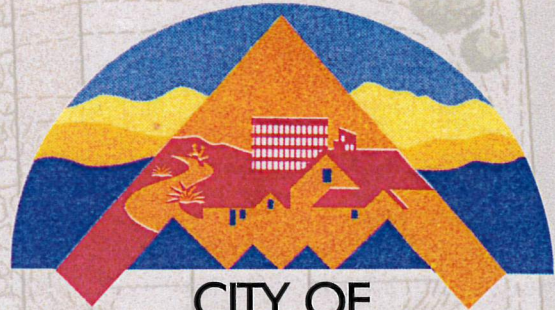


DRAFT

LAS VEGAS WASH FACILITIES STUDY

Volume 1

Prepared for:



**CITY OF
NORTH LAS VEGAS**

Your Community of Choice

OCTOBER 2001



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Engineers/Planners/Surveyors



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509.020

October 4, 2001

William C. Knight, P.E., Project Manager
City of North Las Vegas
Department of Public Works
Engineering Division
2829 Fort Sumter
North Las Vegas, Nevada 89030

Subject: Las Vegas Wash Facilities Study Draft Report

Dear Mr. Knight:

G. C. Wallace, Inc. is pleased to submit fifteen (15) copies of the revised *Las Vegas Wash Facilities Study Draft Report, Volumes 1 and 2* which include the report text and 11-inch by 17-inch drawings and five (5) copies of the revised *Las Vegas Wash Facilities Study Draft Report, Volume 3* which includes the technical appendices and one (1) copy of the GIS application on CD. The GIS application has specific requirements in order to function properly. The report contains the GIS application database user's manual in Section XI of Volume 1.

Please do not hesitate to call if you have any questions or comments during your review of the report.

Very truly yours,

G. C. WALLACE, INC.

Jerry E. Pruitt, P.E.
Vice President
Flood Control Division

JEP:jj

Encl.

pc: Calvin L. Black, GCW

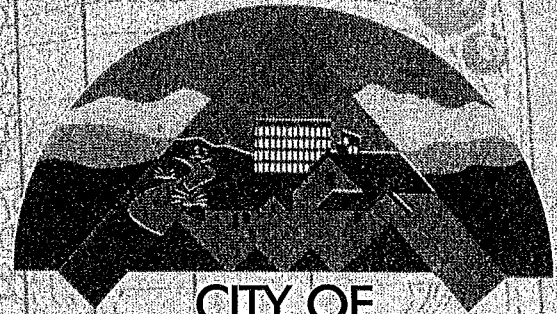
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LAS VEGAS WASH FACILITIES STUDY

Volume 1

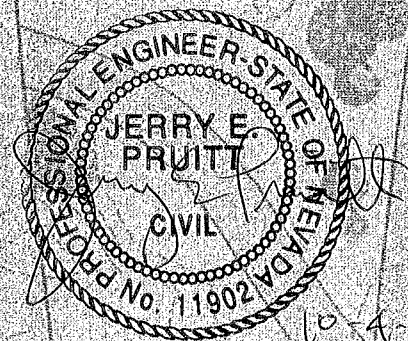
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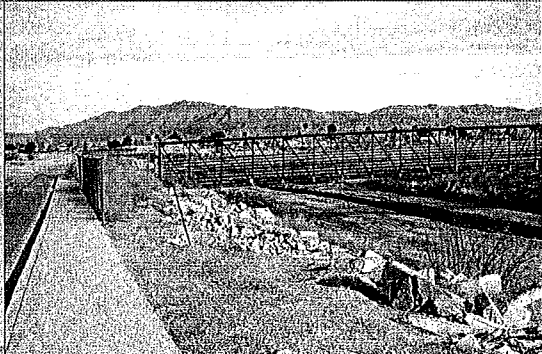
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OCTOBER 2001



G. C. WALLACE, INC.
Engineers/Planners/Surveyors



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2. Clark County Regional Flood Control District, *Flood Control Master Plan Update, Las Vegas Valley*, 1996.
3. Black and Veatch, *Existing Conditions Hydrologic Model for the Las Vegas Wash, Flamingo Wash Confluence to Alexander Road*, November 1998.
4. Black and Veatch, *Technical Memorandum on Hydrology for the 'A' Channel Lining Project*, December 1997.
5. Clark County Regional Flood Control District, *Hydrologic Criteria and Drainage Design Manual*, Adopted August 12, 1999.
7. VTN, *90% Design Report for the Cheyenne Peaking Basin*, January 2001.
8. Louis Berger Group, Inc., *Hydraulic Design Report for the Las Vegas Wash "A" Channel Three Bridges Project, 60% Submittal*, December 19, 2000.
9. Black and Veatch, *Addendum No. 1, Technical Memorandum on Hydrology for "A" Channel Lining Project*, February 1998.
10. Black and Veatch, *Technical Memorandum on Hydraulics for the Lake Mead Intersection*, April 1998.
11. Black and Veatch, *Technical Memorandum on Conveyance for the Las Vegas Wash, Flamingo Wash Confluence to Alexander Road, Volumes 1 to 5*, 1998.
12. Black and Veatch, *'A' Channel Lining Project, Master Plan Amendment for Las Vegas Wash*, January 1999.
13. Las Vegas Wash Coordination Committee, *Las Vegas Wash Engineering Workshop*, August 1999.

14. Black and Veatch, *Preliminary Design Report – “A” Channel Lining Project, Lake Mead Boulevard to Alexander Road*, July 2000.
15. VTN, 90% Submittal, *“A” Channel Improvements, Alexander Road to Cheyenne Avenue*, January 2001.
16. PBS&J, *City of Las Vegas Northwest Neighborhood Flood Control Master Plan, Volume 1*, December 1997.
17. PBS&J, *City of Las Vegas Northwest Neighborhood Flood Control Master Plan Phase 2, Volume 1*, September 1999.

EXECUTIVE SUMMARY

The Las Vegas Wash Facilities Study covers approximately 12 miles of the Las Vegas Wash starting at the confluence with the Monson Channel and extending upstream to the Northwest to Interstate 15. Figures E-1 and E-2 show the location of the study area. The 100-year storm flow rates are taken from the *Preliminary Design Report for the "A" Channel Lining Project*, Black and Veatch, July 1999.

Previous studies have recommended a peaking basin on the Las Vegas Wash between Civic Center Drive and Las Vegas Boulevard. The basin is currently under design by others. The peaking basin will limit the 100-year storm flow in the Las Vegas Wash to 8,500 cfs at Lake Mead Boulevard. Current estimates of the flow in the wash at Lake Mead Boulevard are less than the 8,500 cfs. As development occurs in the upstream drainage area, flows will begin to increase. A method of estimating when the peaking basin will be required was developed. Based on an annual growth rate of 8 to 12 percent, the peaking basin will need to be on line between years 2005 and 2008.

HEC-2 water surface profiles of the existing channel showed several areas where the lack of capacity in the Wash would result in breakouts from the channel at a number of locations. In addition, the existing culverts at Carey Avenue, Cheyenne Avenue, and Las Vegas Boulevard would be overtopped. The resultant velocities exceed the maximum allowable velocities defined in the CCRFCD Design Manual for earth-lined channels which would result in erosion and sedimentation of the current channel.

Alternate channel sections were evaluated based on construction costs, available right-of-way, and maintenance costs. In general, a concrete-lined channel is recommended from Interstate 15 to Nellis Boulevard. Through the Desert Rose Golf Course, from Nellis Boulevard to the footbridge upstream from Sloan Lane, the channel will be left in its current state to be maintained by the golf course. From Sloan Lane to Vegas Valley Drive, the channel will be concrete lined.

South of Vegas Valley Drive, the proposed section has riprap-lined sides and an earthen bottom with grade control beams at 800-foot spacing. Table E-1 outlines the specific channel lining recommended for each reach of the study area and the estimated preliminary costs.

Table E-1: Recommendations with Cost Estimates			
Channel Reach	Length (feet)	Channel Lining	Cost
Monson Channel to Service Road	3,475	Riprap Trapezoidal with Earth Bottom	\$ 5,500,000
Service Road to Vegas Valley Drive	9,635	Riprap Trapezoidal with Earth Bottom	\$ 9,465,000
Vegas Valley Drive to Sloan Channel	1,335	Concrete Trapezoidal	\$ 165,000
Sloan Channel to Flamingo Wash	2,600	Concrete Trapezoidal	\$ 3,330,000
Flamingo Wash to Nellis Boulevard	7,375	Golf Course	\$ 150,000
Nellis Boulevard to Charleston Boulevard	1,315	Concrete Rectangular	\$ 2,190,000
Charleston Boulevard to Stewart Avenue	2,725	Concrete Trapezoidal	\$ 3,540,000

Table E-1: Recommendations with Cost Estimates

Channel Reach	Length (feet)	Channel Lining	Cost
Stewart Avenue to Bonanza Road	3,080	Concrete Trapezoidal	\$ 3,810,000
Bonanza Road to Washington Avenue	3,025	Concrete Trapezoidal	\$ 3,030,000
Washington Avenue to Lamb Boulevard	2,000	Concrete Trapezoidal	\$ 2,140,000
Lamb Boulevard to Owens Avenue	4,500	Concrete Trapezoidal	\$ 5,300,000
Owens Avenue to Lake Mead Boulevard	3,570	Concrete Trapezoidal/ Rectangular	\$ 4,015,000
Lake Mead Boulevard to Carey Avenue	3,200	Concrete Rectangular	*
Carey Avenue to Las Vegas Boulevard	2,725	Concrete Trapezoidal	*
Las Vegas Boulevard to Cheyenne Avenue	3,130	Concrete Trapezoidal	*
Cheyenne Avenue to Civic Center Drive	2,650	Concrete Rectangular	*
Civic Center Drive to I-15	790	Concrete Trapezoidal	*

* Total Cost Lake Mead Boulevard to Interstate 15 -- \$19,000,000.

There is sufficient existing right-of-way for the proposed improvements along a majority of the study area. From Monson Channel to Vegas Valley Drive, the Wash passes through a number of parcels owned by the City of Las Vegas and the Clark County Sanitation District. There are also several privately owned parcels and 3.4 acres of additional right-of-way from the private parcels is required. North of Vegas Valley Drive there are two additional small pieces of right-of-way that need to be acquired: 950 square feet downstream of the Nellis Boulevard Bridge and 150 square feet upstream of the Bonanza Road Bridge. North of Nellis Boulevard the existing right-of-way is generally confined by existing residential and commercial development on both sides. While sufficient right-of-way exists to construct a concrete-lined channel and provide maintenance access, the cost of acquiring additional right-of-way to allow a wider, more natural channel section is prohibitive.

Joint or multiple-use of the drainage corridor is addressed. Discussion with the Parks Departments of the City of North Las Vegas, Clark County, and City of Las Vegas determined that the main interest was in a 10-foot wide trail along one side of the Wash. If more space is available, additional features may or may not be considered. As a minimum, a separate 10-foot space is available along the east side of the channel for the full length of the study area.

INTRODUCTION

Purpose of Study

The purpose of this Study is to provide a preliminary engineering analysis of the Las Vegas Wash from Interstate 15 to the confluence with the Monson Channel. The proposed facilities must provide a systematically coherent plan to convey the 100-year storm event within the guidelines established by the CCRFCD. In addition, the analysis was to identify construction and utility constraints, right-of-way needs or excesses and opportunities for multiple uses within the drainage corridor.

Previous studies on the Las Vegas Wash have established a future need for a Peaking Basin upstream of Las Vegas Boulevard. The basin will be required to prevent the storm flow in the Wash from exceeding 8,500 cfs at Lake Mead Boulevard. The analysis is to develop an analytical procedure to estimate the time frame in which the peaking basin will be needed.

The hydrology for the analysis is taken from two previously approved studies. The *Preliminary Design Report for the "A" Channel Lining Project*, Black and Veatch, July 1999 and the *Existing Conditions Hydrologic Model for the Las Vegas Wash, Flamingo Wash Confluence to Alexander Road*, Black and Veatch, November 1998. Additional hydrologic modeling was not included in this study.

History of the Las Vegas Wash

The Las Vegas Wash forms the main collector for drainage from the Las Vegas Valley to Lake Mead. The existing right-of-way ranges from 100 feet to over 300 feet in width. The Wash extends from Lake Mead to north of I-15 freeway.

The Las Vegas Wash floodplain was initially formed millions of years ago, as a result of filling of the Las Vegas Valley by sediments that were deposited by erosion of surrounding ranges and higher elevations. The majority of these sediments consist of easily eroded silts and clays with minor amounts of sand and gravel.

At the turn of the century, the area known as the Las Vegas Wash was an ephemeral stream, occasionally carrying high flows due to stormwater runoff. As the Las Vegas Valley grew and more land developed, the upper portion of the Wash became a storm drain facility to convey nuisance water and storm flows. The Lower Wash is used to transport treated wastewater effluent, in addition to storm flows, to Lake Mead.

A steady and increasing influx of residents to the Valley caused flows in the Wash to permeate and moisten the floodplain, transforming its vegetation downstream of the Monson Channel from a sparse, desert-shrub community to a greenbelt that included ponds and wetlands. This progressively increasing floodplain saturation caused the Wash to begin flowing continuously in 1955, a drastic change in the hydrologic regime from the previous conditions. As the Clark County Sanitation District and City of Las Vegas began discharging wastewater into the Wash in 1956 and 1957, respectively, wetland vegetation in the Wash downstream was further enhanced. In 1957, a flood event caused minimal erosion in the Wash and, although the floodplain absorbed most of the water, headcutting started.

During the summer of 1984, there were multiple flash floods caused by a prolonged monsoonal period. These flood events caused damage along the entire length of the Wash, including numerous erosional headcuts in the lower portions of the Wash south of the Monson Channel confluence.

The recent floods of July and September 1998 and July 1999 caused channel erosion, overtopped bridges, and destroyed channel and grade-control structures.

Current development along the Wash varies from urban residential and commercial land uses to natural, heavily vegetated tamarisk areas with meandering threads. Improvements to the Wash have been disjointed due to the number of different people and interests involved in development along the Wash. Improvements range from partial concrete linings, earthen trapezoidal sections, concrete linings, riprap, grouted riprap, soil-cement bank protection, grass-lined golf course, and gabions. Developing the Wash in this manner only handles immediate problems, but does not consider the overall effect on how the Wash functions as a system. Some problems encountered include sedimentation under existing bridges as well as bank erosion and local scouring while local flooding continues during major storm events.

Coordination and Meetings

Entities Involved in Coordinated Effort

The Las Vegas Wash Facilities Study involved public agencies and utility companies with interests along the study reach. Monthly coordination meetings were held to inform interested parties of the study's progress and to address concerns and solutions presented. Individual coordination meetings were held with each entity to address local concerns with a wider representation of the park, utility, maintenance, engineering, and fire departments along with Tim Sutko of CCRFCD. Daniel Wilson, P.E. of PBS&J represented North Las Vegas as project manager for the project until June 2001. Thereafter, William Knight, P.E. with the City of North Las Vegas Department of Public Works, took on the role of project manager. Public agencies invited to the meetings included City of North Las Vegas, Clark County Regional Flood Control District, City of Las Vegas Department of Public Works, Clark County Department of Public Works, and Nevada Department of Transportation.

The kick-off meeting was held February 2, 2000 at the North Las Vegas Utilities Building at 2829 Fort Sumter. Minutes from this and subsequent meetings are presented in Appendix A for reference.

The second meeting on March 2, 2000 was a tour of the Las Vegas Wash beginning at the Monson Channel and proceeding northward to Civic Center Drive. Locations visited included:

- Site of proposed Upper Diversion weir upstream from the Monson Channel confluence
- Clark County Wastewater Treatment Plant Service Road
- City of Las Vegas Wastewater Treatment Plant at Desert Inn Road alignment
- Vegas Valley Drive culverts
- Sloan Lane sewer siphons and metal weir
- Flamingo Wash confluence with the Las Vegas Wash
- Sahara Avenue Bridge
- Nellis Boulevard Bridge
- Charleston Boulevard Bridge
- Stewart Avenue Bridge
- Bonanza Road Bridge
- Washington Avenue Bridge
- Lamb Boulevard Bridge
- Washington Channel outfall

Owens Avenue Bridge
Lake Mead Boulevard culverts
Carey Avenue culverts
Las Vegas Boulevard culverts
Cheyenne Avenue culverts
Civic Center Drive Bridge

Entities represented on the tour included CCRFCD, CLV, CNLV, SNWA, and CCPW. Representatives from GCW and PBS&J were also in attendance. In addition to the public works engineers, the City of North Las Vegas sent representatives from the CNLV Parks and Recreation Division.

Significant observations during the tour included noting the limited right-of-way which may restrict recreational usage along the Wash. This will affect the amount of amenities to be constructed to the extent that, in some areas, multi-use will be limited to only a trail. Also, a trail system would apparently be more accessible and continuous if placed along the east side of the Wash.

Tour participants also noted that maintenance access is not sufficient and must be addressed. Additionally, areas of sedimentation, scour, and heavy vegetation were identified during the tour.

This Study involved determining the time frame a proposed peaking basin at Cheyenne Avenue would be warranted to limit 100-year storm flows at Lake Mead Boulevard and Las Vegas Wash to 8,500 cfs. The warrant time frame considered the rate of development in the Northern Watershed. Meetings held on April 11, May 18, and June 29, 2000 were dedicated to this area of concern.

The August 31, 2000 progress meeting focused on the available right-of-way and channel lining alternatives. Alternative linings evaluated included earthen, grass, gabion, and concrete. Earthen and grass linings in the segments from Charleston Boulevard to Lake Mead Boulevard required more right-of-way.

The individual entity meetings were held from September 12, 2000 to March 22, 2001.

The City of Las Vegas meetings were held on September 12 and November 20, 2000, and February 7 and March 1, 2001. The tone for the other entities' meetings was set by suggestions given by a representative from CLV fire department. The request was made for a sturdy fence, suitable for rescue operations, to be placed along the wash to separate any proposed trail from a manway adjacent to the channel top. Maintenance representatives desired separate maintenance access roads from any trail. Trails were set at 10 feet wide maximum. CLV parks personnel proposed innovative solutions for the trail system. GCW was requested to investigate hydraulic feasibility of routing the trail under the bridges. At Charleston Boulevard, such a passageway is not possible because of the 51-inch sewer attached to the bottom of the bridge. It was proposed that a pedestrian overpass would cross Charleston Boulevard diagonally from the north side of the road to south side coming from the east side of the wash to the west side. Completely enclosing the wash in culverts was also discussed. It was determined and reported that completely enclosing the wash from Lake Mead Boulevard to Nellis Boulevard would cost at least \$150 million dollars.

The City of North Las Vegas meetings were held on September 20 and November 7, 2000. Tim Sutko of CCRFCD distributed a draft policy on development of multi-use facilities. Since

the North Las Vegas fire department was not represented at the September 20th meeting, a separate meeting was held with Jim Stubler at the North Las Vegas fire station. Mr. Stubler echoed the desire to separate the trail from the rescue manway adjoining the wash.

Meetings with Clark County were held on September 29, 2000 and March 22, 2001. Maintenance personnel set the tone in these meetings emphasizing the desire for separate trail and maintenance access roads where possible. From these meetings came the proposal to locate the trail on the east and north sides of the wash with the maintenance access roads on the west and south sides of the wash.

Utility Companies Contacted

Nevada Power, Las Vegas Valley Water District, Sprint, Southwest Gas, and Southern Nevada Water Authority were all contacted to obtain utility information along the wash study reach. Needed pothole locations to determine critical utility depths were identified along the wash and approved by the City of North Las Vegas, the City of Las Vegas and Clark County. Kaccel was hired to pothole the pipes at designated locations. Field crews surveyed at least one top elevation of a manhole in each Las Vegas Wash segment for the 'A' Channel and Sandhill Relief Sanitary Sewers. Where the manhole lids could be removed, the distance to the invert of the manhole was also measured.

An individual meeting was held with Southern Nevada Water Authority on February 6, 2001 to address the agency's specific concerns regarding the Whitney Lateral crossing the Wash at Station 362+10. Pothole and top of sewer manholes elevations are shown on the plan and profile drawings for the Las Vegas Wash.

Research and Data Acquisition

Previous Studies and Plans

Previous studies and plans reviewed for this Study included:

Southern Nevada Water Authority plans for:

- North Las Vegas Lateral
- Las Vegas Valley Lateral
- Whitney Lateral

Sandhill Relief Sanitary Sewer Plans

"A" Channel Sanitary Sewer Plans

Technical Memorandum on Hydrology for "A" Channel Lining Project, Black and Veatch, December 1997

Addendum No. 1, Technical Memorandum on Hydrology for "A" Channel Lining Project, Black and Veatch, February 1998

Technical Memorandum on Hydraulics for the Lake Mead Intersection, Black and Veatch, April 1998

Existing Conditions Hydrologic Model for the Las Vegas Wash, Flamingo Wash Confluence to Alexander Road, Black and Veatch, November 1998

Technical Memorandum on Conveyance for the Las Vegas Wash, Flamingo Wash Confluence to Alexander Road, Volumes 1 to 5, Black and Veatch, 1998

'A' Channel Lining Project, Master Plan Amendment for Las Vegas Wash, Black and Veatch, January 1999

FEMA updated FIRM panels 32003C2178D, 2187D, 2180D, and 2176D, June 23, 1999

Las Vegas Wash Engineering Workshop, Las Vegas Wash Coordination Committee, August 1999

Preliminary Design Report - "A" Channel Lining Project, Lake Mead Boulevard to Alexander Road, Black and Veatch, July 2000

Hydraulic Design Report for the Las Vegas Wash "A" Channel Three Bridges Project, Louis Berger Group, 60% Submittal, December 2000

Design Report for the Cheyenne Peaking Basin, VTN, 90% Submittal, January 2001

"A" Channel Improvements, Alexander Road to Cheyenne Avenue, VTN, 90% Submittal, January 2001

Existing utility locations for water, sewer, gas, and power lines were coordinated with the City of North Las Vegas, the City of Las Vegas, Clark County Department of Public Works, Las Vegas Valley Water District, Southern Nevada Water Authority, Southwest Gas, and Nevada Power.

Field Reconnaissance

During the month of January 2000, Jerry Pruitt and Dennis Brown of G. C. Wallace, Inc. visited the study area beginning at the Civic Center Drive Bridge. Mr. Pruitt videotaped the channel noting lining types and conditions, existing utilities, storm drain inflow points, scour, and sedimentation areas. Mr. Brown photographed the Wash using digital and regular cameras. Generally, the photographs were taken at or near the bridge crossings. Where possible, the Wash was followed along existing maintenance access roads.

This photographic reconnaissance proceeded to the south along the maintenance access road along the east bank to a point midway between Civic Center Drive and Cheyenne Avenue where the vehicular travel was blocked. The next stops were at the culverts at Cheyenne Avenue, Las Vegas Boulevard, Carey Avenue, and at the Lake Mead Boulevard and Pecos Road intersection. From the next stop at the Owens Avenue Bridge, a maintenance access road on the west bank was followed to the Washington Channel outfall. The condition of the maintenance road south of the Washington Channel forced another detour to next stop at the Lamb Boulevard Bridge. After the next stop at Washington Avenue, another maintenance access road was followed along the west bank to the footbridge at Marion Drive. Stops were then made at the bridges at Bonanza Road, Stewart Avenue, Charleston Boulevard, Nellis Boulevard, and Sahara Avenue. At the next stop at Sloan Lane and the Las Vegas Wash, the channel was followed westward to photograph a footbridge and the Flamingo Wash Confluence. It was noted that a cable-concrete block lining was newly installed under the golf course footbridge and at the confluence. The next two stops were at the Vegas Valley Drive culverts and the City of Las Vegas Wastewater Treated Effluent Outfall at the Desert Inn Road alignment with the Las Vegas Wash. From there, a maintenance road on the east bank was followed until road damage due to eroding banks was encountered. The next two stops were at the Clark County Wastewater

Treatment Plant Service Road dip section and the Monson Channel area west of the Las Vegas Wash.

On March 2, 2000, the Wash was visited again with representatives from the City of North Las Vegas, the Southern Nevada Water Authority, the Clark County Department of Public Works, the City of Las Vegas Department of Public Works, Clark County Regional Flood Control District, PBS&J, and G. C. Wallace, Inc. The tour began at the Monson Channel and proceeded northerly stopping at the same sites previously visited in reverse order. Insight from the various organizations represented rounded out the perspective gained from the reconnaissance experience.

One difference was noted in the condition of the Wash from the previous visit in January. The cable-concrete lining under the footbridge at the Desert Rose Golf Course and the Flamingo Wash Confluence had failed from storm flows in February.

Photographs from the reconnaissance are included in Appendix B where the prints are arranged by geographical location beginning at the Monson Channel and progressing northward towards Interstate 15. Some of the photos have also been included in the Study text as representative of the existing conditions discussed.

Terms and Definitions

The terms and definitions used throughout this document are summarized as follows:

BULKING - Increase in the volume of a quantity of water due to sand or sediment suspended in the water over the volume of the same quantity of clear water.

DEPTH AREA REDUCTION FACTOR (DARF) - A coefficient to reduce point rainfall to account for aerial storm distribution over large areas.

FEMA SPECIAL FLOOD HAZARD AREAS (SFHA) - Areas designated by the Federal Emergency Management Agency (FEMA) as being inundated by one or more feet of water during the 100-year flood (one percent chance of annual occurrence).

GIS - Geographical Information Systems.

HEC-1 - US Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package. Computer program for establishing a rainfall/runoff relationship based on hydrologic soil type, ground cover, conveyance, slope, and area.

HEC-RAS - US Army Corps of Engineers, Hydrologic Engineering Center, River Analysis System. Computer program used for computing water surface profiles in channels.

HYDRAULICS – Relating to the flow of fluids, particularly water.

HYDROLOGY – That science concerned with the properties, occurrences, distribution, and circulation of rainfall and storm water.

MULTI-USE FACILITIES - Facilities that provide for more than one functional use, such as drainage channels that include trails or recreational areas.

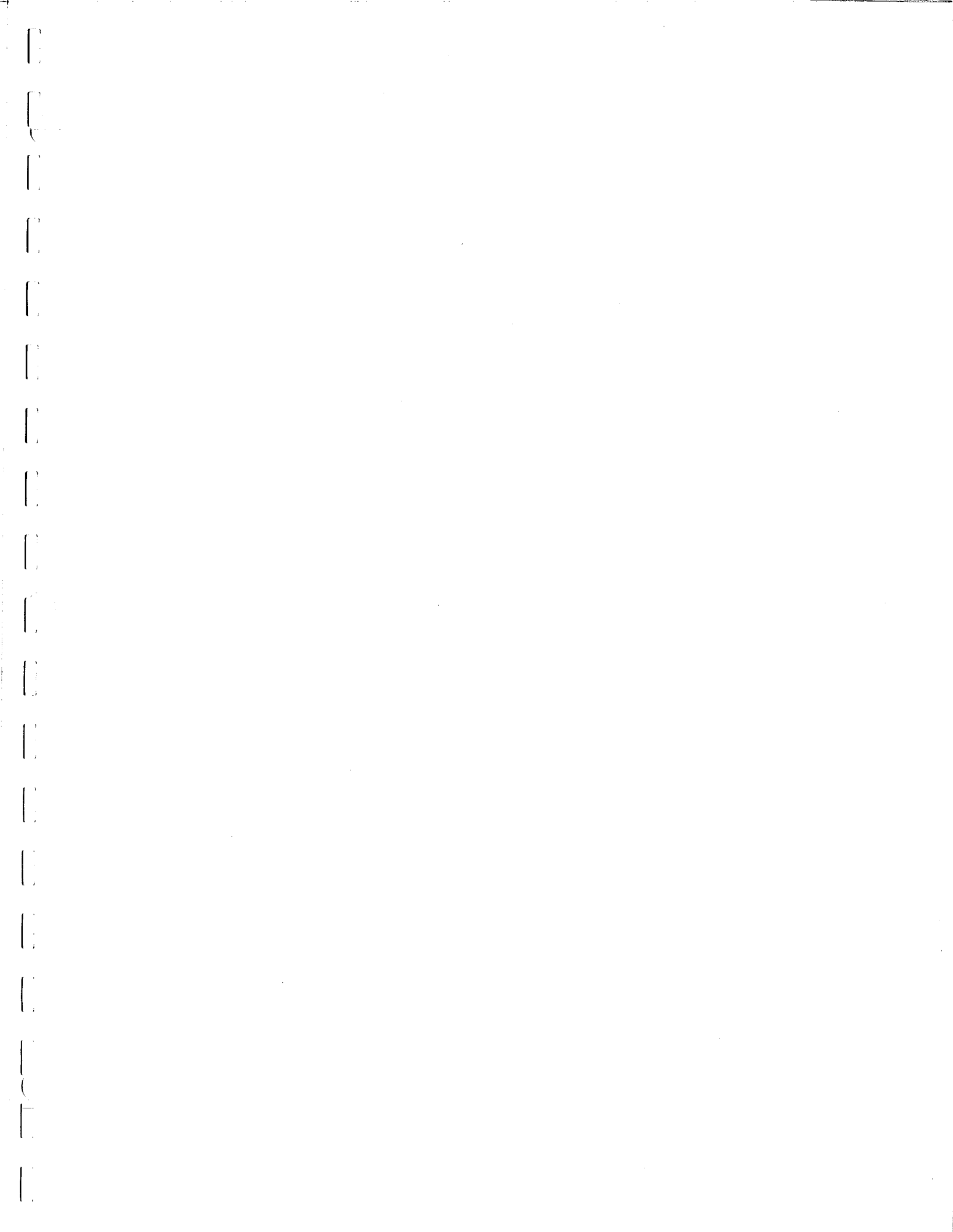
OVERTOPPING - Water flowing over the top of a bridge, embankment, or channel bank.

PEAKING BASIN – An offline detention basin designed to pass low flows through while intercepting the peak flows which exceed the design capacity of downstream facilities.

SUPERCritical FLOWS - Channel flow regime in which the velocity in the channel is greater than the velocity that would be expected at minimum specific energy or critical velocity.

THALWEG - The lowest point, in a drainage way, between the two banks.

WATERSHED - The upstream drainage catchment that contributes storm runoff to a point of concentration.



HYDROLOGY

General

New hydrologic modeling was not included in the project scope of work. However, two existing HEC-1 models of the Las Vegas Wash are referenced in this study. The first is taken from the *Existing Conditions Hydrologic Model for the Las Vegas Wash, Flamingo Wash Confluence to Alexander Road*, Black and Veatch, November 1998 (Reference 3.) The second was prepared for the *Preliminary Design Report for the "A" Channel Lining Project*, Black and Veatch, July 1999 (Reference 1.) These Models have been reviewed and accepted by the CNLV and the CCRFCD.

The *Existing Conditions Hydrologic Model for the Las Vegas Wash, Flamingo Wash Confluence to Alexander Road* (Existing Condition Model) established the current or existing flow in the Wash. This model establishes a 100-year storm flow of 7,140 cfs in the Las Vegas Wash at Lake Mead Boulevard. The *Preliminary Design Report for the "A" Channel Lining Project* (Ultimate Condition Model) defined the flow in the Las Vegas Wash that could be expected with full development in the watershed upstream of Lake Mead Boulevard. The 100-year peak flow was estimated at 12,600 cfs.

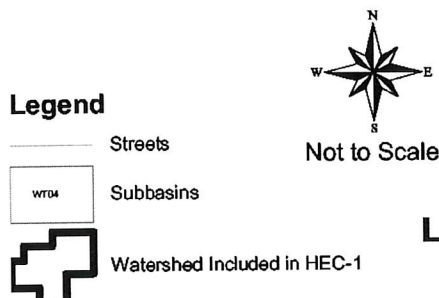
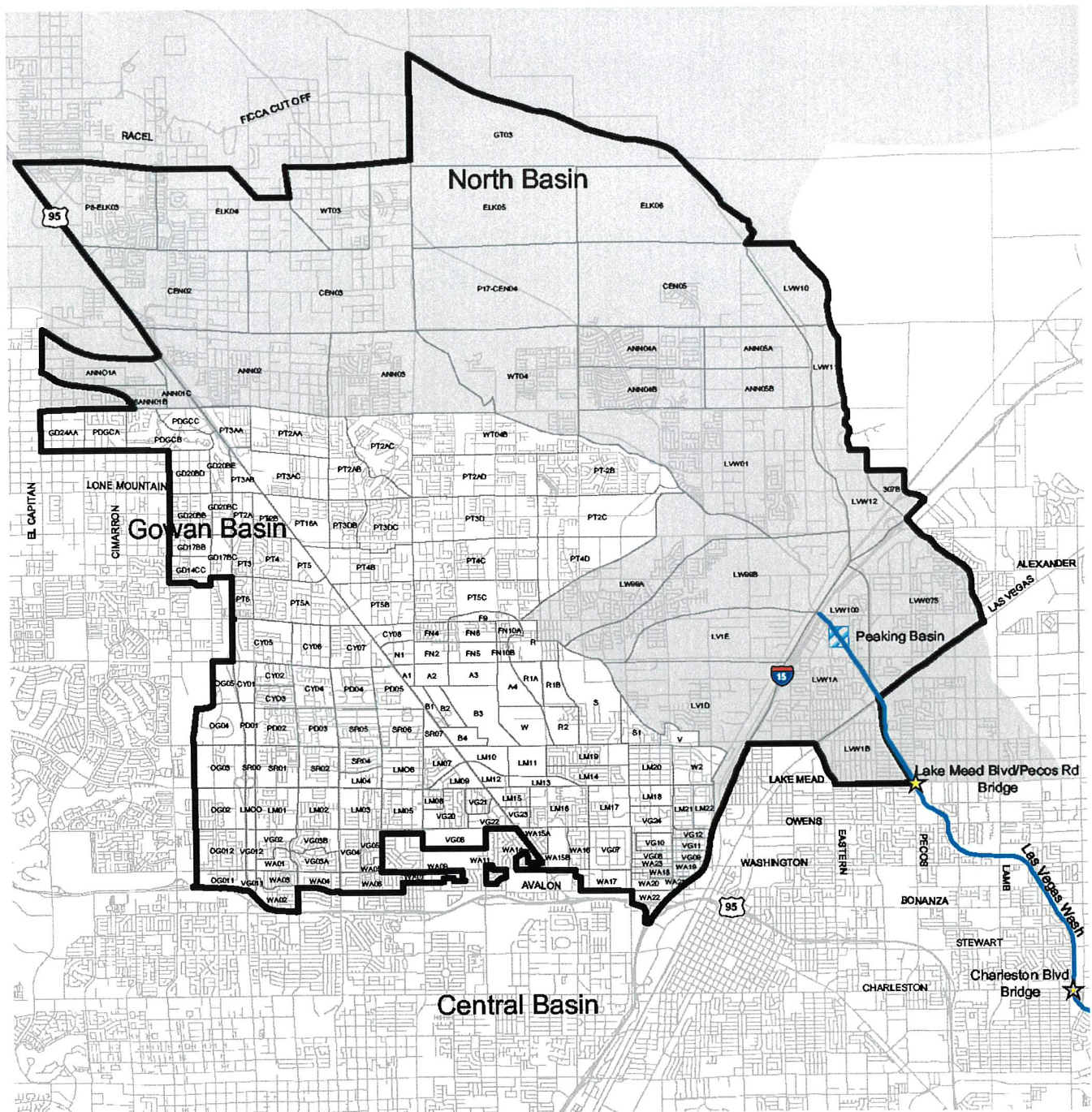
In the process of evaluating the Black and Veatch HEC-1 models, an error was discovered in the data for the Rancho and Lower Las Vegas detention basins. The data for the SV, SQ, and SE cards were limited to 9 fields where 10 fields are required in the fixed field format. Corrections to the models yielded the flows reflected in the table.

Peaking Basin

The Existing and Ultimate HEC-1 models used in this analysis encompasses an area of approximately 77 square miles. The watershed includes portions of the Northern, Gowan, and Central watersheds as defined in the Clark County Regional Flood Control District (CCRFCD) 1996 Master Plan Update (MPU) (Reference 2). The northwest corner of the contributing watershed is in the vicinity of Grande Teton Drive and Rancho Drive. The Upper Las Vegas Wash Detention Basin and the North Las Vegas Detention Basin comprise the northern boundary. The west boundary is east of the Gowan Detention Basins. US Highway 95 forms the southerly boundary. The watershed extends southeasterly to the Lake Mead Boulevard and Pecos Road intersection. The watershed is shown on Figure 2-1.

In the process of preparing the predesign report for the "A" Channel Lining for the Las Vegas Wash (Ultimate Condition Model) it was determined the ultimate 100-year runoff at the Lake Mead Boulevard and Pecos Road culverts was 12,600 cfs. This was more than 6,000 cfs above the design flow of 6,480 cfs listed in the MPU. In January 1999, the MPU was amended to match Ultimate Condition Model. At a 100-year flow of 12,600 cfs, the only existing bridges on the Las Vegas Wash with sufficient capacity were the bridges at Stewart Avenue, Bonanza Road, and Washington Avenue.

Based on an economic feasibility study of alternative methods for conveying the 100-year flow, a decision was made by the CNLV and CCRFCD to limit the flow at the culvert under the intersection of Lake Mead Boulevard and Pecos Road to 8,500 cfs. This reduction in flow is to be accomplished by constructing a peaking basin on the Las Vegas Wash between Civic Center and Cheyenne Avenue. The undersized structures at Carey and Cheyenne are to be replaced with box culverts and additional barrels will be added to the box culvert at Las Vegas Boulevard. The



LAS VEGAS WASH WATERSHED AT LAKE MEAD BLVD
FIGURE 2-1

capacity of the existing culvert at the intersection of Lake Mead Boulevard and Pecos Road is 8,500 cfs; thus, modification of that culvert is not required.

Warrant Analysis

The purpose of the warrant analysis is to use the Existing and Ultimate Condition Models to estimate when the peaking basin will be required to prevent the 100-year storm flows from exceeding the 8,500 cfs capacity of the culverts at Lake Mead Boulevard and Pecos Road. It is the assumption of this Study that the Existing Condition Model sets the conditions existing in 1997 when the *Existing Conditions Hydrologic Model for the Las Vegas Wash, Flamingo Wash Confluence to Alexander Road* report was prepared. The Ultimate Condition Model assumes full development in the upstream watershed and all MPU facilities in place.

The analysis will:

- Compare the two models.
- Devise a method of modifying the hydrologic model parameters in response to the increase in developed land area.
- Establish a relationship between 100-year storm flows and percent of developed area.
- Prepare a timeline to estimate when the peaking basin will be needed based on projected development.
- Develop a method to update the timeline based on actual development at any given time.

Interpolating Between the Two Models

The Existing Condition Model established the existing 100-year flows at the Lake Mead Boulevard and Pecos Road culvert at 7,140 cfs. This flow assumed that the subbasins from the Gowan and Central watersheds (see Figure 2-1) were fully developed. The Existing Condition model also used different subbasin and routing configurations in the Northern Watershed area northwest of Interstate 15 than the Ultimate Condition Model.

According to the report *The Technical Memorandum on Hydrology for the "A" Channel Lining Project* (Reference 4) the subbasin delineation for the Ultimate Condition Model was taken from the MPU. While the overall area was about the same, a review of the subbasins compared to the Geographical Information Systems (GIS) coverage published as part of the CCRFCD 1996 MPU revealed some minor discrepancies in both the area and the name of some of the subbasins. A summary of the Existing Condition Model, the Ultimate Condition Model and the MPU GIS Model and their differences is shown in Table 2-1.

Table 2-1: Subbasin Summary			
Watershed	GIS model (sq. mi.)	Existing (sq. mi.)	Ultimate (sq. mi.)
Northern	39.58	40.24	40.43
Gowan	14.43	14.82	14.43
Central	17.38	17.27	17.27
Downstream	17.38	4.49	4.44
Total	75.83	76.82	76.57

The first step in developing a time line to estimate when the Peaking Basin will be needed was to determine the portions of the Existing and Ultimate Condition models that differ. In the conclusion of the *Existing Conditions Hydrologic Model for the Las Vegas Wash - Flamingo Wash Confluence to Alexander Road*, it was noted that the 100-year storm flow was derived from assuming undeveloped sub-basins in the Northern Watershed, and fully developed conditions in the Gowan and Central Basin Watersheds. Since the Gowan and Central Watersheds are assumed to be fully developed in both the Existing Condition and Ultimate Condition models, a comparison of runoff from just those watersheds for the two models was made.

The Gowan Watershed is combined with the Northern Watershed downstream of the Lower Las Vegas Detention Basin. The Central Watershed is combined with the Northern Basin in the vicinity of Lake Mead Boulevard and Interstate 15. To compare the combined effect of the Gowan and Central watersheds, the flows from each were routed to the common confluence on the Freeway Channel, without adding in any flows from the Northern Watershed. The lengths of the routing were measured from the GIS and the slopes and channel configurations were assigned. The result of the comparison showed that both models peaked at the same time. There was less than 50 cfs difference in the calculated flow rate of approximately 3,670 cfs.

The watershed between Interstate 15 and Lake Mead Boulevard consists of subbasins from the Northern Watershed located southeast of Interstate 15. Due to the difference in the time to peak at Lake Mead Boulevard between the Existing Condition model and the Ultimate Condition model, the hydrographs for the watershed downstream of Interstate 15 for the two models were compared. Table 2-2 shows a summary of the 100-year storm flows for the Existing and Ultimate Condition models and the separate watershed comparisons.

Table 2-2: 100-Year HEC-1 Summary				
Watershed or Concentration Point	Existing Condition		Ultimate Condition	
	Peak Flow (cfs)	Time to Peak (hours)	Peak Flow (cfs)	Time to Peak (hours)
Interstate 15	6,970	5.25	9,410	4.00
Lake Mead Blvd.	7,140	5.67	11,200	4.08
Gowan	3,100	5.17	2,800	5.17
Central	1,390	5.25	1,630	4.25
Combined Gowan and Central	3,670	5.33	3,620	5.33

Based on the preceding evaluations, a HEC-1 model for the warrant analysis was constructed. The Warrant Model has input hydrographs for the Gowan and Central Watersheds. A DARF factor of 0.63 was used to correspond to the concentration point at Interstate 15 and the "A" Channel just north of Civic Center. The Warrant Analysis Hydrograph Comparison is shown on Figure 2-2.

The Ultimate Condition model was used as a basis to prepare a HEC-1 model for the warrant analysis. The northern subbasin configuration and routing was taken directly from the Ultimate Condition model. The curve numbers were changed to match the Existing Condition model. A common multiplier was applied uniformly to the lag times of all the northern subbasins until the peak time of 5.25 hours was achieved to match the peak time of the Existing Model at point

Las Vegas Wash Peaking Basin Warrant Analysis Hydrograph Comparison

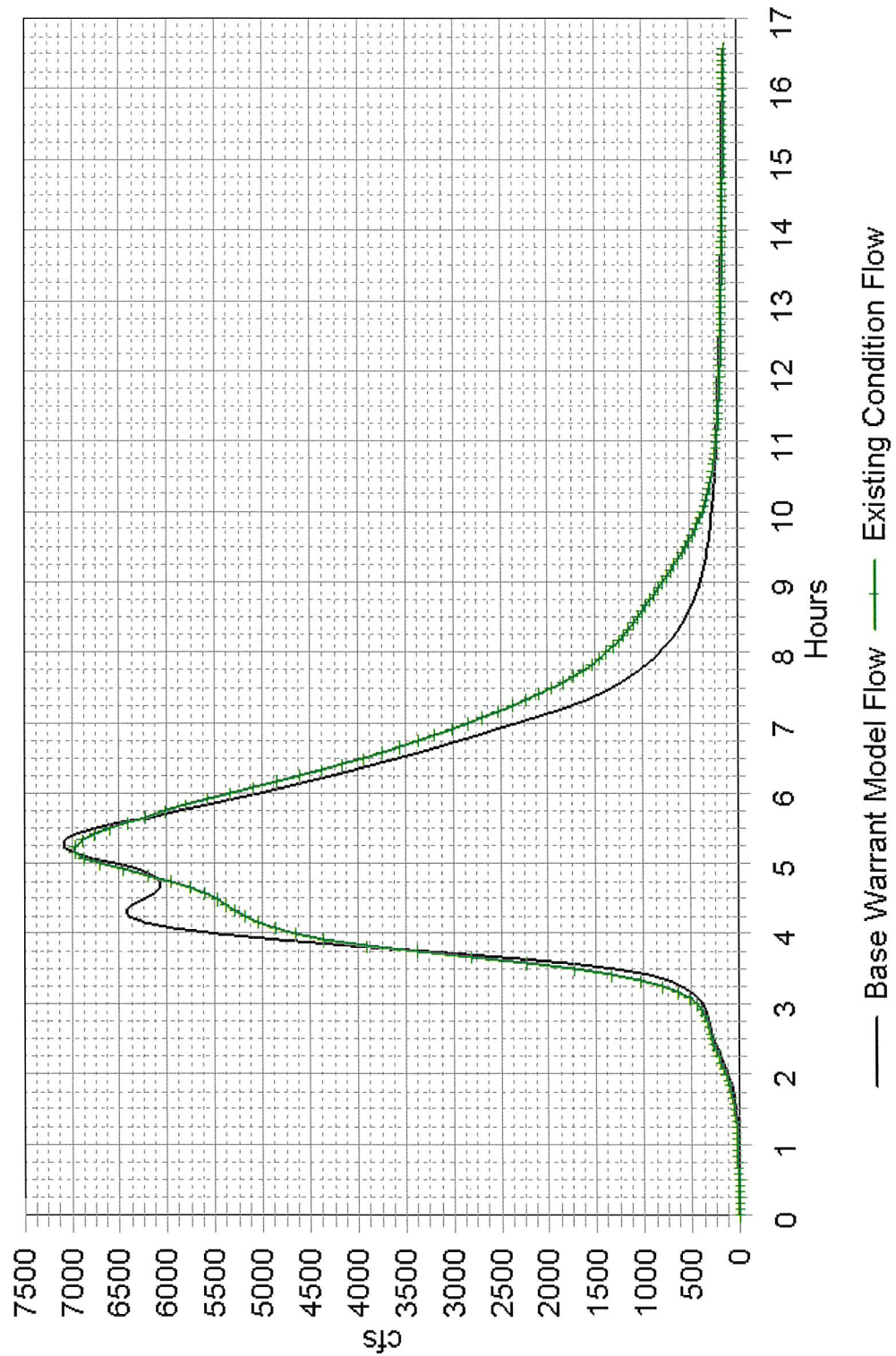


FIGURE 2-2

where the Las Vegas Wash crosses Interstate 15. Using a multiplier of 1.7 for the lag times in the warrant model produced a flow at Interstate 15 of 7,200 cfs. This is approximately 3 percent above the 6,983 cfs calculated in the Existing Condition model. Matching the peak flows closer would shift the peak time from 5.25 hours to 5.67 hours. Due to the minor difference in peak flow, matching the peak time was given a higher priority than matching the flows exactly.

The warrant model's curve numbers and lag times were then adjusted by the percent increase in developed area. To keep the model easy to update, it was decided to apply any increase in development uniformly across all Northern Watershed subbasins. New development increases the curve numbers and decreases the lag times. Figure 2-3 shows the curve relationship between developed area and peak runoff at Lake Mead Boulevard. The flow is shown at the critical concentration points at Interstate 15, the "A" Channel, and the Lake Mead Boulevard-Pecos Road culverts. When the developed area has increased 25 percent, the 100-year storm runoff will warrant the peaking basin. The calculations to this timeline are contained in Appendix C.

To tie land development to a timeline, the area of developed land in a March 1997 aerial photograph was measured. The Clark County Assessor's GIS coverages from 1999 were used to determine the total developed land in 1999. From these methods, the developed land was 5.2 and 6.6 square miles in 1997 and 1999, respectfully. Using geometric summation equations, an annual increase of 12 percent was determined. A spreadsheet (refer to Appendix C) was developed to calculate the year the peaking basin would be needed. The spreadsheet is designed to allow the year the peaking basin will be needed to be updated based on the actual rate of development in any given year or group of years.

In a coordination meeting with the City of North Las Vegas, Clark County Regional Flood Control District, City of Las Vegas, Clark County Public Works, PBS&J and G.C. Wallace, Inc., a projected growth rate of 8 to 12 percent was accepted. In this range, the peaking basin will be warranted between the years 2005 and 2008. The calculations are included in Appendix C.

Population Projections

Table 2-3 shows the population projections provided by the City of North Las Vegas for both 8 and 12 percent annual growth.

Table 2-3: North Las Vegas Population Projections		
Year	Low Growth (8 percent)	High Growth (12 percent)
1998	106,660	106,660
1999	115,192	119,459
2000	124,408	133,794
2001	134,360	149,849
2002	145,109	167,831
2003	156,718	187,971
2004	169,256	210,527
2005	182,796	235,791
2006	197,420	264,086
2007	213,213	295,776

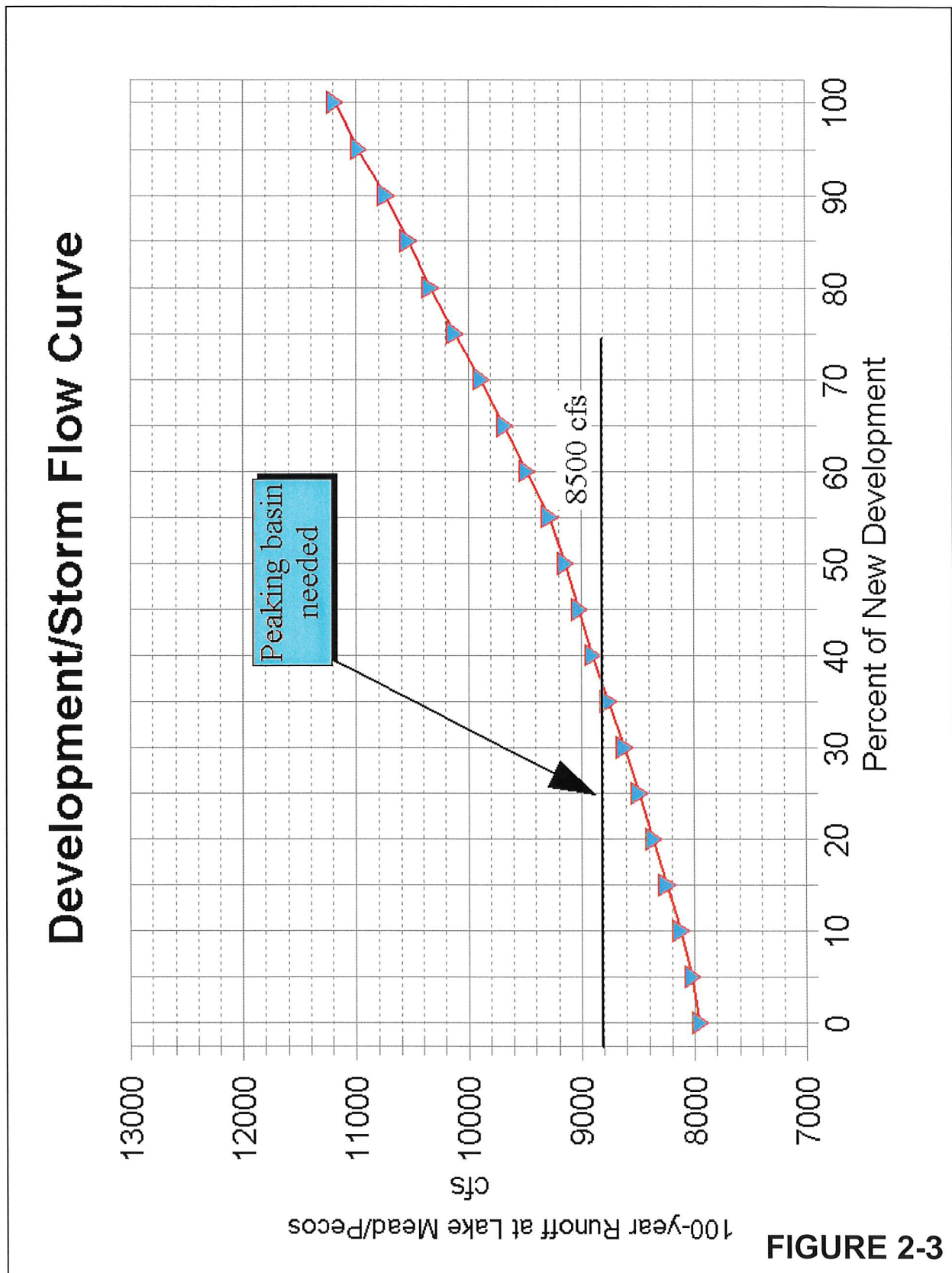


Table 2-3: North Las Vegas Population Projections		
Year	Low Growth (8 percent)	High Growth (12 percent)
2008	230,270	331,269
2009	248,692	371,022
2010	268,588	415,544

Figure 2-4 shows the data graphically.

Thomas Perrigo, Senior Statistical Analyst with the City of Las Vegas provided the following population projections (Table 2-4):

Table 2-4: City of Las Vegas Population Projections	
Year	Population Projection
2000	110,000
2010	200,000
2020	295,000
Buildout	320,000

Although the City of Las Vegas did not provide a growth rate, a plot of the projections on Figure 2-5 shows a near linear relationship.

Peaking Basin Update

Land development rates can vary widely in any given area due to a variety of factors that can be difficult to predict. To better account for fluctuations in development rates, a means of updating the timeline analysis to reflect the actual development in any given year or groups of years was included. The proposed timeline may be updated by the following method:

Calculate the current developed land area in the Northern Watershed area. Utilizing GIS, the northern subbasins are intersected with the merged Assessor's parcel coverages. The resulting coverage is then joined with the Owner's database, which also includes the landuse for the parcels. The coverage is then dissolved on the landuse codes and summarized to calculate the total developed area.

Enter current developed area and year into the spreadsheet to calculate new projections for the peaking basin. The range is read from the columns which calculate 8 and 12 percent growth rates.

Town Center Development

The City of Las Vegas expressed concerns that the Town Center Development located just west of the northern subbasins might accelerate the need for the peaking basin. To access the possible impacts of the Town Center Development on the warrant model, the

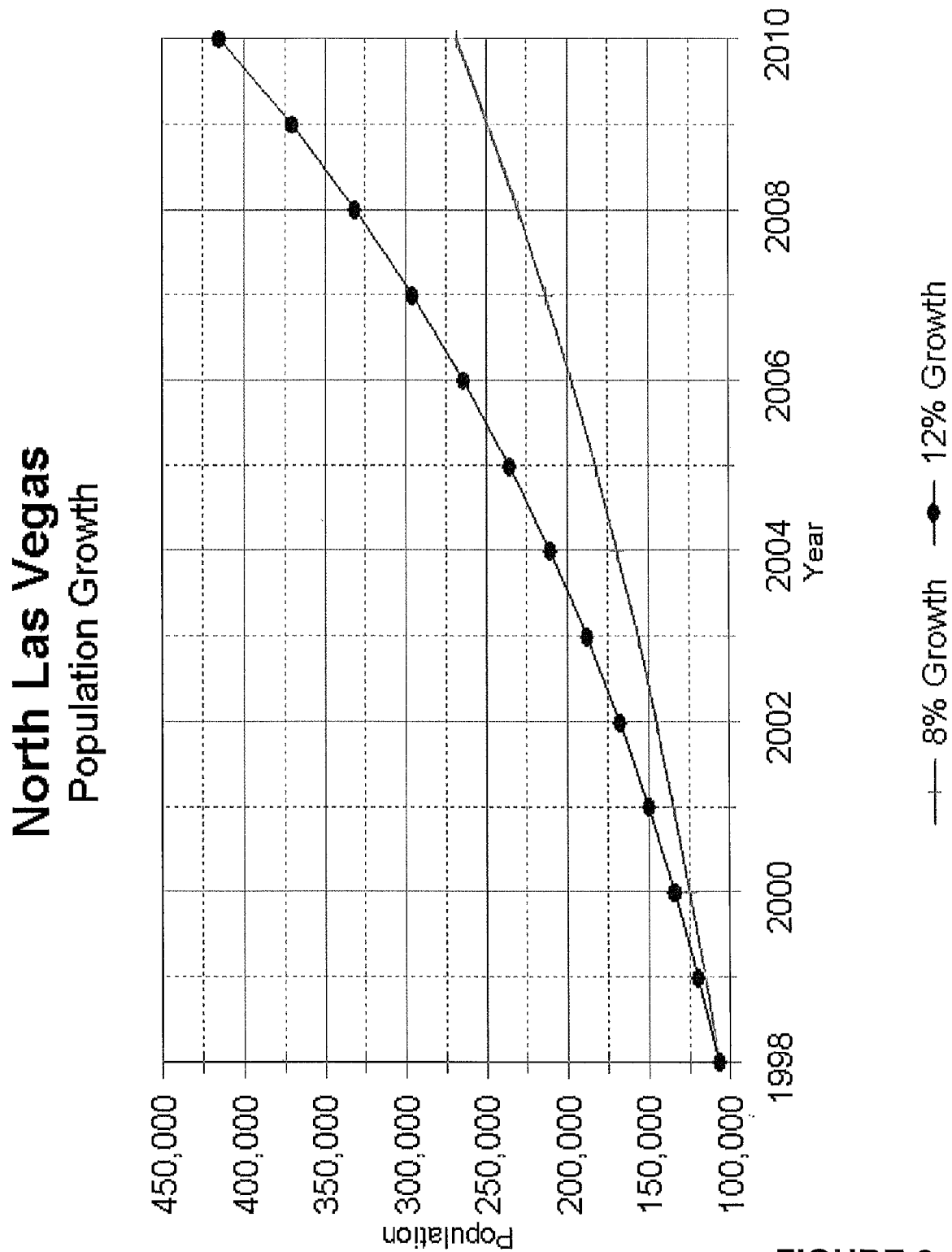


FIGURE 2-4

Las Vegas NW Area Population Growth

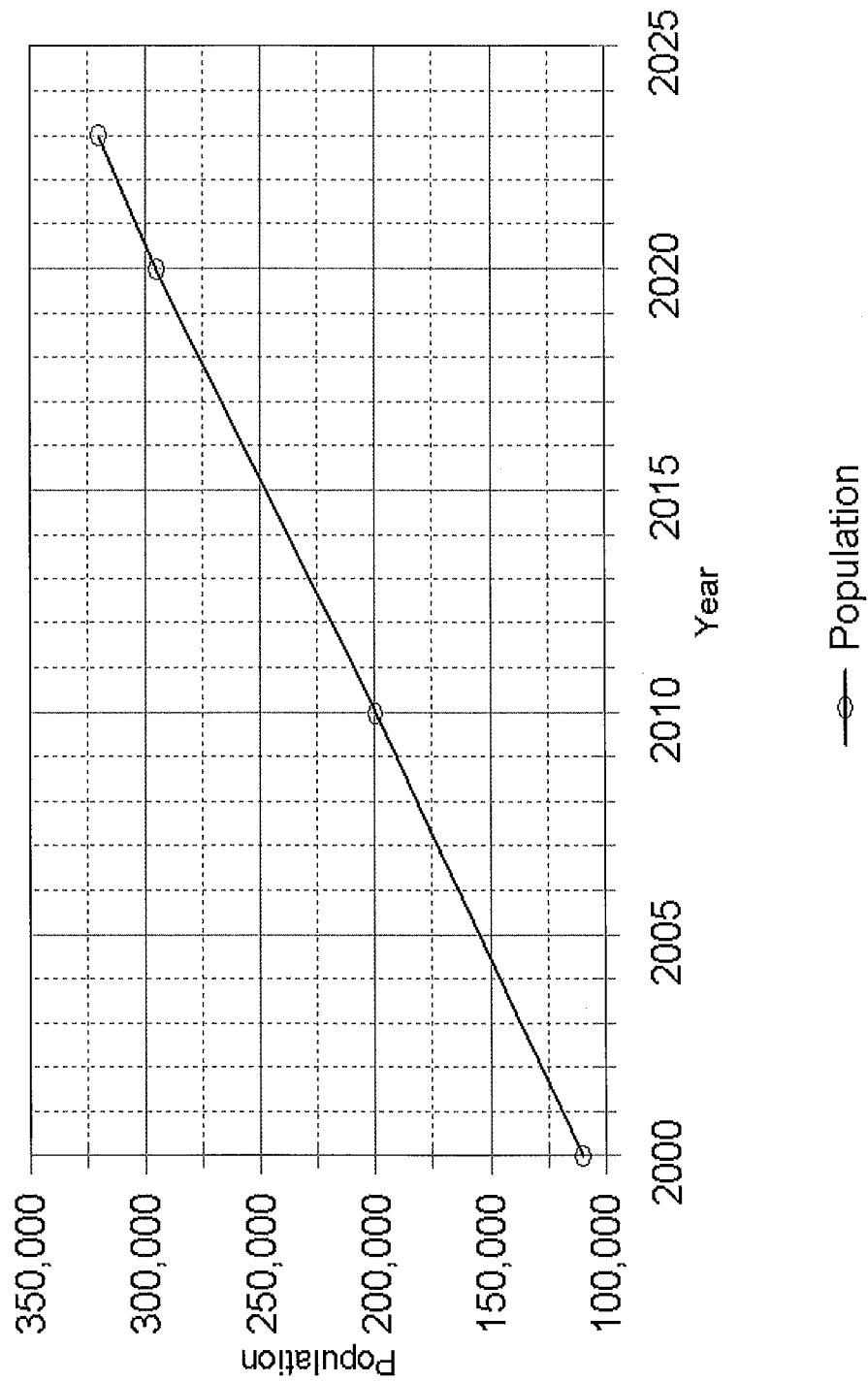


FIGURE 2-5

appropriate subbasins from the HEC-1 model for the Northwest Neighborhood Studies Phases I and II were joined with the base Existing Condition model and the Ultimate Condition model. The Existing Condition model used curve numbers for undeveloped land with desert shrub. The lag times remained the same as the fully developed Town Center model from the Northwest Neighborhood Study.

The Ultimate Condition model used the curve numbers and lag times as now modeled in the Northwest Neighborhood Study. Where Town Center subbasins overlapped the Warrant Analysis subbasins, the Town Center subbasins and routing were used.

Town Center Development increased the watershed area by approximately 4.1 square miles. This was not enough to change the DARF for the concentration point at the Lake Mead Boulevard and Pecos Road culvert. The flow at the Lake Mead Boulevard and Pecos Road culvert increased by 296 cfs from 7,952 cfs to 8,248 cfs for the Existing Condition model. The Ultimate Condition model with the Town Center Development added had an increase in runoff of 174 cfs to 11,359 cfs. Both of these flows are less than 4 percent of the original calculations and do not justify modification of the spreadsheet for the warrant analysis date range.

Peaking Basin Warrant Analysis Conclusions

A base warrant model was created from the Ultimate Condition model to approximate the characteristics of the Existing Condition model by using a multiplier of 1.7 for the Ultimate Condition model lag times and using the curve numbers for the Existing Condition model.

The base warrant model can be modified to reflect land developed conditions at any given time by multiplying the difference between base Existing and Ultimate model curve numbers and lag times by the total percent change in developed area and adding or subtracting the results to the respective curve numbers or lag times of the Base warrant model.

A plot of the Modified HEC-1 models reflecting changes in development area versus peak runoff at Lake Mead Boulevard indicates the peaking basin is warranted when 25 percent of the base warrant model undeveloped land is developed.

A development timeline starts at 5.2 square miles developed in 1997. A spreadsheet using compounded yearly increases indicates a peaking basin requirement range from the year 2005 for 12 percent annual development increase to year 2008 for an 8 percent rate.

Bulking Analysis

The maximum rate of sediment transport is related to the velocity and depth in the channel by the following equation (Equation 704 in the Manual):

$$q_s = C_1 (Y)^{C_2} (V)^{C_3}$$

where q_s is the Sediment Transport Rate in cfs/foot of channel width; Y is the depth in feet; V is the velocity in fps; and C_1 , C_2 , and C_3 are constants. This is the maximum amount of sediment that can be carried by the water in the channel at that depth and velocity. This equation was developed from the Meyer-Peter and Muller bedload transport equation and Einstein's integration of the suspended bed-material discharge. C_1 , C_2 , and C_3 were chosen for very fine sand materials in Table 704 of the

Manual. The depth (Y) and velocity (V) were determined from a normal depth section taken directly upstream of the project.

The calculated Sediment Transport Rate is 3.27 cfs/foot. This equates to a possible peak increase of 275 cfs. According to the Manual, this equation should be accurate within 10 percent. To be conservative, the bulking factor was increased 10 percent to 300 cfs. Therefore, the peak flow used for determining bridge performance for the upstream reaches was increased 3.5 percent, from 8,500 cfs to 8,800 cfs. The same factor (3.5 percent) was applied to the peak flows for subsequent reaches: the peak flow from Flamingo Wash Confluences to the Sloan Channel Confluence was increased from 10,000 cfs to 10,400 cfs and the peak flow for the lower portion of the Wash downstream from Sloan Channel was increased from 10,500 cfs to 10,900 cfs. The increased peak flows were used only in the analysis of bridge performance. The normal depth and freeboard calculations for the analysis of section alternatives were completed using the unbulked peak flow values. Bulking calculations are included in the Appendix G.



HYDRAULICS

Objective

The hydraulics work relative to the Facilities Study was completed to determine existing channel capacities and problem areas. Preliminary hydraulic calculations were performed to identify the minimum cross section geometry for each alternative for each reach. Proposed channel improvements were analyzed to ensure that the improvements meet capacity requirements within the design parameters.

Existing Improvements

The existing channel improvements were modeled using BOSS RMS (HEC-2) to pinpoint problem areas within the Las Vegas Wash from Monson Channel to Lake Mead Boulevard. With the BOSS RMS program, the existing cross sections are automatically generated within AutoCAD for the HEC-2 simulation. The 100-year ultimate design flows were used in the existing analysis.

Alternative Analysis

Seven different lining and geometry alternatives were analyzed for each reach. These different alternatives consisted of the following:

1. Grass-lined trapezoidal section.
2. Earthen (unlined) trapezoidal section.
3. Gabion-lined trapezoidal section.
4. Concrete-lined trapezoidal section.
5. Trapezoidal section lined with concrete cable block.
6. Concrete-lined rectangular section.
7. Unlined channel bottom with riprap side slopes and periodic cut-off-walls.

The individual cross section geometries were determined using normal depth calculations. The minimum channel widths were determined by maintaining permissible velocities and by avoiding the transitional flow regime (Froude Number between 0.86 and 1.13). Freeboard and superelevation for each section were included in the estimates for minimum channel depth. The normal depth calculations were performed with the 100-year peak flow rates determined for the Ultimate Condition.

Proposed Improvements

The proposed channel improvements from Monson Channel to Lake Mead Boulevard were modeled using HEC-RAS. The freeboard and superelevation for each section were determined from the HEC-RAS results by use of the 1999 CCRFCD *Hydrologic Criteria and Drainage Design Manual* equations automated in a spreadsheet format. The bridges and channel capacities were analyzed without and with the bulking factor computed to account for sediment load in the stormwater.

The proposed channels have capacity to convey the ultimate design flows with freeboard. The existing bridges also have capacity to convey the ultimate design flows. However, the existing culverts at Lake Mead Boulevard and the existing bridges at Charleston Boulevard, Nellis Boulevard, and Vegas Valley Drive do not have two feet of freeboard as recommended by the Manual.

Both the proposed channel sections and the existing bridges have capacity to convey the bulked peak flows. The exception to this is the existing bridge at Nellis Boulevard which is overtopped when sediment is included in the hydraulic model. Again, the existing culverts under Lake Mead Boulevard and the existing bridges at Charleston Boulevard and Vegas Valley Drive do not have the recommended two feet of freeboard.

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LAS VEGAS WASH EXISTING CONDITIONS

FEMA Designated Special Flood Hazard Areas

The Special Flood Hazard Areas (SFHA) for Clark County, Nevada and incorporated areas are outlined in the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM), dated August 16, 1995. This study is located on multiple FIRM Community Panels. The panels covering the project limits are listed below beginning with the most southerly:

FIRM Community Panel Number
32003C 2585 D
32003C 2200 D
32003C 2190 D
32003C 2187 D
32003C 2180 D
32003C 2178 D
32003C 2176 D

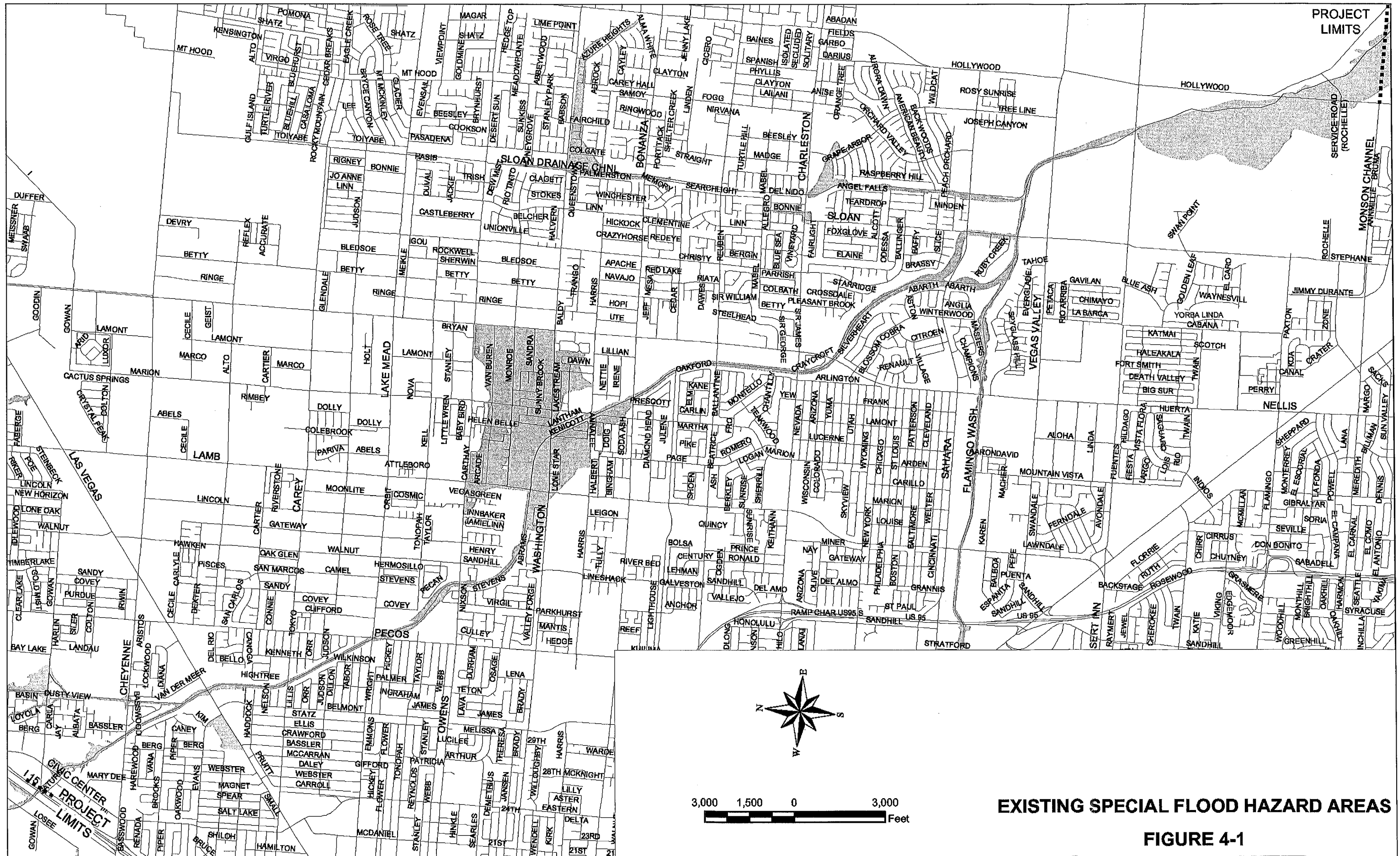
Figure 4-1 is a compilation of the FEMA Flood Insurance Rate Maps (FIRM) for Clark County, Nevada and incorporated areas.

Under existing conditions, designated FEMA Special Flood Hazard Areas extend outside of the main channel of the Las Vegas Wash in several locations along the reach from Lake Mead Boulevard to the Monson Channel. The following is a brief description of the four major areas which extend beyond the Las Vegas Wash:

- From the City of Las Vegas sanitary sewer outfall south to Rochelle Avenue, approximately 200 acres of land west of the main channel are designated as a Special Flood Hazard Area.
- From just north of Sahara Avenue south to Sloan Lane, a Special Flood Hazard Area extends east along the north side of Sahara Avenue to the Sahara Avenue/Sloan Lane intersection then south from that intersection along the Sloan alignment.
- From Bridgewater Street south to Bonanza Drive, well over 0.5 square miles of Special Flood Hazard Area are designated along Van Buren, Monroe, and Washington. Parcels as far away as the intersection of Owens and Nellis are affected.
- From Lake Mead Boulevard south to Bridgewater Street (the Village at Washington subdivision), Special Flood Hazard Areas extend up to 200 feet beyond the main channel banks on both sides of the wash.

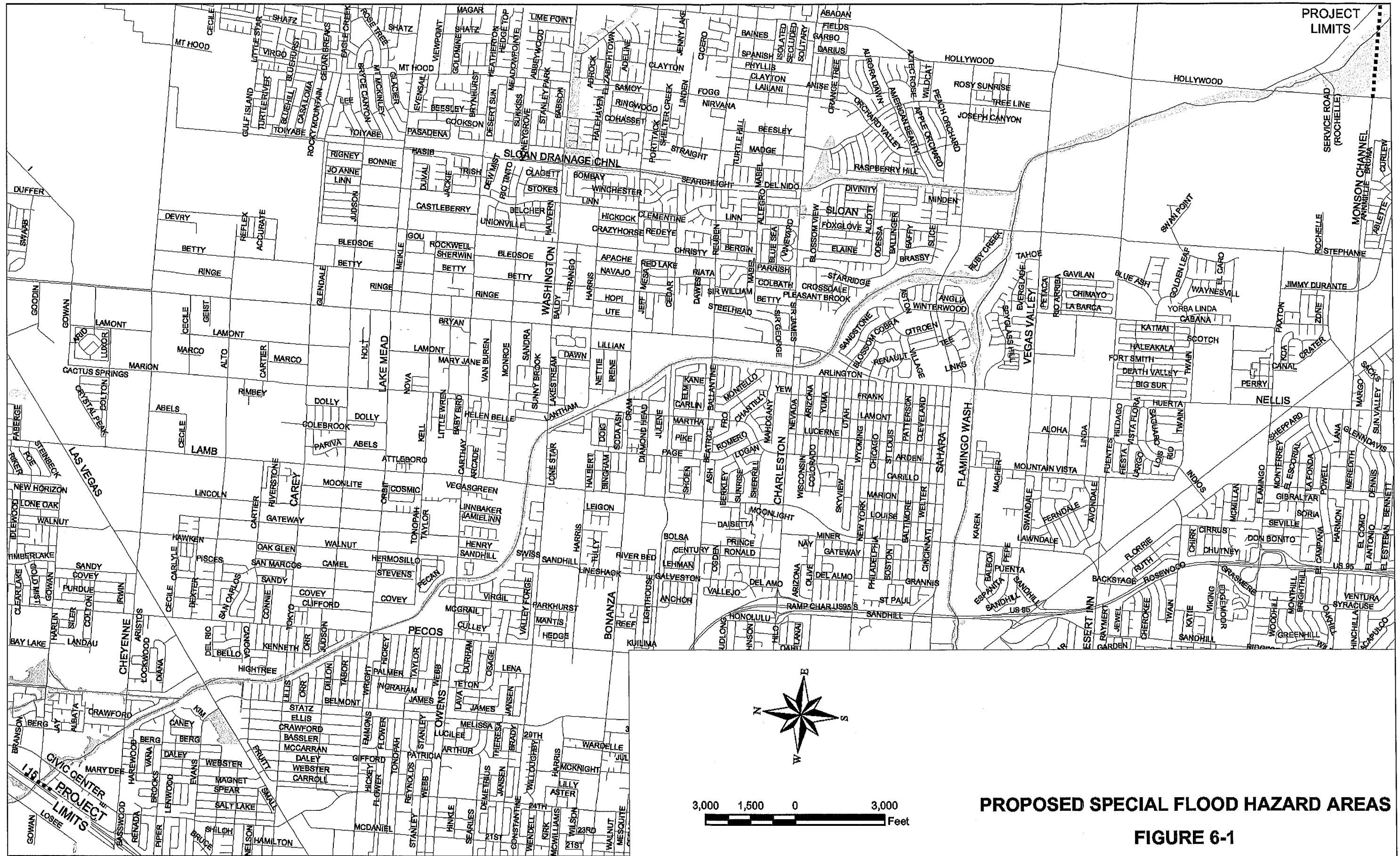
CCRFCFCD Facilities

Figures F-20, F-16, F-15, and F-11 from the 1996 MPU show the Clark County Regional Flood Control District (CCRFCFCD) facilities along the study length of the wash. Copies of these figures are included in Volume 2. The Las Vegas Wash is designated as LVWD extending from Mile Id of 0002 through 1648. The 1996 MPU lists the 100-year flows as 5,800 cfs at Civic Center Drive, 6,480 cfs at Lake Mead Boulevard and Pecos Road, 6,630 cfs at the Washington Avenue Channel confluence,



EXISTING SPECIAL FLOOD HAZARD AREAS

FIGURE 4-1



PROPOSED SPECIAL FLOOD HAZARD AREAS
FIGURE 6-1

6,990 cfs at the Cedar Avenue Channel confluence, 7,400 cfs at the Colorado Avenue Channel confluence, 10,000 cfs at the Flamingo Wash confluence, and 10,500 cfs at the Sloan Channel confluence. These flow rates were amended in 1999 by Black and Veatch in the *Master Plan Amendment for the Las Vegas Wash, Flamingo Wash Confluence to Alexander Road ('A' Channel Lining Project)*. The amended design flows are 10,991 cfs from Interstate 15 to the peaking basin north of Cheyenne Avenue, 6,345 cfs downstream of the peaking basin to Las Vegas Boulevard, 8,077 cfs from Las Vegas Boulevard to Lake Mead Boulevard, 8,500 cfs from Lake Mead Boulevard to the Flamingo Wash confluence, 10,000 cfs from the Flamingo Wash confluence to the Sloan Channel confluence, and 10,500 cfs downstream of the Sloan Channel confluence to the Monson Channel confluence. The facilities proposed in this study supercede those recommended in the MPU.

Existing Las Vegas Wash Right-of-Way

Right-of-way for the Las Vegas Wash has been secured in the past for nearly the entire length of the wash from the Service Road at Rochelle north to Lake Mead Boulevard. The following Table 4-1 contains a list of dedicated right-of-way parcels and parcels containing drainage easements for the Las Vegas Wash. Also included are road rights-of-way secured at bridges along the Wash. Pertinent Clark County Recorder Book and Document numbers and ownership information (if known) are indicated. See the right-of-way exhibits in Volume 2 for specific parcel locations.

TABLE 4-1: RIGHTS-OF-WAY/DRAINAGE EASEMENTS				
Parcel	Book	Document	Owner	Notes
16115801001	707	666707	CC	300-foot Drainage easement across private property (mostly excess) Service Road to Vegas Valley Segment
16115799001	890929	00801	CC	Right-of-way – Service Road to Vegas Valley Segment
16115702001	890317	00516	CC	Drainage easement – Service Road to Vegas Valley Segment
16115696001	891003	00324	CC	Drainage – Service Road to Vegas Valley Segment
16115596001	870522	01032	CC	Drainage – Service Road to Vegas Valley Segment
16110896002	686	645536	CC	Drainage – Service Road to Vegas Valley Segment
16110896001	870306	00680	CC	Drainage – Service Road to Vegas Valley Segment
16110799002	686	645535	CC	Vegas Valley Bridge
16110799001		387414		Vegas Valley Bridge
16110796002	870306	00680	CC	Drainage – Service Road to Vegas Valley Segment
16110796001	686	645536	CC	Drainage – Service Road to Vegas Valley Segment
16110699004	431	347606	CC	For flood control/access road at Vegas Valley Bridge
16110699001	431	347603	CC	Vegas Valley Bridge
16110399004	656	527289	CC	Vegas Valley Bridge
16110399002	66	384736	CC	Vegas Valley Bridge
16110396001	686	645536	CC	Drainage – Service Road to Vegas Valley Segment
16110299005	66	384736	CC	Vegas Valley Bridge
16110296001	692	651927	CC	Drainage – Vegas Valley to Flamingo Wash Segment
16109696001	631	590960	CC	Drainage – Vegas Valley to Flamingo Wash Segment
16109501001	917	736046	CC	Desert Rose Golf Course
16104701002	917	736046	CC	Desert Rose Golf Course
16104201001	917	736046	CC	Desert Rose Golf Course
16104199007	92	72974	CC	Drainage – Nellis to Charleston Segment

TABLE 4-1: RIGHTS-OF-WAY/DRAINAGE EASEMENTS

Parcel	Book	Document	Owner	Notes
16104199001	920708	00537	NDOT	Charleston/Nellis Bridges
14032899010	94	78195	CC	Charleston Bridge
14032896002	920319	00603	CLV	Drainage –Stewart to Charleston Segment
14032799001	443	402618	CLV	Stewart Bridge
14032796001	920319	00603	CLV	Drainage – Stewart to Charleston Segment
14032699011	443	402625	CLV	Stewart Bridge
14032696003	362	321955	CLV	Drainage – Bonanza to Stewart Segment
14032696002	980610	01043	CLV Sewer	Drainage/Sewer – Bonanza to Stewart Segment
14032599003	146	119969	CLV	Bonanza Bridge
14032596001	600	559926	CLV	Drainage – Bonanza to Stewart Segment
14030699005	902	861195	CLV	Lamb Blvd Bridge
14030699004	146	119965	CLV	Lamb Blvd Bridge
14030696004	382	341210	CLV	Drainage - Lamb to Owens Segment
14030696003	980515	01143	CLV Sewer	Drainage - Lamb to Owens Segment
14030696002	980515	01145	CLV Sewer	Drainage - Lamb to Owens Segment
14030696001	980515	01142	CLV Sewer	Drainage - Lamb to Owens Segment - Legal does not match Assessor's parcel information
14030296003	890403	00449	CLV	Drainage - Lamb to Owens Segment
14030296002	839	798496	CLV	Drainage - Lamb to Owens Segment
14030296001	890403	00449	CLV	Drainage - Lamb to Owens Segment
14030199005	9	10372	CC	Owens Bridge
14030199004				Owens Bridge
14030196001	749	708408	CLV	Drainage - Lamb to Owens Segment
14029899030	20	19378	CLV	Bonanza Bridge
14029899029	59	50172	CC	Bonanza Bridge/Drainage North of Bridge
14029899015	431	390442	CLV	Bonanza Bridge
14029899008	1446	1405829	CLV	Portion of street parcel not vacated.
14029899001	537	432173	CLV	Harris Ave ROW
14029896002	980610	01044	CLV	Drainage - Bonanza to Washington Segment
14029896001	485	444435	CLV	Drainage - Bonanza to Washington Segment
14029801002	450	409871	CLV	Drainage Easement (See next record) – Bonanza to Washington Segment
14029801002	990223	00792	CLV	Deed – CC Assessor's record still shows private owner
14029799008	537	432173	CLV	Harris Ave ROW
14029499009	537	432177	CLV	Marion ROW
14029499008	537	432177	CLV	Marion ROW
14029496001	473	432399	CLV	Drainage - Bonanza to Washington Segment
14029399012	537	432177	CLV	Marion ROW
14029399001	146	119968	CLV	Washington Ave/Lamb Blvd Bridges
14029396001	473	432399	CLV	Drainage - Bonanza to Washington Segment
14029299005	543	436822	CLV	Lamb Blvd Bridge
14029299004	146	119968	CLV	Washington Ave/Lamb Blvd Bridges

TABLE 4-1: RIGHTS-OF-WAY/DRAINAGE EASEMENTS

Parcel	Book	Document	Owner	Notes
14029296001	472	431024	CLV	Drainage - Washington to Lamb Segment
14019499014	310	250443	CC	Owens Bridge
14019499013	470	379182	CC	Owens Bridge
14019499009		684114		Owens Bridge
14019496001	469	428553	CC	Drainage - Owens to Pecos Segment
14019396001	419	378549	CC	Drainage - Owens to Pecos Segment
14019310000	920228	01029	CC	Drainage Easement by Pecos/Lake Mead Bridge Final Map, Pecos Creek Condominiums

Encumbrances

A number of encroachments/limitations exist along the Las Vegas Wash from the Service Road at Rochelle to Lake Mead Boulevard. The following Table 4-2 is a summary of easements with limitations that could have impacts on future construction.

TABLE 4-2: EASEMENTS WITH LIMITATIONS

Book	Document	Owner	Parcel
81	67575	Nevada Power	16115801002, 16115801001, 16110296001
964	774319	SNWA	16115696001
870522	01032	CC	16115596001
88	73384	CLV (No Explicit Restrictions)	16110896001
950323	01218	CCSD	16110296001
326	285852	CCSD	16110296001
66	383526	Nevada Power	16109696001, 16104201001
519	417901	Nevada Power	16104701002
881222	00862	LVVWD	16104701002
573	532858	CCSD	16104201001
232	188435	Nevada Power	14032796001
507	466445	Nevada Power	14032696003, 14032601005
980610	01043	CLV Sewer	14032696002
980515	01143	CLV Sewer	14030696003
980515	01145	CLV Sewer	14030696002
980515	01142	CLV Sewer	14030696001
833	792050	LVVWD	14029899029, 14029810006
980515	01146	CLV Sewer	14029896002, 14029801002
476	383971	Nevada Power	14029801002
1101	1060787	CLV Sewer	14029296001, 14029201001
413	333228	CCSD	14019496001
64	370154	Nevada Power	14019496001
64	370978	Nevada Power	14019496001

A brief summary of typical restrictions placed on each easement type follows. Notable exceptions are also included.

City of Las Vegas Sewer

The City of Las Vegas has the right to operate, add to, maintain, and remove sewer lines and appurtenances together with a right of access and a right to cut or trim bushes and trees if necessary. The parcel owner has the right to fence, plant, maintain, and use the property as long as such use complies with safety standards and does not interfere with the rights granted to the City of Las Vegas.

Clark County Sanitation District

The Clark County Sanitation District has the right to operate, add to, maintain, and remove sewer lines and appurtenances together with a right of access and a right to cut or trim bushes and trees if necessary. The parcel owner has the right to fence, plant, maintain, and use the property as long as such use complies with safety standards and does not interfere with the rights granted to the Clark County Sanitation District.

Las Vegas Valley Water District

No buildings, structures, fences, or trees may be placed on or under the easement except for other utilities and streets, roads, or driveways. If the LVVWD facilities must be relocated or repaired due to changes of grade or other construction, the property owner must bear the full cost.

Nevada Power Company

The Nevada Power Company has the right to operate, add to, maintain, and remove power lines and appurtenances together with a right of access and a right to cut or trim bushes and trees if necessary. The parcel owner has the right to fence, plant, maintain, and use the property as long as such use complies with safety standards and does not interfere with the rights granted to Nevada Power. In addition, more recently granted easements state that no structure may be constructed or placed in the easement without prior permission from Nevada Power.

Southern Nevada Water Authority

No buildings, structures, fences, or trees may be placed on or under the easement except for other utilities and streets, roads, driveways, or various other similar exceptions. If the SNWA facilities must be relocated or repaired due to changes of grade or other construction, the property owner must bear the full cost. The Whitney Lateral easement has the added restrictions that no trees or vines may be planted and that, unless prior authorization from the United States Government is granted, no structures may be placed on the easement.

Other

As part of the Order of Condemnation for Parcel 161-15-596-001, Clark County is required to preserve access of the Thoroughbred Ranch Limited Partnership and successors to City of Las Vegas Wastewater Treatment effluent. As part of this agreement, the County must maintain an effluent pipeline to the Ranch.

The above restrictions should not place any limitations on proposed improvements to the Wash as long as any conflicting utilities are properly relocated and prior review/approval is received from the pertinent entities. Particular care should be taken within SNWA easements that contain major waterlines (66-inch Whitney Lateral).

Reach by Reach Descriptions

The following summary contains the existing channel conditions by segments as defined by common hydraulic conditions. The stationing used on the plan and profiles by Black and Veatch in the *Preliminary Design Report for the "A" Channel Lining Project, Lake Mead Boulevard to Alexander Road*, July 1999 was incorporated into G. C. Wallace, Inc.'s preliminary plan and profile drawings. Orthographic photographs showing the existing conditions between Owens Avenue and the Monson Channel are included in Volume 2. Additional photographs taken during the field reconnaissance phase of the project are included in Appendix B.

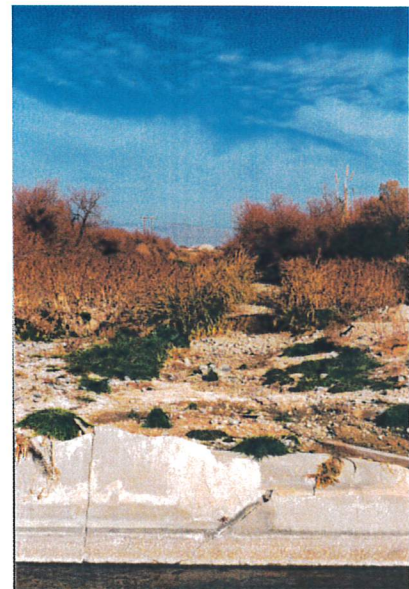
Monson Channel to Service Road

Responsible Governing Entity: Clark County.

Plan and Profile Segment Location: Extends from Station 303+55.35 to Station 338+30.

Channel Characteristics

This area is a densely vegetated, natural meandering channel with several thalweg threads serving as an entrance to the Wetlands Park. The channel gradient increases from 0.003 feet per foot at the Wastewater Treatment Plant Service Road to over one percent towards the southern end.



Above: Looking north across Collection Channel from Service Road.

Left: End of Collection Channel at Service Road looking north.

MPU Design Flows and Channel Capacity

The MPU (1999 Amended) 100-year design flow for this segment is 10,500 cfs. During flood events, the area is inundated hundreds of feet beyond the natural banks. The floodwaters are not currently a problem due to the lack of development in the area.

Utilities

A 36-inch sanitary sewer is buried in the east bank approximately 120 feet from the control line. At Station 337+94, a 66-inch sanitary sewer crosses the Wash.

Maintenance Access Roads and Ramps

Maintenance issues through this segment include the need to access and maintain the Wash while striving for a natural meandering channel that approaches the Wetlands Park. While the dense vegetation and multiple thalwegs restrict access to the channel at all locations, an existing maintenance road meanders through the shrubbery from the Service Road on the west side of the westerly thread for access to the confluence with the Clark County effluent outfall. Access is also possible at some locations from the east side of the channel. The greatest need for maintenance is sediment removal on the Service Road after storm events.

Width of Available Right-of-Way/Drainage Easements

The Wash flows through parcels owned by the Clark County Sanitation District varying from a quarter mile to a half mile in width, sufficient for the 100-year flood zone.

Major Inflow Points

Monson Channel enters the Wash at the most southerly limits of the study area. The 1996 MPU lists this channel as a proposed concrete-lined trapezoidal section 30 feet wide with 2H:1V side slopes designed to handle a 100-year flow of 2,950 cfs. Currently, the Monson Channel is a trapezoidal earthen channel 14 feet wide. The Clark County Treatment Plant, located to the east of the channel, discharges treated effluent into the Wash through a trapezoidal earthen channel approximately 25 feet wide, just north of the Monson Channel confluence at Station 321+00.

Bridges and Crossings

A service road dip section crosses the Wash at approximately the Rochelle Avenue extended alignment to access the wastewater treatment site owned by the Clark County Sanitation District. The centerline of the road is at Station 338+30 on the plan and profiles. The roadway shoulders are lined with grouted riprap to protect against erosion during major storm events. Nuisance water is routed under the road through nuisance flow culverts, dual 5-foot by 2-foot RCB culverts.

Problem Areas

Erosion/Sedimentation: Head cutting is occurring at Station 312+60. The location of the head cut is rapidly progressing northward. The greatest need for maintenance is sediment removal on the service road after storm events.

Significant Impediments to Flow: The dense vegetation presents the greatest impediment to flow along this segment of the Las Vegas Wash.

Overtopping: The flood zone extends out to nearly 1,300 feet during the 100-year storm event.

Breakouts: The 100-year flow, although very wide, does not leave the parcels owned by the Clark County Sanitation District.

Service Road to Vegas Valley Drive

Responsible Governing Entity: Clark County.

Plan and Profile Segment Location: Extends from Station 338+30 to Station 434+65.

Channel Characteristics

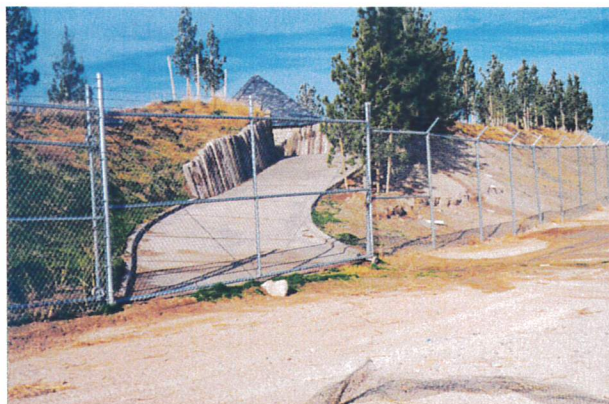
The Wash at the Service Road is a densely vegetated, multi-threaded natural channel with a floodplain approximately 1,300 feet wide. The natural channel gradient is approximately 0.003 feet per foot from the Service Road to Station 385+00. At this point northward, the channel slope flattens to 0.0014 feet per foot. As the Wash approaches the City of Las Vegas Wastewater Treated Effluent Outfall at Station 406+00, the Wash becomes a better-defined unlined trapezoidal section with a bottom width of approximately 145 feet. North of the effluent outfall, the dense tree vegetation disappears from the overbank area. Tall grasses then become prominent in the wash bed. At Station 430+10, the channel is a concrete-lined trapezoidal section, 120 feet wide with 3H:1V side slopes. A transition begins at Station 432+50 for the culverts at Vegas Valley Drive.



Las Vegas Wash at Vegas Valley Drive looking southeast at north culvert face.



Las Vegas Wash at Vegas Valley Drive on top of bridge looking north. Note sedimentation along west bank.



Las Vegas Wash at Vegas Valley Drive on the west bank looking at the golf course maintenance path.



Las Vegas Wash at Vegas Valley Drive looking east at monitoring station.

MPU Design Flows and Channel Capacity

The MPU 100-year design flow for this segment is 10,500 cfs. The flat slope forces the flow into the subcritical flow regime. The existing section does not have the capacity for the 100-year design flow.

Utilities

Several utility lines cross this segment of the Wash. In ascending order by station, these utility crossing are as follows:

- Station 339+40 – a 36-inch sanitary sewer crosses the Wash.
- Station 343+90 – an overhead power line approaches the Wash at a skew from the southeast, crossing the Wash at this station.
- Station 348+88 – an 8-inch sanitary sewer crosses the Wash.
- Station 353+77 – a gas pipeline crosses the Wash at a skew from the southwest.
- Station 362+10 – Southern Nevada Water Authority's Whitney Lateral 66-inch pipeline crosses the Wash.
- Station 404+80 – an overhead power line crosses the Wash.
- Station 405+93 – SNWA has a 78-inch water pipeline on the east bank with a 36-inch blow-off pipe outletting into the Wash.
- Station 433+00 – a 20-inch sanitary sewer approaches the Wash at a skew from the southwest, crossing at this station.
- Station 434+65 – 12-inch waterlines are attached to the north and south edges of the bridge deck at Vegas Valley Drive.

Maintenance Access Roads and Ramps

An existing access ramp to the channel bottom is located just south of Vegas Valley Drive on the west side of the channel. An access road along the west side of the Wash exists from Station 337+60 to Station 354+25 and from Station 388+80 to Station 434+15 (at Vegas Valley Drive). The east side of the Wash is accessible from Station 368+00 to Station 434+15 from Vegas Valley Drive. However, the existing access road on the east side is unsafe due to bank erosion occurring from Station 369+40 to Station 404+35, downstream of the CLV Effluent Outfall.

Width of Available Right-of-Way/Drainage Easements

The Las Vegas Wash passes through Clark County Sanitation District property that varies in width from 1,066 feet to a half mile from Station 338+30 to Station 355+86. From Station 355+86 to Station 362+25, the right-of-way varies in width from 422 feet to 538 feet. The Wash again crosses Clark County Sanitation District property from Station 362+25 to Station 404+83. This property varies in width from a quarter mile to a half mile. The right-of-way from Station 404+83 to Station 419+85 increases from 250 feet wide to 300 feet wide. The right-of-way remains at a 300-foot width to Vegas Valley Drive at Station 433+50.

Major Inflow Points

The City of Las Vegas Wastewater Treatment Plant discharges treated effluent into the Wash at Station 406+00. The effluent outfall is a 5-foot deep, 30-foot wide concrete

trapezoidal channel with 1.5H:1V side slopes. The main effect of the discharge is the dynamic increase in nuisance water.

Bridges and Crossings

Vegas Valley Drive is built on top of a 10-barrel, 13-foot wide by 10-foot high RCB culvert. The centerline of the culvert occurs at Station 434+65. Deep sedimentation occurs on the upstream west side of the channel. Bridge deck damage is evident on the northeast side of the pedestrian sidewalk. A storm water monitoring station is located on the north side of the culverts. This structure was overtopped during the July 8, 1999, storm event due in part to the blocked culverts.

Problem Areas

Erosion/Sedimentation: Erosion of the channel banks is evident from Station 366+50 to Station 405+30. Sedimentation is a problem upstream of the box culvert crossing under Vegas Valley Drive.

Significant Impediments to Flow: The main impediment to flow in this segment is the dense vegetation. The pipeline vault located on the east side of the channel forces channel improvement alignment westward.

Overtopping: Vegas Valley Drive was overtopped during the July 8, 1999 storm event.

Breakouts: The channel overtops the banks from the Service Road to Station 402+41, which is downstream of the CLV Effluent Outfall. South of the City of Las Vegas Effluent Outfall, the design flows exceed the channel banks. Presently, the floodplain is undeveloped in this segment. However, new residential development is planned for the area south of the CLV effluent outfall on the west side of the Wash.

Vegas Valley Drive to Sloan Channel

Responsible Governing Entity: Clark County.

Plan and Profile Segment Location: Extends from Station 434+65 to Station 448+00.

Channel Characteristics

The channel section transitions from a concrete rectangular section upstream of the ten 13-foot wide by 10-foot high RCB culverts at Vegas Valley Drive to a concrete trapezoidal section with 3H:1V side slopes and a 120-foot bottom width at Station 437+28. The existing channel slope is 0.004 feet per foot. Because the slope flattens just downstream of the existing culverts under Vegas Valley Drive, a hydraulic jump occurs upstream of the Vegas Valley Drive culverts.

MPU Design Flows and Channel Capacity

The MPU 100-year design flow for this segment is 10,500 cfs. The existing section has sufficient capacity to convey the 100-year design flow.

Utilities

A 12-inch sanitary sewer crosses the Wash immediately upstream of the Vegas Valley Drive culverts. Southern Nevada Water Authority has a 78-inch water pipeline located

approximately 34 feet from of the top edge of the concrete-lined channel on the northeast side.

Maintenance Access Roads and Ramps

Access roads in good condition exist on both side of the channel. However, no ramps to provide access to the bottom exist in this segment.

Width of Available Right-of-Way/Drainage Easements

The right-of-way width is 300 feet wide throughout this segment.

Major Inflow Points

The Sloan Channel confluence occurs at the upstream end of this segment. The existing section for the Sloan Channel is a concrete-lined 60-foot wide trapezoidal channel with 2-foot horizontal to 1-foot vertical side slopes. The depth of the channel is 6 feet. The MPU lists the 100-year design flow for Sloan Channel as 3,540 cfs.

Bridges and Crossings

There are no bridges or crossings through this segment.

Problem Areas

Erosion/Sedimentation: The deep sedimentation blocking the upstream west side of the Vegas Valley Drive culverts is evidence of the energy transition (from supercritical flow regime to subcritical flow). As the existing channel is concrete lined, erosion is not a problem in this reach.

Significant Impediments to Flow: The flat slope downstream of Vegas Valley Drive causes the hydraulic jump upstream of Vegas Valley Drive. This condition results in deep sedimentation that restricts flow through the culvert under Vegas Valley Drive.

Overtopping: No bridges are located in this reach.

Breakouts: No breakouts occurred through this reach.

Sloan Channel to Flamingo Wash

Responsible Governing Entity: Clark County.

Plan and Profile Segment Location: Extends from Station 448+00 to Station 474+00.

Channel Characteristics

The channel segment begins as a 120-foot wide concrete-lined trapezoidal section with 3H:1V side slopes. The concreted-lined section extends upstream to Station 453+50. The channel slope is 0.004 feet per foot. Upstream of the concrete lining, between Stations 454+20 and 464+50, the channel is a trapezoidal earthen section that narrows to a bottom width of 50 feet. To protect the sewer siphon crossing the channel at Sloan Lane, a metal weir was installed at approximately Station 464+50. The north bank of the channel from Sloan Lane westward is concrete lined between Stations 464+50 and 468+15. A bank dip section is provided in this area to accept surface inflow from Sloan Lane on the north. Between Stations 468+96 and 469+89, the channel is a 42-foot wide

cable-concrete block-lined trapezoidal channel with 4H:1V side slopes. The cable-concrete block lining was intended to protect the banks beneath a single span golf cart bridge that crosses the channel at Station 469+60. The Desert Rose Golf Course begins at Station 469+48. The Wash through the golf course is incorporated as a grass-lined multi-use facility with a varying channel section. The cable-concrete block lining is again used from Station 474+75 to the confluence with the Flamingo Wash. The cable-concrete block lining in this area has failed.



Las Vegas Wash and Flamingo Wash confluence after installation of cable-concrete block lining.



Las Vegas Wash and Flamingo Wash confluence after lining failure shortly after installation.

MPU Design Flows and Channel Capacity

The MPU 100-year design flow for this segment is 10,000 cfs. The existing channel does not have capacity to contain the 100-year flow.

Utilities

Sanitary sewer siphons, 25-inch and double 33-inch, cross the Wash at Station 464+41 and Station 464+90, respectively. A 60-inch sanitary sewer parallels the channel in the south bank, approximately 170 feet from the control line beginning at Station 464+20. Overhead power lines cross the Wash at Stations 465+24, 465+64, and 471+69.

Maintenance Access Roads and Ramps

Maintenance roads in good condition currently exist on both the north and south sides of the Wash. Access to the bottom of the Wash exists at Station 453+50 on both sides, just upstream from the Sloan Channel confluence.

Width of Available Right-of-Way/Drainage Easements

The right-of-way for this segment between the Sloan Channel confluence and the Desert Rose Golf Course is 300 feet wide. Right-of-way within Desert Rose Golf Course varies from 700 feet to 1,100 feet.

Major Inflow Points

The Flamingo Wash is a grass-lined trapezoidal channel 45 feet wide with 4H:1V side slopes. The MPU lists the 100-year design flow for this channel as 7,315 cfs.

Bridges and Crossings

A single-lane, single-span steel bridge for golf carts and pedestrian traffic crosses the Wash at Station 469+64, just downstream of the Flamingo Wash confluence. The channel under the footbridge is a cable-concrete block-lined trapezoidal section, 40 feet wide with 4-foot horizontal to 1-foot vertical side slopes. This bridge was not included in the HEC-2 model of existing conditions.

Problem Areas

Erosion/Sedimentation: Erosion is evident between Stations 455+00 and 464+60, the latter of which is near the metal weir protecting the sanitary sewer siphons.

Significant Impediments to Flow: A major impediment to flow is the narrow channel section under the golf course footbridge at Station 469+60, just downstream of the confluence with the Flamingo Wash. Another impediment is the existing metal weir intended to slow the flow to protect the sewer siphon at Sloan Lane.

Overtopping: The single-span steel bridge for golf carts and pedestrian traffic (Station 469+64) was not included in the HEC-2 model.

Breakouts: The HEC-2 model indicates that the banks are exceeded between Sections 5300 (Station 474+03.85) and 5250 (Station 472+45.48). However, these flows return to the channel within the golf course.

Flamingo Wash to Nellis Boulevard

Responsible Governing Entity: Clark County.

Plan and Profile Segment Location: Extends from Station 474+00 to Station 547+73.

Channel Characteristics

An underground pipeline to convey low flows extends from Station 475+00 to Station 485+30 and discharges at the Flamingo Wash Confluence. The slope of the channel in this reach is about 0.16 percent grade except near the Flamingo Wash Confluence where the slope is increased to about 1.5 percent grade to match the Flamingo Wash invert. The channel is concrete-lined under the Sahara Avenue bridge (Station 497+60) with a triangular nuisance flow section 10 feet wide.

The bridge does not appear to be designed to allow the channel to be lowered. The well-groomed grass-lined channel ends at a footbridge at Station 539+44. Tall grass bushes line the bottom from this station upstream to Nellis Boulevard.



Las Vegas Wash at Nellis Boulevard looking south at channel access and east bridge face.

MPU Design Flows and Channel Capacity

The MPU 100-year design flow for this segment is 8,500 cfs. Although the HEC-2 model of this section indicates a 100-year water surface above the natural ground at the adjoining residential areas, the flood walls at the golf course property boundaries provide the necessary flood protection. The channel is adequate to convey the 100-year design flow.

Utilities

A gas pipeline is attached to the north edge of the Sahara Avenue Bridge deck. Overhead power lines cross the Wash at Stations 498+00, 521+78, and 525+65 through 526+25. A 25-inch sanitary sewer siphon crosses the Wash at Station 546+88.

Maintenance Access Roads and Ramps

Maintenance is available along the series of existing asphalt golf cart paths. An existing access ramp to the channel bottom is located just east of Nellis Boulevard on the south side of the channel.

Width of Available Right-of-Way/Drainage Easements

Right-of-way in this segment varies from 210 feet to 930 feet within the Desert Rose Golf Course.

Major Inflow Points

The MPU lists the Christy Lane Channel as a major inflow source to the Wash. This proposed facility is listed as a 10-foot by 5-foot RCB culvert conveying a 100-year design flow of 700 cfs. The proposed facility will be located at approximately Station 517+00.

Bridges and Crossings

Single-lane single-span steel bridges for golf carts and pedestrian traffic cross the Wash at Stations 486+15 and 539+43, downstream and upstream of the Sahara Avenue Bridge. The footbridges cross irregular grass-lined sections with a well-defined nuisance channel. These bridges were not included in the HEC-2 model.

Sahara Avenue crosses the Las Vegas Wash over a 132-foot long concrete bridge placed on top of two rows of circular columns. The side abutments are vertical. The centerline of the bridge is located at Station 497+60 on the plan and profiles. An attached golf cart crossing is located on the south side of the bridge separated from the vehicular traffic by a low wall with a high arching inward fence. A pedestrian underpass is located on the east side of the channel approximately 4 feet above the channel bottom. The Las Vegas Wash channel under the bridge is concrete-lined with a triangular nuisance section 10 feet wide and 0.6 feet deep in the center. The channel depth is approximately 12 feet deep. The 100-year design flow of 8,500 cfs is able to pass under the bridge.

Nellis Boulevard crosses the Las Vegas Wash at Station 547+73 over a skewed 135-foot long concrete bridge. The bridge deck is supported on four rows of circular concrete columns. The side abutments are concrete-lined and sloped at 1.5H:1V. The channel under the bridge has an earthen lining. The channel depth under the bridge is approximately 12 feet deep. The pedestrian paths on each side of the bridge are separated from the vehicular traffic by concrete barrier rails. A gas pipeline is attached

to the east edge of the bridge deck. The 100-year design flow of 8,500 cfs is able to pass under the bridge only under pressure flow conditions.

Problem Areas

Erosion/Sedimentation: Sedimentation occurs at the Nellis Boulevard Bridge.

Significant Impediments to Flow: There are no significant impediments to flow through this segment.

Overtopping: The single-span steel footbridges at Stations 486+15 and 539+43 were not included in the HEC-2 model. The bridges at Sahara Avenue and Nellis Boulevard were not overtopped in the model.

Breakouts: The HEC-2 model indicates a breakout occurring downstream of Sahara Avenue in the Desert Rose Golf Course between Sections 5800 (Station 490+46.35) and 5700 (487+11.58) over the right bank. Another breakout occurs near the confluence with the Flamingo Wash between Sections 5300 (Station 474+03.85) and 5250 (Station 472+45.48), but the model shows the flows returning to the channel. The floodwalls bordering the golf course were not included in the HEC-2 model. These floodwalls confine the 100-year storm to the golf course property.

Nellis Boulevard to Charleston Boulevard

Responsible Governing Entity: Clark County.

Plan and Profile Segment Location: Extends from Station 547+73 to Station 560+86.

Channel Characteristics

The existing 70-foot wide trapezoidal earthen channel has gabion lining on the outside curve from Station 548+25 to Station 554+88. The current channel slope is 0.003 feet per foot. The bottom is vegetated with tall grass and bushes. A chain-link fence marks the east right-of-way line. Block walls and a covered parking structure form the west right-of-way line.



Las Vegas Wash north of Charleston Boulevard bridge looking west at storm drain outfall.



Las Vegas Wash north of Charleston Boulevard bridge looking west at sanitary sewer manhole.

MPU Design Flows and Channel Capacity

The MPU design 100-year flow for this segment is 8,500 cfs. The existing channel has capacity to convey the design flow.

Utilities

A 24-inch water pipeline crosses the Wash under the Nellis Boulevard Bridge. A 12-inch waterline crosses the Wash just downstream of the Charleston Boulevard Bridge. An overhead power line crosses the Wash on the south edge of the Charleston Boulevard Bridge. A 51-inch sanitary sewer is suspended from the bottom of the Charleston Boulevard Bridge.

Maintenance Access Roads and Ramps

No room exists currently for maintenance roads. Channel access is severely restricted.

Width of Available Right-of-Way/Drainage Easements

The right-of-way for this segment is 150 feet wide.

Major Inflow Points

Colorado Avenue Channel outfalls at Station 551+70. This 18-foot by 8-foot RCB culvert sloping at 0.002 feet per foot is designed to convey 1,200 cfs.

Bridges and Crossings

Charleston Boulevard crosses the Las Vegas Wash over a 144-foot long concrete bridge located at Station 560+86. The bridge deck is supported on four rows of circular concrete columns. The side abutments are concrete lined and sloped at 1.5H:1V. The channel under the bridge has an earthen lining. A 6-foot deep concrete and steel structure supports a 51-inch sanitary sewer suspended from the bottom of the bridge deck. This structure severely blocks channel flow under the bridge. The remaining open channel depth is approximately 4 feet. A specially constructed concrete area on the northwest side of the bridge acts as an apron to a storm drain outfall and protection for a sanitary sewer manhole.

Problem Areas

Erosion/Sedimentation: Sedimentation under the Charleston Boulevard Bridge ranges from 2.5 feet to 5 feet.

Significant Impediments to Flow: The 6-foot protective wall for the 51-inch sanitary sewer restricts the flow area under the Charleston Boulevard Bridge.

Overtopping: The Charleston Boulevard Bridge was overtopped during the July 8, 1999, storm event. In the HEC-2 model, the Charleston Boulevard Bridge was overtopped by 670 cfs.

Breakouts: No breakouts occurred in this segment.

Charleston Boulevard to Stewart Avenue

Responsible Governing Entity: City of Las Vegas.

Plan and Profile Segment Location: Extends from Station 560+86 to Station 588+10.

Channel Characteristics

The section is a 100-foot wide trapezoidal channel with 2H:1V soil-cemented side slopes, 12 feet deep. Block walls line the channel right-of-way on both sides. Current channel slope is approximately 0.003 feet per foot.

MPU Design Flows and Channel Capacity

The MPU 100-year design flow for this segment is 8,500 cfs. The channel through this reach has capacity to convey the 100-year flow.

Utilities

The 66-inch Sandhill Relief Sewer runs the length of this segment starting in the west bank then angling into the channel bottom by Station 580+20. Cable-concrete block is installed over this sanitary sewer and the channel bottom along the west side. A sanitary sewer siphon consisting of one 12-inch and two 15-inch pipes crosses the Wash just upstream of the Charleston Boulevard Bridge.

Maintenance Access Roads and Ramps

An existing concrete access ramp is located just south of Stewart Avenue on the east side of the channel. However, no maintenance roads are currently provided in this segment.

Width of Available Right-of-Way/Drainage Easements

The right-of-way is 150 feet wide with a 10-foot wide storm drain access easement separated from the Wash by an existing wall.

Major Inflow Points

There are no major inflows into the channel through this segment.

Bridges and Crossings

Stewart Avenue crosses the Las Vegas Wash over a skewed 144-foot long concrete bridge located at Station 588+10. The bridge deck is supported on four rows of circular concrete columns. The side abutments are concrete-lined and sloped at 1.5H:1V. The channel under the bridge is approximately 16 feet deep with an earthen lining and a well-defined nuisance channel. An access ramp is located just south of the bridge on the east side of the channel. Storm drain pipes under the bridge from both abutments outlet into the Wash under the bridge: a 48-inch RCP pipe on the west side and an 18-inch RCP pipe on the east side.

Problem Areas

Erosion/Sedimentation: Removal of sediment and vegetation through this reach is necessary periodically.

Significant Impediments to Flow: This segment has no significant impediments to flow.

Overtopping: The bridge under Stewart Avenue does not overtop in the HEC-2 model.

Breakouts: No breakouts occur through this segment.

Stewart Avenue to Bonanza Road

Responsible Governing Entity: City of Las Vegas.

Plan and Profile Segment Location: Extends from Station 588+10 to Station 618+87.

Channel Characteristics

The channel is an earthen trapezoidal section, 75 feet wide with a slope of approximately 0.0035 feet per foot. The outside curve on the east side of the channel is concrete-lined from Stewart Avenue to Station 596+85.



Las Vegas Wash on top of Bonanza Bridge looking south.
Note cable-concrete block lining over sanitary sewer.



Las Vegas Wash at Bonanza Road looking south across
private landscaping.

MPU Design Flows and Channel Capacity

The MPU 100-year design flow for this segment is 8,500 cfs. This segment has sufficient capacity for the 100-year design flow of 8,500 cfs.

Utilities

The Sandhill Relief Sewer is installed in the channel bottom on the west side. Cable-concrete block is located over this sewer line.

Maintenance Access Roads and Ramps

A maintenance road exists on the east side of the channel from Stewart Avenue to the Cedar Avenue Channel confluence (Station 602+15). North of the confluence, the maintenance road narrows and disappears. An earthen access ramp angling upstream has been constructed over the existing concrete lining at Station 596+00.

Width of Available Right-of-Way/Drainage Easements

The right-of-way for this segment is 150 feet wide.

Major Inflow Points

Cedar Avenue Channel outfalls into Las Vegas Wash at Station 602+15. This concrete-lined trapezoidal channel is listed in the MPU as having a 14-foot bottom width and a depth of 8 feet, designed for a 100-year storm flow of 1,539 cfs.

Bridges and Crossings

Bonanza Road crosses the Las Vegas Wash over a skewed 163-foot long concrete bridge located at Station 618+87. The bridge deck is supported on four rows of vertical

pier walls with rounded nose faces upstream and downstream. The side abutments are concrete-lined and sloped at 1.5H:1V. The channel under the bridge is approximately 14 feet deep with an earthen lining. A cable-concrete block lining has been placed over the sanitary sewer pipeline alignment. Gas and water pipelines are attached to the south edge of the bridge deck. From the east and west abutments under the bridge, 24-inch storm drain pipes outlet into the Wash.

Problem Areas

Erosion/Sedimentation: Periodic removal of sediment and vegetation within the channel is necessary.

Significant Impediments to Flow: There are no significant impediments to flow in this segment.

Overtopping: The bridge at Bonanza Road does not overtop in the HEC-2 model.

Breakouts: No breakouts occur in this segment.

Bonanza Road to Washington Avenue

Responsible Governing Entity: City of Las Vegas.

Plan and Profile Segment Location: Extends from Station 618+87 to Station 649+10.

Channel Characteristics

Generally, the cross section is an earthen trapezoidal channel with a bottom width that varies from 75 feet near Bonanza Road to 60 feet wide near Washington Avenue. At Station 645+08, the channel is a concrete-lined trapezoidal section with a 90-foot bottom width and 1.5H:1V side slopes, 12 feet deep. The channel gradient is approximately 0.003 feet per foot. Periodic maintenance clears the sedimentation and vegetation from the wash bottom.



Las Vegas Wash north of Washington Avenue looking northwest. Note installation of gabions on south bank, cable-concrete block over sanitary sewer, drop structure and concrete lining on north bank.



Las Vegas Wash looking southeast at the north bridge face of Washington Avenue.



Las Vegas Wash at Washington Avenue looking north.

MPU Design Flows and Channel Capacity

The MPU 100-year design flow for this segment is 8,500 cfs. The channel has capacity to convey the 100-year design flow.

Utilities

The 54-inch Sandhill Relief Sanitary Sewer continues in the bottom of the channel near the west bank. Cable-concrete block is installed over the sewer line.

Maintenance Access Roads and Ramps

Maintenance access is available on the east side of the channel for the entire segment. A maintenance road on the west side of the Wash extends northward from Marion Avenue (Station 633+42) to Washington Avenue. An earthen access ramp is located upstream of Bonanza Road.

Width of Available Right-of-Way/Drainage Easements

The right-of-way for this segment is 150 feet wide.

Major Inflow Points

There are no major inflow points for this segment.

Bridges and Crossings

An existing pedestrian footbridge crosses the Wash at Marion Avenue (Station 633+42) to allow access to the Dell H. Robison Middle School on the east side of the Wash. This bridge was not included in the HEC-2 model.

Washington Avenue crosses the Las Vegas Wash over a skewed 162-foot concrete bridge located at Station 649+10. The bridge deck is supported on three rows of vertical pier walls with rounded nose faces upstream and downstream. The side abutments and the channel under the bridge are concrete lined. The channel under the bridge is approximately 11 feet deep. A 36-inch storm drain pipe outlets into the channel under the bridge from the west abutment.

Problem Areas

Erosion/Sedimentation: The steep channel slope (0.03 feet per foot) under the Washington Avenue Bridge combined with the flat 0.002 feet per foot slope downstream causes a hydraulic jump upstream of the bridge. This change in energy creates continued sedimentation and maintenance concerns in this area.

Significant Impediments to Flow: Periodic removal of sediment and vegetation is necessary for this reach.

Overtopping: Overtopping was not a problem for this segment in the HEC-2 model.

Breakouts: No breakouts occurred through this segment.

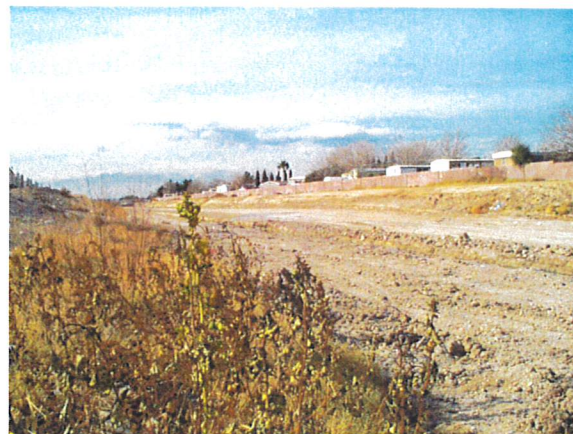
Washington Avenue to Lamb Boulevard

Responsible Governing Entity: City of Las Vegas.

Plan and Profile Segment Location: Extends from Station 649+10 to Station 669+09.

Channel Characteristics

A trapezoidal concrete-lined channel, 90 feet wide, with 1.5H:1V side slopes extends from Washington Avenue to Station 651+07. The cross section upstream of Station 651+07 is a 75-foot bottom width partially-lined trapezoidal section with 2H:1V side slopes. Newly installed gabions line the west and south banks to protect a commercial development. A concrete lining protects the east and north banks. An existing concrete drop structure is located at approximately Station 657+00. The existing channel gradient is 0.006 feet per foot, excluding the drop structure.



Las Vegas Wash at Lamb Boulevard looking west.



Las Vegas Wash at Lamb Boulevard looking north at west bridge face.



Las Vegas Wash looking east at west bridge face of Lamb Boulevard.

MPU Design Flows and Channel Capacity

The MPU 100-year design flow for this segment is 8,500 cfs. The existing Wash does not have capacity in this segment to convey the 100-year design flow.

Utilities

The 54-inch Sandhill Relief Sewer is located in the channel bottom on the north side of the channel. A cable-concrete block lining is installed over the Sandhill Relief Sewer. A 10-inch sanitary sewer is located in the north bank within a 20-foot wide sewer easement.

Maintenance Access Roads and Ramps

A maintenance access road exists on east and north bank over the top of an existing 10-inch sanitary sewer. An access ramp exists at Station 661+95 from the south side of the channel.

Width of Available Right-of-Way/Drainage Easements

The right-of-way for this segment is 140 feet wide. A 20-foot wide sanitary sewer easement adjoins the Wash right-of-way on the north side.

Major Inflow Points

There are no major inflow points for this segment.

Bridges and Crossings

Lamb Boulevard crosses the Las Vegas Wash at Station 669+09 over a skewed 144-foot long concrete bridge. The bridge deck is supported on three rows of vertical pier walls with rounded nose faces upstream and downstream. The side abutments are concrete lined and sloped at 1.5H:1V. The channel under the bridge is approximately 11 feet deep and has an earthen lining. A storm water monitoring station is located on the east side of the bridge. A gas pipeline is attached to the east edge of the bridge deck. A 48-inch storm drain pipe outlets into the channel from the north abutment under the bridge.

Problem Areas

Erosion/Sedimentation: Sedimentation occurs under the Lamb Boulevard Bridge, decreasing conveyance capacity.

Significant Impediments to Flow: The concrete drop structure, located midway between Washington Avenue and Lamb Boulevard, flattens the channel slope upstream creating a depth of up to 2.5 feet against the walls on the north side of the channel between Sections 11200 (Station 666+97.75) and 11100 (Station 662+97.96). Property in this area is at risk of flooding during the 100-year storm event.

Overtopping: The Lamb Boulevard Bridge was overtopped during the July 8, 1999 storm event. This structure was overtopped in the HEC-2 model by 1,525 cfs.

Breakouts: No breakouts occurred through this segment. However, the calculated depth in the channel flowed up to 2.5 feet high against the walls on the north side of the channel.

Lamb Boulevard to Owens Avenue

Responsible Governing Entity: City of Las Vegas.

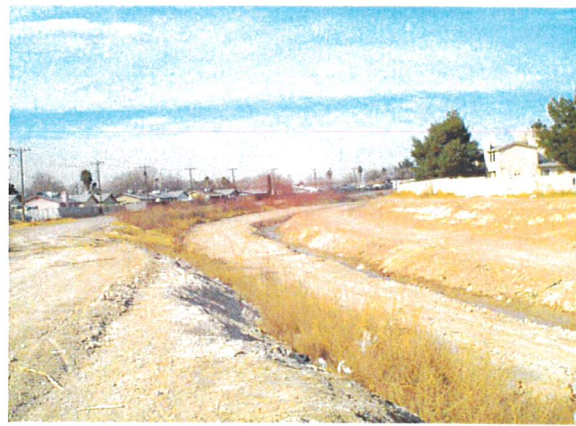
Plan and Profile Segment Location: Extends from Station 669+09 to Station 714+07.

Channel Characteristics

The earthen trapezoidal channel has a bottom width that varies from 75 feet to 50 feet. The channel depth decreases from 10 feet at Lamb Boulevard to less than 6 feet at Owens Avenue. The Owens Avenue Bridge is nearly completely filled in from sediment deposits. The channel gradient is approximately 0.01 feet per foot.



Las Vegas Wash looking northeast at south face of Owens Avenue bridge.



Las Vegas Wash north of Washington Channel looking northwest.



Washington Channel confluence with Las Vegas Wash looking northwest.



Las Vegas Wash south of Owens Avenue looking south.

MPU Design Flows and Channel Capacity

The MPU 100-year design flow for this segment is 8,500 cfs. The existing Wash does not have capacity in this segment to convey the 100-year design flow. The Wash has capacity to convey the 100-year design flow through this segment.

Utilities

The 54-inch Sandhill Relief Sewer continues on the north side of the channel bottom and moves to the top of the east bank at approximately Station 696+00. Cable-concrete block lining protects this sewer. Another sanitary sewer, 45 inches in diameter, is located along the south and west banks from Station 695+62 to Owens Avenue. Two 10-inch sanitary sewer pipes cross the channel at Station 713+40 with a cable-concrete block protective cap.

Maintenance Access Roads and Ramps

A 20-foot wide maintenance road on the west bank extends north from Sandhill Road, over the Washington Channel confluence to Owens Avenue. An existing graded access ramp is located downstream of the Washington Channel confluence from the west bank at Station 690+00.

Width of Available Right-of-Way/Drainage Easements

The right-of-way for this segment is 150 feet wide from Station 669+47 to Station 695+69 where a parcel for the Washington Channel Confluence is encountered. This 2.5-acre parcel on the west side of the channel is not needed for maintenance of the Las Vegas Wash. From Station 700+19 to Station 713+55, the right-of-way is 160 feet wide with a 20-foot wide sanitary sewer easement adjoining the west right-of-way line.

Major Inflow Points

The Washington Channel outfalls into Las Vegas Wash at Station 694+60. The MPU lists this facility as three 12-foot by 8-foot RCB culverts designed to convey a 100-year flow of 4,000 cfs.

Bridges and Crossings

Owens Avenue crosses the Las Vegas Wash over a 124-foot long concrete bridge located at Station 714+07. The bridge deck is supported by four rows of circular columns. The side abutments are concrete lined and sloped at 1.5H:1V. The channel under the bridge is approximately 4 feet deep with an earthen lining. Deep sedimentation leaves little flow area for storm runoff. A 48-inch storm drain pipe outlets into the channel from the west abutment under the bridge. The pedestrian lanes on the bridge are separated from the vehicular traffic by concrete barrier rails.

Problem Areas

Erosion/Sedimentation: Sediment upstream and under the Owens Avenue Bridge greatly reduces the capacity of the bridge. Sedimentation from the Owens Avenue Bridge to the Washington Channel outfall structure is evident. Channel capacity has been greatly reduced.

Significant Impediments to Flow: There are no significant impediments to flow through this segment.

Overtopping: The Owens Avenue Bridge was overtopped during the July 8, 1999 storm event. The Owens Avenue Bridge was overtopped by 4,119 cfs in the HEC-2 model.

Breakouts: The HEC-2 did not indicate any breakouts through this segment.

Owens Avenue to Lake Mead Boulevard

Responsible Governing Entity: Clark County.

Plan and Profile Segment Location:

Extends from Station 714+07 to Station 749+76.

Channel Characteristics

Channel is mainly a trapezoidal earthen shape, 8 feet deep with a 45-foot bottom width. Tall grasses line the channel invert. Grouted riprap lines the east bank from Station 742+26 to Station 734+15. The channel gradient is flat from Station 714+07 to Station 721+50. The slope then increases to approximately 0.006 feet per foot.



South of Lake Mead Boulevard looking north at culverts and proposed access ramp location.

MPU Design Flows and Channel Capacity

The MPU 100-year design flow for this segment is 8,500 cfs. The section is insufficient to convey the 100-year design flow.

Utilities

The 48-inch "A" Channel Sanitary Sewer runs the length of the wash bottom near the east bank.

Maintenance Access Roads and Ramps

Maintenance roads are not well defined through this segment.

Width of Available Right-of-Way/Drainage Easements

The right-of-way for this segment varies in width. The right-of-way width begins at 160 feet at Station 730+89.52, gradually narrowing to 125 feet with an abrupt reduction to 98 feet at Station 733+88.7. This narrow 98-foot wide strip continues to Station 734+13.43. The right-of-way then increases to 108 feet wide by Station 748+85. This width is maintained northward to the Lake Mead Boulevard and Pecos Road intersection.

Major Inflow Points

There are no major inflow points through this segment.

Bridges and Crossings

The Lake Mead Boulevard and Pecos Road intersection crosses the Las Vegas Wash at Station 749+76. This intersection is built on top of three 12-foot by 8-foot RCB culverts and four 8-foot by 8-foot RCB culverts forced into a wing shape on the upstream and downstream faces. A storm water monitoring station is located on the upstream face of the culverts.

Problem Areas

Erosion/Sedimentation: Sedimentation occurs upstream of the Owens Avenue Bridge. Erosion in the form of piping is occurring in the east bank downstream of Lake Mead Boulevard. Sediment and debris restrict the capacity of the culverts under the Lake Mead Boulevard/Pecos Road intersection.

Significant Impediments to Flow: The sediment blocking bridge at Owens Avenue and the culverts at Lake Mead Boulevard present the greatest impediment to flow.

Overtopping: The HEC-2 model passes the 100-year design flow through the culverts under the Lake Mead Boulevard/Pecos Road intersection, but the water surface upstream is above the channel banks. Debris and sediment blocking the culverts severely restrict the capacity of the culverts. The Lake Mead Boulevard/Pecos Road culverts were overtopped during the July 8, 1999 storm event.

Breakouts: The HEC-2 model shows a breakout over the right bank between Section 13450 (Station 731+63.75) and 13300 (Station 726+82.14). Approximately 150 cfs of this flow does not return to the Wash.

Lake Mead Boulevard to Carey Avenue

Responsible Governing Entity: City of North Las Vegas.

Plan and Profile Segment Location: Extends from Station 749+76 to Station 781+75.

Channel Characteristics

The channel is earthen trapezoidal channel, 65 feet wide, sloping 0.004 feet per foot with a depth of 9 feet. Natural vegetation grows in the channel bottom.



Las Vegas Wash at Carey Avenue looking south through chain-link fence.



Las Vegas Wash at Carey Avenue looking at lining failure on south side.

MPU Design Flows and Channel Capacity

The MPU 100-year design flow for this segment is 8,077 cfs. The Wash does not have sufficient capacity through this reach.

Utilities

The 48-inch "A" Channel Sanitary Sewer continues through this segment under the channel on the east side. Another sanitary sewer, 24 inches, is located under the channel on the west side near to the bank toe. A sanitary sewer crossing the channel upstream of Lake Mead Boulevard has a protective concrete cap. Another concrete cap located at Station 767+70 protects a 10-inch sanitary sewer crossing. A 16-inch waterline crosses the channel just downstream of the Carey Avenue culverts.

Maintenance Access Roads and Ramps

An existing narrow access road is located along the west bank.

Width of Available Right-of-Way/Drainage Easements

The right-of-way for this segment is 150 feet wide.

Major Inflow Points

There are no major inflow points for this segment.

Bridges and Crossings

Carey Avenue crosses the Las Vegas Wash skewed over five 120-inch CMP culverts at Station 781+75. A new bridge is currently being designed by others.

Problem Areas

Erosion/Sedimentation: Some lining failure exists immediately downstream of Carey Avenue. Sediment significantly reduces the capacity of the culverts at Lake Mead Boulevard.

Significant Impediments to Flow: There are no impediments to flow through this segment.

Overtopping: A new bridge is currently being designed by others for Carey Avenue. The existing structure was overtopped during the July 8, 1999 storm event.

Breakouts: The Wash lacks capacity through this reach. A new channel section is currently being designed by others.

Carey Avenue to Las Vegas Boulevard

Responsible Governing Entity: City of North Las Vegas.

Plan and Profile Segment Location: Extends from Station 781+75 to Station 809+00.

Channel Characteristics

Channel is earthen trapezoidal section 80 feet wide and 6 feet deep. Native grasses grow in the channel bottom along the entire length of this segment of the Wash. The channel gradient is 0.004 feet per foot. Concrete lining extends downstream from Las Vegas Boulevard a short distance around the outside channel curve. A drop in the channel occurs at the Las Vegas Boulevard culverts.

MPU Design Flows and Channel Capacity

The MPU 100-year design flow for this segment is 8,077 cfs. The channel lacks capacity through this reach.

Utilities

A 12-inch waterline blow-off structure is located on the north side of Carey Avenue in the middle of the Wash. The 48-inch "A" Channel Sanitary Sewer continues through this segment in the channel bottom on the east side. A 24-inch sanitary sewer beneath the channel crosses from the west side to the east bank at the channel bend downstream of Las Vegas Boulevard.

Maintenance Access Roads and Ramps

Maintenance roads currently exist on both sides of the channel. Access ramps are located at Station 785+34 from the west facing upstream and at Station 793+50 from the east facing downstream.

Width of Available Right-of-Way/Drainage Easements

The right-of-way for this segment is 150 feet wide.

Major Inflow Points

The Cartier Channel outlets into the Wash at Station 795+50. The MPU lists this channel as a 10-foot wide concrete-lined trapezoidal section with 2H:1V side slopes designed to convey the 100-year flow of 800 cfs.

Bridges and Crossings

Las Vegas Boulevard crosses the Las Vegas Wash over five 12-foot by 7-foot RCB culverts at Station 809+00. A drop in the channel occurs immediately downstream of the culverts. A new bridge is currently being designed by others.

Problem Areas

Erosion/Sedimentation: Periodic maintenance of the reach is necessary to remove sediment and debris.

Significant Impediments to Flow: The water blow-off valve in the middle of the Wash upstream of Carey Avenue collects debris that decreases channel capacity.

Overtopping: The Las Vegas Boulevard culverts were overtopped during the July 8, 1999 storm event. A new structure for this crossing is currently under design by others.

Breakouts: The Wash lacks capacity through this reach. A new channel section is currently under design by others.

Las Vegas Boulevard to Cheyenne Avenue

Responsible Governing Entity: City of North Las Vegas.

Plan and Profile Segment Location: Extends from Station 809+00 to Station 840+30.

Channel Characteristics

The majority of this segment is a trapezoidal earthen section with a 65-foot bottom width and a slope of 0.0055 feet per foot. The channel is concrete-lined downstream of Cheyenne Avenue from Station 838+40 to Station 839+50. Dense vegetation lines the wash bottom.



Las Vegas Wash at Cheyenne Avenue looking west at outlet structure on north side of road.



Las Vegas Wash at Cheyenne Avenue looking west at north culvert face.

MPU Design Flows and Channel Capacity

The MPU 100-year design flow for this segment is 6,345 cfs. The existing Wash does not have capacity to convey the design flow.

Utilities

No utilities are noted for this segment.

Maintenance Access Roads and Ramps

Maintenance roads exist on both sides of the Wash. An access ramp is located on the west bank at Station 836+40 facing downstream.

Width of Available Right-of-Way/Drainage Easements

The right-of-way for this segment is 150 feet wide.

Major Inflow Points

The "N" Channel confluence outlets at Station 818+00. The MPU lists this facility as a concrete-lined trapezoidal channel 8 feet wide, 5 feet deep with 2H:1V side slopes. The 100-year design flow is 1,080 cfs.

Bridges and Crossings

Cheyenne Avenue crosses the Las Vegas Wash skewed over five 132-inch CMP culverts at Station 840+30. A new structure for this crossing is currently under design by others.

Problem Areas

Erosion/Sedimentation: Periodic maintenance is required in this reach to control vegetation, sediment, and erosion.

Significant Impediments to Flow: There are no major impediments to flow in this reach.

Overtopping: Cheyenne Avenue culverts are currently being studied by others for replacement.

Breakouts: The existing Wash section lacks capacity in this reach. A new channel section is currently under design by others.

Cheyenne Avenue to Civic Center Drive

Responsible Governing Entity: City of North Las Vegas.

Plan and Profile Segment Location: Extends from Station 840+30 to Station 866+80.

Channel Characteristics

The Wash through this reach is an earthen trapezoidal section with a bottom width that varies from 60 feet to 10 feet. The channel slope is 0.005 feet per foot. The channel bottom is vegetated with native grasses close to Cheyenne Avenue. About midway in this segment, the meandering channel has scoured down to caliche layers. This segment crosses the planned detention peaking basin site.



Las Vegas Wash at Civic Center Drive looking southwest at northwest bridge face.



Las Vegas Wash midway between Cheyenne Avenue and Civic Center Drive looking southeast. Note inflow to left.



Las Vegas Wash at Cheyenne Avenue looking northwest.



Las Vegas Wash looking southeast towards Cheyenne Avenue.

MPU Design Flows and Channel Capacity

The MPU 100-year design flow for this segment is 6,345 cfs downstream of the proposed peaking basin site. The channel does not have sufficient capacity through this reach.

Utilities

No utilities are noted for this segment.

Maintenance Access Roads and Ramps

Maintenance roads currently exist on both sides of the Wash.

Width of Available Right-of-Way/Drainage Easements

The right-of-way for this segment is 150 feet wide.

Major Inflow Points

There are no major inflow points along this segment of the Wash.

Bridges and Crossings

Civic Center Drive crosses the Las Vegas Wash at a minor skew over a concrete bridge at Station 866+80. The bridge deck is supported on two concrete pier walls with beveled nose faces upstream and downstream. The pedestrian path is separated from vehicular traffic by a metal guardrail.

Problem Areas

Erosion/Sedimentation: The channel has scoured down to caliche approximately midway between Cheyenne Avenue and Civic Center Drive.

Significant Impediments to Flow: There are no major impediments to flow in this segment.

Overtopping: The bridge at Civic Center Drive was not overtopped by the July 8, 1999 storm event.

Breakouts: The channel does not have adequate capacity through this reach. A new channel section is currently under design by others.

Civic Center Drive to I-15

Responsible Governing Entity: City of North Las Vegas.

Plan and Profile Segment Location: Extends from Station 866+80 to Station 874+70.

Channel Characteristics

The channel is a concrete-lined trapezoidal section with a 75-foot wide bottom and 2H:1V side slopes except for the first 50 feet upstream of the Civic Center Bridge where the bottom is not lined. Tall grasses grow in this area. The channel gradient is 0.002 feet per foot. A drop structure is located just downstream of the I-15 Bridge.



Las Vegas Wash at Civic Center Drive looking west at channel lining on northwest side of bridge. Note end of concrete lining.



Las Vegas Wash at Civic Center Drive looking northwest towards I-15. Note drop structure.

MPU Design Flows and Channel Capacity

The MPU 100-year design flow for this segment is 10,991 cfs. The channel through this reach has capacity to convey the 100-year design flow.

Utilities

A gas pipeline is attached to the west edge of the Civic Center Drive Bridge deck.

Maintenance Access Roads and Ramps

An access ramp is located on the southwest side at Station 870+00. A maintenance road is located on the southwest side of the channel. The channel slope prevents maintenance access from the northeast channel bank.

Width of Available Right-of-Way/Drainage Easements

The right-of-way for this segment is 150 feet wide.

Major Inflow Points

There are no major inflows into this segment.

Bridges and Crossings

There are no bridges through this segment as the segment ends downstream of the I-15 Bridge.

Problem Areas

Erosion/Sedimentation: As the majority of this reach is concrete-lined, erosion and sedimentation do not appear to be a problem.

Significant Impediments to Flow: No major impediments to flow exist in this segment.

Overtopping: Overtopping was not a problem for this segment in the HEC-2 model.

Breakouts: No breakouts occur through this reach.

ALTERNATIVE ANALYSES

Goals and Objectives

The Alternative Analyses portion of the study encompasses preparing a maximum of four channel cross section and lining alternatives with comparative cost estimates for each segment of the Las Vegas Wash with similar conveyance characteristics. The cross sections will show alternatives for storm water conveyance, identify opportunities for joint use, and identify possible construction constraints.

Each analyzed cross section is designed to safely convey the 100-year flow through the reach based on permissible velocities and flow regime. The individual cross sections were then evaluated for each reach considering lining and construction costs, right-of-way constraints, utility conflicts, and the opportunity to incorporate parks, trails, and natural conditions into the design.

Design Criteria and Requirements

Design Q

The proposed flows were used to analyze the various alternatives for the Wash. The Wash from Lake Mead Boulevard to the Flamingo Wash confluence was analyzed for 8,500 cfs. Between the Flamingo Wash and the Sloan Channel confluences, the flow used in the alternatives analyses was increased to 10,000 cfs. The analysis of alternatives within the Wash downstream of the Sloan Channel confluence was completed using 10,500 cfs.

Channel Geometry

Four sections were analyzed for possible inclusion in the preliminary design for the Las Vegas Wash as part of the original contract:

- Grass-lined trapezoidal section with 4H:1V side slopes;
- Earthen (unlined) trapezoidal section with 3H:1V side slopes;
- Gabion-lined trapezoidal section with 2H:1V side slopes;
- And concrete-lined trapezoidal section with 2H:1V side slopes.

At the request of the entities, three additional alternatives have been considered, as follows:

- Trapezoidal section with 2H:1V side slopes lined with concrete-cable block;
- Concrete-lined rectangular section;
- And unlined channel bottom with 3H:1V riprap side slopes ($d_{50} = 12$ -inch, thickness = 24 inches) and 6-foot concrete cutoff walls placed periodically to control erosion of the channel bottom.

Table 5-1 summarizes the Manning's "n" used for each lining type.

Table 5-1: Summary of Manning's "n"	
Channel Lining	"n"
Heavy Vegetation	0.050
Grass	0.025
Earth (unlined)	0.024
Concrete	0.015
Gabion	0.030
Concrete-Cable Block	0.034
Riprap	0.030

The results of the alternative cross section analyses are summarized on a reach by reach basis in a table and figure included in Appendix E.

Permissible Velocities

Analysis of the various alternatives was completed by maintaining the maximum allowable velocity for each channel lining type. This was accomplished by adjusting the cross section width as necessary to meet the velocity criteria. The majority of the maximum permissible velocities were obtained from Table 703 of the *1999 Hydrologic Criteria and Drainage Design Manual*. The maximum velocity used for grass-lined channels is 8 fps; the maximum velocity for concrete cable-block is 10 fps. The allowable velocities for each lining type are summarized in Table 5-2.

Table 5-2: Permissible Velocities	
Channel Lining	Maximum Velocity (fps)
Heavy Vegetation	8
Grass	8
Earth (unlined)	5
Concrete	25
Gabion	15
Concrete Cable Block	10
Riprap	10

Flow Regime

Second to velocity, the flow regime determined the width and depth of the proposed sections for each lining type within each reach. Where possible, a supercritical flow regime was maintained to present the most efficient channel section and reduce sediment concerns. Due to extremely flat slopes throughout the project, supercritical flow regimes were not possible for all section options. In these cases, the channel section was widened to avoid the transitional flow regime, Froude Numbers between 0.86 and 1.13, in conformance with the practices of the Manual. However, in the reach from Lake Mead Boulevard to Owens Avenue, some of the analyzed cross sections were so wide that this criterion was impractical to enforce. The calculated flow regimes are noted on the summary table and figure included in Appendix E for each calculated normal depth section.

Existing Utilities

The possible impacts to existing utilities were used in the consideration of each cross section option. Issues involved include access for maintenance as well as conflicts in location. The cross sections were analyzed to minimize the impacts to existing utilities.

Available ROW and Land Ownership

The analyzed cross sections minimized the right-of-way requirements as much as possible without exceeding permissible velocities and disrupting the flow regime. Available right-of-way was a key factor in the determination of the impacts of each option. Insufficient right-of-way is quantified in the cost estimates for each option as a line item for right-of-way acquisition.

Maintenance Access

Regular maintenance of flood control facilities is necessary to ensure proper operation of the facilities. Access must be provided for maintenance, inspection, and emergency response, also called operation access.

The 1999 *Hydrologic Criteria and Drainage Design Manual* requires 12-foot maintenance access roads on the top of both sides of the channel for channels with a top width wider than 30 feet. Where top access is not possible on both sides, vehicular access will be provided in the bottom and on the top of one side of the channel and a 5-foot wide personnel operation access will be provided on the other bank.

A minimum 12-foot wide access road will be provided at the top of both sides of the proposed channel sections. An additional 3-feet is provided adjacent to rectangular sections to allow for 4-foot high chain link fence. Along one side of the concrete-lined trapezoidal channel, the personnel operation access requirement is met with a 3-foot rescue zone and 4-foot high chain link fence with an additional 10 feet minimum of right-of-way reserved for a public use trail system.

Since the majority of the surface inflows and channel confluences occur on the west side of the Las Vegas Wash, it is recommended that the east bank be designated for the placement of the possible trail system.

Required access roads were added to each analyzed cross section for the calculation of right-of-way needs. Excess right-of-way is designated for trails. Specific maintenance access configurations are noted with the proposed improvements section.

Where access on the channel bottom is proposed, access ramps to the proposed channel bottom are required on the downstream side of bridges (major street crossings) and at a maximum one-mile spacing along the maintenance road. The ramps should be parallel to the channel centerline and have a minimum width of 12 feet with a slope no greater than 10 percent in the same direction as the channel flow.

In general, the recommended ramp configurations and locations meet or exceed the minimum CCRFCD maintenance access requirements. The exception is at Bonanza Road where existing development and right-of-way constraints preclude strict adherence to these criteria. This situation was reviewed to approach maximum compliance with this standard. Proposed ramps locations are shown on the preliminary Plan and Profile sheets. Specific maintenance access configurations are noted with the proposed improvements section.

Potential for Multiple Uses (Recreation/Trails) of Drainage Corridor

Federal policy encourages the increased use of non-motorized transportation. A possible trail system would consist of a path a minimum of 10 feet wide intended for use by pedestrian and bicycle traffic. Motorized vehicles would be restricted to motorized wheelchairs, maintenance vehicles, and electric bicycles with top speeds less than 20 mph. A public trail system, including trail access, would be required to meet ADA requirements. Such a trail system may consist of compacted gravel or paved paths. According to Lewis Wallenmeyer of the Clark County Health Department, gravel paths are acceptable with less than 150 vehicle trips per day and a surface condition that prevents opacity exceeding 20 percent, meeting silt content and loading restrictions.

Parks and recreation personnel from the entities have indicated a willingness to allow dual use of a trail system for maintenance; maintenance personnel have expressed their reluctance for such a system. This prompts the recommendation that the areas allotted specifically for maintenance roads be fenced to deter public access.

Where maintenance roads and trails occupy the same space, public access to the maintenance road may be blocked during maintenance operations with temporary barricades and warning signs. With improvement of the channel section, routine maintenance issues such as sediment removal and channel repair will interfere less with the public use of the envisioned trail system.

The ideal trail system is one that is continuous. Where possible, overpasses or underpasses should be provided at the street crossings to separate trail users from vehicular traffic. At-grade access to the streets would also be advantageous. Design of a specific trail system, including crossings and access issues, is outside the scope of this study. However, at the request of the City of Las Vegas, the bridges were analyzed for hydraulic capacity if a portion of the trapezoidal section under the bridges were used for pedestrian walkway. The results of these analyses are noted for the individual reaches in the respective sections.

Costs

A common cost analysis was performed to compare the various cross section alternatives. The costs for each option are based upon a typical section and include estimated excavation/fill, installation of the channel lining, and acquisition of right-of-way. The cost comparisons do not include costs associated with the engineering, design, preparation of final drawings, resolution of utility conflicts, construction of fencing and guardrails, nor permits required to construct each section. The expected annual cost of maintenance is also estimated for cross section value comparison.

Strengths and Weaknesses of Each Alternative

The earthen (unlined) cross section allows easy access to utilities in the Wash. At the same time, this section does not provide a high level of protection for adjacent and underground utilities. Provision for nuisance flows, whether by small size storm drain or low-flow channel, must be made to prevent natural cutting of a low-flow waterway. Unlined channel sections require extremely wide cross sections and, therefore, a great deal of right-of-way in order to maintain non-erosive velocities. Even with these precautions, erosion and deposition problems within the channel section are likely. This has been evidenced in the large deposition of sediments at the existing bridges resulting in the restriction of conveyance capacities and overtopping of the bridges. The unlined channel section allows for the growth of natural vegetation and habitation of wildlife. However, in most reaches, implementation of an unlined cross section would result in the displacement of numerous residents and businesses currently located adjacent to the Wash.

The grass-lined trapezoidal section can handle slightly higher velocities than the unlined channel section. However, the required cross section to accommodate the large flows in the Las Vegas Wash is still very wide, requiring extensive additions to right-of-way to provide a stable section. Acquisition of right-of-way would result in a significant impact to existing adjacent homes and businesses. The grass-lined section will still require a nuisance storm drain and/or low-flow channel to prevent channel cutting by nuisance flows. In addition, the maintenance of a grass-lined channel is intensive and expensive. Grass lining will require an irrigation system and regular maintenance, including mowing, reseeding, watering, and inspection/repair of damaged cover and irrigation systems. Again, this option provides easy access to underground utilities, but little protection.

The gabion-lined trapezoidal section can handle much higher velocities. Gabions allow the growth of vegetation and discourage graffiti. On the down side, gabion lining is one of the more expensive options that were analyzed for this project. Gabions are rougher resulting in a less efficient section and subcritical flow regime. Due to the subcritical flow regime, sediment deposits are more likely to be a problem.

The concrete-lined trapezoidal section can handle much higher velocities. Despite the flat slopes, a concrete-lined section allows for supercritical flow regimes in some areas and, therefore, the most efficient channel section. Accordingly, concrete lining requires the least amount of right-of-way for the channel section. This results in the least impact to existing homes and businesses adjacent to the wash. At the same time, it provides the greatest level of protection for the existing adjacent development. Concrete lining requires a minimal maintenance effort. Sediment deposits are less likely for this scenario. Due to the reduction of sediment build-up before the bridges, this option allows the existing bridges to work most effectively, reducing the likelihood of expensive bridge replacements.

Concrete-cable block has been used in the reach directly downstream of the confluence with the Flamingo Wash to the satisfaction of the Clark County Public Works. According to the City of Las Vegas, the concrete-cable block has provided effective cover for sanitary sewer in other areas within the city limits. The cable block does allow the growth of vegetation, easier access to underground utilities, and discourages graffiti. On the down side, concrete-cable block is the most expensive option to construct and will require regular maintenance including mowing. Concrete cable block lining is rougher which results in subcritical flow regimes and less efficient cross sections. Also due to the subcritical flow regime, sediment deposits are more likely to be a problem.

The concrete-lined rectangular section usually requires even less right-of-way than the concrete-lined trapezoidal section. The advantages and disadvantages of the rectangular and trapezoidal sections are similar. In addition to the disadvantages already noted, the rectangular section requires an additional three feet adjacent to the channel for placement of fence and is slightly more expensive than the trapezoidal section per foot to construct. However, this option is usually narrower than the trapezoidal section, requiring the least amount of right-of-way.

The last section consists of an unlined channel bottom with 3H:1V riprap side slopes ($d_{50} = 12$ -inch, thickness = 24 inches) and 6-foot concrete cutoff walls placed periodically to control erosion of the channel bottom. The unlined bottom allows easy access to utilities in the Wash. The width of the channel is more restricted than an unlined channel despite the lack of protective lining on the bottom. This is because erosive velocities are allowed during major storm events with the understanding that damage to the channel will occur. This means that significant repairs will be required after any major storm event. Provision for nuisance flows, whether by small size storm drain or low-flow channel, must be made to prevent natural cutting of a low-flow waterway. The unlined channel bottom allows for the growth of natural vegetation and habitation of wildlife. This section will require maintenance of growth including mowing.

Alternatives Eliminated

In the reach between Lake Mead Boulevard and Owens Avenue, the grass-lined channel, the unlined channel, and the dirt bottom with cut-off walls options were eliminated because, despite extending the channel widths, the flow regimes still remain in the transitional area (Froude Number between 0.86 and 1.13).

Preliminary cost opinions were prepared for the remaining sections. The design for each reach was chosen to minimize costs, utility conflicts, right-of-way acquisition requirements, and expected maintenance.

Maintenance Requirements

Regular maintenance of flood control facilities is essential to ensure the long-term reliability of facilities to serve their function. The level and nature of maintenance is based on the size and type of channel section.

All channels other than concrete lined shall be constructed with a low flow channel or an underground low flow storm drain to carry nuisance base flows. According to the CCRFCD Manual, the minimum capacity should be 1.0 percent of the major storm flow. Low flow channels shall be constructed of concrete or other approved materials to minimize erosion and facilitate maintenance.

A grass-lined channel requires the most amount of routine maintenance. In addition to a low flow storm drain or channel, a grass-lined channel requires a sprinkler irrigation system. During the summer months, the grass will need to be mowed and the irrigation system inspected weekly. In the winter, this maintenance may be performed less frequently. At a minimum, the grass will need to be fertilized and reseeded annually. Inspection of a grass-lined channel should be made annually and after major storm events to remove sediment and address any local erosion problems.

Earth-lined, gabion-lined, and concrete cable block lining channels will require a low flow storm drain or channel. This requirement was met for the channel with concrete cable block lining by a 3 percent cross fall to direct low flows to the center of the channel. At a minimum, maintenance will be required annually and after major storm events. Annual maintenance will include removal of trees and bushes as well as sediment. In addition, any damage to the channel section will require repair.

In addition to the maintenance requirements for earthen channels, the earth-lined section with riprap side slopes and cut-off walls will require more drastic action in the event of a major storm event. This section was designed with the understanding that a major storm event will cause significant movement of the channel bottom. This channel section will require replacement of material in the bottom and repair to the sides with the occurrence of a major storm event.

The concrete-lined channel section does not require a low flow storm drain or channel. However, the channel bottom is designed with a three percent cross fall to direct low flows to the center of the channel. Inspection of the channel should take place annually and after any major storm event. Maintenance will include sediment removal and repairs to the channel lining, if necessary.

Cost Estimate for Each Alternative

The following paragraphs estimate the unit costs for construction for each cross section option reviewed. These values are generated for an average section. The numbers presented in this section are intended to provide a controlled comparison of the major costs for each cross section. The expected annual maintenance costs are also estimated to aid in the value comparison.

The predominant construction cost for the earth, or unlined, channel option consists of the excavation/fill required to construct such wide channel sections. Assuming a typical section of a 1,000-foot bottom width, 3H:1V side slopes, and a depth of 10 feet, the expected volume per foot of channel is 9,300 cubic feet, or 345 cubic yards. Using an estimated cost of \$5 per cubic yard for excavation/fill, the construction cost for a stable unlined channel section is \$1,725 per linear foot. The total right-of-way required is 1,084 feet. The additional right-of-way that must be obtained for this option is 934 feet; this is the equivalent of 5 lots. At \$2,400 per foot per acquired lot, the right-of-way acquisition costs are estimated at \$12,000 per foot of channel. Annual maintenance costs are estimated to be 1.5 percent of the construction cost: \$26 per foot of channel.

Excavation/fill contributes significantly to the construction cost for the grass-lined channel. In addition, the cost of installing irrigation systems and seeding is estimated at \$2 per square foot of channel. Assuming a typical section of a 190-foot bottom width, 4H:1V side slopes, and a depth of 10 feet, the expected volume per foot of channel is 1,300 cubic feet, or 48 cubic yards, and the area is 273 square feet per foot of channel. Using an estimated cost of \$5 per cubic yard for excavation/fill, the construction cost for the grass-lined channel section is \$786 per linear foot. The total right-of-way required is 294 feet, requiring approximately 144 feet of right-of-way acquisition. This is the equivalent of 1 lot, or \$2,400 per foot of channel. The grass lining will require more intense maintenance, including regular mowing, reseeding, watering, and inspection and repair of the irrigation system. Annual maintenance costs are expected to be about 5 percent of the construction cost, or \$40 per foot of channel.

For the gabion-lined trapezoidal section with 2H:1V side slopes, the average section consists of a bottom width of 80 feet and depth of 11 feet. Assuming the gabion lining is 18 inches thick, the

volume of this cross section is 194 cubic feet per foot, or 7.2 cubic yards per foot. Using a cost of \$125 per cubic yard of gabion, the cost for this option is approximately \$900 per linear foot for installation and materials. This cross section option is contained within the approximate right-of-way width of 150 feet. Therefore, no major right-of-way acquisition effort will be required. Annual maintenance costs are estimated to be 1.5 percent of the construction cost, or \$14 per foot of channel.

For the concrete-lined trapezoidal section with 2H:1V side slopes, an average section was used consisting of a bottom width of 75 feet and depth of 8 feet. Assuming a thickness of 6 inches for the concrete, the total volume of concrete per foot of channel is 2.1 cubic yards. Assuming a cost of \$350 per cubic yard, the cost for this option is approximately \$720 per linear foot for installation and materials. This cross section option is contained within the approximate right-of-way width of 150 feet. Therefore, no major right-of-way acquisition effort will be required. Annual maintenance costs are estimated to be 1.5 percent of the construction cost, or \$11 per foot of channel.

The cost of the cable block system was assumed to be \$75 per square yard. The average cross section for this option consists of an 80-foot bottom width and 11.5-foot depth; this results in 132 square feet per foot, or 14.6 square yards per foot. The cost for this option is approximately \$1,100 per linear foot for installation and materials. This cross section option is contained within the approximate right-of-way width of 150 feet. Therefore, no major right-of-way acquisition effort will be required. Annual maintenance costs are estimated to be 1.5 percent of the construction cost, or \$17 per foot of channel.

For the concrete-lined rectangular section, an average section was used consisting of a bottom width of 75 feet and depth of 8.5 feet. A cost of \$350 per cubic yard of concrete was used for the bottom; \$400 per cubic yard was assumed for the vertical walls. With a 6-inch thick bottom, the volume for the channel bottom is 38 cubic feet per linear foot of channel, or 1.4 cubic yards. Assuming 12-inch walls, the total volume for the channel walls is 17 cubic feet per linear foot of channel, or 0.6 cubic yards. The estimated cost for this option is \$745 per linear foot for installation and materials. This cross section option is contained within the approximate right-of-way width of 150 feet. Therefore, no major right-of-way acquisition effort will be required. Annual maintenance costs are estimated to be 1.5 percent of the construction cost, or \$11 per foot of channel.

The last section considered consists of an unlined channel bottom with 3H:1V riprap side slopes (d_{50} = 12-inch, thickness = 24 inches) and 6-foot concrete cutoff walls placed periodically to control erosion of the channel bottom. The average section used for the unit construction cost has a 163-foot bottom width and 10-foot depth. As the proposed channel is wider than the existing channel section, excavation/fill costs are estimated for this option. The total volume of excavation, less 700 cubic feet for the existing wash, is 588 cubic feet, or 22 cubic yards per linear foot of channel. At \$5 per cubic yard, the estimated cost per foot for excavation/fill is \$110. Assuming the cut-off walls are 6 feet deep by 1-foot by 163 feet wide and are placed every 800 feet, the unit cost for the cut-off walls distributed over the channel is \$18 per foot (\$400 per cubic yard of concrete). The riprap for the sides will extend all the way to the top of the channel as well as 6 feet into the ground. This results in a volume of riprap of 150 cubic feet per foot, or 5.6 cubic yards of riprap per foot of channel. Assuming a unit cost of \$90 per cubic yard of riprap, the unit cost for riprap is approximately \$504 per foot. This results in a total unit cost of \$632 per foot. Please note that this does not include excavation costs. The total right-of-way required is 250 feet, requiring approximately 100 feet of right-of-way acquisition. This is the equivalent of 1 lot, or \$2,400 per foot of channel. The unlined section will require more frequent inspection and repair of the channel will

be necessary after each major storm event. Annual maintenance costs are expected to be about 10 percent of the construction cost, or \$63 per foot of channel.

The estimated construction costs per linear foot of channel are summarized in Table 5-3.

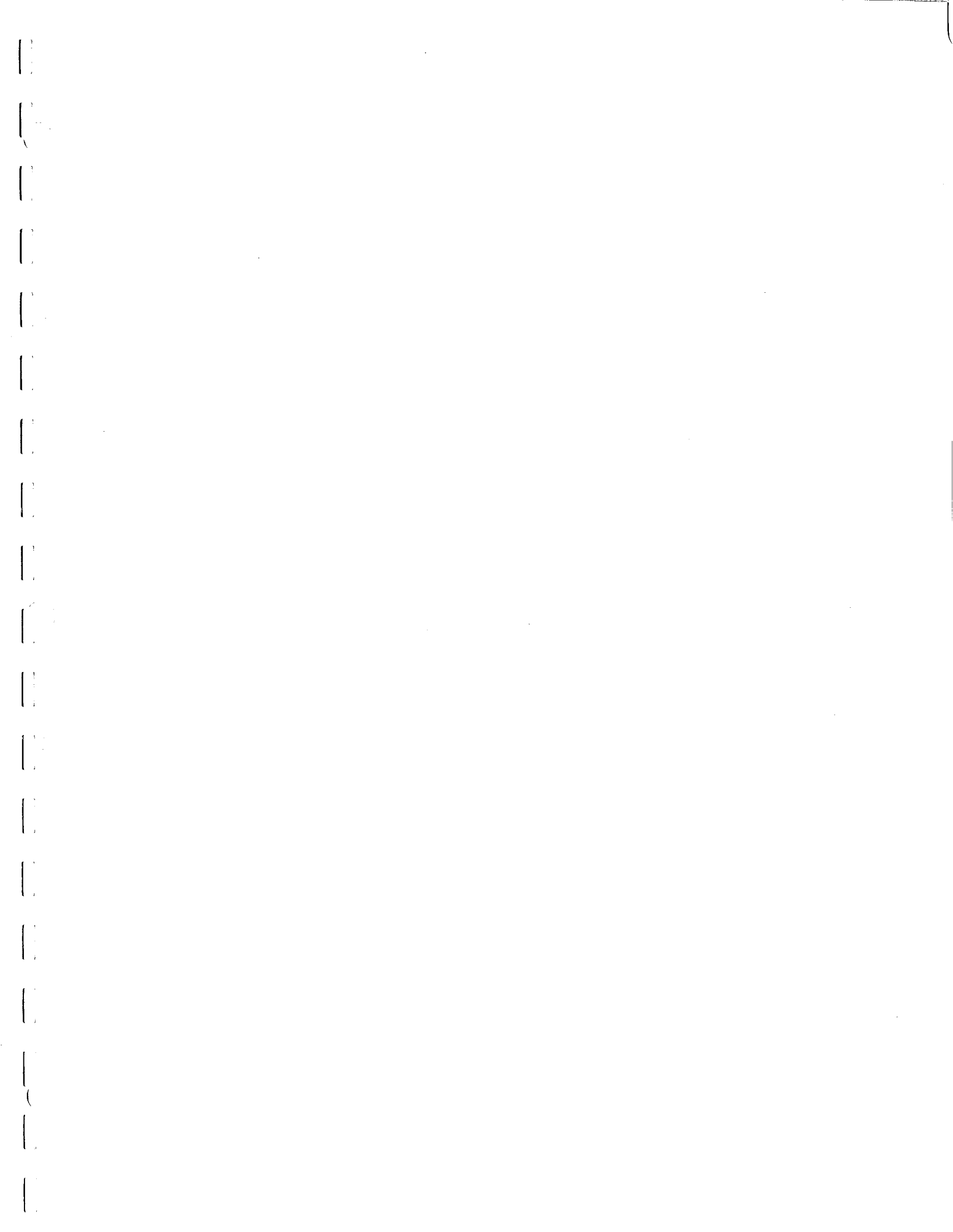
Table 5-3: Summary of Costs per Linear Foot of Channel				
Channel Cross Section Description	Construction Costs	Right-of-Way Acquisition	Annual Maintenance Costs	First Year Total Costs
Unlined trapezoidal section; BW=1,000 ft; 3H:1V SS; d=10 ft	\$1,725	\$12,000	\$26	\$13,751
Grass-lined trapezoidal section; BW=190 ft; 4H:1V SS; d=10 ft	\$786	\$2,400	\$40	\$3,226
Gabion-lined trapezoidal section; BW=80 ft; 2H:1V SS; d=11 ft	\$900	\$0	\$14	\$914
Concrete-lined trapezoidal section; BW=75 ft; 2H:1V SS; d=8 ft	\$720	\$0	\$11	\$731
Concrete-cable block trapezoidal section; BW=80 ft; 2H:1V SS; d=11.5 ft	\$1,100	\$0	\$17	\$1,117
Concrete-lined rectangular section; BW=75 ft; d=8.5 ft	\$745	\$0	\$11	\$756
Unlined channel bottom/riprap sides (d_{50} = 12-inch, thickness = 24 inches) and 6-foot concrete cutoff walls; BW=163 ft; 3H:1V SS; d=10 ft	\$632	\$2,400	\$63	\$3,095

In addition, the City of Las Vegas requested a cost estimate if the channel were completely enclosed in reinforced concrete box culvert, allowing the entire right-of-way surface to be used as a linear park. An 8-barrel, 10-foot wide by 10-foot high box culvert extending from Nellis Boulevard to Cheyenne Avenue (29,400 feet) was used to estimate the expense of this option. The end area per foot of 8-barrel, 10-foot wide by 10-foot high RCB is 13 cubic yards of concrete. Using a unit cost of \$400 per cubic yard of concrete, the cost of such a facility would be over \$153 million for installation and materials. With the enormous cost and the increased difficulty in maintaining the storm drains and sanitary sewers, this option is not considered viable.

Reaches Requiring Additional Evaluation/Costing

Desert Rose Golf Course

A portion of the Las Vegas Wash is incorporated into the Desert Rose Golf Course, publicly owned and maintained by Clark County Public Works. Improvements for the grass-lined portions of the golf course were not evaluated. However, at the instigation of Clark County Public Works if acquired by the City of Las Vegas, further improvements in the Desert Rose Golf Course reach may be considered to reduce the maintenance issues inherent with a golf course channel section.



PROPOSED IMPROVEMENTS

FEMA Designated SFHA

The proposed improvements will confine the 100-year peak flows to the main channel of the Las Vegas Wash from Lake Mead Boulevard south to the Service Road (Rochelle Avenue). Thus it would be possible, through subsequent LOMR, to remove the Special Flood Hazard Area designation from all regions adjacent to wash that are currently impacted by overbank flows. The total area impacted is approximately 650 acres. Figure 6-1 is a map of Special Flood Hazard Areas reflecting the proposed revisions.

Clark County Regional Flood Control District MPU Proposed Conditions

The 1996 MPU proposed concrete channel lining of the Las Vegas Wash runs from Interstate 15 to Lake Mead Boulevard. This concept is unchanged for this reach of the channel.

The Las Vegas Wash Channel south of Lake Mead Boulevard to Owens Avenue was proposed in the 1996 MPU to be gabion lined. A riprap lining was proposed south of Owens Avenue to a few hundred feet downstream of the Nellis Boulevard Bridge. The recommended gabion lined and riprap lined channel sections have been changed to concrete in this study.

The portion of the channel contained in a golf course between Nellis Boulevard and Sloan Lane will remain essentially unchanged from the 1996 MPU. However, an articulated block lining is proposed in the bottom of the channel for the portion of the reach of the Wash from the confluence of the Flamingo Wash to the approximate alignment of Sloan Lane.

The recommended section downstream of Sloan Lane to Vegas Drive remains concrete as shown in the 1996 MPU.

South of Vegas Valley Drive has been changed from the 1996 MPU proposed rock-lined dikes on either side of the channel to an incised channel with riprap sides. The bottom will be earth-lined with grade control beams at 800-foot spacings.

A detailed discussion of the recommended channel sections and dimensions is discussed on a reach by reach basis later in this section.

Required Additional and Existing Excess Rights-of-Way

Required Additional Rights-of-Way

The proposed Las Vegas Wash improvements take advantage of existing drainage right-of-way whenever possible. However, in a number of locations along the Las Vegas Wash, additional right-of-way will be required in order to accommodate proposed maintenance roads and channel improvements. The following table contains a summary of impacted parcels along with ownership information.

Table 6-1: Required Additional Rights-of-Way			
Parcel	Owner	Segment	Proposed Take Area
161-23-101-001	CCSD	Service Road to Vegas Valley	5.8 acres

Table 6-1: Required Additional Rights-of-Way (continued)

Parcel	Owner	Segment	Proposed Take Area
161-14-401-001	CCSD	Service Road to Vegas Valley	3.5 acres
161-15-801-002	Private	Service Road to Vegas Valley	1.2 acres
161-15-701-002	Private	Service Road to Vegas Valley	0.8 acre
161-15-601-001	Private	Service Road to Vegas Valley	1.4 acres
161-15-501-001	CLV	Service Road to Vegas Valley	1.2 acres
161-10-401-003	CLV	Service Road to Vegas Valley	1.0 acre
161-04-103-003	Private	Flamingo Wash to Nellis	950 sq. ft.
140-29-810-006	Private	Bonanza to Washington	150 sq. ft.

A detailed discussion of impacts to these parcels follows.

Parcels 161-23-101-001 and 161-14-401-001

This land was deeded to the Clark County Sanitation District for the building and maintenance of the wastewater treatment plant and associated utilities. Currently, no right-of-way or easement specifically for the Las Vegas Wash drainage exists across these parcels. A road/drainage easement for the Monson Channel is located in the southern 110 feet of Parcel 161-23-101-001. Proposed channel and maintenance road improvements in this area would require approximately 9.4 acres (See Figure 6-2).

Parcel 161-15-801-002

The adjacent drainage right-of-way (Parcel 161-15-702-001) is not of sufficient width in this location to accommodate the proposed channel and adjacent maintenance roads. Approximately 1.2 acres of the northwest corner of this parcel is needed for proposed channel and maintenance road improvements (See Figure 6-3).

Parcel 161-15-701-002

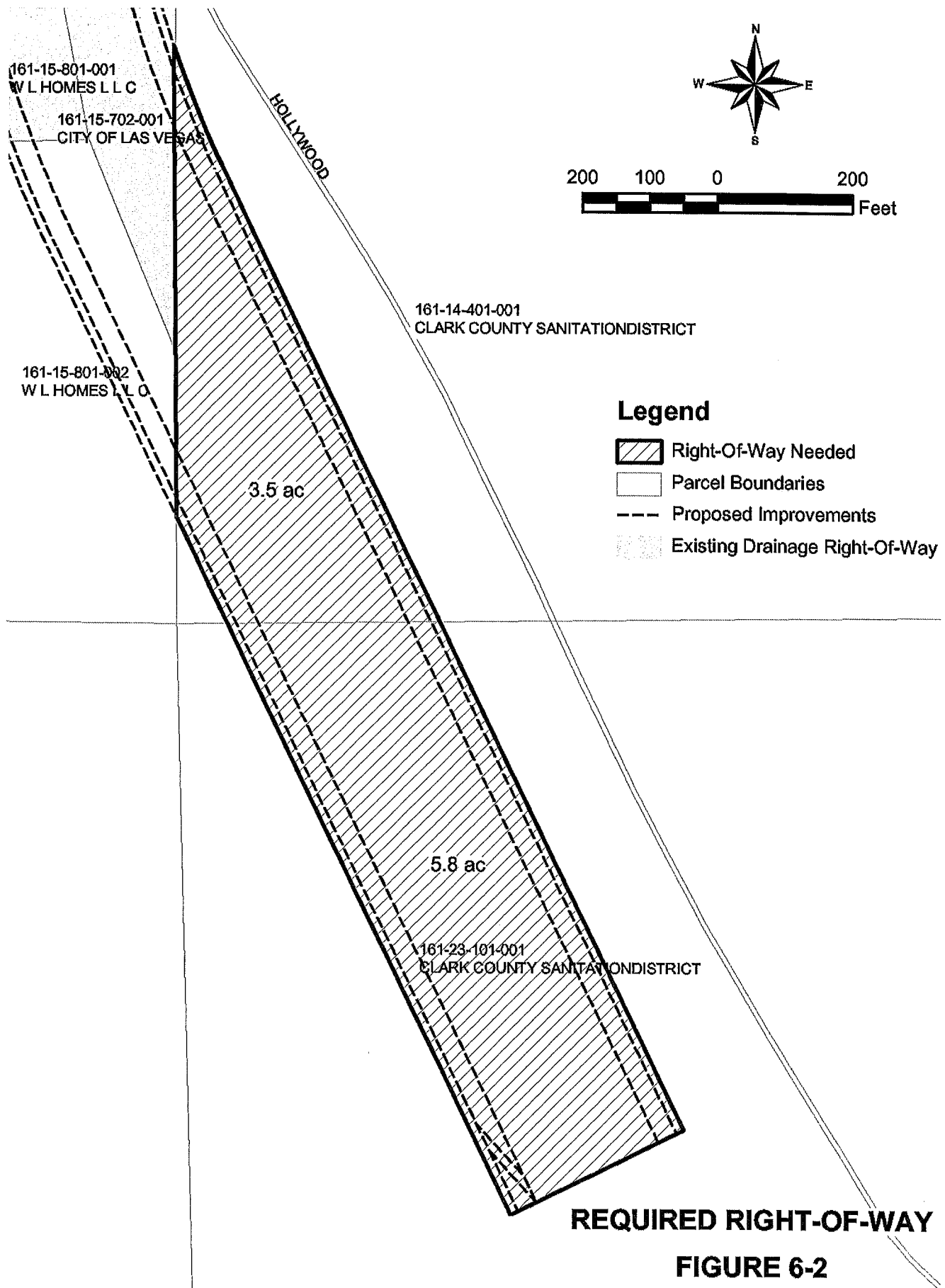
An approximately 0.8 acre acquisition is necessary along the eastern boundary of this parcel in order to accommodate proposed channel and maintenance roads (See Figure 6-4).

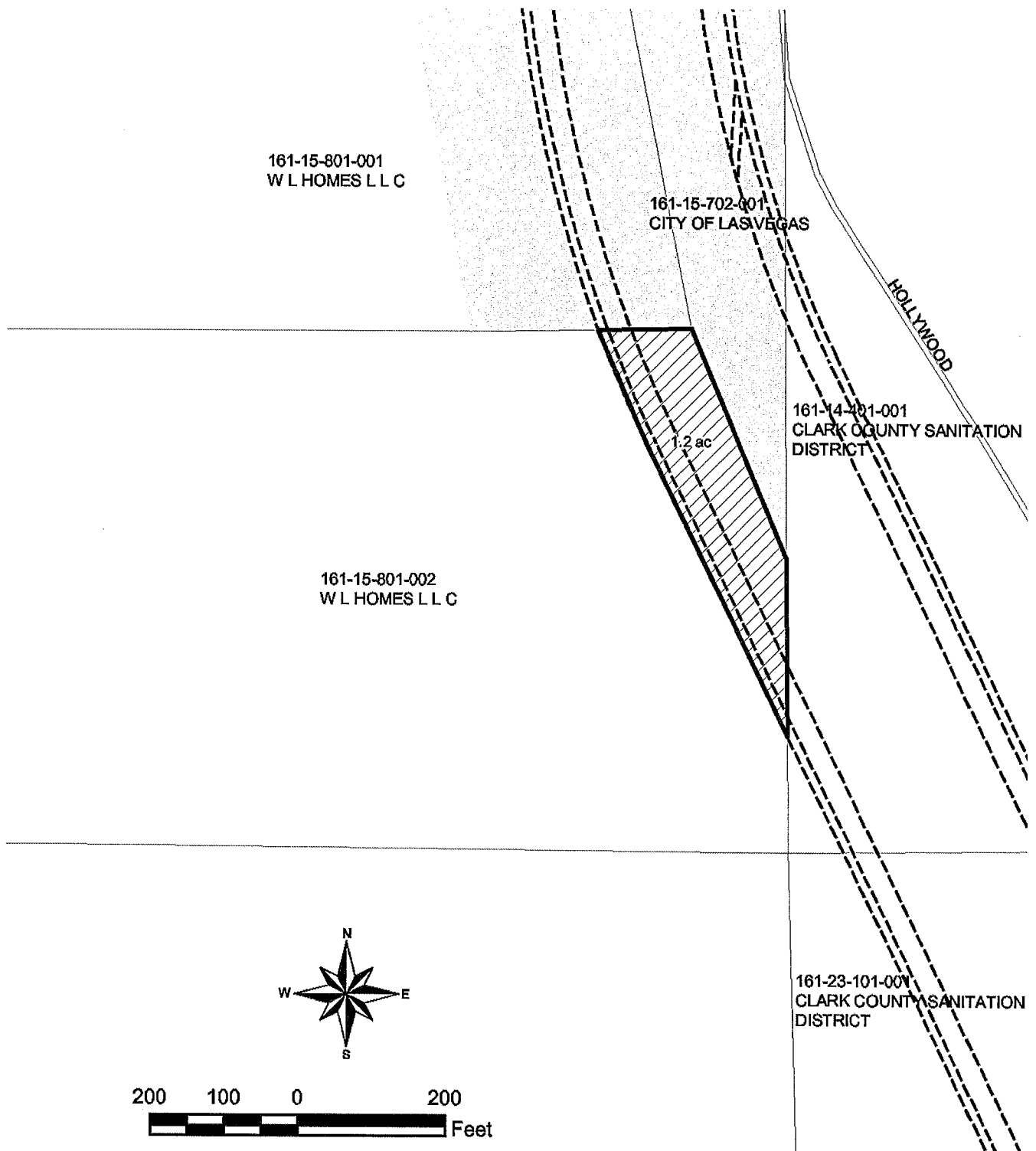
Parcels 161-15-601-001 and 161-15-501-001

Existing 250-foot right-of-way (Parcels 161-15-696-001 and 161-15-596-001) is insufficient for proposed improvements. Approximately 35 feet of additional right-of-way from the west side of the Wash will be needed for proposed channel and maintenance road improvements (See Figure 6-5).

Parcel 161-10-401-003

Just south of the City of Las Vegas sewer outfall the proposed wash improvements pass through a portion of this parcel. This portion is also entirely covered by a City of Las Vegas easement for road and utility purposes (presumably for Desert Inn Road). North of this point the existing Las Vegas Wash right-of-way is again restricted to approximately 250 feet in width. If the area covered by the easement is included in the total, approximately 1.1 acres of additional right-of-way will need to be acquired from Parcel 161-10-401-003 (See Figure 6-6).



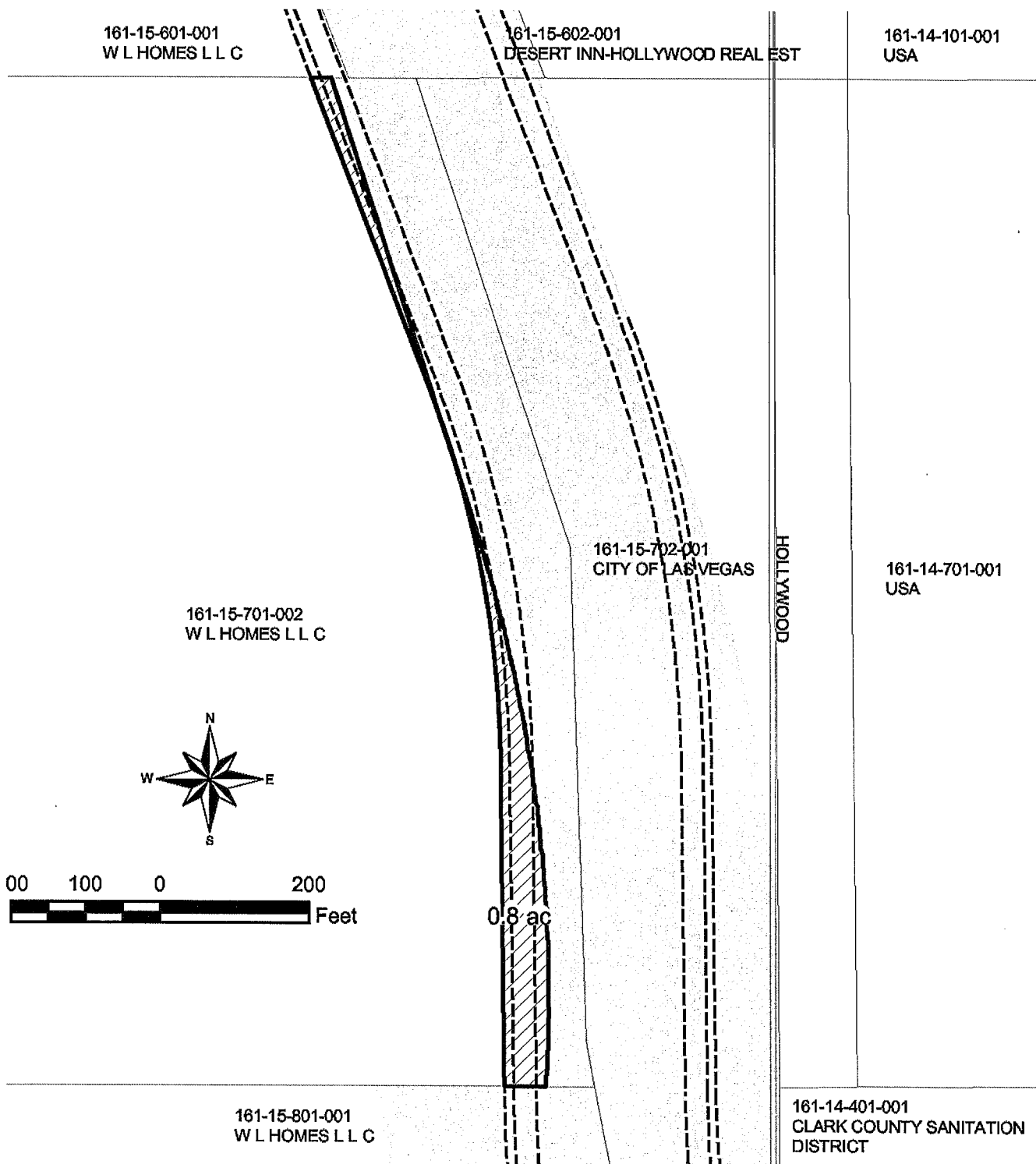


Legend

-  Right-Of-Way Needed
-  Proposed Improvements
-  Parcel Boundaries
-  Existing Drainage Right-Of-Way

REQUIRED RIGHT-OF-WAY

FIGURE 6-3

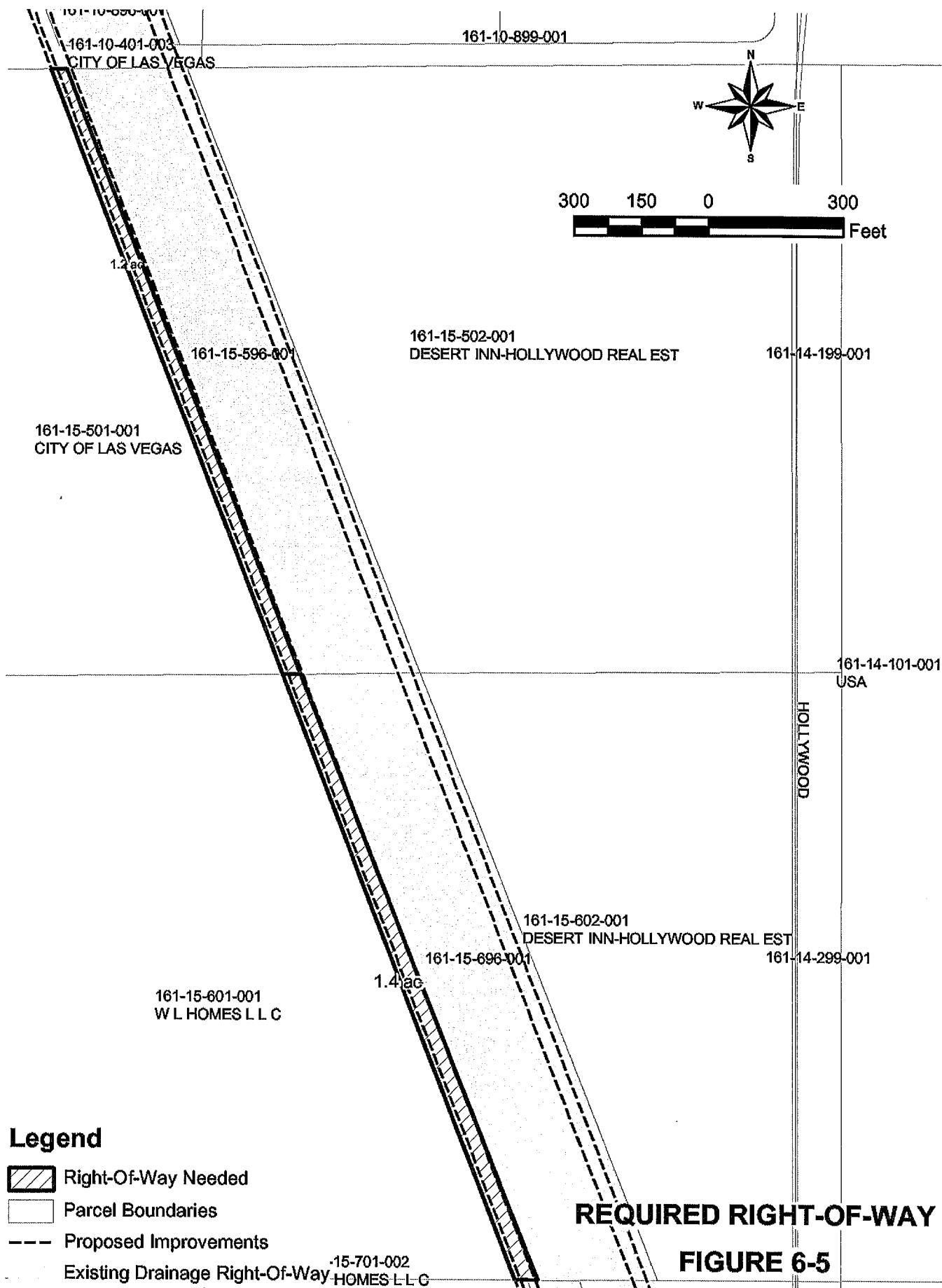


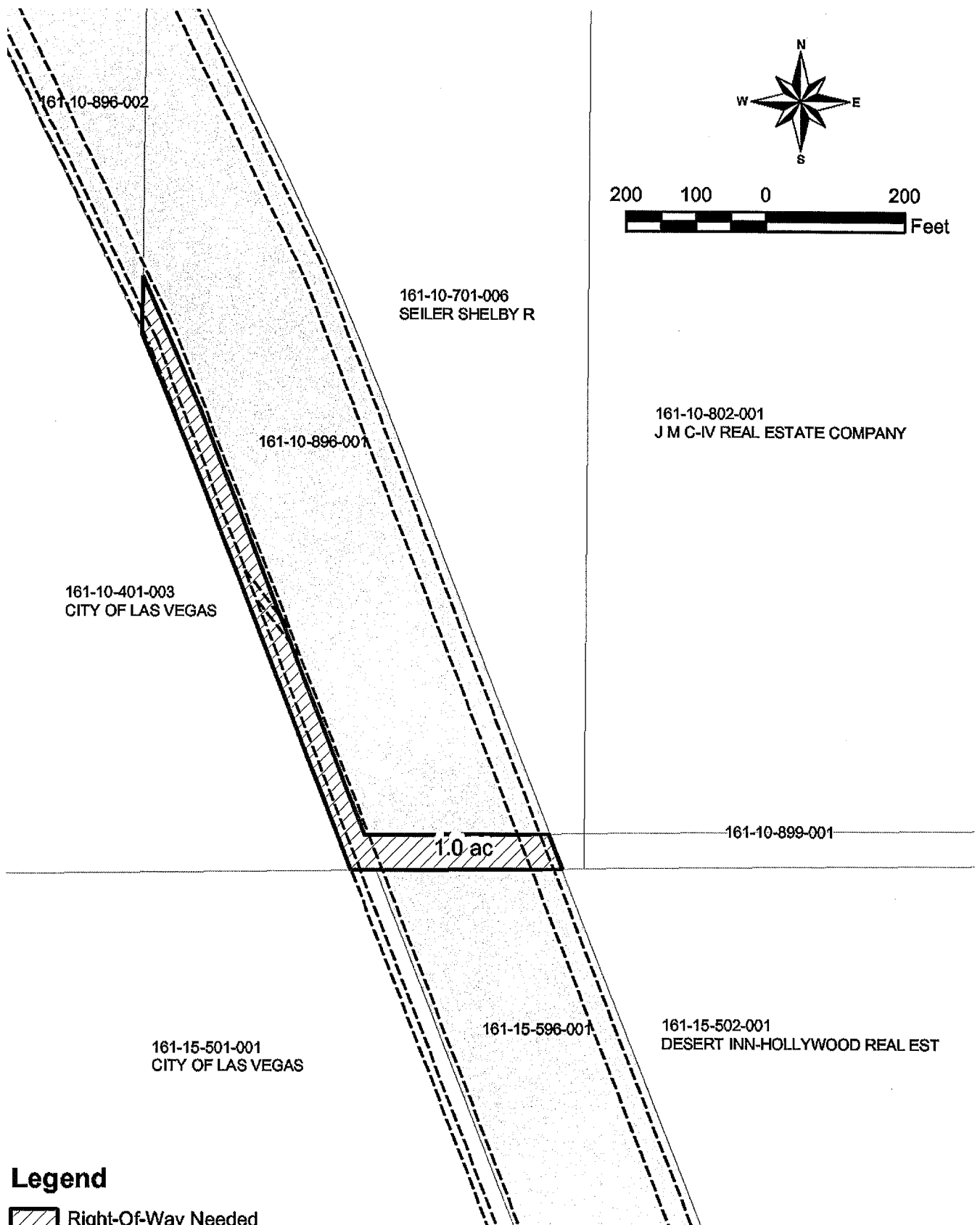
Legend

-  Right-Of-Way Needed
-  Proposed Improvements
-  Parcel Boundaries
-  Existing Drainage Right-Of-Way

REQUIRED RIGHT-OF-WAY

FIGURE 6-4





REQUIRED RIGHT-OF-WAY
FIGURE 6-6

Parcel 161-04-103-003

A corner of Parcel 161-04-103-003 (approximately 950 square feet) will be needed for the transition from the Nellis Bridge to the existing Desert Rose Golf Course channel (See Figure 6-7).

Parcel 140-29-810-006

A corner of this lot (approximately 150 square feet) will be needed to accommodate the proposed channel improvements. The portion required is part of the vacated Marco Street easement, is unfenced, and includes existing channel improvements (See Figure 6-8).

Existing Excess Right-of-Way

Excess Las Vegas Wash right-of-way exists in only one location along the Wash, within the segment from Lamb Boulevard to Owens Avenue. The pertinent property is Parcel 140-30-296-001 and a portion of Parcel 140-30-296-003 located along both sides of the Wash just north of Washington Avenue at Sandhill Road (See Figure 6-9). The total excess area is approximately 2.50 acres.

In addition, the majority of a 300-foot wide easement crossing privately-owned Parcel 161-15-801-001 is not utilized for the proposed Wash improvements. Most of the proposed channel passes through the adjacent Parcel 161-15-702-001, which is dedicated for drainage purposes (See Figure 6-9).

Drawings, Renderings, and Exhibits***Preliminary Channel Plan and Profile Drawings***

The plan and profile drawings included in Volume 2 are intended to show existing utilities, preliminary alignment, channel lining improvements, transitions 100-year storm event hydraulic grade line, top of bank, and energy grade line. Locations of maintenance ramps are also shown. Pedestrian underpasses or bridges are not shown.

Conceptual Landscape and Trail Renderings

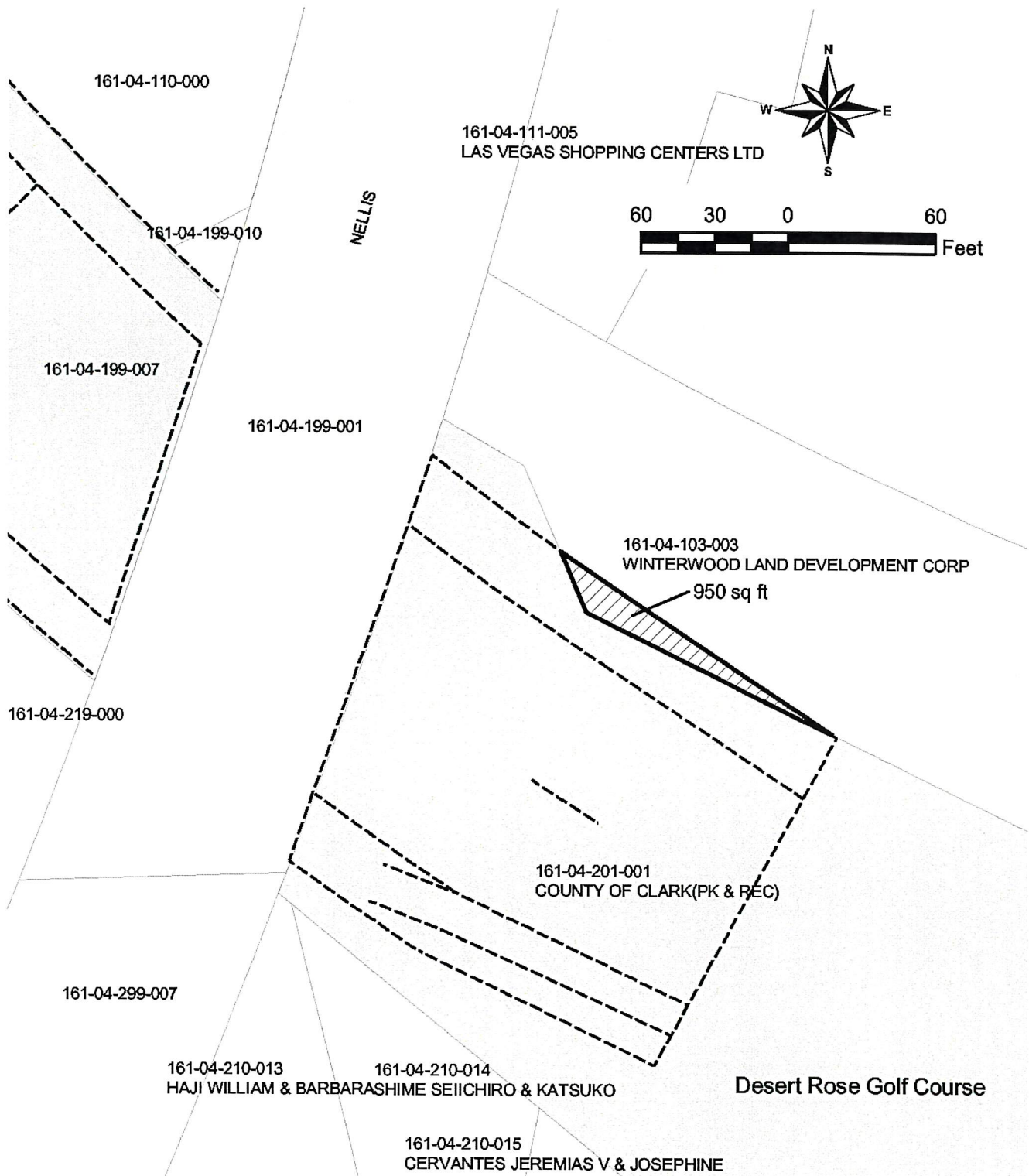
The renderings included in Volume 2 show conceptual trail and landscaping at Whitney Lateral, Charleston Boulevard, south of Owens Avenue and midway between Owens Avenue and Lake Mead Boulevard. The trail is shown meandering for illustrative purposes only.

Preliminary Right-of-Way Exhibits

Right-of-way exhibits included in Volume 2 show parcels and easement information for the study area. Pertinent Clark County Recorder document numbers are indicated in the exhibits for reference.

Reach by Reach Proposed Improvements

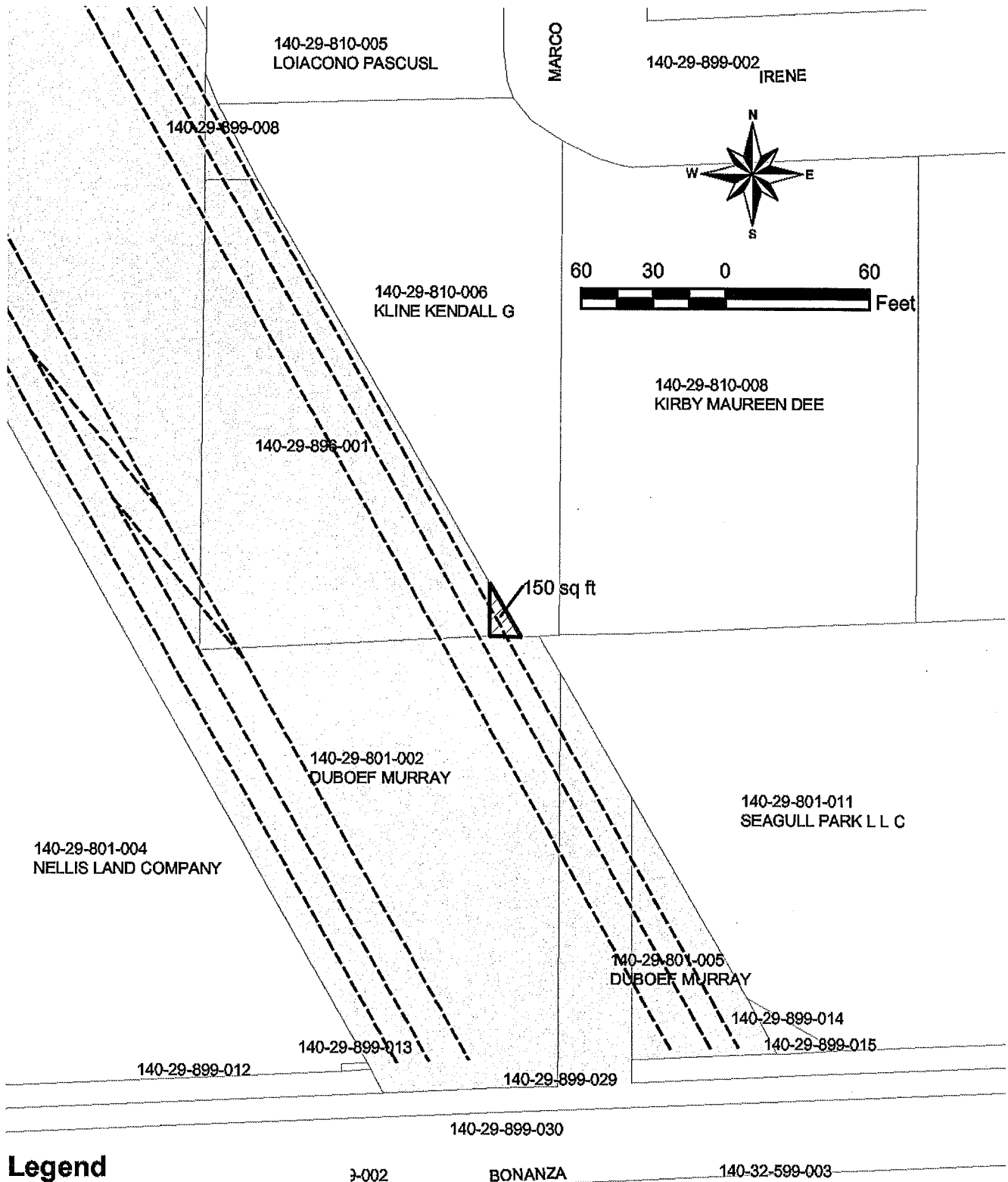
The stationing for the Las Vegas Wash study area starts at Station 749+76 at the intersection of Lake Mead Boulevard and Pecos Road and decreases southward. These stations were chosen to



Legend

- Right-Of-Way Needed
- Parcel Boundaries
- Proposed Improvements
- Existing Drainage Right-Of-Way

REQUIRED RIGHT-OF-WAY
FIGURE 6-7

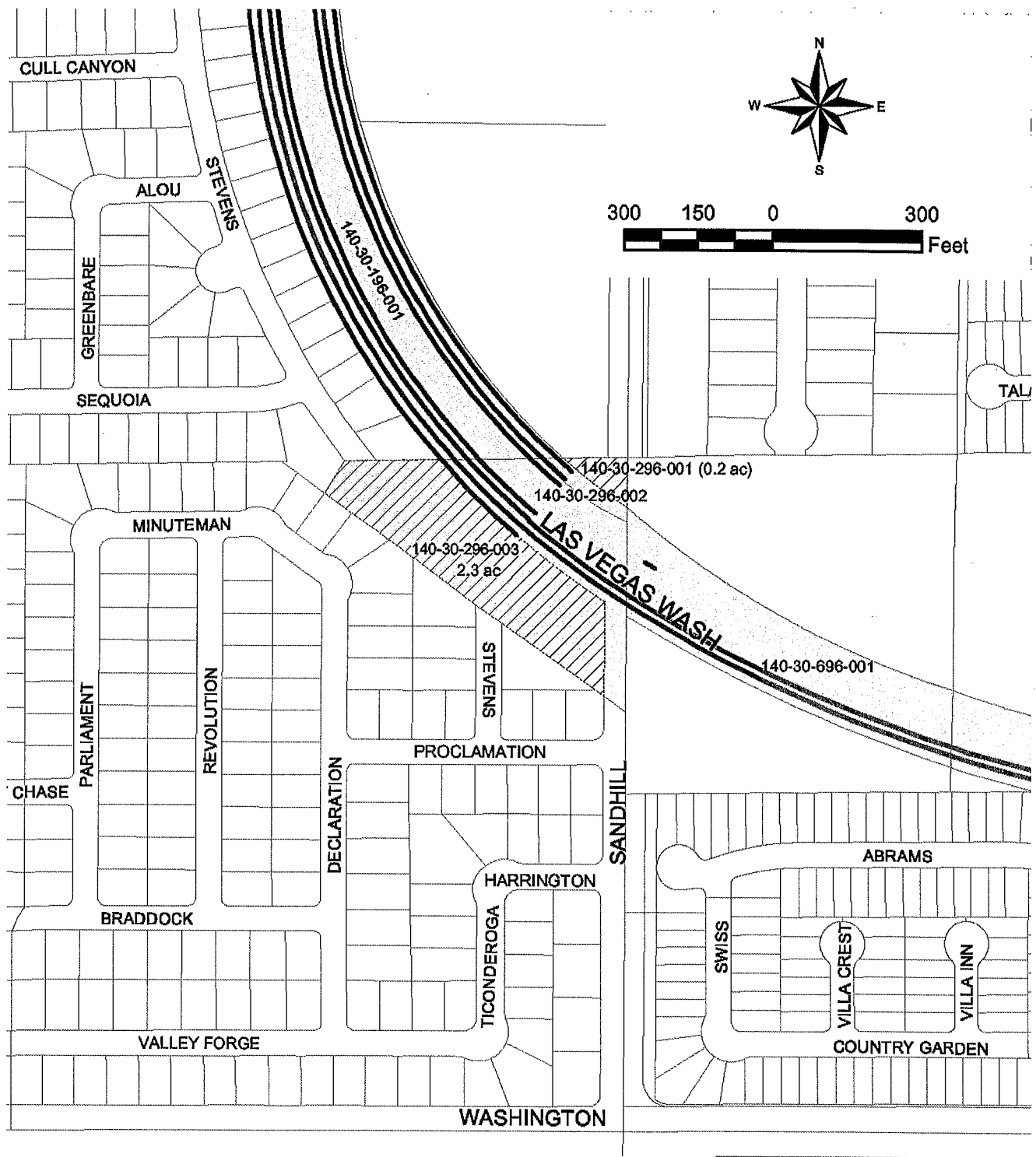


Legend

- Right-Of-Way Needed
- Parcel Boundaries
- Proposed Improvements
- Existing Drainage Right-Of-Way

REQUIRED RIGHT-OF-WAY

FIGURE 6-8



Legend

- Drainage Right-Of-Way
- Parcel Boundaries
- Proposed Improvements
- Excess Right-Of-Way

EXCESS RIGHT-OF-WAY

FIGURE 6-9

continue the stationing for the preliminary plan and profiles created by Black and Veatch for the "A" Channel north of the Lake Mead Boulevard/Pecos Road intersection.

Where possible, the channel grade was designed to use the existing inverts under the bridges. Some changes to inverts under the bridges were necessary to accommodate utilities installed after the bridges were constructed.

HEC-RAS 3.0 was used to model the proposed conditions. The values for Manning's roughness coefficient were set as follows:

Grass-lined	0.025	Gabion	0.030
Earthen	0.024	Cable-Concrete Block	0.034
Concrete-lined	0.015	Heavy vegetated channel	0.050

Table 6-2, below, is a summary of the hydraulic calculations for the proposed typical cross sections.

TABLE 6-2											
TYPICAL HEC-RAS RESULTS											
River Station	Q _{total} (cfs)	Channel Invert	WS Elevation	Channel Velocity (fps)	Radius (ft)	Super-elevation (ft)	Freeboard (ft)	Side Slopes	Bottom Width (ft)	Calculated Depth (ft)	Proposed Depth (ft)
71550	8500	1793.24	1798.67	22.3	625	2.15	1.98	2	70	9.7	10.0
67060	8500	1771.39	1777.29	19.1	1525	0.70	1.86	2	75	8.5	8.5
66755	8500	1770.11	1777.66	14.0	—	0.00	1.69	2	75	9.3	11.5
66362	8500	1768.73	1775.23	16.9	—	0.00	1.79	2	75	8.4	8.5
61725	8500	1748.06	1755.70	14.3	—	0.00	1.70	1.5	75	9.4	8.5
56236	8500	1724.23	1734.88	9.5	—	0.00	1.91	1.5	75	12.6	13.5
55000	8500	1722.36	1735.18	6.4	1400	0.10	1.14	0	110	14.1	14.0
46905	10000	1696.76	1703.63	13.0	500	1.47	3.13	2	120	11.5	11.5
46500	10000	1695.20	1701.04	16.0	500	2.16	1.72	2	120	9.8	10.0
40700	10500	1678.32	1686.46	7.5	—	0.00	1.36	3	200	9.6	10.0

The HEC-RAS model is contained in Appendix F.

The estimated overall cost for the proposed improvements from I-15 to the Monson Channel is \$61,645,000. The detailed cost estimate is included in Appendix I.

Recommended channel improvements are listed by hydraulic segment as follows:

Monson Channel to Service Road

Responsible Governing Entity: Clark County.

Plan and Profile Segment Location: Extends from Station 303+55.35 to Station 338+30.

Channel Geometry

The meandering thalwegs are to be left as natural as possible as an entrance into the Wetlands Park. The top width in the Wash for the 100-year storm is nearly 1,300 feet across. Nuisance flow is contained in the meandering thalwegs which are approximately 15 feet wide with a slope of 0.003 feet per foot near the Service Road. The slope increases to over 0.01 feet per foot near the Monson Channel confluence. To mitigate the head

cutting occurring near the Monson Channel Confluence, SNWA proposes several weirs near the Monson Channel confluence. This creates a backwater to prevent head cutting and stabilizes the banks. The flow regime is subcritical through this reach.

Maintenance Access Roads and Ramps

Maintenance access roads currently meander through the dense vegetation. In order to preserve the natural aspect of the area, additional maintenance access roads are not recommended. The channel bottom is accessible through the dip section on the Service Road.

Right-of-Way Required

Right-of-way is sufficient for the channel in this area.

Cost Estimate

The cost estimate considered the following line items for this segment.

Description	Quantity	Unit	Unit Cost	Total
Monson Weir *	1	LS	\$752,857.00	\$752,857.00
Upper Diversion Weir *	1	LS	\$3,646,210.00	\$3,646,210.00
			Line Items Sum	\$4,399,067.00
			25% Contingency	\$1,099,766.75
* SNWA estimate			Segment Total	\$5,498,833.75

The full estimate for all the segments is included in Appendix I.

Trail System/Recreation Constraints

CCRFCD recommends that trails and recreation facilities be located above the 25-year storm event water surface. Determining this water surface was outside the scope of this study. The existing maintenance road may serve as a trail. However, the dense foliage, the remote location, and the lack of regular security patrols in this area create public safety concerns.

Fencing and Signage Requirements

The vegetation creates a natural barrier to the Wash. Fencing is not recommended through this segment. Two signposts with the Flood Warning Icon and corresponding written text warning signs should be placed along the Service Road on each side of the Wash.

Service Road to Vegas Valley Drive

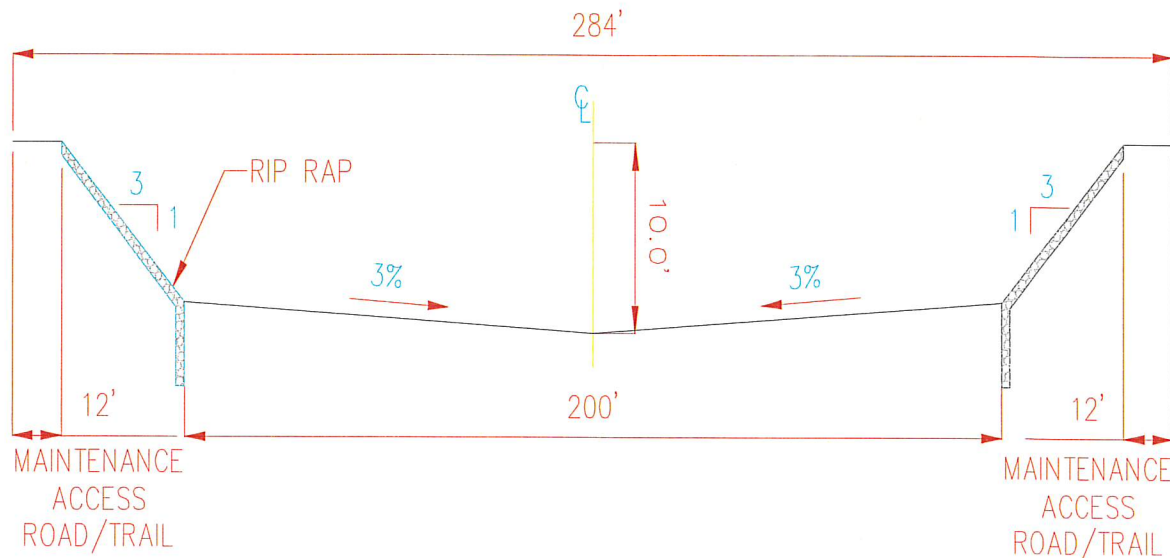
Responsible Governing Entity: Clark County.

Plan and Profile Segment Location: Extends from Station 338+30 to Station 434+65.

Channel Geometry

An earthen bottom trapezoidal channel, 200 feet wide, with 3H:1V riprap-lined side slopes is recommended for this segment as shown in the cross section below. The riprap median

stone size, 12 inches, is to be placed at a thickness of 24 inches. To mitigate the 100-year storm velocities, concrete cutoff walls 6 feet deep are placed at 800-foot intervals in the channel. The channel bottom has a 3 percent crossfall to direct low flows towards the center. In addition, Clark County Public Works has suggested including a storm drain to convey all nuisance and treated effluent flows to a point downstream of the Wetlands Park. The channel slope is 0.0034 feet per foot from the Service Road to Station 385+00. Upstream of Station 385+00 to Vegas Valley Drive, the slope flattens to 0.0014 feet per foot. The flow is in the subcritical regime.



Maintenance Access Roads and Ramps

The maintenance access roads, 12 feet wide, will adjoin the channel on both sides. Access ramps are located north of the Service Road, at Station 359+00 on the east side and at Station 410+00 on the west side. An existing ramp is located downstream of Vegas Valley Drive on the west side.

Right-of-Way Required

The recommended channel geometry requires a minimum of 284 feet of right-of-way. From Station 362+33 to Station 414+55, an additional 34-foot wide strip is needed (refer to Figure 6-5). Some of the parcels upon which the improved channel encroaches are owned by public entities. In these areas, the right-of-way may be handled by an easement without cost. For conservative purposes, the costs for right-of-way acquisition were estimated at \$90,000 per acre regardless of ownership.

Cost Estimate

The cost estimate considered the following line items for this segment.

Description	Quantity	Unit	Unit Cost	Total
Excavation	164,422	CY	\$5.00	\$822,110.00
Riprap	9,011	LF	\$504.00	\$4,541,544.00
Concrete Cutoff walls @ 800 foot intervals	11	EA	\$23,111.00	\$254,221.00

Description	Quantity	Unit	Unit Cost	Total
12' wide asphalt trail/maintenance road	19,050	LF	\$18.50	\$352,425.00
Transition	1	EA	\$50,000.00	\$50,000.00
Access Ramp	3	EA	\$70,000.00	\$210,000.00
6' chain-link Fence	60	LF	\$10.00	\$600.00
Additional Easement	14.9	AC	\$90,000.00	\$1,341,000.00
Line Items Sum				\$7,571,900.00
25% Contingency				\$1,892,975.00
Segment Total				\$9,464,875.00

The full estimate for all the segments is included in Appendix I.

Trail System/Recreation Constraints

The trail system utilizes the same right-of-way as the maintenance access roads on both sides of the channel. During times of maintenance operations, the trail on one side or the other will be blocked to public access. The trail is asphalted to accommodate the various pedestrian and cyclist traffic needs. SNWA East Valley Lateral 78-inch water pipeline borders the east side of the Wash right-of-way. To protect this pipeline, cathodic protection stations are placed at periodic locations along the pipeline. Barriers need to be placed at these locations to restrict public access to these stations.

Fencing and Signage Requirements

To regulate public access to the trail system during maintenance operations, chain-link gates should be placed along the Service Road and Vegas Valley Drive entrances to the trail. This segment of the channel is located within a drainage easement, not dedicated right-of-way. Therefore, fencing adjacent to the channel will require coordination with the property owner and the local entity.

Signposts with the Trail Icon Sign and the Las Vegas Wash Trail Marker should be placed at the entrances to the trail system. Another signpost with the Bike Route and Bicycle Yield signs should be placed approximately 100 feet from the entrance demarcation signs. These sign faces should be perpendicular to the trail. The Flood Warning Icon sign and the No Unauthorized Entrance Icon sign, both with corresponding warning text, should be placed alternating at 150-foot intervals along the Wash. These warning sign faces should be placed parallel to the trail.

Vegas Valley Drive to Sloan Channel

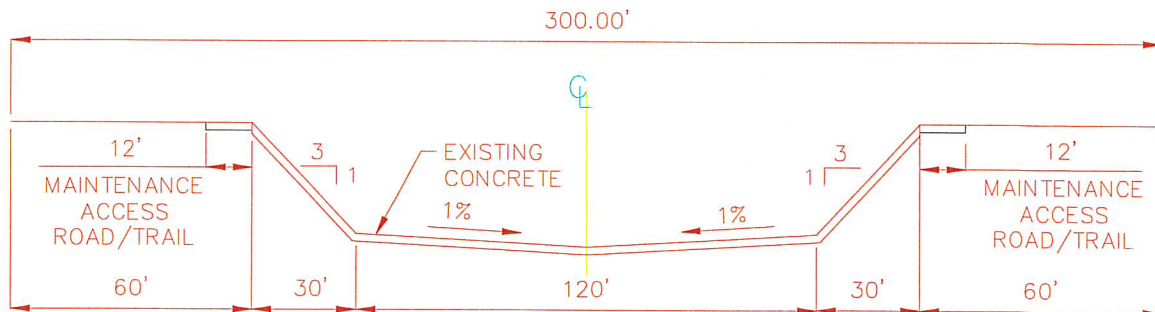
Responsible Governing Entity: Clark County.

Plan and Profile Segment Location: Extends from Station 434+65 to Station 448+00.

Channel Geometry

No cross section changes are recommended for this segment. The channel is currently a concrete-lined trapezoidal channel 120 feet wide with 3H:1V side slopes and a depth of 10 feet, as shown in the cross section below. The channel slope is 0.004 feet per foot. The

existing channel bottom is cross-sloped one percent towards the center to confine the nuisance flow. The flow is supercritical until Station 441+20 where a hydraulic jump occurs overtopping the existing channel banks. A floodwall, 4 feet high, is recommended on both sides of the existing channel at the top of the lining from Vegas Valley Drive to Station 443+00 to accommodate the backwater upstream of the Vegas Valley Drive culverts.



Maintenance Access Roads and Ramps

Existing maintenance access roads, 12 feet wide, are graded on both sides of the channel. These roads should be improved and better defined. Ramps into the channel bottom are not required through this segment due to the proximity of the access ramp downstream of Vegas Valley Drive. The 10-foot high culverts at Vegas Valley Drive are sufficient for maintenance vehicular access.

Right-of-Way Required

Right-of-way is sufficient for channel and maintenance operations through this segment.

Cost Estimate

The cost estimate considered the following line items for this segment.

Description	Quantity	Unit	Unit Cost	Total
10' wide asphalt trail	1,504	LF	\$15.45	\$23,236.80
Gravel Maintenance Road - 12' wide	1,530	LF	\$4.90	\$7,497.00
4' chain-link Fence	670	LF	\$10.00	\$6,700.00
Floodwall	1,575	LF	\$60.00	\$94,500.00
Line Items Sum				\$131,933.80
25% Contingency				\$32,983.45
Segment Total				\$164,917.25

The full estimate for all the segments is included in Appendix I.

Trail System/Recreation Constraints

A 10-foot wide asphalt trail is proposed for the north side of the channel. The trail is asphalted to accommodate the various pedestrian and cyclist traffic needs. However, the Sloan Channel interrupts the continuity of the trail. As the valley-wide trail system recommendations are determined, access across the Sloan Channel may be considered.

SNWA East Valley Lateral 78-inch water pipeline borders the east side of the Wash right-of-way. To protect this pipeline, cathodic protection test stations are placed at periodic locations along the pipeline. Barriers need to be placed at these locations to prevent public access to these stations.

Fencing and Signage Requirements

A 4-foot high chain-link fence or selected equivalent should be placed along the north side to delineate the trail from the channel and to promote public safety. As with the previous segment, trail demarcation signs should be placed on Vegas Valley Drive with the sign face parallel to the road. Another signpost with the Bike Route and Bicycle Yield signs should be placed approximately 100 feet from the entrance demarcation signs. These sign faces should be perpendicular to the trail. The Flood Warning Icon sign with its corresponding warning text and the No Unauthorized Entrance Icon sign with its corresponding warning text should be placed alternating at 150-foot intervals along the Wash. These warning sign faces should be placed parallel to the trail.

Sloan Channel to Flamingo Wash

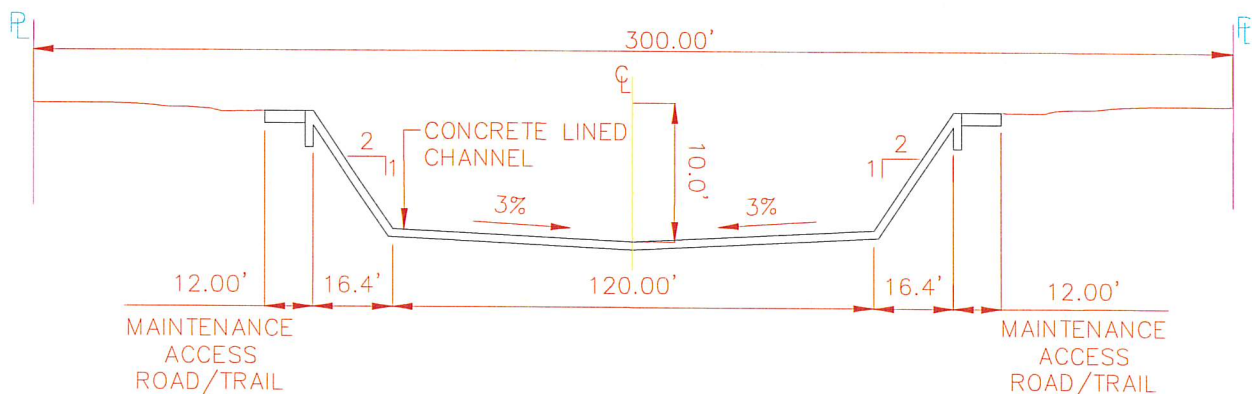
Responsible Governing Entity: Clark County.

Plan and Profile Segment Location: Extends from Station 448+00 to Station 474+00.

Channel Geometry

This section is a proposed trapezoidal concrete-lined channel using 2H:1V side slopes, 120-foot bottom width, and 10-foot depth from the Sloan Channel to Station 468+98 (see cross section below). The proposed section eliminates the need for the metal weir in this segment. From Station 468+98 to the existing cable-concrete block lining at the Flamingo Wash Confluence, the lining will be a trapezoidal cable-concrete block with 120-foot bottom width, 2H:1V side slopes, and 11.5-foot depth. The channel slope is 0.004 feet per foot to Station 474+00 then steepens to 0.0153 feet per foot to match the existing golf course grade. The bottom of the channel is cross-sloped by 3 percent to direct the nuisance flow to the center. The flow is supercritical from Sloan Channel to Station 470+50. From this point to the Flamingo Wash Confluence, the flow regime becomes subcritical.

Widening the channel at the boundary of the Desert Rose Golf course will necessitate replacing the existing golf cart pedestrian bridge to match the proposed conditions. Some modifications to golf tees may also be required. These items are beyond the scope of this study.





Right-of-Way Required

The channel right-of-way is sufficient for both maintenance access roads and a trail system through this segment.

Cost Estimate

The cost estimate considered the following line items for this segment.

The full estimate for all the segments is included in Appendix I.

Trail System/Recreation Constraints

The trail will be placed on the north side of the channel. The trail is asphalted to accommodate the various pedestrian and cyclist traffic needs. The ample right-of-way width allows for the possibility of meandering the trail and providing some landscaping within this segment. No recreation constraints are evident through this segment.

Fencing and Signage Requirements

The trail should be fenced with 4-foot high chain-link fence or suitable alternative along the channel adjacent to the trail to promote public safety and denote areas unsafe to public access. The trail demarcation signs should be placed at the end of Sloan Lane, perpendicular to the road. The Flood Warning Icon sign with its corresponding warning text and the No Unauthorized Entrance Icon sign with its corresponding warning text should be placed alternating at 150-foot intervals along the Wash. These warning sign faces should be placed parallel to the trail.

Flamingo Wash to Nellis Boulevard

Responsible Governing Entity: Clark County.

Plan and Profile Segment Location: Extends from Station 474+00 to Station 547+73.

Channel Geometry

No improvements through the golf course are currently proposed. A trapezoidal concrete-lined transition with 2H:1V side slopes and 110-foot bottom width will be used as a transition from the groomed grass lining to the Nellis Boulevard Bridge. The sloping abutments will be changed from 1.5H:1V to 1H:1V to accommodate the wider channel bottom. The channel slope is 0.015 feet per foot from the Flamingo Wash Confluence to Station 478+72 when the slope flattens to approximately 0.0016 feet per foot through remainder of the golf course. Nuisance flows are conveyed in a 24-inch RCP pipe from Station 475+00 to 485+20. Upstream of Station 485+20, the nuisance channel is a well-groomed and defined channel 13.5 feet wide and approximately 2 feet deep. Small footbridges cross the nuisance channel downstream of Sahara Avenue. The flow regime through this reach is predominately subcritical.

Maintenance Access Roads and Ramps

Existing golf cart paths double as maintenance roads through the golf course. An existing graded ramp downstream of Nellis Boulevard will be replaced with a concrete ramp.

Right-of-Way Required

Right-of-way, generally, is sufficient for the multi-use drainage and recreation demands for this reach. However, a small area, 0.022 acres, is needed to accommodate the transition from Nellis Boulevard to the golf course (see Figure 6-7). The value of the needed right-of-way is estimated at \$1,980 (\$90,000 per acre).

Cost Estimate

The cost estimate considered the following line items for this segment.

Description	Quantity	Unit	Unit Cost	Total
Transition	1	EA	\$50,000.00	\$50,000.00
Access Ramp	1	EA	\$70,000.00	\$70,000.00
Additional Right-of-Way	0.022	AC	\$90,000.00	\$1,980.00
			Line Items Sum	\$121,980.00
			25% Contingency	\$30,495.00
			Segment Total	\$152,475.00

The full estimate for all the segments is included in Appendix I.

Trail System/Recreation Constraints

Currently, access to the golf course area is restricted to golf course users.

Fencing and Signage Requirements

No additional fencing or signage is recommended through this segment.

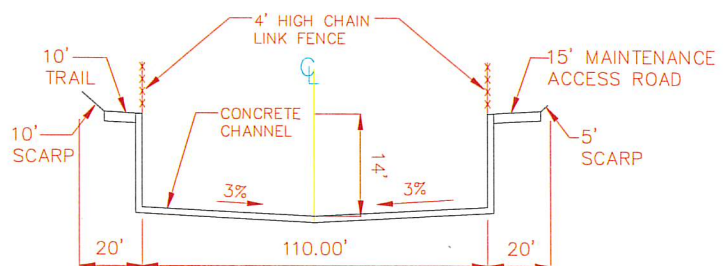
Nellis Boulevard to Charleston Boulevard

Responsible Governing Entity: Clark County.

Plan and Profile Segment Location: Extends from Station 547+73 to Station 560+86.

Channel Geometry

A rectangular concrete section, 110 feet wide and 14 feet deep, is recommended through this segment due to right-of-way constraints. The section includes a maintenance access road, 15 feet wide, adjacent to the north and east side of the channel and a 10-foot wide trail adjacent to the south and west sides of the channel (refer to cross section above). The remaining strip of land, 5 feet and 10 feet wide on the north and south sides, respectively, will provide a scarp to match existing grade at the right-of-way boundary. The channel is sloped 0.0011 feet per foot keeping the flow in the subcritical regime. The rectangular shape and the channel width maximize storm flow capacity through the Charleston Boulevard and Nellis Boulevard Bridges. The bottom of the channel is cross-sloped by 3 percent toward the center to confine the nuisance flow.



adjacent to the south and west sides of the channel (refer to cross section above). The remaining strip of land, 5 feet and 10 feet wide on the north and south sides, respectively, will provide a scarp to match existing grade at the right-of-way boundary. The channel is sloped 0.0011 feet per foot keeping the flow in the subcritical regime. The rectangular shape and the channel width maximize storm flow capacity through the Charleston Boulevard and Nellis Boulevard Bridges. The bottom of the channel is cross-sloped by 3 percent toward the center to confine the nuisance flow.

Maintenance Access Roads and Ramps

The maintenance access road was placed on the north and east side of the channel through this reach. The access ramp will be located downstream of Charleston Boulevard.

Right-of-Way Required

The right-of-way is sufficient for the recommended channel section.

Cost Estimate

The cost estimate considered the following line items for this segment.

Description	Quantity	Unit	Unit Cost	Total
Excavation	32,085	CY	\$5.00	\$160,425.00
Type II base bedding	990	LF	\$91.30	\$90,387.00
Concrete Lining - 12" thick rectangular	990	LF	\$1,278.00	\$1,265,220.00
10' wide asphalt trail	1,295	LF	\$15.45	\$20,007.75
Transition	2	EA	\$50,000.00	\$100,000.00
Gravel Maintenance Road - 15' wide	1,143	LF	\$6.10	\$6,972.30
Access Ramp	1	EA	\$70,000.00	\$70,000.00
Slope Paving (trail)	2,606	SF	\$2.00	\$5,212.00
Slope Paving (maintenance road)	3,919	SF	\$2.00	\$7,838.00
4' chain-link Fence	2,425	LF	\$10.00	\$24,250.00
Line Items Sum				\$1,750,312.05
25% Contingency				\$437,578.01
Segment Total				\$2,187,890.06

The full estimate for all the segments is included in Appendix I.

Trail System/Recreation Constraints

The trail is placed on the south and west side of the channel at the request of the City of Las Vegas. The trail is asphalted to accommodate the various pedestrian and cyclist traffic needs. The trail can be contiguous from the Service Road to the Flamingo Wash Confluence and from Nellis Boulevard to Civic Center Drive, but the Desert Rose Golf Course is currently only for golfers, creating a gap in the system. In addition, Wyoming Channel and the Colorado Avenue Channel create discontinuities in the trail alignment. Crossings at these locations may be considered.

Fencing and Signage Requirements

A 4-foot high fence must be located on both sides of the channel for safety reasons. The trail demarcation signs should be placed at the entrances to the trail at Nellis Boulevard and Charleston Boulevard parallel to the roads. Another signpost with the Bike Route and Bicycle Yield signs should be placed approximately 100 feet from the entrance demarcation signs. These sign faces should be perpendicular to the trail. The Flood Warning Icon sign with its corresponding warning text and the No Unauthorized Entrance Icon sign with its corresponding warning text should be placed alternating at 150-foot intervals along the Wash. These warning sign faces should be placed parallel to the trail.

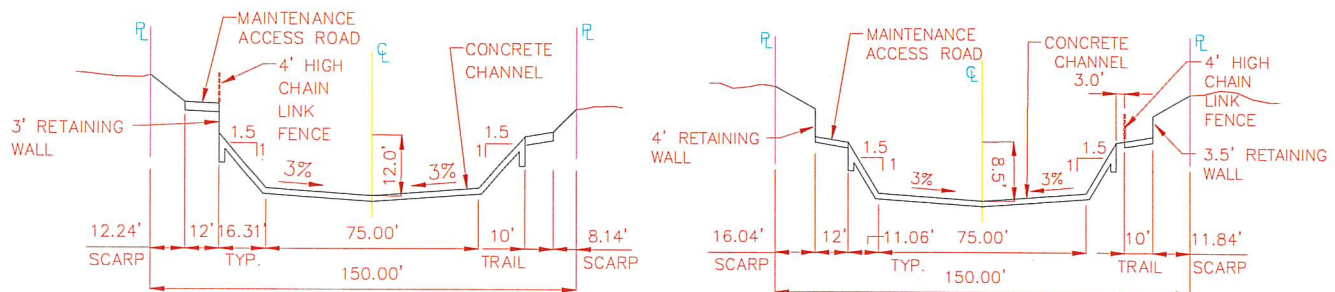
Charleston Boulevard to Stewart Avenue

Responsible Governing Entity: City of Las Vegas.

Plan and Profile Segment Location: Extends from Station 560+86 to Station 588+10.

Channel Geometry

As shown below, the proposed cross section through this segment is a concrete-lined trapezoidal section with 1.5H:1V side slopes and a bottom width of 75 feet. The channel is 13.5 feet deep to Station 566+00 with 2-foot and 4-foot high retaining walls on the west and east sides of the channel, respectively. Upstream of Station 567+00, the channel is 12.0 feet deep with 3-foot and 2-foot high retaining walls on the west and east sides of the channel, respectively. The channel slope is 0.0045 feet per foot. The bottom of the channel has a 3 percent cross slope to direct low flows to the center of the channel. The flow regime is supercritical from Stewart Avenue to Station 566+25 where the constriction at the Charleston Boulevard Bridge creates a hydraulic jump



Maintenance Access Roads and Ramps

The 12-foot wide maintenance access road is located adjacent to the west side of the concrete lining. The existing access ramp on the east side of the channel, downstream of Stewart Avenue, should be reconstructed in its present location.

Right-of-Way Required

The right-of-way is adequate for the channel and maintenance requirements.

Cost Estimate

The cost estimate considered the following line items for this segment.

Description	Quantity	Unit	Unit Cost	Total
Excavation	26,903	CY	\$5.00	\$134,515.00
Type II base bedding	2,017	LF	\$110.30	\$222,475.10
Concrete Lining - 6" thick - 13.5 feet deep	503	LF	\$836.00	\$420,508.00
Concrete Lining - 6" thick - 12.0 feet deep	2,017	LF	\$797.00	\$1,607,549.00
Type II base bedding	503	LF	\$104.90	\$52,764.70
10' wide asphalt trail	2,630	LF	\$15.45	\$40,633.50
Transition	2	EA	\$50,000.00	\$100,000.00

Description	Quantity	Unit	Unit Cost	Total
Gravel Maintenance Road - 12' wide	2,630	LF	\$4.90	\$12,887.00
Access Ramp	1	EA	\$60,000.00	\$60,000.00
Retaining Wall (maintenance road) 2' high	806	LF	\$20.00	\$16,120.00
Retaining Wall (maintenance road) 3' high	1,613	LF	\$30.00	\$48,390.00
Retaining Wall (trail) 4' high	806	LF	\$40.00	\$32,240.00
Retaining Wall (trail) 2' high	1,613	LF	\$20.00	\$32,260.00
4' chain-link Fence	5,260	LF	\$10.00	\$52,600.00
Line Items Sum				\$2,832,942.30
25% Contingency				\$708,235.58
Segment Total				\$3,541,177.88

The full estimate for all the segments is included in Appendix I.

Trail System/Recreation Constraints

Access is currently unavailable for this section due to the channel slope configuration. Room for a trail was made by narrowing the channel section and constructing retaining walls. The trail is asphalted to accommodate the various pedestrian and cyclist traffic needs.

Fencing and Signage Requirements

A 4-foot high chain-link fence or suitable alternative should be located adjacent to the east side of the channel along side the trail to delineate the trail and for public safety purposes. The trail demarcation signs should be placed at the entrances to the trail at Charleston Boulevard and Stewart Avenue, parallel to the roads. Another signpost with the Bike Route and Bicycle Yield signs should be placed approximately 100 feet from the entrance demarcation signs. These sign faces should be perpendicular to the trail. The Flood Warning Icon sign with its corresponding warning text and the No Unauthorized Entrance Icon sign with its corresponding warning text should be placed alternating at 150-foot intervals along the Wash. These warning sign faces should be placed parallel to the trail.

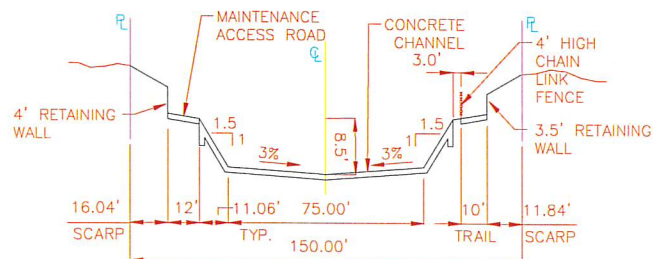
Stewart Avenue to Bonanza Road

Responsible Governing Entity: City of Las Vegas.

Plan and Profile Segment Location: Extends from Station 588+10 to Station 618+87.

Channel Geometry

The proposed channel section through this segment is a concrete-lined trapezoidal channel, 8.5 feet deep with 1.5H:1V side slopes, and a 75-foot wide bottom as shown in the cross section at right. Retaining walls 4.0 feet and 3.5 feet high are proposed for the west and east sides of the channel,



respectively. The channel slope is 0.0042 feet per foot. The bottom of the channel is cross-sloped by 3 percent towards the center to confine the nuisance flow. The 100-year design storm flow is in the supercritical regime.

Maintenance Access Roads and Ramps

A 12-foot wide maintenance access road is located on the west side of the channel. The access ramp is located upstream of the Cedar Avenue Channel Confluence.

Right-of-Way Required

The existing right-of-way is sufficient for the channel and maintenance operations.

Cost Estimate

The cost estimate considered the following line items for this segment.

Description	Quantity	Unit	Unit Cost	Total
Excavation	37,655	CY	\$5.00	\$188,275.00
Concrete Lining - 6" thick	2,965	LF	\$706.00	\$2,093,290.00
Type II base	2,965	LF	\$92.10	\$273,076.50
10' wide asphalt trail	2,985	LF	\$15.45	\$46,118.25
Transition	2	EA	\$50,000.00	\$100,000.00
Gravel Maintenance Road - 12' wide	2,981	LF	\$4.90	\$14,606.90
Access Ramp	1	EA	\$42,500.00	\$42,500.00
Retaining Wall (maintenance road) 4' high	2,863	LF	\$40.00	\$114,520.00
Retaining Wall (trail) 3.5' high	2,863	LF	\$35.00	\$100,205.00
Slope Paving (trail)	23,026	SF	\$2.00	\$46,052.00
4' chain-link Fence	2,985	LF	\$10.00	\$29,850.00
Line Items Sum				\$3,048,493.65
25% Contingency				\$762,123.41
Segment Total				\$3,810,617.06

The full estimate for all the segments is included in Appendix I.

Trail System/Recreation Constraints

The 10-foot wide trail located on the east side of the channel is asphalted to accommodate the various pedestrian and cyclist traffic needs.

Fencing and Signage Requirements

A 4-foot high chain-link fence or suitable alternative should be located 3 feet from the east side of the channel along side the trail to delineate the trail and for public safety purposes. The trail demarcation signs should be placed at the entrances to the trail at Stewart Avenue and Bonanza Road, parallel to the roads. Another signpost with the Bike Route and Bicycle Yield signs should be placed approximately 100 feet from the entrance demarcation signs.

These sign faces should be perpendicular to the trail. The Flood Warning Icon sign with its corresponding warning text and the No Unauthorized Entrance Icon sign with its corresponding warning text should be placed alternating at 150-foot intervals along the Wash. These warning sign faces should be placed parallel to the trail.

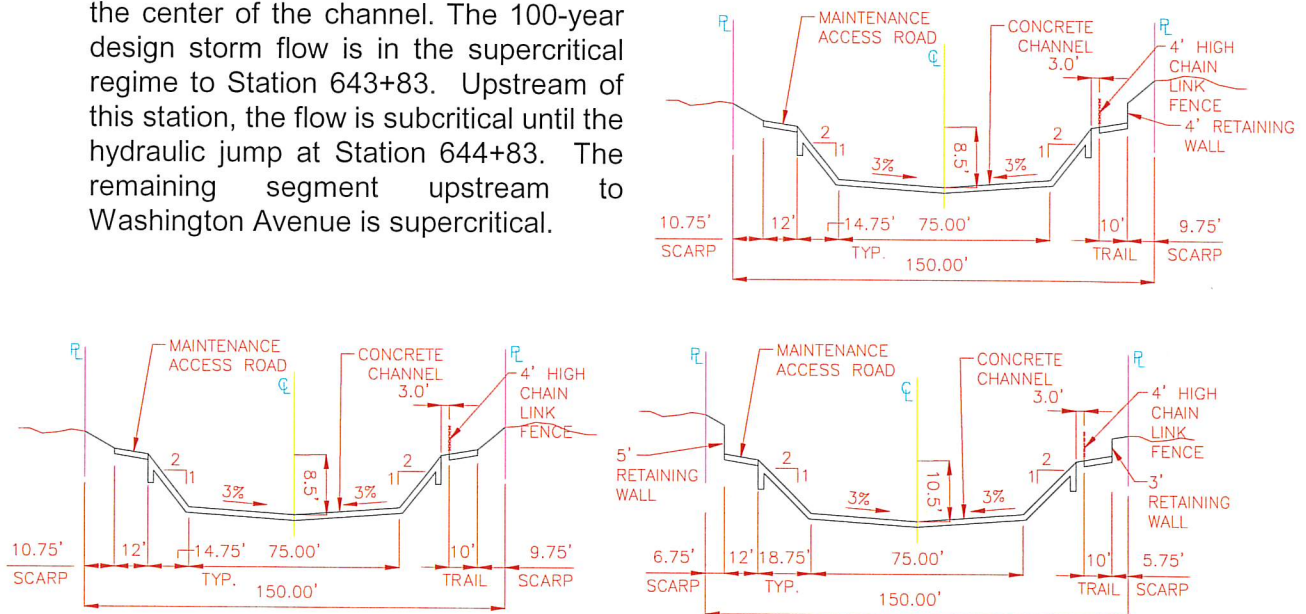
Bonanza Road to Washington Avenue

Responsible Governing Entity: City of Las Vegas.

Plan and Profile Segment Location: Extends from Station 618+87 to Station 649+10.

Channel Geometry

A concrete-lined trapezoidal channel, 8.5 feet deep with 2H:1V side slopes and a 75-foot wide bottom is proposed for Bonanza Road to Station 639+93 (refer to the cross sections below). A retaining wall 4 feet high is located east side of the channel. Upstream of Station 642+00, the channel deepens to 10.5 feet with retaining walls 5 feet and 3 feet located on the west and east sides, respectively. The retaining walls are necessary to meet existing ground and still provide room for the trail. The channel slope is 0.0033 feet per foot. The bottom of the channel is cross-sloped at 3 percent to direct the nuisance flows to the center of the channel. The 100-year design storm flow is in the supercritical regime to Station 643+83. Upstream of this station, the flow is subcritical until the hydraulic jump at Station 644+83. The remaining segment upstream to Washington Avenue is supercritical.



Locations/Widths of Maintenance Access Roads and Ramps

A 12-foot wide maintenance access road is proposed for the west side of the channel. Access ramps will be located on the west sides of the channel at Station 630+00 and downstream of the existing concrete lining at Washington Avenue.

Right-of-Way Required/Excess

Generally, the right-of-way is sufficient for the channel. However, a small notch encroaching on the right-of-way remains from a series of street vacations and deed transfers. The small area is approximately 0.003 acres (see Figure 6-8). Cost for the parcel was estimated at \$270 (\$90,000 per acre).

Cost Estimate

The cost estimate considered the following line items for this segment.

Description	Quantity	Unit	Unit Cost	Total
Excavation	33,208	CY	\$5.00	\$166,040.00
Concrete Lining - 6" thick - 8.5 feet deep	2,257	LF	\$706.00	\$1,593,442.00
Type II base bedding for 8.5 foot deep section	2,257	LF	\$92.10	\$207,869.70
Concrete Lining - 6" thick - 10.5 feet deep	108	LF	\$758.00	\$81,864.00
Type II base bedding for 10.5 foot deep section	108	LF	\$99.40	\$10,735.20
10' wide asphalt trail	2,912	LF	\$15.45	\$44,990.40
Transition	2	EA	\$50,000.00	\$100,000.00
Gravel Maintenance Road - 12' wide	2,934	LF	\$4.90	\$14,376.60
Access Ramp	1	EA	\$52,500.00	\$52,500.00
Retaining Wall (trail) 4' high	490	LF	\$40.00	\$19,600.00
Retaining Wall (trail) 3' high	478	LF	\$30.00	\$14,340.00
Retaining Wall (maintenance road) 5' high	478	LF	\$50.00	\$23,900.00
Slope Paving (trail)	18,816	SF	\$2.00	\$37,632.00
Slope Paving (maintenance road)	14,468	SF	\$2.00	\$28,936.00
Additional Right-of-Way	0.003	AC	\$90,000.00	\$270.00
4' chain-link Fence	2,912	LF	\$10.00	\$29,120.00
Line Items Sum				\$2,425,615.90
25% Contingency				\$606,403.98
Segment Total				\$3,032,019.88

The full estimate for all the segments is included in Appendix I.

Trail System/Recreation Constraints

The 10-foot wide trail on the east side of the channel is asphalted to accommodate the various pedestrian and cyclist traffic needs. An existing footbridge crosses the Wash at the end of Arrowroot Avenue. The trail passes by the Dell H. Robison Middle School at the intersection of Marion Drive and Harris Avenue.

Fencing and Signage Requirements

A 4-foot high chain-link fence or suitable alternative should be located 3 feet from the east side of the channel lining along side the trail to delineate the trail and for public safety purposes. The trail demarcation signs should be placed at the entrances to the trail at Bonanza Road and Washington Avenue parallel to the roads. Another signpost with the Bike Route and Bicycle Yield signs should be placed approximately 100 feet from the entrance demarcation signs. These sign faces should be perpendicular to the trail. The Flood Warning Icon sign with its corresponding warning text and the No Unauthorized Entrance Icon sign with its corresponding warning text should be placed alternating at 150-foot intervals along the Wash. These warning sign faces should be placed parallel to the trail.

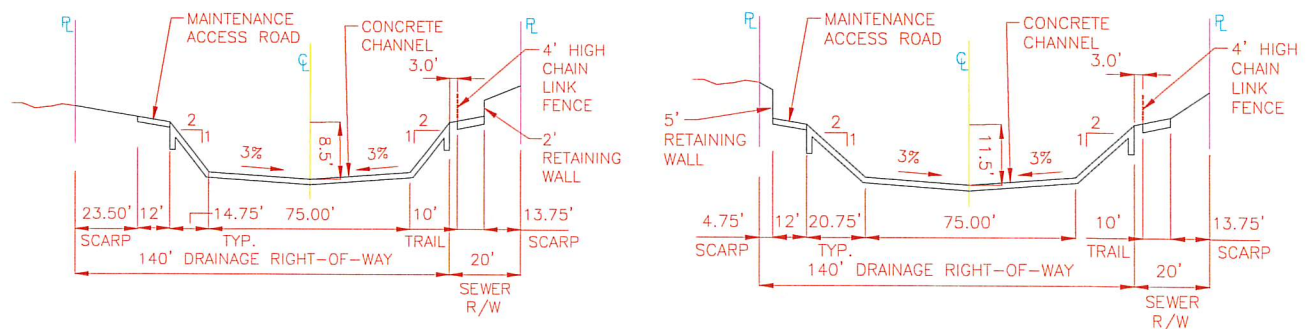
Washington Avenue to Lamb Boulevard

Responsible Governing Entity: City of Las Vegas.

Plan and Profile Segment Location: Extends from Station 649+10 to Station 669+09.

Channel Geometry

As shown below, the proposed channel section through this segment is a concrete-lined trapezoidal channel, 8.5 feet deep with 2H:1V side slopes and a 75-foot wide bottom. This section extends from Washington Avenue to Station 666+00. A retaining wall 2 feet high is recommended on the east side of the channel. Upstream of Station 666+00, the proposed channel deepens to 11.5 feet with a retaining wall 5 feet high, located on the west side. The retaining wall is needed to meet existing grade at the edge of right-of-way and still have room for a trail. The channel slope is 0.0035 feet per foot. The bottom of the channel is cross-sloped by 3 percent to the center of the channel to confine the nuisance flow. The 100-year design storm flow is in the supercritical regime.



Maintenance Access Roads and Ramps

The 12-foot wide gravel maintenance access road is proposed on the west side of the channel. The access ramp is recommended at Lamb Boulevard on the east side.

Right-of-Way Required

The current right-of-way is sufficient for the channel, trail, and maintenance operations.

Cost Estimate

The cost estimate considered the following line items for this segment.

Description	Quantity	Unit	Unit Cost	Total
Excavation	30,396	CY	\$5.00	\$151,980.00
Concrete Lining - 6" thick - 8.5 feet deep	1,416	LF	\$706.00	\$999,696.00
Type II base bedding for 8.5 feet deep	1,416	LF	\$92.10	\$130,413.60
Concrete Lining - 6" thick - 11.5 feet deep	55	LF	\$784.00	\$43,120.00
Type II base bedding for 11.5 feet deep	55	LF	\$103.00	\$5,665.00
10' wide asphalt trail	2,000	LF	\$15.45	\$30,900.00
Transition	3	EA	\$50,000.00	\$150,000.00
Gravel Maintenance Road - 12' wide	1,790	LF	\$4.90	\$8,771.00

Description	Quantity	Unit	Unit Cost	Total
Access Ramp	1	EA	\$57,500.00	\$57,500.00
Retaining Wall (trail) 5' high	1,786	LF	\$50.00	\$89,300.00
Retaining Wall (maintenance road) 2' high	500	SF	\$2.00	\$1,000.00
Slope Paving (maintenance road)	12,165	SF	\$2.00	\$24,330.00
4' chain-link Fence	2,000	LF	\$10.00	\$20,000.00
Line Items Sum				\$1,712,675.60
25% Contingency				\$428,168.90
Segment Total				\$2,140,844.50

The full estimate for all the segments is included in Appendix I.

Trail System/Recreation Constraints

The 10-foot wide trail on the east side of the channel is asphalted to accommodate the various pedestrian and cyclist traffic needs. An existing sanitary sewer under the recommended trail alignment will cause some design restrictions.

Fencing and Signage Requirements

A 4-foot high chain-link fence or suitable alternative shall be located 3 feet from the east side of the channel along side the trail to delineate the trail and for public safety purposes. The trail demarcation signs should be placed at the entrances to the trail at Washington Avenue and Lamb Boulevard, parallel to the roads. Another signpost with the Bike Route and Bicycle Yield signs should be placed approximately 100 feet from the entrance demarcation signs. These sign faces should be perpendicular to the trail. The Flood Warning Icon sign with its corresponding warning text and the No Unauthorized Entrance Icon sign with its corresponding warning text should be placed alternating at 150-foot intervals along the Wash. These warning sign faces should be placed parallel to the trail.

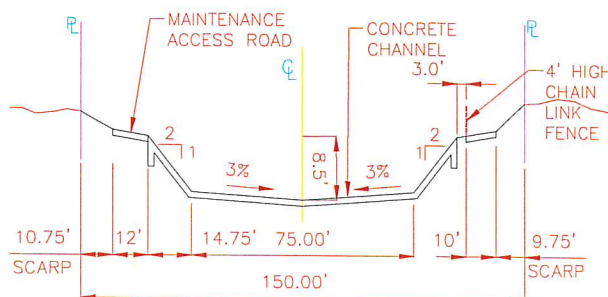
Lamb Boulevard to Owens Avenue

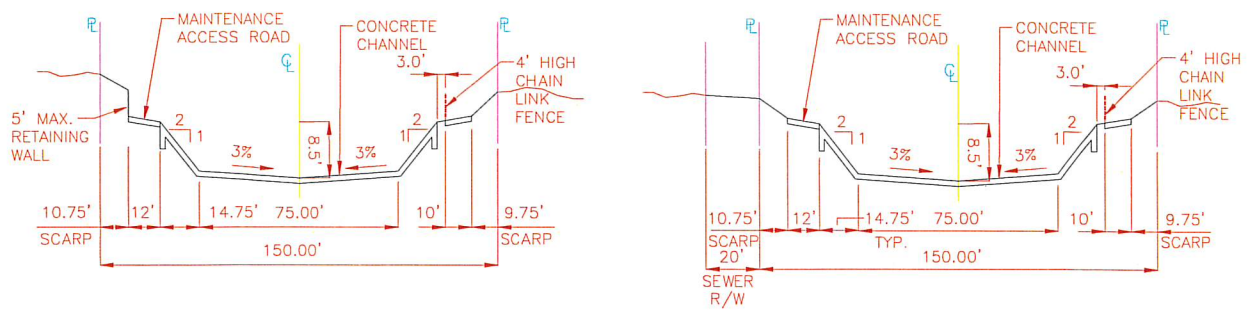
Responsible Governing Entity: City of Las Vegas.

Plan and Profile Segment Location: Extends from Station 669+09 to Station 714+07.

Channel Geometry

As shown below, the proposed cross section through this reach is a concrete-lined trapezoidal channel, 8.5 feet deep with 2H:1V side slopes, and a 75-foot wide bottom. A retaining wall 5 feet high is located on the west side of the channel from Station 670+60 to Station 683+96. The retaining wall is necessary to eliminate scarp to leave room for a trail. The channel slope is 0.005 feet per foot. The 100-year design storm flows in the supercritical regime. The bottom of the channel is cross-sloped by 3 percent towards the center to confine the nuisance flow.





Maintenance Access Roads and Ramps

A 12-foot wide gravel maintenance access road is recommended adjacent to the west bank of the channel. An access ramp is proposed downstream of the Washington Channel at Station 690+00 on the west side. Another west side ramp is proposed just downstream of Owens Avenue.

Right-of-Way Required/Excess

The existing right-of-way is sufficient for the channel and maintenance operations. A parcel of land beginning at Sandhill Road is in excess of channel needs (refer to Figure 6-9).

Cost Estimate

The cost estimate considered the following line items for this segment.

Description	Quantity	Unit	Unit Cost	Total
Excavation	83,844	CY	\$5.00	\$419,220.00
Concrete Lining - 6" thick - 8.5 feet deep	4,190	LF	\$706.00	\$2,958,140.00
Type II base	4,190	LF	\$92.10	\$385,899.00
10' wide asphalt trail	4,355	LF	\$15.45	\$67,284.75
Transition	2	EA	\$50,000.00	\$100,000.00
Gravel Maintenance Road – 12' wide	4,512	LF	\$4.90	\$22,108.80
Access Ramp	1	EA	\$42,500.00	\$42,500.00
Retaining Wall (maintenance road) 5' high	1,336	LF	\$50.00	\$66,800.00
Slope Paving (maintenance road)	22,396	SF	\$2.00	\$44,792.00
Slope Paving (trail)	45,365	SF	\$2.00	\$90,730.00
4' chain-link Fence	4,355	LF	\$10.00	\$43,550.00
Line Items Sum				\$4,241,024.55
25% Contingency				\$1,060,256.14
Segment Total				\$5,301,280.69

The full estimate for all the segments is included in Appendix I.

Trail System/Recreation Constraints

The 10-foot wide trail located on the east side of the channel is asphalted to accommodate the various pedestrian and cyclist traffic needs. A sanitary sewer located under the trail alignment may cause some design restrictions.

Fencing and Signage Requirements

A 4-foot high chain-link fence or suitable alternative should be located adjacent to the east side of the channel along side the trail to delineate the trail and for public safety purposes. The trail demarcation signs should be placed at the entrances to the trail at Lamb Boulevard and at Owens Avenue, parallel to the roads. Another signpost with the Bike Route and Bicycle Yield signs should be placed approximately 100 feet from the entrance demarcation signs. These sign faces should be perpendicular to the trail. The Flood Warning Icon sign with its corresponding warning text and the No Unauthorized Entrance Icon sign with its corresponding warning text should be placed alternating at 150-foot intervals along the Wash. These warning sign faces should be placed parallel to the trail.

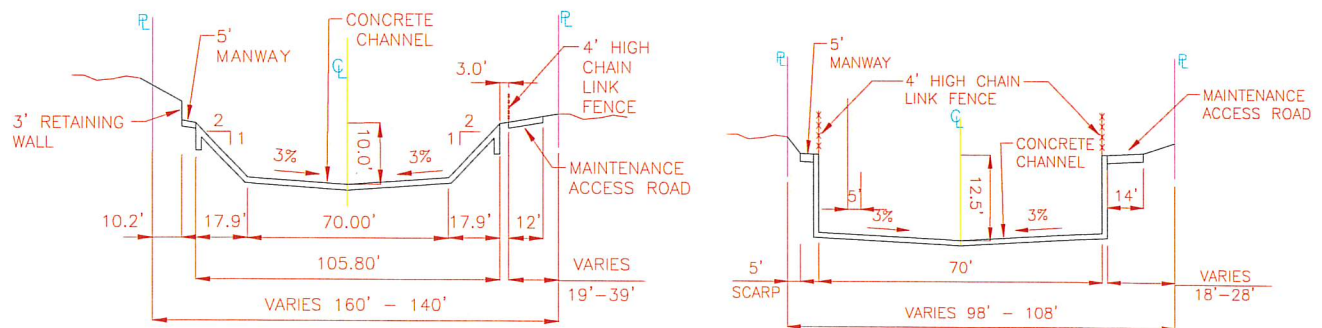
Owens Avenue to Lake Mead Boulevard

Responsible Governing Entity: Clark County.

Plan and Profile Segment Location: Extends from Station 714+07 to Station 749+76.

Channel Geometry

The proposed channel section through this segment is a concrete-lined trapezoidal section from Owens Avenue to Station 727+00, then transitions to a rectangular section at Station 730+54 as shown in the cross sections below. The trapezoidal channel is 10 feet deep with 2H:1V side slopes and a 70-foot wide bottom. A retaining wall 3 feet high is located 5 feet from the channel west bank. The rectangular concrete section is 12.5 feet deep with a 70-foot wide bottom. The channel slope is 0.0067 feet per foot from Owens Avenue to Station 745+00. The slope increases to 0.011 feet per foot to Station 747+30. From this station to Lake Mead Boulevard, the slope is 0.007 feet per foot. The bottom of the channel is cross-sloped to the center of the channel at 3 percent to confine the nuisance flow. The 100-year design storm flow is in the supercritical regime to Station 747+30. The rest of the reach operates under subcritical flow conditions.



Maintenance Access Roads and Ramps

A 5-foot wide manway is proposed adjacent to the west bank. The maintenance access road will be 12 feet wide along the east side of the channel along the trapezoidal section.

Along the rectangular section, the maintenance road width is increased to 14 feet. An access ramp will be located off Pecos Road at Station 744+50, just downstream of Lake Mead Boulevard.

Right-of-Way Required

The existing right-of-way is narrow, but the channel section has been designed to fit within the boundaries. Therefore, no additional right-of-way is needed.

Cost Estimate

The cost estimate considered the following line items for this segment.

Description	Quantity	Unit	Unit Cost	Total
Excavation	26,242	CY	\$5.00	\$131,210.00
Concrete Lining - 6" thick – trapezoidal	1,066	LF	\$713.00	\$760,058.00
Type II base bedding under trapezoidal	1,066	LF	\$93.50	\$99,671.00
Concrete Lining – 12" thick – rectangular	1,981	LF	\$852.00	\$1,687,812.00
Type II base bedding under rectangular	1,981	LF	\$58.70	\$116,284.70
10' wide asphalt trail	3,456	LF	\$15.45	\$53,395.20
Transition	3	EA	\$50,000.00	\$150,000.00
Gravel Maintenance Road - 14' wide	3,238	LF	\$5.70	\$18,456.60
Access Ramp	1	EA	\$70,000.00	\$70,000.00
Retaining Wall (manway) 3' high	1,800	LF	\$30.00	\$54,000.00
Slope Paving (manway)	8,791	SF	\$2.00	\$17,582.00
4' chain-link Fence	5,541	LF	\$10.00	\$55,410.00
Line Items Sum				\$3,213,879.50
25% Contingency				\$803,469.88
Segment Total				\$4,017,349.38

The full estimate for all the segments is included in Appendix I.

Trail System/Recreation Constraints

The trail will share the maintenance access road on the east side of the channel. The road is asphalted to accommodate the various pedestrian and cyclist traffic needs. During the periods of maintenance operations, public access to the trail may be restricted.

Fencing and Signage Requirements

A 4-foot high chain-link fence or suitable alternative is recommended to be located 3 feet from the east side of the channel to Station 727+00. Thereafter, the fence should be placed adjacent to the east side of the channel along side the trail to delineate the trail and for public safety purposes. The trail demarcation signs should be placed at the entrances to the trail at Owens Avenue and at Lake Mead Boulevard, parallel to the roads. Another signpost with the Bike Route and Bicycle Yield signs should be placed approximately 100 feet from the entrance demarcation signs. These sign faces should be perpendicular to the

trail. The Flood Warning Icon sign with its corresponding warning text and the No Unauthorized Entrance Icon sign with its corresponding warning text should be placed alternating at 150-foot intervals along the Wash. These warning sign faces should be placed parallel to the trail.

Lake Mead Boulevard to Carey Avenue

Responsible Governing Entity: City of North Las Vegas.

Plan and Profile Segment Location: Extends from Station 749+76 to Station 781+75.

Channel Geometry

This segment is currently under design by others. Preliminary drawings for this segment are included in Volume 2. The proposed channel section for this reach is a concrete-lined, rectangular section, 84 feet wide, 10 to 13 feet deep. The channel slope is 0.0033 feet per foot from Lake Mead Boulevard to Station 780+41 where the slope increases to 0.026 feet per foot to Carey Avenue. The flow is subcritical upstream of the Lake Mead Boulevard culverts to Station 76+167. The remaining segment operates under supercritical flow conditions.

Maintenance Access Roads and Ramps

The 12-foot wide gravel maintenance access roads are located on both sides adjacent to the channel. An access ramp is proposed on the west side of the channel at Station 756+00, 550 feet upstream of Lake Mead Boulevard.

Right-of-Way Required

Current right-of-way is sufficient for the channel section, maintenance operations, and a trail.

Cost Estimate

The cost estimate provided in the predesign report calculated the entire cost for channel improvements from Lake Mead Boulevard to Civic Center Drive to be \$19 million. The preliminary design report did not break the costs down into each segment.

Trail System/Recreation Constraints

A trail system can occupy the same space as the maintenance access road on the east side of the channel. Sufficient room exists to place items such as landscaping, exercise stations, or picnic areas along the trail. Excess right-of-way is available to allow trail alignment to meander.

Fencing and Signage Requirements

It is recommended that a 4-foot high chain-link fence or suitable alternative be located at the top of the channel wall for public and maintenance operations safety. The trail demarcation signs should be placed at the entrances to the trail from the intersection of Lake Mead Boulevard and Pecos Road and from Carey Avenue. The sign faces should be perpendicular to the trail. Another signpost with the Bike Route and Bicycle Yield signs should be placed approximately 100 feet from the entrance demarcation signs. These sign faces should also be perpendicular to the trail. The Flood Warning Icon sign with its

corresponding warning text and the No Unauthorized Entrance Icon sign with its corresponding warning text should be placed alternating at 150-foot intervals along the Wash. These warning sign faces should be placed parallel to the trail.

Carey Avenue to Las Vegas Boulevard

Responsible Governing Entity: City of North Las Vegas.

Plan and Profile Segment Location: Extends from Station 781+75 to Station 809+00.

Channel Geometry

This reach is currently being designed by others. The proposed channel section consists of a concrete-lined trapezoidal channel with 2H:1V side slopes, 80-foot bottom width, and 10-foot depth. The channel slope is 0.0109 feet per foot from Carey Avenue to Station 783+06.45, flattens to 0.0036 feet per foot to Station 807+50, and then steepens to 0.04 feet per foot to Las Vegas Boulevard. The calculated flow regime is supercritical. The preliminary plan and profile drawings for the "A" Channel are included in Volume 2.

Maintenance Access Roads and Ramps

The 12-foot wide gravel maintenance access roads are proposed on both sides adjacent to the channel. An access ramp is located on the west side of the channel at Station 803+50, 550 feet downstream of Las Vegas Boulevard.

Right-of-Way-Required

The existing right-of-way is sufficient for the channel, maintenance operations, and trail system.

Cost Estimate

The cost estimated provided in the predesign report did not break down the costs per segment. The entire cost for channel improvements from Lake Mead Boulevard to Civic Center Drive was estimated to be \$19 million.

Trail System/Recreation Constraints

A trail system can occupy the same space as the maintenance access road on the east side of the channel. The trail passes by the Fay Herron Elementary School.

Fencing and Signage Requirements

A 4-foot high chain-link fence or suitable alternative should be located 3 feet from the top of the channel lining on the east side for public and maintenance operations safety. The trail demarcation signs should be placed at the entrances to the trail from Carey Avenue and from Las Vegas Boulevard. The sign faces should be perpendicular to the trail. Another signpost with the Bike Route and Bicycle Yield signs should be placed approximately 100 feet from the entrance demarcation signs. These sign faces should also be perpendicular to the trail. The Flood Warning Icon sign with its corresponding warning text and the No Unauthorized Entrance Icon sign with its corresponding warning text should be placed alternating at 150-foot intervals along the Wash. These warning sign faces should be placed parallel to the trail.

Las Vegas Boulevard to Cheyenne Avenue

Responsible Governing Entity: City of North Las Vegas.

Plan and Profile Segment Location: Extends from Station 809+00 to Station 840+30.

Channel Geometry

This portion of the wash is currently under design by others. The proposed section is a concrete-lined trapezoidal section with 2H:1V side slopes, 80-foot bottom width, and 10-foot depth. The slope is 0.0052 feet per foot from Las Vegas Boulevard to Station 838+64. The slope then steepens to 0.0069 feet per foot to Cheyenne Avenue. The flow regime is supercritical. Preliminary drawings are included in Volume 2.

Maintenance Access Roads and Ramps

Maintenance access roads, 12-feet wide, are proposed on both sides of the channel. The access ramp will be located on the west side of the channel at Station 816+00, just downstream of the confluence with the "N" Channel.

Right-of-Way Required

The existing right-of-way is sufficient for the channel, maintenance operations, and trail system.

Cost Estimate

The predesign report estimate of the entire cost for channel improvements from Lake Mead Boulevard to Civic Center Drive to be \$19 million. The report did not break the costs down into each segment.

Trail System/Recreation Constraints

A trail system can occupy the same space as the maintenance access road on the east side of the channel. The "N" Channel Confluence interrupts the continuity of the trail. A footbridge may be added at this location. The Lincoln Elementary School is located a short distance from the Wash near Cheyenne Avenue.

Fencing and Signage Requirements

A 4-foot high chain-link fence or suitable alternative should be located 3 feet from the top of the channel lining on the east side for public and maintenance operations safety. The trail demarcation signs should be placed at the entrances to the trail from Las Vegas Boulevard and Cheyenne Avenue. The sign faces should be perpendicular to the trail. Another signpost with the Bike Route and Bicycle Yield signs should be placed approximately 100 feet from the entrance demarcation signs. These sign faces should also be perpendicular to the trail. The Flood Warning Icon sign with its corresponding warning text and the No Unauthorized Entrance Icon sign with its corresponding warning text should be placed alternating at 150-foot intervals along the Wash. These warning sign faces should be placed parallel to the trail.

Cheyenne Avenue to Civic Center Drive

Responsible Governing Entity: City of North Las Vegas.

Plan and Profile Segment Location: Extends from Station 840+30 to Station 866+80.

Channel Geometry

The channel design for this segment is under design by others. The recommended channel improvements pass through the proposed Cheyenne Peaking Detention Basin site. Copies of the drawings for this project are included in Volume 2. Table 6-3 below gives the station range and type of improvements. Improvements are given from downstream to upstream.

Table 6-3: Cheyenne to Civic Center Improvements		
Station Range	Improvements	Slope
76+00 to 74+10	Currently under design by Louis Berger	
74+10 to 69+58	Concrete Rectangular Channel 90 feet by 7 feet	0.004
69+58 to 68+08	Transition	0.004
68+08 to 65+87	60-foot by 7.25-foot RCB with 2-foot center pier	0.004
65+87 to 65+37	Transition	0.0015
65+37 to 58+84	Concrete Rectangular Channel 60 feet by 11 feet; Portions of side walls act as Side weirs	0.0015
58+84 to 56+84	Transition	0.0246
56+84 to 50+00	Concrete Rectangular Channel 120 feet by 10 feet	0.001
50+00 to 48+61	Transition	0.0275

Flow is subcritical through the peaking detention basin area to allow the side weirs to function properly. In all other areas, the flow is supercritical.

Nuisance flow is centered in the channel section by cross-sloping the bottom at 2 percent.

Maintenance Access Roads and Ramps

Along side the Las Vegas Wash, the maintenance access roads are 16 feet wide and located on both sides of the channel. At the peaking detention basin, the roads widen to 20 feet and are located on top of the basin berm. An access ramp will be constructed just downstream of Civic Center Drive into the channel bottom.

Right-of-Way Required

The City of North Las Vegas is in the process of obtaining the required right-of-way to construct the Cheyenne Peaking Detention Basin. The right-of-way plans show the new configuration.

Cost Estimate

The preliminary design report estimated the entire cost for channel improvements from Lake Mead Boulevard to Civic Center Drive to be \$19 million. The costs for each segment were not reported separately.

Trail System/Recreation Constraints

The trail will continue on the east side of the channel and around the perimeter of the peaking detention basin. A pedestrian bridge will be constructed to cross foot traffic to the west side of the peaking detention basin. Street lights will be placed along the trail around the basin. Pedestrian access to the bottom of the basin will not be provided nor permitted.

Fencing and Signage Requirements

NDOT Type "R" Pedestrian Rail will be placed on the approaches to the pedestrian footbridge. The area around the peaking detention basin does not require fencing, although signs stating "Danger!! Do Not Enter Subject to Flooding. No Trespassing. NRS 207.200" will be posted along the perimeter trail at the top of the basin berm.

Civic Center Drive to I-15

Responsible Governing Entity: City of North Las Vegas.

Plan and Profile Segment Location: Extends from Station 866+80 to Station 874+70.

Channel Geometry

A concrete channel lining will be extended north 48 feet from Civic Center Drive to the existing concrete lining. The existing lining is a trapezoidal section with 2H:1V side slopes, 10-foot depth, and 72-foot bottom width. The flow is supercritical. The slope of the channel is 0.064 feet per foot. The channel bottom is cross-sloped at 2 percent to direct nuisance water flows to the center of the channel.

Maintenance Access Roads and Ramps

Maintenance access roads, 12 feet wide, exist on top of the channel on each side. On the north side, a chain-link fence separates the maintenance road from the channel. On the south side, the maintenance road connects to the access ramp located midway between Civic Center Drive and I-15.

Right-of-Way Required

The right-of-way is sufficient for the channel and maintenance operations.

Cost Estimate

The entire cost for channel improvements from Lake Mead Boulevard to Civic Center Drive was estimated to be \$19 million. The preliminary design report did not break the costs down into each segment.

Trail System/Recreation Constraints

The maintenance road configuration does not lend itself to a trail system in this area. The restriction on space and the lack of an access to the west of I-15 limit recreational opportunities.

Fencing and Signage Requirements

No fencing and additional signs are required in this area.

PROJECT PHASING

Recommendations for Construction Phasing

Proposed phasing of construction should consider both the protection of existing development and ease of construction. Storm drainage facilities are generally constructed from the downstream to the upstream to minimize the effect that an improved channel section may have on downstream unimproved sections. Existing utilities and the intense development that exists along the Las Vegas Wash through the study area was given emphasis during the construction phasing recommendations.

There is existing head cutting in the Las Vegas Wash at the Monson Channel that is an ongoing process resulting from both the effluent discharge of the Clark County and City of Las Vegas sewer treatment plants' nuisance and storm flows. Loss of the Whitney Lateral which crosses under the wash in this location could have a significant impact on the Valley water supply and was considered the most eminent concern in the limits of the study area. The Southern Nevada Water Authority (SNWA) is currently designing the Upper Diversion and Monson Channel weirs to eliminate the head cutting problem.

The second major concern is the inflows into the Las Vegas Wash at Interstate 15. Projections in the analysis note that as early as 2005, development within the watershed could increase the 100-year peak flow in the Las Vegas Wash beyond what the existing and proposed facilities are designed to handle.

The next area of concern is the portion of the Las Vegas Wash that passes through the high density urban and commercial development located between Nellis Boulevard and Cheyenne Avenue. Hydraulic modeling of this area shows a number of locations of overtopping of existing culvert and bridge structures and breakouts from the existing channel into the urbanized areas.

There are existing sanitary sewer siphons underneath the Las Vegas Wash in the alignment of Sloan Lane. However, temporary facilities and the construction of the siphon itself have mitigated problems that might be associated with erosion in this area and it does not appear to be an immediate need.

The last area, the Service Road to Vegas Valley Drive Reach, lacks hydraulic capacity and is subject to flooding during major storm events. However, the lack of development adjacent to the wash and the heavy vegetation in the overbank areas reduces the need for immediate action.

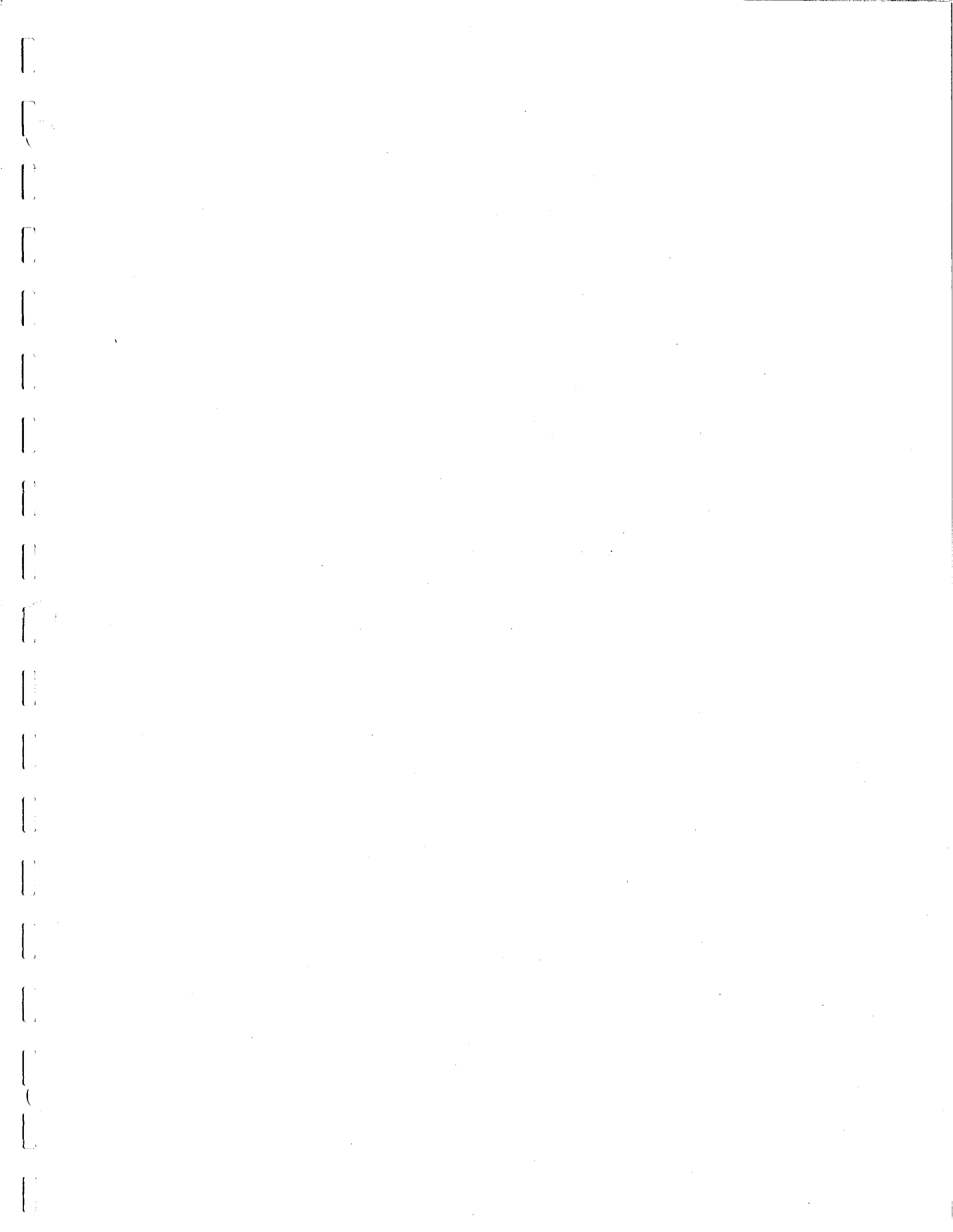
Table 7-1 lists the recommended construction phasing for the Las Vegas Wash.

Table 7-1: Construction Phasing	
Phase	Description
1	Inline Weirs at Monson Channel
2	Las Vegas Wash Channel Cheyenne Avenue to I-15
3	Cheyenne Peaking Detention Basin
4	Las Vegas Wash Channel Lamb Boulevard to Lake Mead Boulevard
5	Carey Avenue, Las Vegas Blvd and Cheyenne Avenue Bridges

Table 7-1: Construction Phasing

Phase	Description
6	Las Vegas Wash Channel Lake Mead Boulevard to Cheyenne Avenue
7	Las Vegas Wash Channel Nellis Boulevard to Lamb Boulevard
8	Las Vegas Wash Channel Sloan Channel Confluence to Desert Rose Golf Course
9	Las Vegas Wash Channel Service Road to Vegas Valley Drive

The most critical project is to stop the head cutting at the Monson Channel to protect the Whitney Lateral. Phases 2 and 3 are the construction of portions of the Cheyenne peaking basin to limit the inflow into the Las Vegas Wash. Phase four is the improvement of the Las Vegas Wash between Lamb Boulevard and Lake Mead Boulevard to minimize the breakouts into existing urban development. Phase 5 is the upgrading of the culverts at Cary Avenue, Las Vegas Boulevard, and Cheyenne Avenue. Phase 6 is the construction of the Las Vegas Wash Channel from Lake Mead Boulevard to Cheyenne Avenue. Phase 7 is the construction of the Las Vegas Wash Channel from Nellis Boulevard to Lamb Boulevard. Phase 8 is the construction of the proposed Las Vegas Wash Channel from the Sloan Channel confluence to the Flamingo Wash confluence and the last phase in the construction of the channel reach from the Service Road to Vegas Valley Drive.



PERMITS

This section provides a discussion of the following permits:

- Section 404 of the Clean Water Act Permit
- Dust Control Permit
- CCRFCD Section 14 Environmental Review
- Storm Water Discharge Permit for Construction Activities
- Temporary Permit for Working in Waterways (Rolling Stock Permit)

As additional information, Appendix J contains the complete permit matrices assembled by PBS&J for the City of North Las Vegas. Not all permits listed in the matrices may be applicable to the Las Vegas Wash.

Permits necessary are summarized below:

Section 404 of the Clean Water Act Permit:

Issued by: US Army Corps of Engineers, Sacramento District
Contact: Ms. Nancy Kang, (775) 784-5304
Address: Clifton Young Federal Building
300 Booth Street, Room 2103
Reno, NV 89509-8126

This permit is required for placing fill material within wetlands or *Waters* of the United States. The applicant is required to demonstrate that the proposed fill into the waters of the United States is unavoidable and the least environmentally-damaging practical alternative for the aquatic ecosystem that will achieve the basic project purpose. For unavoidable impacts, the guidelines also require appropriate and practical mitigation measures.

The water surface created by the continually flowing water in the Las Vegas Wash would be considered *Waters* of the United States. Wetlands are determined by the presence of aquatic soils, specific plants, and surface water recharge. All three components must be present for a wetlands designation. It is likely that at least a portion of the Las Vegas Wash being addressed in this analysis would be identified as wetlands.

The 404 Permit Application should include a wetlands survey by a qualified biologist to define the limits of wetlands impacted by the project. Alternatives considered and any mitigations plans that may be required would also need to be addressed in the application. The application must include the following:

- Department of the Army ENG Form 4345.
- Description of the project.
- Pre-construction photographs of the project site.
- Site location map and a view of the project showing areas and acreages to be impacted.
- Volume and type of fill material to be placed.

- Total area of waters of the United States to be directly or indirectly affected.
- Verified delineations of waters of the United States in project area.
- A description of habitat including plant community located in the area.
- Descriptions of methods to avoid, minimize, or mitigate adverse impacts and alternatives considered.
- Best Management Practices for use during construction to control siltation and erosion.
- Any other information pertinent to wetlands, stream, or water body involved.
- Proposed construction schedule.

The USACE requires comments from the following federal and state agencies as part of the 404 Permit process:

1. US Department of Environmental Protection Agency (USEPA)

Contact: Kathleen Dadey
Address: Region IX-Wetlands Section (WTR-8)
75 Hawthorne Street
San Francisco, CA 94105-3901

The USEPA will review the project to ensure that consideration was given to maintaining wetlands where possible. The use of hard line channels must be justified in terms of public safety, available right-of-way, cost, and practicability.

2. US Fish and Wildlife Service (USFWS)

Contact: Erik Orsak, (702) 647-5230
Address: 1510 North Decatur Boulevard
Las Vegas, NV 89109

The USFWS will review the project to verify consistency with the Endangered Species Act and the Migratory Bird Treaty Act. Negative impacts could be mitigated by wetlands replacement, limiting the months that construction is allowed to that portion of the year when migratory birds are not nesting, and similar measures.

3. Nevada's State Historical Preservation Office (NSHPO)

Contact: Rebecca Palmer, (775) 684-3443
Address: Capitol Complex
100 Stewart Street
Carson City, NV 89710

The NSHPO will review the project for proximity to identified cultural historical sites. If a project is found to be near an area where historical sites could be anticipated, an Archaeological Survey may be required. If significant sites are identified within the project limits during the survey process, a Treatment Plan would be developed for the site. The Treatment Plan would have to be completed prior to issuance of a 404 Permit or construction. If Native American artifacts or remains are uncovered, the Treatment Plan may require consultation with local Native American Tribes.

the USACOE will notify the applicant and the above agencies that a Standard Permit will be required.

Dust Control Permit

Issued by: Clark County Health District Air Pollution Control Division
Contact: Ms. Cindy Mikes, (702) 383-1276
Address: 625 Shadow Lane
Las Vegas, NV 89106

This permit is required for dust emissions from construction grading and trenching operations within the Las Vegas Valley. The Permit must be obtained by the contractor.

CCRFCD Section 14 Environmental Impact Analysis

Issued by: Clark County Regional Flood Control District
Contact: Timothy Sutko, (702) 455-3139
Address: 600 South Grand Central Parkway
Las Vegas, NV 89106

In 1991, the Environmental Impact Statement (EIS) for Clark County Regional Flood Control District's Master Plan (Dames & Moore, 1990) was approved by the US Bureau of Land Management (USDI BLM, 1991). The EIS not only addressed the environmental impacts of facilities described in the Master Plan, but also how the impacts of modified and new facilities proposed subsequent to the EIS will be handled. In order to assure that appropriate environmental analysis would be performed for each new facility, a repeatable, thorough environmental review process was stipulated and described in Section 14 of the EIS. The Record of Decision issued by the BLM (USDI BLM, 1991) directs that when new facilities are to be located on land other than federally managed lands, the CCRFCD will administer the programmatic application of site-specific analyses in accordance with the Section 14 Environmental Review requirements stipulated in the EIS.

The resources that must be addressed in the Section 14 Environmental Review are as follows:

- Air quality
- Geology and soils
- Groundwater
- Surface water
- Terrestrial and Aquatic Biology
- Land use
- Visual resources
- Socioeconomics
- Cultural resources

Storm Water Discharge Permit for Construction Activities (NPDES)

Issued by: Nevada Division of Environmental Protection,
Bureau of Water Pollution Control
Contact: Rob Sanders, (775) 687-4670, Fax (775) 687-4684
Address: 333 West Nye Lane, Room 138
Carson City, NV 89706-0851

Required for construction sites over 5 acres that will discharge storm water runoff into the storm drain system or the waters of the US. Application must include what Best Management Practices will be required to reduce fugitive sediment from leaving the site during construction.

Temporary Permit for Working in Waterways (Rolling Stock Permit)

Issued by: Nevada Division of Environmental Protection,
Bureau of Water Pollution Control
Contact: Ms. Icyl Mulligan, (775) 687-4670 ext. 3139, Fax (775) 687-4684
Address: 333 West Nye Lane
Carson City, NV 89706-0851

This permit is for operating equipment during construction in waters of the state of Nevada. The permit is required for construction in "In Line" waters or contributing area that impacts waters. The application must include Best Management Practices (BMP) and proper implementation of the BMPs. The BMPs must address sedimentation, erosion, fuel and fluid spillage, and the practices necessary to protect the waters and prevent pollutants from entering the waters.

Other

In addition, drawings for proposed improvements which encroach on the Southern Nevada Water Authority (SNWA) Engineering Department right-of-way will need to be reviewed and signed by SNWA. The contact and address at SNWA are listed below.

Approval from: Southern Nevada Water Authority Engineering Department
Contact: Leanne Miller, Project Manager, (702) 862-3460
Address: 1900 East Flamingo, Suite 170
Las Vegas, NV 89119

CONCLUSIONS

Las Vegas Wash Facilities Study Conclusions

The channel can be constructed through the project limits to safely convey the 100-year design storm. For a majority of the project, there is existing right-of-way with sufficient capacity to construct the channel and to provide access for maintenance of the channel. In addition, there is generally sufficient right-of-way for a minimum of a 10-foot wide trail along one side of the channel. Because of existing right-of-way constraints through a large section of the project limits, most of the segments will be concrete-lined.

The peaking basin warrant analysis determined that the peaking basin will be required when 33 percent of the upstream watershed or 13 square miles are developed.

A 404 Permit and a Section 14 will be required for the limits of the project in the channel.

While the dimensions and typical cross sections of the channel have changed, the general character of the Wash is essentially as outlined in the 1996 MPU. However, the segment of the Wash downstream from Lake Mead Boulevard to Nellis Boulevard has changed from a gabion and riprap-lined channel to concrete lining.

POLICIES AND PROCEDURES MANUAL

CCRFCFCD Policies and Procedures Manual

Currently under consideration is an amendment to Section IIIB of the CCRFCFCD *Policies and Procedures Manual* to add the following design criteria for multiple uses of CCRFCFCD facilities:

3. *If a Master Plan Facility is to incorporate multiple uses, then the following policy statements must be met:*
 - a. *Public safety and the proper functioning of the drainage facilities are of the highest concern and cannot be compromised by other uses.*
 - b. *Flood control facilities must be clearly signed to identify them as areas subject to flooding, and as areas that should not be used during rainfall or floods. Signs must include a 24-hour emergency telephone number. Signs should be bilingual and pictorial. Signs should be spaced at all ingress and egress points and not more than one hundred fifty (150) feet apart along or around the perimeter of a flood control facility.*
 - c. *The use of "benching" or "tiering" to create areas which would not be subject to flooding during more frequent events is encouraged. Consideration must be given to storm water flow across these "benched" areas to lower lying areas.*
 - d. *The use of those portions of detention basins subject to flooding during a 10-year or more frequent event, other than as wildlife habitat, should not be encouraged in any way. This includes locating recreational amenities, the creation of trails/paths, or the use of turf in those areas.*
 - e. *In general, passive recreation zones, picnic areas, soccer fields and ball fields may be suitable uses for the lower elevated tiers located above the 10-year pool.*
 - f. *Tot lots, play areas and court games should be located in the higher elevated tiers location above the 25-year pool.*
 - g. *Parking areas, restrooms, concession stands, habitable structures, and swimming pools must be located outside of the 100-year pool elevation.*
 - h. *The establishment of wetlands, passive vegetation zones, or other desirable habitat will require coordination with and approval by appropriate local, State and Federal agencies, as well as the development of a workable habitat management plan that allows for the periodic maintenance of the drainage facilities.*

- i. Detention basin embankments should have gentle slopes (3:1 or less) on the impoundment area side to allow the public to exit multiple use facilities.*
- j. Picnic tables, benches, trash receptacles and other amenities located in flood control facilities must be securely fastened in place.*
- k. Channel bottoms are often subject to unhealthy conditions due to the presence of untreated nuisance flows and the accumulation of litter, as well as to high velocity flows during storms. The use of channel bottoms for recreational uses should be avoided. Channels that have a depth * velocity product greater than 6 ($DV \geq 6$) should not be considered for recreational uses.*
- l. Access and maintenance roads along channels may be suitable for pedestrian and biking access. A pedestrian separation device separating the channel from the road is required. The pedestrian separation device must be designed and installed in a manner that does not impair normal operations and maintenance activities, or emergency response and rescue activities.*
- m. Facilities, particularly those which are intended to be used for organized recreational activities, must have use-plans developed which clearly state the conditions under which these facilities will be closed to the public, as well as an implementation plan to ensure that the facilities are not being used under those conditions. The entities will develop agreements for the use of the facilities that, at a minimum, indemnify and hold the District harmless from damages resulting from the use of flood control facilities for recreational activities. Neither the development nor the implementation of these use-plans or agreements is the responsibility of the Regional Flood Control District.*

Policies and Procedures for Multiple Use Development of the Las Vegas Wash

1. The Las Vegas Wash must safely convey the 100-year storm flow through the project limits.
2. Design should minimize costs for both construction and maintenance without compromising safety.
3. Provide access for maintenance and emergency vehicles.
4. Where possible, incorporate park features, trails, and natural conditions into the design of the channel.
 - a. Trails shall be 10-foot wide located on one side of the channel.
 - b. Generally, trails shall be separated from maintenance roads.

- c. Trails shall, at a minimum, be above the 10-year water surface.
 - d. A minimum 3-foot manway will be provided on the side of the channel opposite the maintenance road.
 - e. A fence sturdy enough to provide support in rescue operations will be constructed on the outside of the manway.
5. Fencing and signage shall be installed as follows:
- a. Trails should utilize a visual barrier to demarcate the trail limits and warn the public of unsafe areas. Part of this visual barrier is a low fence placed 3 feet from the edge of the channel. The fence posts should be sturdy enough to provide support for rescue operations. The fence height should be low enough to allow firemen access, but high enough to discourage entrance into the flood area. Acceptable fences could include tube rail, 4-foot chain-link, and hanging chain fences. Another part of the visual barrier could be signage placed along the fence to warn of floodwaters and prohibited access.
 - b. Several signs are proposed for use along the wash to demarcate trail markers, bike route signs, warning signs to bikers to yield to pedestrians, warning signs for possible flood hazards, and signs marking limits for public access. Descriptions of these signs follow:

Bike Route Sign - white bike graphic with white lettering "BIKE ROUTE" on green background rectangle guide sign placed under Bicycle Yield to Pedestrians sign at entry points to trail.

Bicycle Yield to Pedestrians sign - black bike graphic over black lettering "YIELD TO PEDS" on white rectangle regulatory sign placed over Bike Route sign at entry points to trail.

Bike Route Sign
Bicycle Yield to Pedestrians
 Place 25 feet from
 entry points to trail



Trail sign - white hikers graphic on green rectangle guide sign.

Las Vegas Wash Trail marker – white lettering "LAS VEGAS WASH TRAIL" on brown trapezoid guide sign placed at entry points to the trail.

Trail Icon Sign
Las Vegas Wash Trail Marker
 Place at entry points to trail



Flood Warning Icon sign – yellow equilateral sign with blue water wave.

Flood Warning sign – black lettering “Warning!! Flood Hazard” on square prohibition sign placed under Flood Warning Icon sign. Sign posts should be placed near fence barrier at 300-foot intervals – 150 feet from No Unauthorized Entrance signs.

Flood Warning Icon Sign

Flood Warning Sign

Place along barrier fence parallel to trail at 300 feet intervals, 150 feet from No Unauthorized Entrance signs



No Unauthorized Entrance Icon sign – red circle with diagonal slash across black image of man on white background

No Unauthorized Entrance – black lettering “DANGER!! DO NOT ENTER SUBJECT TO FLOODING NO TRESPASSING NRS 207.200” on square prohibition sign placed under No Unauthorized Entrance Icon signs.

No Unauthorized Entrance Icon Sign

No Unauthorized Entrance Sign

Place along barrier fence parallel to trail at 300 feet intervals



The icon signs communicate the intent without posting signs in multiple languages. However, if it is determined to be appropriate, alternating signs could be provided using English and Spanish.

GIS APPLICATION DATABASE AND USER'S MANUAL

Introduction

GIS is the common abbreviation for Geographical Information System, which is the combination of computer equipment, software programs, and graphically represented information tied to databases and photographs. Locations are represented as points, areas and boundaries as polygons, and routes or alignments as a series of lines. Of the many GIS software applications available, this particular application was developed using ArcView version 3.2 from Environmental Science Research Institute, Inc. (ESRI), located in Redmond, California. ArcView's native file format for these lines, points, and polygons is called Themes. Themes consist of three files with the extensions: SHX, SHP, and DBF. Sometimes a fourth file with the extension SBN is also generated. These four files must reside in the same directory. Numeric data and descriptive text tied to these graphical features are organized in tables of rows and columns. Each row or record is a collection of various attributes for the graphical feature. Each column or field is the specified attribute. These tables known as databases are Dbase IV compatible. Records containing attributes of a desired value or within a specified range may be selected by querying data. Possible calculations on the attributes include summation, average, standard deviation, variance, count, maximum and minimum values, and first and last occurrence of the value.

ArcView can display and query Arc/Info GIS files known as Coverages, but cannot modify those files. Attribute values may also be represented graphically with various colors, linetypes, or hatch patterns tied to a legend for that Theme or Coverage. ArcView also has the capability to display AutoCAD .dwg files and geo-referenced photographs. A graphical collection of the displayed Themes, Coverages, .dwg files, and photographs along with each legend is called a View. Layouts are customized displays that may include north arrows, scale bars, borders, charts, legends, and other graphics for producing hard copies. ArcView version 3.2 allows the users to develop customized software routines using an object-oriented scripting language called Avenue, which is similar to Visual Basic. In later versions of ArcView, Avenue is no longer supported. All of the settings for the various views, layouts, customizations, and Avenue script files are saved in a single file called Projects with an extension of APR.

Compact Disc (CD) Contents

The supplied CD contains two project files, MERGER.APR and LVWSTUDY.APR. With the exception of the Assessor's parcel coverages and the Assessor's ownership database file, AOEXTRACT, all necessary Themes, tables, and program script files are contained on the CD under the LVWGIS subdirectory. Photographs of the wash are contained in the LVWGIS\Pictures subdirectory in GIF format. AutoCAD version 14 drawing files of the Las Vegas Wash right-of-way and plan and profiles of recommended improvements to the wash are located in the DWG\IMPROV subdirectory.

System Requirements

The GIS application for the Las Vegas Wash Facilities Study contains two project files. The following minimum criteria lists the hardware and software requirements to access the project files.

Operating System:	Windows 95, 98, ME, NT, or 2000.
Software:	ArcView version 3.2 (must purchase) Volo View Express 1.7 (supplied on CD)
Hardware:	Intel Pentium compatible system running a clock speed of 450 megahertz or faster with 128 megabytes or more of RAM with a

hard drive with more than one gigabyte of storage available and a compact disc reader (CDROM).

Environmental
variables:

PARCLHME and LVWHOME

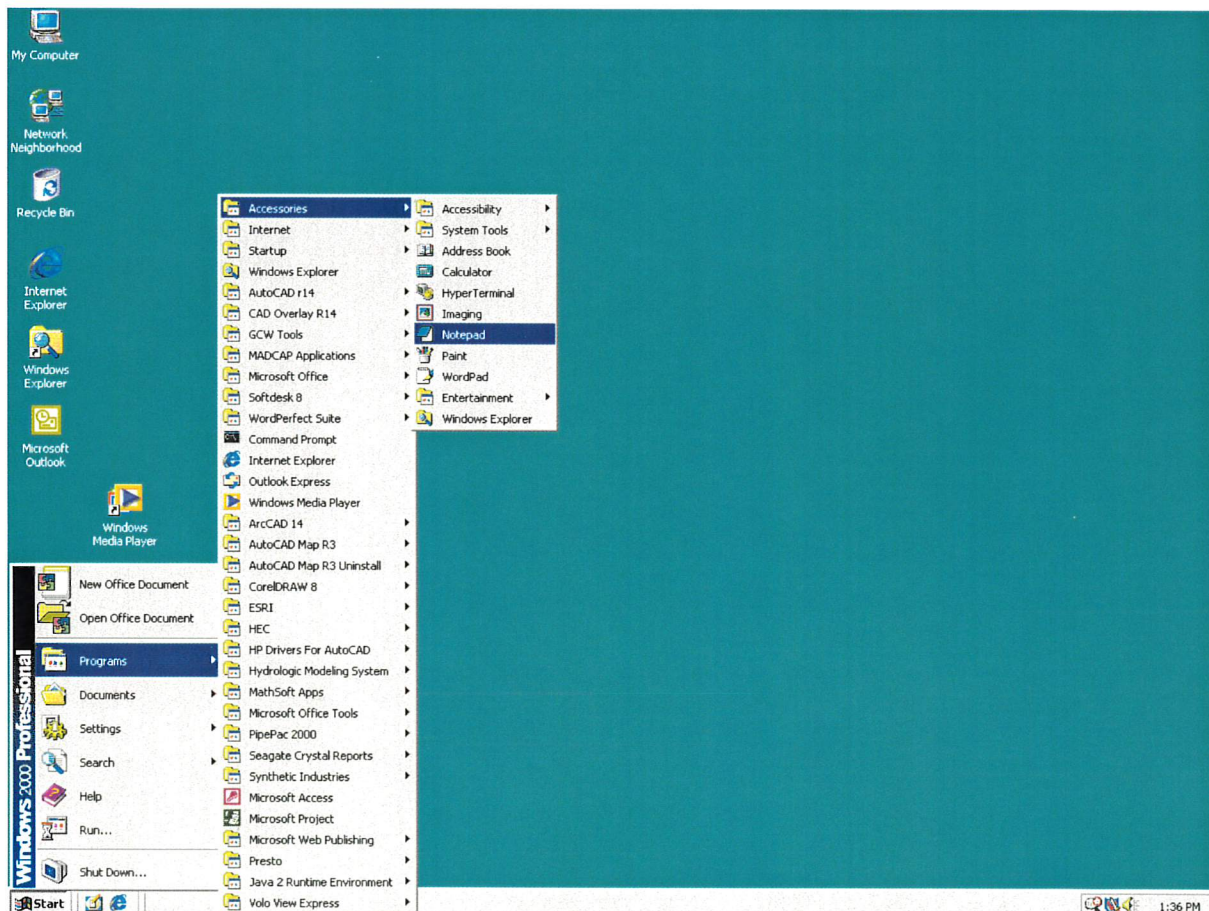
User's Themes and
Coverages:

Access to the Clark County GIS coverages from the Clark County GIS Management Office (GISMO).

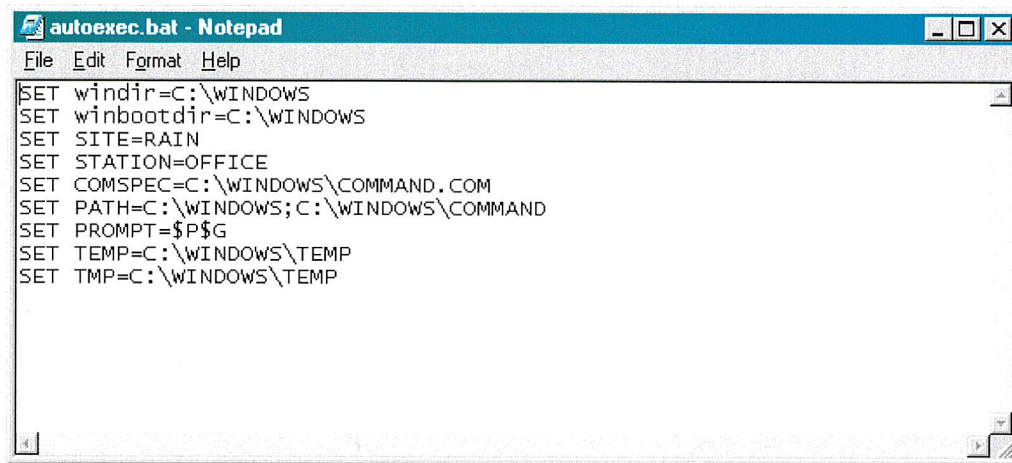
System Setup

In order for the application to run smoothly, the user's computer needs to be setup to allow the application to find and view the data files and photographs. The first step is to define certain environmental variables. The environmental variables allow the paths to the GISMO coverages and the application files located on the supplied compact disc to easily reflect the individual user's circumstances. The PARCLHME environmental variable sets the path to the Assessor's parcel polygon coverages and extract database (AOEXTRACT information database) used to calculate current developed area in the North Watershed for the Peaking Detention Basin Warrant Analysis.

The LVWHOME environmental variable sets the path to the application's files located on the CD in the \509-020\LVWGIS directory. These environmental variables are set in one of two ways depending upon the operating system installed. In Windows 95, 98, or ME, the environment variables are set in the Autoexec.bat file located in the c:\windows directory. This file can be modified with the Notepad program that comes with the Windows operating system. Notepad is located on the Start menu under Programs, Accessories, Notepad.



With Notepad running, open Autoexec.bat located in the C:\ directory.

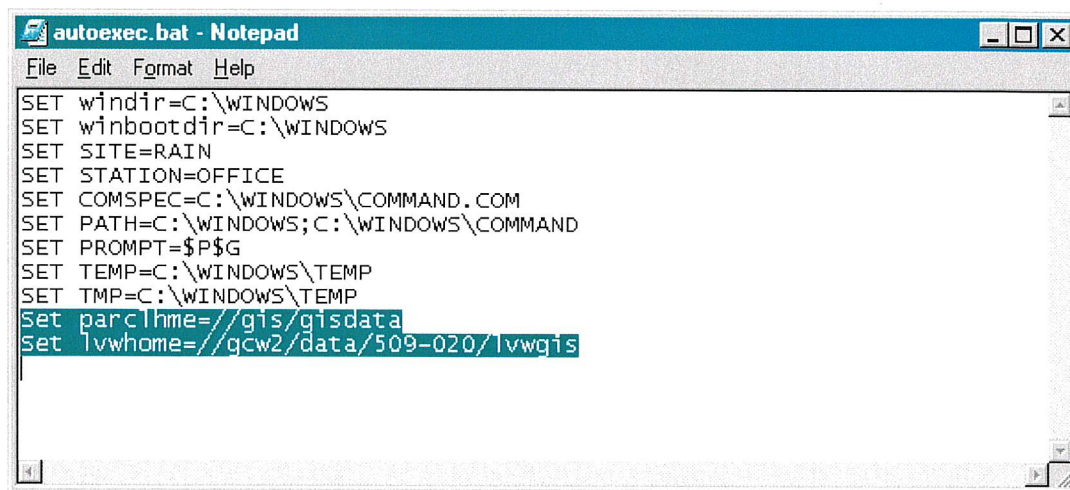


```
autoexec.bat - Notepad
File Edit Format Help
SET windir=C:\WINDOWS
SET winbootdir=C:\WINDOWS
SET SITE=RAIN
SET STATION=OFFICE
SET COMSPEC=C:\WINDOWS\COMMAND.COM
SET PATH=C:\WINDOWS;C:\WINDOWS\COMMAND
SET PROMPT=$P$G
SET TEMP=C:\WINDOWS\TEMP
SET TMP=C:\WINDOWS\TEMP
```

Add these two lines to the bottom of the file:

Set parclhme=//gis/gisdata

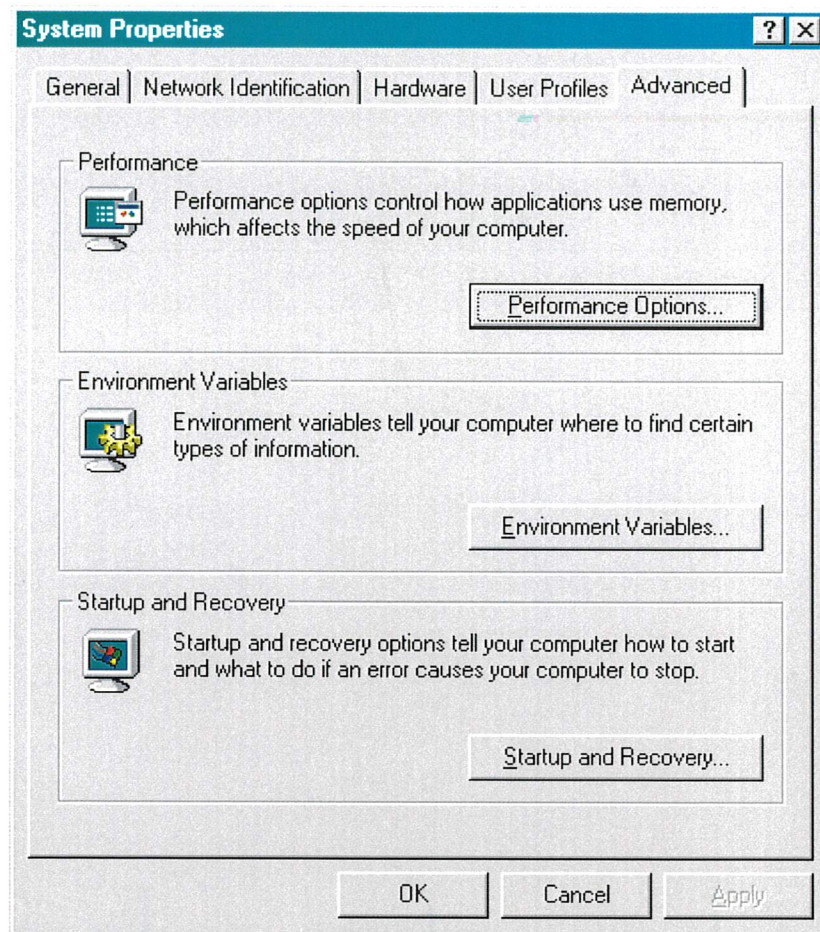
Set lvwhome=//gcw2/data/509-020/lvwgis



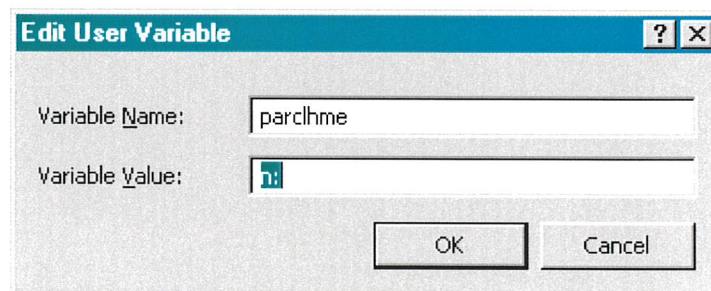
```
autoexec.bat - Notepad
File Edit Format Help
SET windir=C:\WINDOWS
SET winbootdir=C:\WINDOWS
SET SITE=RAIN
SET STATION=OFFICE
SET COMSPEC=C:\WINDOWS\COMMAND.COM
SET PATH=C:\WINDOWS;C:\WINDOWS\COMMAND
SET PROMPT=$P$G
SET TEMP=C:\WINDOWS\TEMP
SET TMP=C:\WINDOWS\TEMP
Set parclhme=//gis/gisdata
Set lvwhome=//gcw2/data/509-020/lvwgis
```

Change the value `//gis/gisdata` in the first line to match the appropriate path. Change the value `//gcw2/data/509-020/lvwgis` in the second line to match the path to CD drive or directory where \509-020\lvwgis data has been saved. Note the use of the forward slash in the environment variable instead of the normal windows backslash. This is a requirement of ArcView and ArcInfo programs. To avoid problems, please maintain the directory structure found on the CD when saving the data to a hard drive. Save the file and reboot the computer before running ArcView to activate the environment variables.

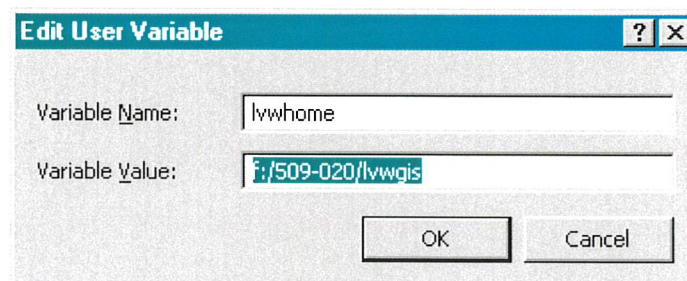
In Windows NT 4.0 or Windows 2000, the environment variables can be changed on the fly in SYSTEM PROPERTIES program. In Windows 2000, SYSTEM PROPERTIES can be accessed by right clicking on MY COMPUTER icon on the desktop. Select the PROPERTIES option at the bottom of the list. SYSTEM PROPERTIES can also be accessed through the settings option on the START MENU. Select CONTROL PANEL and then select SYSTEM in the popup menu. Once SYSTEM PROPERTIES is open, select the ADVANCED tab to the far right just under the title bar.



Select the ENVIRONMENT VARIABLES button. Select the NEW button under the USER VARIABLES FOR (current user) section. Type the environment name *parclhme* in the text box right of VARIABLE NAME. Type the path to the GISMO coverages and click the OK button to save.



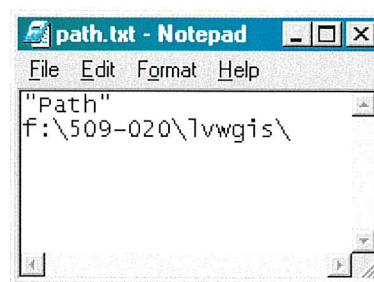
Repeat the process for the LVWHOME environment variable setting the value in the VARIABLE VALUE to the appropriate path to the CD drive or where \509-020\lvwgis data has been saved.



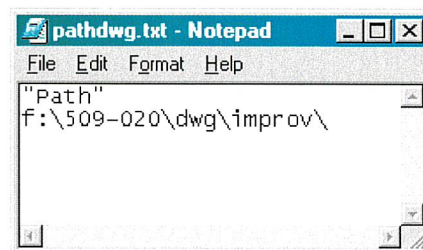
Click OK button three times in the displayed windows to save and exit the SYSTEM PROPERTIES program. ArcView may then be used to access the Las Vegas Wash projects located in the

\509-020\lvwgis directory. NT 4.0 or Windows 2000 do not require the system to be rebooted to activate the new environmental variables.

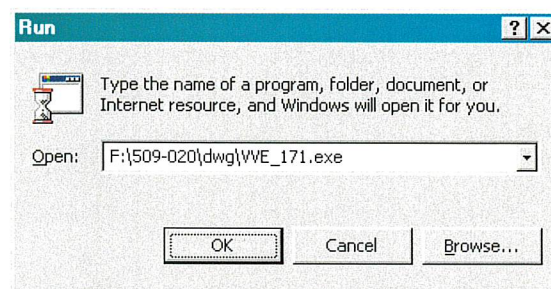
The next step is to copy and modify text files containing the specific path, the user will be using to access the database files. The path.txt and pathdwg.txt file located in the LVWGIS directory on the CD needs to be copied to C:\temp directory on your hard drive. If this file is not copied to the appropriate directory, the project will ask where the file can be found upon starting. In order to modify these files to reflect the user's path to the CD, the files' properties need to be changed to allow editing. Start the Windows Explorer program and navigate to the C:\temp subdirectory. Highlight the newly copied path.txt and pathdwg.txt files. Click the right button on the mouse to display a popup window showing possible file operation options. Select Properties at the bottom of the list. Change the attributes of the file by unchecking the check box to the left of *Read Only*. Double-click on the path.txt file. The Notepad application should run with path.txt contents displayed.



The second line will display *f:\509-020\dwg\improv*. Edit the "f:" to reflect the drive letter of the user's CD drive. Save the text file and open the pathdwg.txt file.



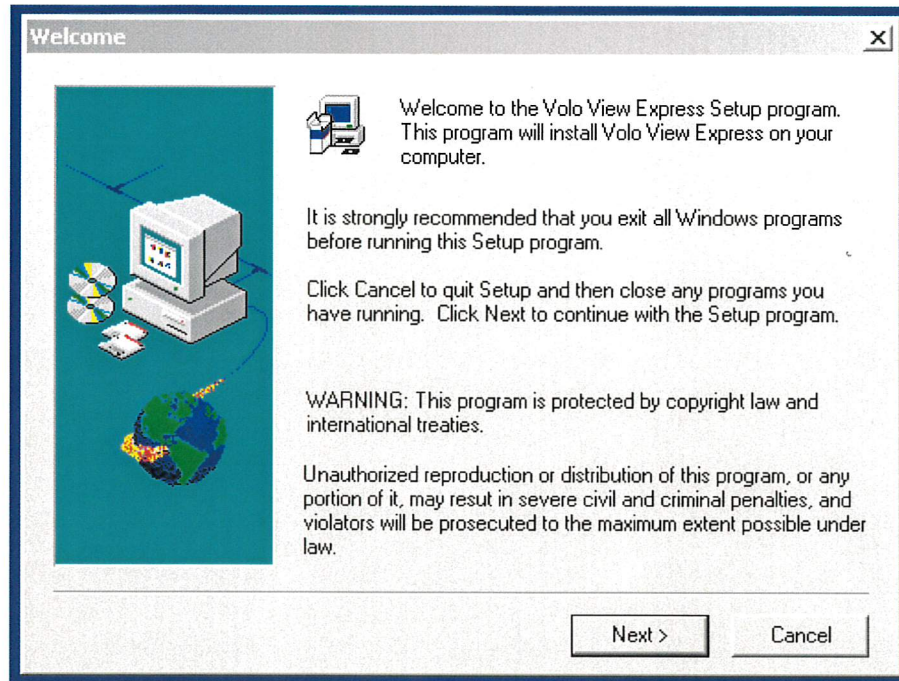
Again, edit the "f:" in the second line to reflect the appropriate drive letter of the user's CD drive. Save the file and close Notebook.



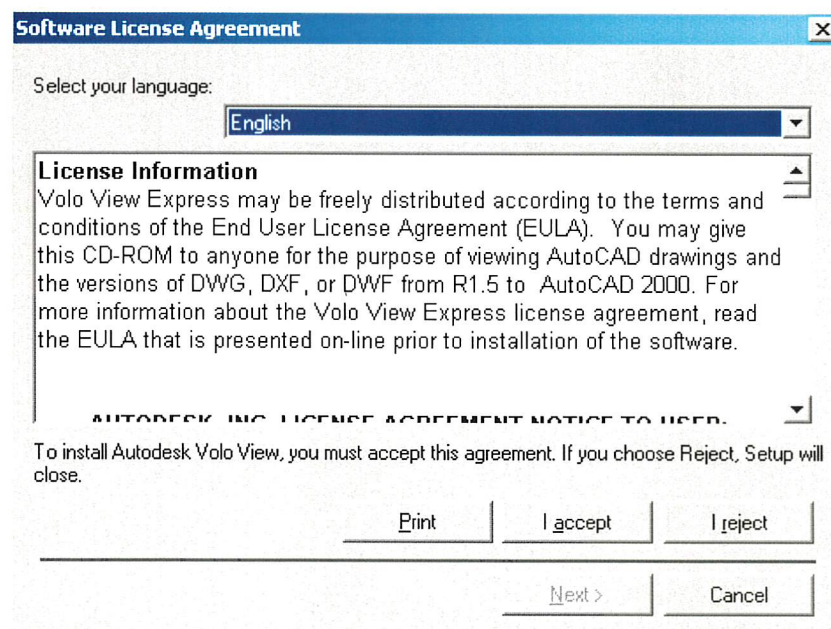
The final step in the setup process is to install a freeware program from Autodesk, Volo View Express version 1.7 to view AutoCAD drawing files without AutoCAD. This program is provided for your use in the 509-020\dwg subdirectory on the CD. In Windows NT 4.0 and Windows 2000, the user must have administrator rights to be able to install the program. From the Windows Start

Menu, select Run... and type in f:\509-020\dwg\VVE_171.exe. The f:\ is the drive letter for the CD. Please substitute the appropriate letter on the user's computer. Also, note that the program name contains two "V" characters and not one "W" as might be interpreted from the view on-screen.

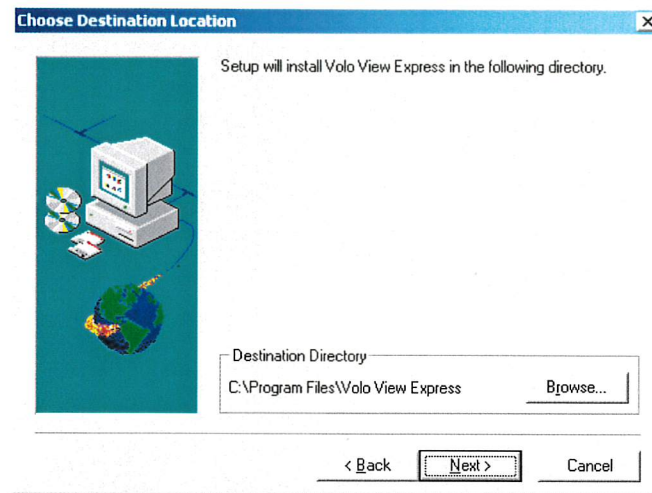
After selecting OK, the Welcome screen should appear.



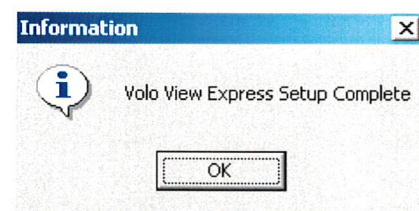
Clicking Next will bring up the license agreement screen.



After selecting the "I accept" button, the Next button will become available. Select Next to input the program directory. **Allow Volo View Express to install into the default directories.**



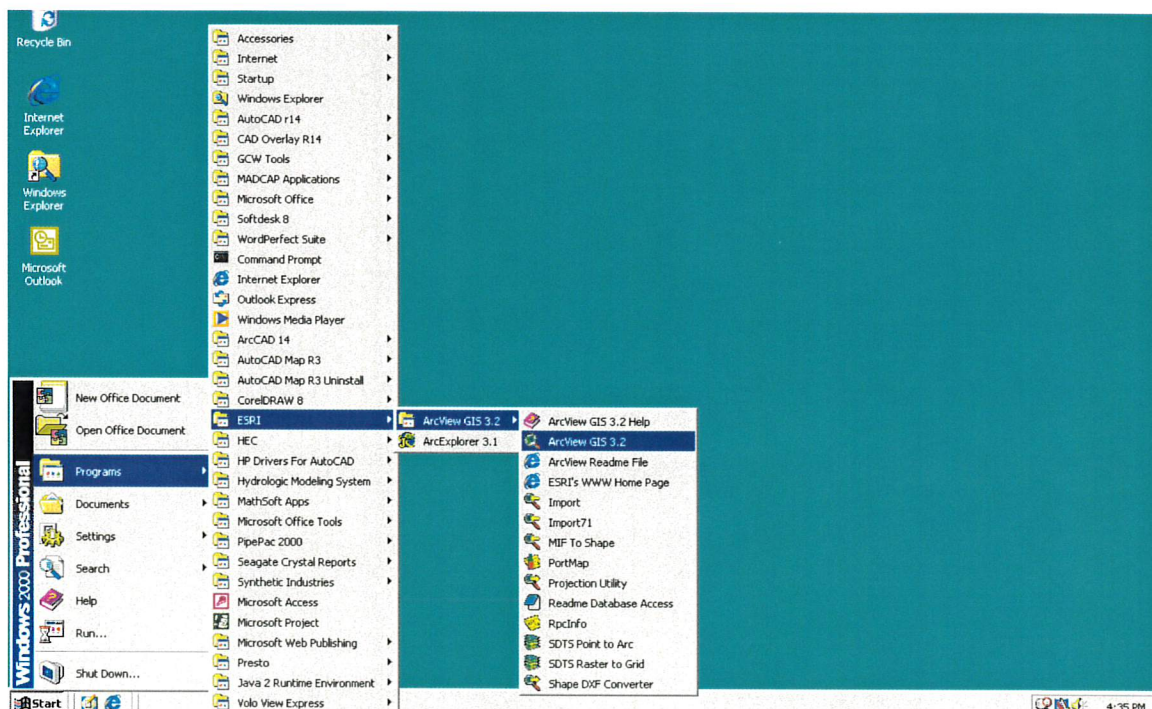
Installation progress is monitored on the Next screen. When the program has been successfully installed, a final confirmation screen will appear.

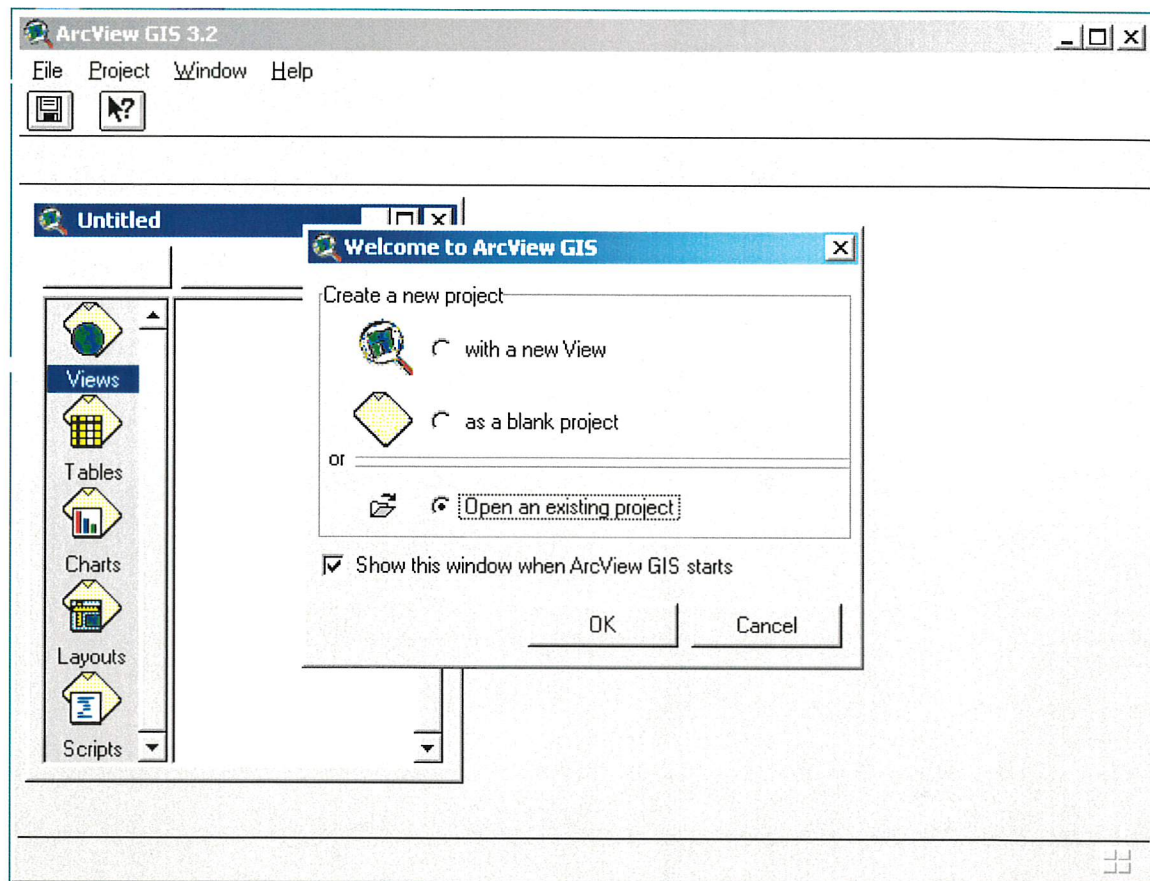


Starting The Application

After the setup process has been completed and where appropriate, the computer has been rebooted, the ArcView may be started. Usually, the program is accessed by navigating through cascading menuing beginning at the Startup Menu, to Programs, to ESRI, to ArcView 3.2, finally selecting ArcView GIS 3.2.

After the program loads, the project files can be loaded through the popup dialog box entitled "Welcome to ArcView GIS." Select the "Open an existing project" option and click on the OK button.



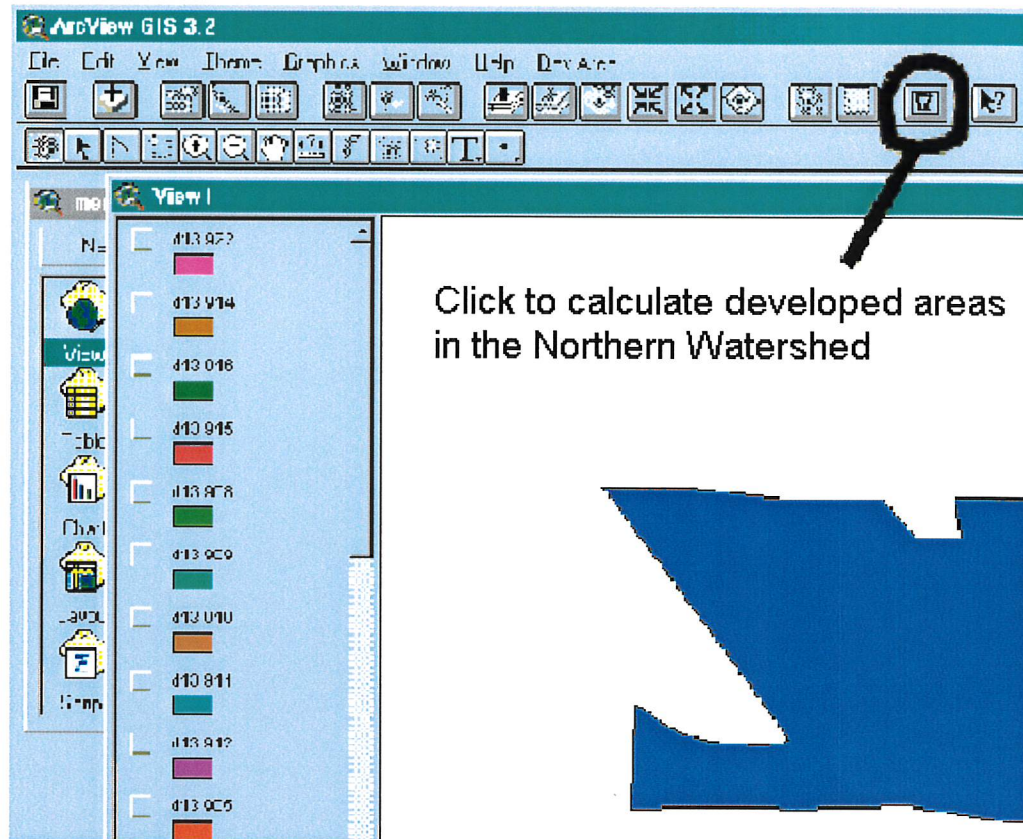


If the popup dialog has been turned off, the project file can be load by clicking on "File" in the menu at the top of the screen and selecting "Open project." Navigate to the desired project file, merger.apr or lwvstudy.apr, located under the LVWGIS subdirectory. The features specific to each project are described in detail below.

Merger Project

Merger Project was developed to calculate the current developed area in the Northern Watershed. This calculated area is used to adjust the Cheyenne Peaking Basin warranted range time frame. The MERGER project contains two ArcView shapefiles, NORTHWO.shp and NORTHWTC.shp. NORTHWO is the merged polygon of the portion of the Northern Watershed under consideration. NORTHWTC contains the Northern Watershed with the Town Center development area added. Tables in the MERGER project include AOEXTRACT information database (previously described) and LU_PARCL.dbf, which is a dBase IV database of the sections involved in the Northern Watershed. An Avenue script program called Dev_land was developed to automate the calculation for the current amount of developed land. The complete program listing is stored in the \509-020\lwvgis subdirectory in the file Dev_land.ave.

A new menu item, Dev Area, has been added to the right of Help menu selection. Selecting the Calculate Develop Area item under the Dev Area menu will execute the Avenue script adding the Assessor's polygon coverages for the sections in the Northern Watershed to the view. Clicking on the button to the left of the Help button also executes the program.



The sections are merged into a theme called m_parc1.shp and intersected with the northwo.shp theme. The resulting theme is saved as wotc1.shp. This process can take upwards of a half of an hour. To assure the user that the program is working, a message box indicating the successful completion of the intersected theme pops up. Clicking OK will begin the process to join the AOEXTACT database with the intersected shapefile, wotc1.

A new field, Dev_land is added to the joined database to hold an indication of developed or undeveloped status. The developed status is only used in cases that raise the curve numbers for the HEC-1 model. Table 11-1 gives a summary of the hydrologic land use classifications with the associated assessor's land use codes. The developed column indicates which classification was used in determining the total developed area in the watershed.

Table 11-1: Hydrologic Defined Developed Land Uses

Code	Description	Accessor's Land Use Codes	Developed
1	Undeveloped land	0, 510, 520, 530, 710, 720, 730	No
2	Parks, golf courses	195, 345, 440, 470	No
3	Residential 1 ac. or more	110	No
4	Residential 0.5 ac	110	No
5	Residential 0.25 ac	110	No
6	Residential 0.125 ac	110, 120, 130, 140, 180, 185, 188, 199, 380	Yes
7	Multi-family, Public Facility	150, 160, 170, 420, 430, 450, 460, 630	Yes
8	Commercial Retail, Casino	250, 260, 310, 311, 312, 320, 321, 325, 330, 340, 360, 365, 370, 375, 385, 399, 620	Yes
9	Industrial (low impervious)	230, 378	No
10	Industrial (high impervious)	210, 240,	Yes

Table 11-1: Hydrologic Defined Developed Land Uses

Code	Description	Accessor's Land Use Codes	Developed
11	Schools	410	Yes
12	Lakes		No
13	Paved Areas	Null	Yes
14	Gravel Pit	221	No
15	Residential 0.33 ac		Yes
16	Residential 2 ac	110	No
17	Mining	220, 610	No
18	Neighborhood Commercial	335, 338, 350, 355, 358, 359	Yes

A summary database, saved as dev_wotc.dbf, gives the total developed and undeveloped area. The program will display the results in a message box and ask if the developed area including Town Center is desired.

Generally, the calculation for the Town Center developed area is not needed. If the next calculation is selected, the program will create a new intersected theme called wtc.shp. The summary database will be called dev_wtc.dbf. A message box will give the total developed area.

The resulting developed area and current year can be input into the dev_area.wbs, Quattro Pro version 8 spreadsheet, warrant analysis page. A new warrant year range will then be computed for growth rates from 4 percent to 15 percent. The warrant range previously agreed upon used growth rates of 8 percent and 12 percent. For convenience, the spreadsheet warrant analysis page was converted to Excel format. The charts are not included in the Excel file.

LVWSTUDY Project

The LVWSTUDY project contains data from the topography file, utility companies, photograph locations, survey benchmark locations, recommended channel improvements, parcel ownership, and FEMA flood zones. Table 11-2 contains a summary of the available Themes.

Table 11-2: Available Themes

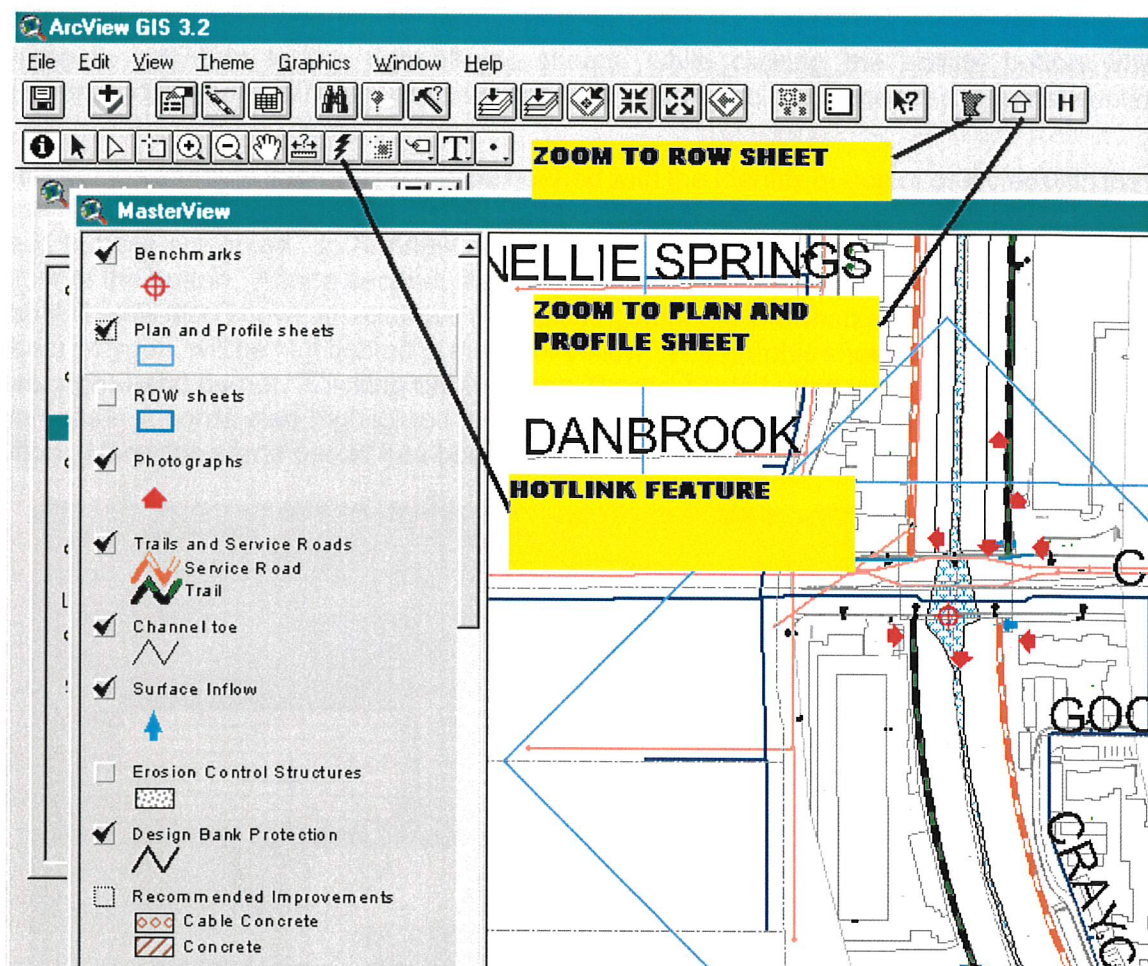
Name	Source	Type	Display		Hot-Linked
			Max.	Min.	
Benchmarks	f:\509-020\lvwgis\bm.shp	Point	0	0	No
Plan and Profile sheets	f:\509-020\lvwgis\ppsht.shp	Polygon	0	0	Yes
ROW sheets	f:\509-020\lvwgis\rowsht.shp	Polygon	0	0	Yes
Photographs	f:\509-020\lvwgis\pictures.shp	Point	1200	10000	Yes
Trails and Service Roads	f:\509-020\lvwgis\trail.shp	PolyLine	0	0	No
Channel toe	f:\509-020\lvwgis\improv_line.shp	PolyLine	0	0	No
Surface Inflow	f:\509-020\lvwgis\flowarw.shp	PointZ	3600	0	No
Erosion Control Structures	f:\509-020\lvwgis\ecs2.shp	Polygon	0	0	No
Design Bank Protection	f:\509-020\lvwgis\design bank protection.shp	PolyLine	0	0	No
Recommended Improvements	f:\509-020\lvwgis\improv.shp	Polygon	0	0	Yes
Street Centerlines	f:\509-020\lvwgis\street_cl.shp	PolyLine	0	18000	No
Street Centerline (small lettering)	f:\509-020\lvwgis\street_cl.shp	PolyLine	3000	18000	No
Drop Inlets-CNLV-TopoFile	f:\509-020\lvwgis\xcgcb.shp	PolyLine	3600	0	No

Table 11-2: Available Themes

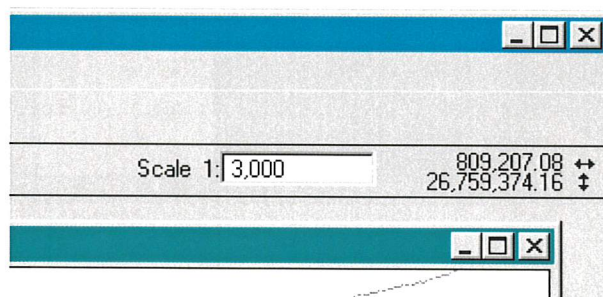
Name	Source	Type	Display		Hot-Linked
			Max.	Min.	
Storm Drain-CNLV-TopoFile	f:\509-020\lvwgis\strmcnlv.shp	PolyLine	3600	0	No
Storm Drain	f:\509-020\lvwgis\strm.shp	PolyLine	3600	0	No
Storm Drain MH	f:\509-020\lvwgis\strm-mh.shp	Point	3600	0	No
Gas-CNLV-TopoFile	f:\509-020\lvwgis\gas-cnlv.shp	PolyLine	3600	0	No
Water-LVVWD-GIS	f:\509-020\lvwgis\pipes_12.shp	PolyLine	3600	0	No
Water-CNLV-TopoFile	f:\509-020\lvwgis\wtr-cnlv.shp	PolyLine	3600	0	No
Water-SNWA-C103A	f:\509-020\lvwgis\wtr-78in.shp	PolyLine	3600	0	No
Water-SNWA-C103A-MH	f:\509-020\lvwgis\wmh-78in.shp	Point	3600	0	No
Water-CNLV	f:\509-020\lvwgis\lvwwater.shp	PolyLine	3600	0	No
Sewer-CNLV-TopoFile	f:\509-020\lvwgis\swr-cnlv.shp	PolyLine	3600	0	No
Sewer-CNLV-TopoFile-MH	f:\509-020\lvwgis\smh-cnlv.shp	Point	3600	0	No
Sewer-SAND-GIS	f:\509-020\lvwgis\swsys2.shp	PolyLine	3600	0	No
Sewer-SAND-GIS-MH	f:\509-020\lvwgis\swsysmh2.shp	Point	3600	0	No
Sewer-Sandhill	f:\509-020\lvwgis\shsewer.shp	PolyLine	3600	0	No
Sewer-Sandhill-MH	f:\509-020\lvwgis\sh-smh.shp	Point	3600	0	No
Sewer-CNLV	f:\509-020\lvwgis\lvwsewer.shp	PolyLine	3600	0	No
Sewer-CLV-GIS	f:\509-020\lvwgis\lcs-clv2.shp	PolyLine	3600	0	No
Sewer-CLV-GIS-MH	f:\509-020\lvwgis\lcsclvpt2.shp	Point	3600	0	No
Power-NEVP	f:\509-020\lvwgis\power.shp	PolyLine	3600	0	No
Telephone-CNLV-TopoFile	f:\509-020\lvwgis\tel-cnlv.shp	PolyLine	3600	0	No
Misc Pipes	f:\509-020\lvwgis\pipemisc.shp	PolyLine	3600	0	No
Misc Concrete Structures	f:\509-020\lvwgis\concmisc.shp	PolyLine	3600	0	No
Misc Manmade Structures	f:\509-020\lvwgis\manmade.shp	PolyLine	3600	0	No
Misc Utility Structures	f:\509-020\lvwgis\util.shp	PolyLine	3600	0	No
Misc Utility Features	f:\509-020\lvwgis\miscutil.shp	PolyLine	3600	0	No
Misc Existing Manholes	f:\509-020\lvwgis\xmh.shp	Point	3600	0	No
Buildings	f:\509-020\lvwgis\bldds.shp	PolyLine	3600	0	No
Fences	f:\509-020\lvwgis\fences.shp	PolyLine	3600	0	No
Roads	f:\509-020\lvwgis\road.shp	PolyLine	3600	0	No
Plants	f:\509-020\lvwgis\plants.shp	PolyLine	3600	0	No
Misc Features	f:\509-020\lvwgis\misc.shp	PolyLine	3600	0	No
1-ft Contours	f:\509-020\lvwgis\contours.shp	PolyLine	3600	0	No
Parcel Ownership	f:\509-020\lvwgis\parcel\lvw-row.shp	Polygon	0	0	No
Low Flow Water Surface	f:\509-020\lvwgis\lwtrarea.shp	Polygon	3600	0	No
Existing Channel Lining	f:\509-020\lvwgis\lining.shp	Polygon	3600	0	No
Brush	f:\509-020\lvwgis\brush.shp	Polygon	3600	0	No
FEMA Floodway	f:\509-020\lvwgis\fway.shp	Polygon	0	3600	No
FEMA FIRM	f:\509-020\lvwgis\firm.shp	Polygon	0	3600	No

Four of the Themes have external graphic files related to features. This relationship, called "Hotlink," activates another program to view the graphic files when the feature is selected on the screen. The modifications to allow this feature to work were covered in the System Setup section above. Feature buttons have been added to the Toolbar to allow the user to display the extents of selected ROW sheets or Plan and Profile sheets. These features are noted in the graphic below. The hotlink only works when the Theme is "active." A Theme is made active by clicking on the theme to make the name stand out. Themes are made visible by checking the box to the left of the theme name. In the picture below, the Plan and Profile sheets theme is active. Benchmarks, Plan

and Profile sheets, Photographs, Trails and Service Roads, Channel toe, Surface Inflow, and Design Bank Protection are all marked as visible.



These Themes will all display as long as the scale in the upper right is within the display range for a particular theme.



As listed in Table 11-2 above, most of the more detailed themes will only display if the scale is less than 3600.

Themes that are hotlinked are Plan and Profile Sheets, ROW Sheets, Photographs, and Recommended Improvements. When the Theme Photographs is active, clicking on the hotlink lightning button will display photographs taken along the wash. Remember to close each picture after it is displayed to avoid having an excessive number of open windows. The red arrows indicate

