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DESIGN ANALYSIS REPORT
FOR
PIKES PEAK GREENWAY TRAIL
LOW WATER CROSSING AT
FOUNTAIN CREEK

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PURPOSE

The purpose of this project is to enhance and lengthen the popular Pikes Peak Greenway Trail and allow it to continue south of the creek and city.

BACKGROUND

The Pikes Peak Greenway Trail runs along the corridor of Fountain Creek as it travels through the City of Colorado Springs. In 1996, the Parks and Recreation Department built a low water crossing across Fountain Creek along with major trail improvements and additions. After a storm in 1999, the low water crossing was washed out and now lies in a heap along the bank of the creek. A large portion of the northern bank of the creek has also been eroded as an effect of this storm. In addition to the modifications that the Parks and Recreation Department have made to the creek, there have also been large amounts of soil and debris dumped along the banks of the creek.

PREVIOUS REPORTS

In 1994, Muller Engineering Company, Inc. performed a Drainage Basin Planning Study for Fountain Creek. In their report they detailed creek improvements including sloping boulder drops, acquiring property in frequently flooding areas, and adding trails and look-out stations to make the area more aesthetically pleasing. Among other locations, this report suggested the placement of sloped boulder drops at stations 164+00, 154+00, 150+30, and 150+20, which are between the Nevada Street Bridge and the natural confluence with Shooks Run.

There is also information on Fountain Creek in the Federal Emergency Management Act (F.E.M.A.) Flood Insurance Study (F.I.S.) publications. According to the F.I.S., the F.I.S. water surface elevations are based on a study prepared by the United States Army Corp of Engineers (A.C.O.E.) Flood Plain Information study on Fountain Creek in Colorado Springs and Fountain in 1973. Appendix A contains parts of the F.E.M.A. Flood Insurance Rate Map (F.I.R.M.) panels #08041C0729F and #08041C0737F, which

encompass the project location. The proposed project is located in Zone AE as indicated on these F.I.R.M. panels.

GENERAL LOCATION

The project location is just downstream of the Nevada Avenue Bridge over Fountain Creek and just upstream of the natural confluence with Shooks Run. Appendix A contains a map of the project location. As shown on Project Plan Sheet 4 in Appendix D, the proposed low water crossing and trails begin at the existing trail on the north side of the creek, crosses over the creek and continues downstream to an existing trail. The proposed low water crossing is at the same location as the previous one and the additional creek improvements are in close proximity to and resemble those of the Drainage Basin Planning Study by Muller Engineering.

TOPOGRAPHIC INFORMATION

Since there have been numerous studies performed along Fountain Creek, the changes in the bed elevations can be traced. Appendix A contains a contour map with FIMS contours supplemented by JR Engineering contour data and A.C.O.E./F.E.M.A. contours overlaid. According to the contour maps used by the A.C.O.E. for the F.E.M.A. F.I.S. in 1973 and shown in Appendix A, the bed elevation of the creek near the proposed structure was approximately 5886.3 feet. In 1994, Muller Engineering Company reported the bed elevation to be 5887.8 feet and in 2001 the survey data collected by JR Engineering shows the bed elevation to be 5883.1 feet. Appendix B contains two graphs showing the comparison between F.E.M.A. elevations and the most recent survey data. The first is a comparison of elevations for a cross section near the proposed structure. This graph shows the F.E.M.A., F.I.M.S. and JR Engineering elevations, as well as the creek after the proposed project. The second graph shows the channel bed slope according to the different elevation data and for the proposed project. There have been several major storms in Fountain Creek since 1973, which can explain some of the changing bed elevations. Between 1973 and 2001 the creek slope in this area has changed from .63% to a more stable .4%. In 1994, there appeared to be a significant change in elevation (a head cut) just downstream of the confluence with Shooks Run and now, the significant change in bed elevation appears to have moved upstream to be closer to the Nevada Avenue Bridge. Based on the comparison of the 1973 F.E.M.A. contours to current F.I.M.S. contours, supplemented by JR Engineering contour data, it appears

that substantial fill has been added on both sides of the banks in the vicinity of the low water crossing. This can be seen in the contour map in Appendix A.

HYDRAULIC ANALYSIS

According to the effective F.E.M.A. Flood Insurance Rate Study (F.I.S.), the 100-year flow rate in the project reach is 44,700 cfs. Using this flow rate and cross section data from F.E.M.A.'s HEC-2 analysis and contour maps, 100-year floodplain and floodway levels were estimated using the HEC River Analysis System (HEC-RAS). All modeled conditions were run in sub-critical flow regime, as were runs in F.E.M.A.'s original flow analysis.

Four cross sections were used to model the section of Fountain Creek near the proposed low water crossing. The most upstream cross section for the models, STA 157+00, is at the same location as F.E.M.A. Flood Insurance Rate Map (F.I.R.M.) cross section "DT." Similarly, the most downstream cross section, STA 144+00, is at the same location as F.E.M.A. F.I.R.M. cross section "DS." The locations of these cross sections can be seen in the contour map in Appendix A. The original HEC-2 input from the F.E.M.A. F.I.R.M. Study was not available from F.E.M.A. so HEC-2 input was obtained locally. This input was used for both cross sections STA 157+00 and STA 144+00 for each of the models.

The first model is a Duplicate Effective. This model has only two cross sections, 157+00 and 144+00, and models the local HEC-2 input in HEC-RAS in order to duplicate the published base flood elevations in the F.E.M.A. F.I.S. Although HEC-2 and HEC-RAS are different versions of the same program, they do have a tendency to give different results due to slightly different methods of calculations. The F.I.S. base flood elevations were matched at the lower cross section without adjustment. At the upper cross section, the "n" values were adjusted to match the F.I.S. base flood elevation.

The second model, the Modified Effective, represents the Duplicate Effective model with cross sections added near the low water crossing. The added cross sections were defined from the contour map used for the original flood study. In the overbank areas, the cross sections were defined to represent an average condition of the general area, as the topography varies considerably within the area. Localized depressions such as Shooks Run were omitted.

The next model shows the pre-project conditions or the present-day conditions. The cross sections at the F.I.S. locations were kept the same as previous models while the cross sections near the proposed low water crossing, STA 152+79 and STA 152+81, were adjusted based on the recent survey data, collected by JR Engineering, for this Pre-Project Model. This model shows that the base flood elevations have increased since the F.E.M.A. F.I.S. This increase is caused by the apparent previously mentioned fill added on both sides of the creek that can be seen in the contour map in Appendix A.

The last of the models is the Post-Project Model which models how the creek will function after the proposed low water crossing, creek improvements and grading have been done. The model indicates that the base flood elevations will decrease from the existing condition base flood elevations with completion of the project.. The chart in Appendix B compares the base flood elevations for the different models. HEC-RAS generated profiles, elevation reports and cross sections for each of the four models are contained in Appendix C. The proposed structure and creek improvements do not impede the original F.E.M.A. creek bed or have an apparent negative affect on the existing 100-year flood elevations as seen in the cross section elevation comparison, bed slope elevation comparison and base flood elevation chart in Appendix B.

SUMMARY OF PROPOSED IMPROVEMENTS

There are several types of proposed improvements along this stretch of Fountain Creek including trails and grading, a low water crossing, a sloped boulder drop, and rip-rap protection along the banks. Plan Sheets 3 through 5, found in Appendix D provide details of the proposed improvements.

Approximately 415 feet of concrete trails will be added to the existing trails along Fountain Creek. The 290 feet of trail on the north side of the creek will begin at the existing trail where it was washed out by previous storms and then turn towards the creek and slope down at 8.3% to the low water crossing. The 125 feet of trail on the south side will begin at the low water crossing and slope up at 4.0%, curve to be parallel to the creek and connect to the existing gravel trail. Some gravel trail on both the north and south sides of the creek will need to be removed and possibly replaced.

The proposed low water crossing is a reinforced concrete bridge structure that will span the distance between banks of the creek allowing normal flows to pass below the path while limiting the amount of mass blocking the creek during larger flows. With an opening of 1.5 feet, an estimated flow of approximately 380 cfs will flow under the deck of the structure without over topping it. A table of the results of various methodologies used to estimate the low flow conveyance capacity is in Appendix B. The table indicates flow rates yielding a maximum elevation of 5885, the bottom of the crossing slab, and 5886, the top of the crossing slab. The calculations that produced the data contained in the summary table are also contained in Appendix B. It is estimated that a flow greater than the capacity of the opening of the structure will occur 2-3 times every year. This estimation is based on the past 25 years worth of peak flow rates through the creek measured from U.S.G.S. at gage 07105500 near the Tejon and Nevada Street Bridges. A graph of these peak daily flows is contained in Appendix B. It was determined from the data on the graph that if the capacity of the low water crossing is 380 cfs, it would be usable, on average, for 97% of the days in a given year which is only 10 days of being over topped. A table of low flows through Fountain Creek, located in Appendix B, provides more detail to these historic flow rates. Project Plan Sheets 6 and 7 show the structural details of the low water crossing.

The proposed sloped boulder drop begins at STA 153+16.88 and continues to STA 152+63.68. This is approximately 115 feet downstream from the proposed location of a drop structure in the Fountain Creek Drainage Basin Planning Study (D.B.P.S.) and does not interfere with the other proposed drop locations. Appendix B contains a diagram showing the locations of these drop structures as proposed in the D.B.P.S. The proposed drop for this project will have a 1:5 slope and a drop of 2.5 feet. Boulders with a minimum diameter of 3-feet grouted-in-place along with several hard point grade control structures have been included in the design to maintain the integrity of the drop. The D.B.P.S. specified 24" diameter boulders and no hard point grade control structures. Plan Sheets 8 and 9 show details of the sloped boulder drop.

Because the water and soil in the creek are constantly moving, bank protection is needed to help stabilize the trail and crossing. Rip rap with a d_{50} = 24" to be grouted in place, is proposed on both sides of the creek and trails. In addition to the permanent rip-rap, reinforcement matting will be placed along the trail and some graded areas to facilitate vegetation re-growth. Plan Sheet 3 shows the location of the proposed reinforcement matting and Sheet 4 shows the location of the rip rap.

CONCLUSION

Currently, Fountain Creek between the Nevada Avenue Bridge and Shooks Run is an eyesore. Parts of the banks are washed out, the existing trail ends abruptly, and there is a pile of concrete rubble from the remains of the last low water crossing. This proposed project will reconnect the currently segmented trail. The project calls for removal of the rubble pile, removal of the old gravel and broken asphalt trail, and the addition of 415 feet of new concrete trail. Not only will this project enhance the Pikes Peak Greenway Trail, but it will also help to stabilize Fountain Creek. The proposed drop structure will create a more stable creek bed and the rip rap bank protection will reduce the erosive effects of future storms. Also, the low water crossing is proposed to be five feet lower than the previous one allowing large storms to freely overtop it. Moreover, the fact that the low water crossing is constructed on caissons that are approximately 18' long, and the low water crossing is tied to the drop structure which is secured to bedrock gives it additional stability. The Fountain Creek D.B.P.S. prepared in 1994 suggested additional trails, creek improvements, and the acquisition of property adjacent to the creek in this section of Fountain Creek. This project is the first step to making the Fountain Creek floodplain a safer place to be and fulfilling the suggestions of the Fountain Creek D.B.P.S.

PREPARED BY:

JR Engineering

Julie Anne Wildschut

Julie Anne Wildschut, E.I.,
Design Engineer I

/kd/9247.20/Greenway Report

ENGINEER'S STATEMENT:

The above letter, report and attachments were prepared under my direction and supervision and are correct to the best of my knowledge and belief. The evaluation performed for this report indicates that no significant increase to the existing flood elevation will occur as a result of the construction of the proposed improvements.

COLORADO REGISTERED CYNTHIA MEINEN BLEVINS 34484 PROFESSIONAL ENGINEER

Cynthia M. Blevins, P.E. #34484
For and On Behalf of JR Engineering

7-03-01
Date

BIBLIOGRAPHY:

1. Federal Emergency Management Agency 1990. Flood Insurance Study for the City of Colorado Springs. Washington, D.C.

2. Federal Emergency Management Agency 1997. Flood Insurance Rate Map, El Paso County, Colorado and Incorporated Areas, Panels #08041C0 729F and 737F. Washington, D.C.

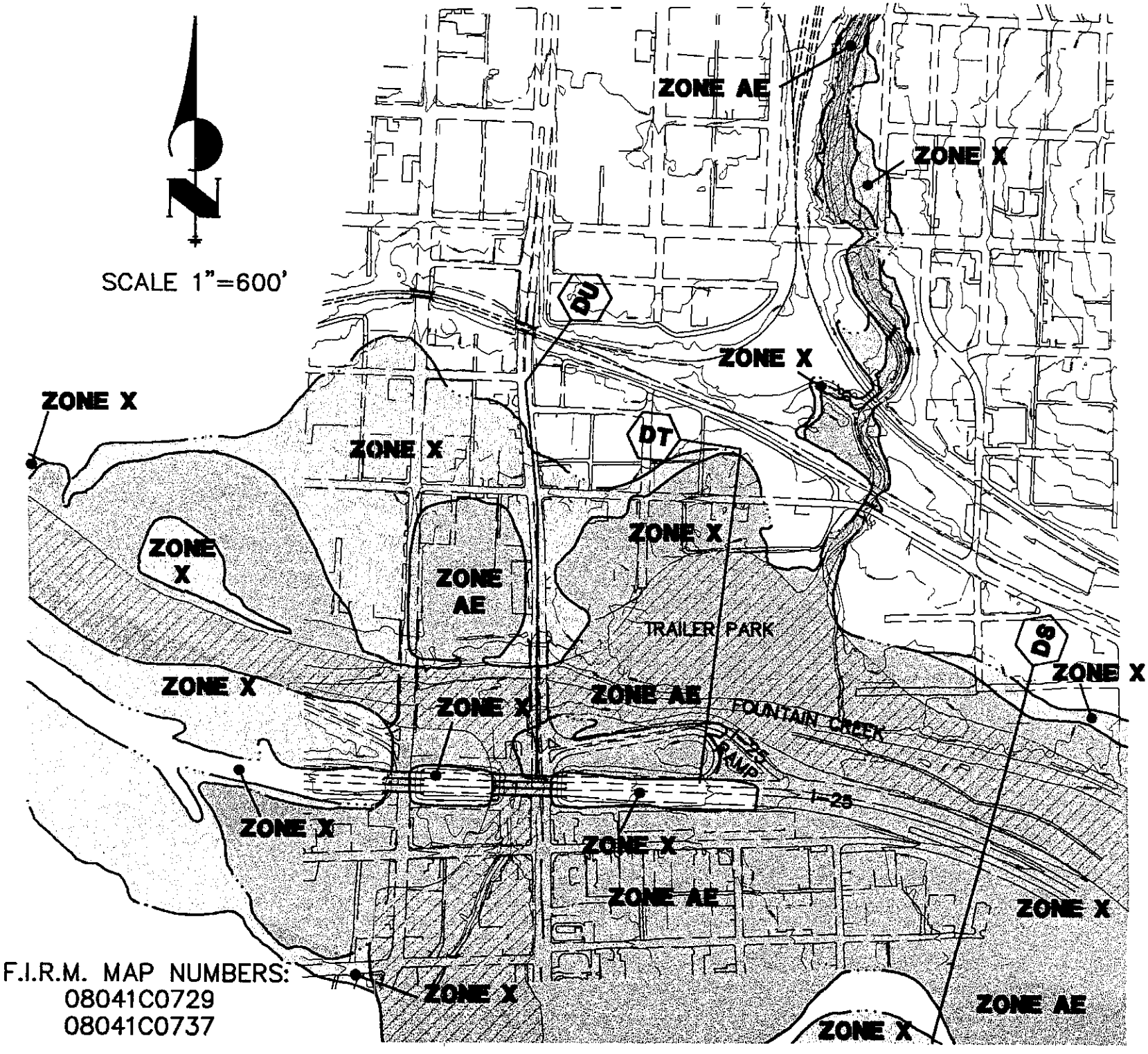
3. Muller Engineering Company, Inc. 1994. Fountain Creek Drainage Basin Planning Study. Prepared for The City of Colorado Springs, Colorado.

4. U.S. Army Corps of Engineers, Albuquerque District 1973. Floodplain Information, Fountain Creek and Jimmy Camp Creek, Colorado Springs and Fountain, El Paso County, Colorado. Prepared for Pikes Peak Area Council of Governments.

5. US Geological Survey data for gage 07105500 on Fountain Creek near Tejon and Nevada via USGS website, www.usgs.gov

APPENDIX A

F.E.M.A. F.I.R.M. MAP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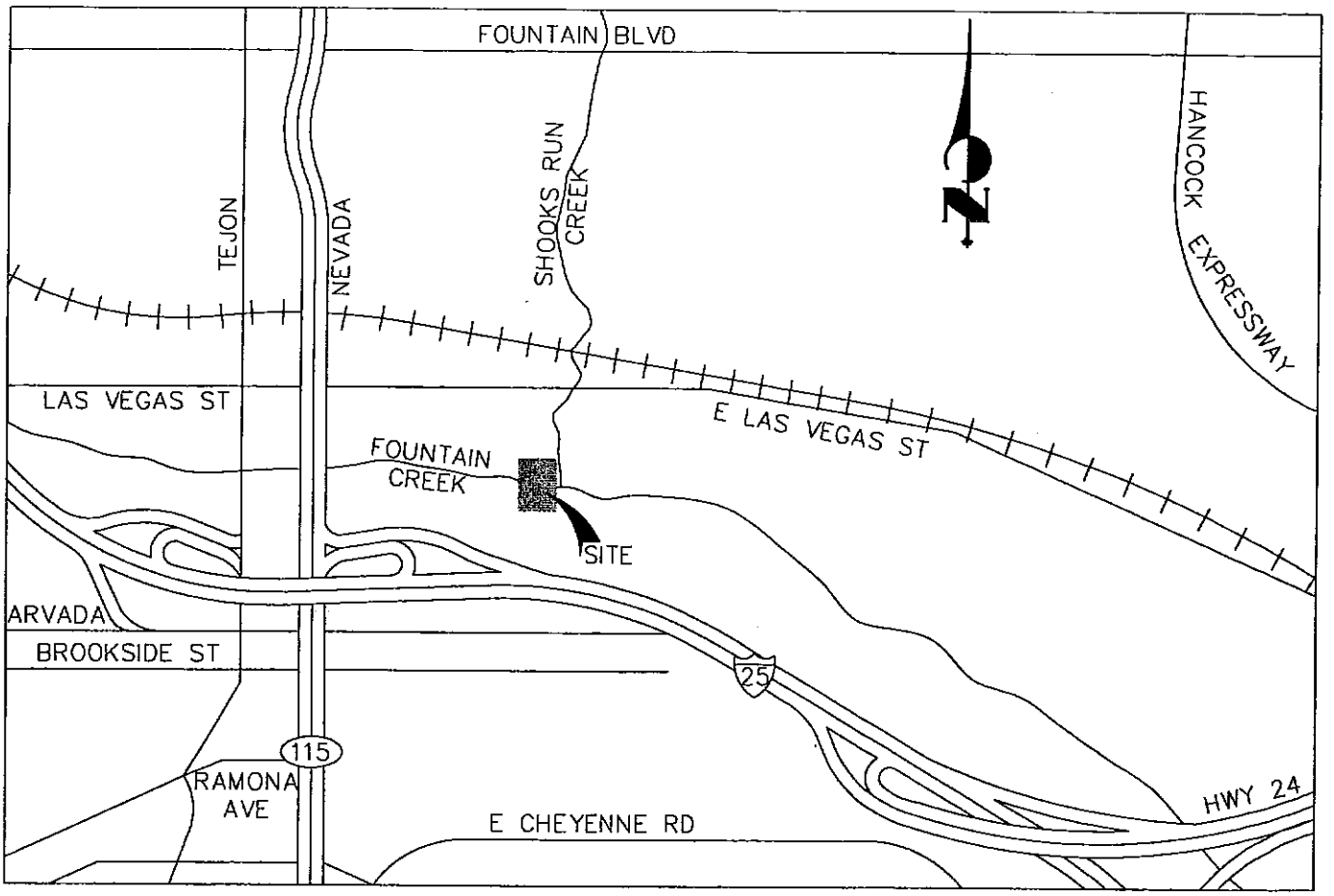
08041C0737

VICINITY MAP



VICINITY MAP

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CONTOUR MAP