ JOB NO. ______ CHECKED BY ______ CALC. BY ______ DATE ______

STREAM	LOCATION	No	SURFACE IRREGULARITIES	X-SECTION SHAPE	OBSTRUCTIONS	VEGETATION	MEANDERS	N
RANGE WASH	2780' U.S. FROM L.V. WASH							
	L.O.B.	.024	.005	0	0	.02	0	.049
	R.O.B.	.024	.005	0	0	.015	0	.044
	CHNL	.024	.005	0	0	0	0	.029
	1800' U.S. FROM BONANZA, L.O.B.	.024	.010	0	0	.005	0	.039
	1200' U.S. FROM LAMB BLVD. ON W. TRIB.							
	L.O.B.	.024	.005	.01	0	0	0	.039
	R.O.B.	.024	.005	.005	0	0	0	.034
	CHNL	.024	.005	.005	0	.005	0	.039

DATE
CLIENT JOB NO. CALC. BY
DESCRIPTION CHECKED BY

NATURAL STREAM	LOCATION	FIS LOB	FIS ROB	FIS CHNL	N - VALUES LOB	N - VALUES ROB	N - VALUES CHNL
DUCK	800' U.S. FROM EASTERN	.050	.050	.040	.049	.034	
	800' D.S. FROM SUNSET RD.	.040	.040	.033	.039	.049	
FLAMINGO	BUFFALO	.10	.10	.030	.029	.054	
	800' U.S. FROM TROPICANA AVE.	.10	.10	.031	.034	.039	
	900' U.S. FROM DECATUR	.045	.045	.036	.044	.044	.034
TROPICANA	S. BRANCH @ PATRICK	.040	.040	.040	.034	.034	
	N. BRANCH 1760' EAST OF JONES	.040	.040	.040	.044	.049	
	500' U.S. FROM PARADISE	.040	.040	.045	.054	.054	.054

DATE ______
CLIENT ______ JOB NO. ______ CALC. BY ______
DESCRIPTION ______ CHECKED BY ______

N - VALUES

NATURAL STREAM	LOCATION	FIS LOB	FIS ROB	FIS CHNL	LOB	ROB	CHNL
RANGE WASH	2780' U.S. FROM L.V. WASH	.050	.050	.045	.049	.044	.029
	1800' U.S. FROM BONANZA	.045			.039		
	1200' U.S. FROM LAMB ON W. TRIB.	.070	.070	.040	.039	.034	.039
LAS VEGAS WASH	STA 149+00	.10	.10	.10	.074	.034	.084
	STA 348+80	.030	.030	.028	.039	.029	
LAS VEGAS CREEK	7500 FT. U.S. FROM L.V. WASH	.050	.040	.040	.034	.039	

DATE 5/17

CLIENT ______ JOB NO. ______ CALC. BY MJB

DESCRIPTION DUCK CREEK - N VALUE VERIFICATION CHECKED BY ______

X-SEC	CHANGES
1	OK
2	ALTERED TO REFLECT DIFFERENCE BETWEEN L.O.B. & R.O.B.
3	R.O.B. - URBAN AREA
4	OK
5	CHNL N VALUE VARIED
6	OK
7	OK
8	OK
9	OK
10	OK
11	OK
12	L.O.B. - URBAN COMMERCIAL - BUT VALUE ALREADY GIVEN APPROPRIATE - NO CHANGE
13	OK
14	OK
15	L.O.B. - URBAN AREA
16	REPEAT 15
17	" "
18	CHANGED TO OPEN LAND
19	OK
20	OK
21	OK
22	OK
23	L.O.B. - URBAN AREA
24	L.O.B. - OPEN LAND
25	OK
26	OK
27	OK
28	OK
29	R.O.B. - OPEN LAND
30	OK
31	L.O.B. - URBAN AREA
32	L.O.B. - RURAL URBAN
33	OK

DATE 5/17

CLIENT ______ JOB NO. ______ CALC. BY M.J.B

DESCRIPTION DUCK CREEK - N VALUE VERIFICATION CHECKED BY ______

X-SEC	CHANGES
34	OK
35	OK
36	OK
37	L.O.B. & R.O.B. - URBAN APTS
38	L.O.B. - OPEN LAND
39	L.O.B. - RURAL URBAN
40	REPEAT
41	L.O.B. & R.O.B. - RURAL & CUSTOM URBAN
42	OK
43	OVER BANKS - RURAL URBAN
44	REPEAT
45	REPEAT
46	REPEAT
48	OK
49	OK
50	OK
51	OK
52	OK
53	OK
54	OK
55	OK

DEBRIS ANALYSIS FOR LAS VEGAS VALLEY OVERFLOW STUDY

JAMES M. MONTGOMERY, CONSULTING ENGINEERS, INC.

MEMORANDUM

TO:	Distribution	**DATE:**	April 7, 1987
FROM:	[redacted] Mike Bagstad	**JOB NO.:**	1758.0090
SUBJECT:	Debris Analysis for Las Vegas Valley Overflow Study	**CLIENT:**	CCRFCD

Mike and I completed the debris analysis for the Las Vegas Valley Overflow Study. I have attached a description of this analysis which will eventually become a chapter in our final report. The write-up contains a table with a listing of each bridge and culvert in the study area (at least those which were identified in the CCRFCD Flood Control Master Plan), with an assigned debris loading factor. This factor is the width of debris obstruction which should be assumed to occur on both sides of each pier and at each abutment if there is no wingwall. For example, if the debris factor is 2 feet, then each pier would be widened by 2 feet on each side (a total of 4 feet), and the abutment would be widened by 2 feet unless there is a wingwall. Thus for a two 10-foot wide by 6-foot high RCB with square abutments and a debris factor of 2 feet, the 10-foot openings of each barrel would be reduced to an effective width of only 6 feet.

To use this information, find your structures in the table and read the debris loading factor. Then look at the geometry of the bridge opening to see how the factor should be applied to the piers and abutments. Finally, change the appropriate bridge data in the existing HEC-2 run accordingly. The factors affected are net area of the opening (BAREA), total pier width (BWP), and pier shape coefficient (XK) which should always be 1.25 (square nose). The same kinds of adjustments would be made for circular or arch openings, with the debris added to the "piers" between the openings. Note in your engineering notes exactly what was done for each structure.

If you have new structures which are not on the list in the attached write-up, or if you have any questions on how to apply the debris procedure to a particular bridge, please give me a call. We want things to be as consistent as possible from one stream to the next.

Distribution:

Doug Hahn
Arsalan Dadkhah
Steve Mano
Vicki Scharnhorst

May 4, 1987

CLARK COUNTY REGIONAL FLOOD CONTROL DISTRICT

Las Vegas Valley Overflow Analysis

DEBRIS EVALUATION

An important difference between the FEMA Flood Insurance Study and the Clark County Regional Flood Control District (CCRFCD)/Corps of Engineers (COE) hydraulics analysis is in the treatment of debris and sediment loading. In accordance with the FEMA Guidelines to Study Contractors, the FIS hydraulic analysis assumed that no obstructions would occur at bridges and culverts due to debris blockage or sediment deposition. However, the analysis for the COE requires that consideration be given to the potential for structure openings to be partially plugged with debris and/or sediment. This Technical Memorandum describes the general approach to conducting the debris bulking analysis, as well as specific assumptions made at each structure.

General Approach

The approach for conducting the Las Vegas Valley debris analysis consisted of three steps.

1. Investigation of areas where debris and sedimentation problems have historically occurred, and local conditions which typically lead to debris obstruction problems. Due to the subjectivity of much of the debris evaluation, this historical information is particularly valuable.

2. Development of debris criteria specific to the Las Vegas Valley study area, consistent with the COE approach to debris analyses.

3. Assignment of debris obstruction factor to each bridge and culvert structure on the streams of study.

The first step was carried out by contacting public works agencies in the Las Vegas Valley. The following individuals were contacted:

Virginia Valentine - Clark County Regional Flood Control District
Gus Cederburg - Clark County Department of Public Works
Steve Jackson - City of Las Vegas
John Murchie - City of North Las Vegas
Saeed Ahmad - City of Henderson
Kent Mayer - Nevada Department of Transportation

Based on these local agency contacts, the following important facts were gathered.

- Problems with debris in channels are valley-wide, and are primarily associated with trash and vegetation from urban areas.

- Locations where nuisance flows are present and where there is extensive public access are particularly susceptible to debris problems.

- Virtually all multiple barrell box culverts have potential debris problems. Although debris may catch on the supports of span bridges, their larger capacities minimize the problem.

- The following structures were specifically mentioned as having debris or sedimentation problems: Vegas Valley Drive on Las Vegas Wash; Swenson Road on Flamingo Wash; UPRR bridge and Boulder Highway on Duck Creek; lower Pittman Wash and Whitney Wash; Vandenburg Channel in North Las Vegas; Lake Mead Blvd. on Las Vegas Wash; 18th Street and 21st Street on Washington Avenue Channel; Lamb Blvd. on Flamingo Wash; Charleston Blvd. on Las Vegas Wash; Lake Mead Blvd. on the C-1 Channel.

- Flamingo Wash has continuous flow in the largely unlined reach between Cambridge Road and Las Vegas Wash.

- Most sediment load is generated from eroding channel banks in unimproved reaches rather than sheet erosion from the upland watersheds. This is verified by the relatively small amounts of sediment collected in the local detention basins.

In consideration of the above local information and the Los Angeles District's standard procedures for modeling debris obstructions, five criteria have been developed for analyzing each stream reach and structure.

1. Structures with a significant debris potential will be modeled with an assumed 2-foot debris obstruction on both sides of each pier. For clear span bridges, the 2-foot obstruction would be applied to each abutment, unless the abutments are wingwalls, in which case no obstruction would be applied. This is in accordance with the specific provisons of our contract.

2. For structures located in reaches with significant debris potential, but which are only a short distance downstream of another structure with debris problems, a 1-foot obstruction will be applied to each pier or abutment.

3. Unlined stream reaches in urban areas are assumed to have significant debris potential, particularly those with continuous flow.

4. Unfenced stream reaches in urban areas are assumed to have significant debris potential.

5. Sediment deposition is assumed to occur in structures which have experienced severe sedimentation problems in past floods. Depths of assumed sedimentation with blockage at the time of peak discharge will be either 1 or 2 feet, depending on the severity of reported historical deposition.

RESULTS

Based on the above criteria, each bridge and culvert structure in the study reaches was evaluated with regard to its debris potential. An obstruction factor equal to the required assumed blockage on each side of the piers was then assigned to each structure. This blockage was applied to both sides of all piers, as well as to the abutments if no wingwalls are present. Results of this evaluation are presented in the attached table.

May 4, 1987

Table

Debris Analysis

Stream	Crossing Location	Debris Load (ft)	Comments
	I-15	2	
Las Vegas Wash	Civic Center	1	Urban area; immediately below 3 other structures
	Cheyenne	2	Urban area; arch culverts
	Las Vegas Blvd.	2	Urban area; box culvert
	Carey	2	Urban area; arch culvert
	Pecos/Lake Mead	2	Urban area; box culvert; historical problems
	Vegas Drive	2	Urban area; unlined channel
	Lamb	~~0~~ 2	Dip section; no obstruction
	Bonanza	2	Urban area; unlined channel
	Stewart	2	Urban area; unlined channel
	Charleston	2	Urban area; historical problems; unlined channel
	Nellis	1	Urban area; unlined channel; immediately below another structure
	Sahara	2	Urban area, unlined channel
	Vegas Valley	2	Urban area; unlined channel; historical problems with sedimentation; add 2 feet of sediment deposition
Las Vegas Creek	Rancho	2	Urban area; most upstream structure
	Highland ramp	2	Urban area; box culverts
	Highland	1	Urban area; immediately below another structure
	F Street	2	Urban area; box culverts
	U.P.R.R.	0	Transition with no piers
	Casino Center	2	Urban area; unlined channel
Washington Ave. Channel	Bruce Street	1	Urban area; immediately below box culvert outlet
	18th Street	2	Urban area; box culvert; historical problems
	21st Street	2	Urban area; box culvert; historical problems
	Eastern	2	Urban area; box culvert; historical problems
	Mojave	2	Urban area; box culvert; historical problems
	Pecos	0	Dip section; no obstruction
	Lamb	2	Urban area; box culvert

Table

Debris Analysis

Stream	Crossing Location	Debris Load (ft)	Comments
Range Wash	Lone Mountain	2	Most upstream structure; box culvert; historical problems
	Vanderburg	1	Box culvert; historical problems; immediately downstream of another structure
	Craig	~~1~~ 2	Box culvert; historical problems; immediately downstream of another structure
	Lamb	2	Box culvert; unlined channel
	Alexander	2	Box culvert; unlined channel
	Las Vegas Blvd.	2	Box culvert; unlined channel
	Marion & Gowan	1	Box culvert; lined channel
	Nellis	1	Box culvert; lined channel
	Gowan	1	Box culvert; lined channel
	Judson	2	Urban area; box culvert; below unregulated tributary
	Lake Mead	1	Urban area; box culvert; lined channel
	Owens	1	Urban area; box culvert; lined channel
	Washington	2	Urban area; box culvert; unlined channel
	Bonanza	2	Urban area; box culvert; unlined channel
	Stewart	2	Urban area; box culvert; unlined channel
	Charleston	2	Urban area; box culvert; unlined channel
Flamingo Wash	Rainbow	2	Most upstream structure
	Tropicana	1	Urban area; unlined channel; below another structure
	Torrey Pines	1	Urban area; unlined channel; below another structure
	Jones	1	Same as above
	Decatur	2	Urban area; box culvert; unlined channel
	UPRR	2	Urban area; unlined channel
	I-15	1	Industrial area; unlined channel; immediately downstream of another structure
	Caesar's Palace	1	Industrial area; unlined channel; immediately downstream of another structure
	Koval	2	Urban area; box culvert
	Paradise	2	Urban area; box culvert; unlined channel

Table

Debris Analysis

Stream	Crossing Location	Debris Load (ft)	Comments
Flamingo Wash (continued)	Swenson	2	Urban area; unlined channel
	Cambridge	1	Urban area; unlined channel; continuous flow; immediately downstream of another structure
	Maryland	1	Urban area; unlined channel; continuous flow; immediately downstream of another structure
	Spencer	2	Urban area; unlined channel; continuous flow
	Gold Course	0	Footbridge; free span; no obstruction
	Gold Course	0	Footbridge; free span; no obstruction
	Tioga	2	Urban area; unlined channel; continuous flow; golf course
	Gold Course	0	Footbridge; free span; no obstruction
	Eastern	1	Urban area; unlined channel; continuous flow; immediately below another structure
	Pecos/McLeod	0	Free span bridge; no obstruction
	Desert Inn	2	Urban area; unlined channel; continuous flow
	Mojave	1	Urban area; lined channel; immediately below another structure
	Boulder Hwy. u/s	2	Urban area; box culvert; unlined channel; continuous flow
	Boulder Hwy. d/s	1	Same as above but immediately below another structure
	Freeway	0	Free span bridge; no obstruction
	Lamb	2	Urban area; unlined channel; continuous flow; historical problems
	Nellis	2	Urban area; unlined channel; continuous flow
Tropicana Wash	UPRR	2	Most upstream structure; pipe culvert
	I-15	2	Urban area; box culvert; unlined channel
	Tropicana	1	Urban area; unlined channel; immediately below another structure

Table

Debris Analysis

Stream	Crossing Location	Debris Load (ft)	Comments
Tropicana Wash (continued)	Las Vegas Blvd.	~~2~~ 1	Urban area; unlined channel with vegetation; box culvert; immediately below another structure
	Koval	1	Unlined channel; below golf course; box culvert
	Harmon	2	Urban area; unlined channel with vegetation; box culvert
	Paradise	2	Urban area; unlined channel; box culvert
	Swenson	1	Urban area; unlined channel; downstream of another structure
	Flamingo	1	Urban area; small opening; immediately below another structure
Duck Creek	Eastern	2	Most upstream structure; CMP's
	UPRR	2	Urban area; unlined channel
	Pachuca	2	Urban area; unlined channel; pipe culverts
	Pecos	0	Free span bridge; no obstruction
	Annie Oakley	0	Free span bridge; no obstruction
	Sunset	2	Urban area; unlined channel
	Mountain Vista	2	Urban area; unlined channel
	Russell	1	Urban area; unlined channel; immediately below another structure
	Future Freeway	0	Free span bridge; no obstruction
	Stephanie	2	Urban area; unlined channel; pipe culvert
	Emerald	2	Urban area; unlined channel; pipe culvert
	Boulder Highway	2	Urban area; unlined channel; box culvert; historical problems with sedimentation; add 1' sediment depth
	Stadium	2	Unlined channel; vegetation
Pittman Wash	UPRR	2	Most upstream structure
	Sunset at Stephanie	2	Unlined channel; box culvert
	Sunset at Gibson	2	Unlined channel; box culvert
	Russell Road	2	Pipe culverts
C-1 Channel	Boulder Highway	1	Arch pipe bridge; grouted rip rap at entrance
	Warm Springs	2	Urban area; most upstream structure
	Lake Mead	2	Urban area; historical problems