DUNKLE

Preliminary Hydrology and Hydraulics Report

For

Interstate Highway 25 Improvements Cimarron / Bijou Interchange Colorado Springs, Colorado CDOT Project IM 0252-334

July 2003

WILSON
&COMPANY

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W & C Project No. X031000320

PRELIMINARY HYDROLOGY AND HYDRAULICS REPORT
FOR
INTERSTATE HIGHWAY 25
CIMARRON / BIJOU INTERCHANGE
COLORADO SPRINGS, COLORADO
CDOT PROJECT IM 0252-334

INTRODUCTION

The Colorado Department of Transportation (CDOT) has planned an improvement project for Interstate Highway 25 at the Cimarron Street (US Highway 24) and Bijou Street interchanges. This report presents the preliminary design of the local storm drainage facilities included in the project. The report describes the storm drainage patterns of the project area, the design criteria used, and the analysis that has been done. The local drainage improvements to be included in the project are illustrated in the report. Monument Creek, Fountain Creek, and Bear Creek are adjacent to and or cross portions of the project. Floodplain issues related to the project for these streams are discussed in a separate preliminary floodplain assessment dated July 2003.

GENERAL PROJECT LOCATION AND DESCRIPTION

This improvement project of I-25 from south of the Cimarron Street interchange to north of the Bijou Street interchange is located within Sections 7, 18, and 19, Township 14 South, Range 66 West; and Sections 13 and 24, Township 14 South, Range 67 West; in the City of Colorado Springs, El Paso County, Colorado, as illustrated on the Project Location Map included in the Appendix. I-25 is oriented generally north-south in the project area and parallels the west sides of Monument Creek and Fountain Creek. The project begins about 4000 feet south of Cimarron Street (Milepost 140.5) and extends to about 2600 feet north of Bijou Street (Milepost 142.4), a distance of about 1.9 miles.

The project includes complete reconstruction of the highway. The proposed design provides for an ultimate highway with four through lanes and an auxiliary lane in each direction. The Cimarron Street and Bijou Street interchanges will be completely reconstructed, including new bridges and ramps. The I-25 bridge over Colorado Avenue and the Cimarron Street bridge over Fountain Creek will be reconstructed, and a new bridge will be constructed for I-25 over Bear Creek. The project may also include reconstruction of the Bijou Street bridge over Monument Creek and the Union Pacific Railroad. The alignment of the highway will be widened and shifted to the west requiring right-of-way acquisition from adjacent properties.

I-25 south of this project is currently being reconstructed as part of the Nevada Avenue and Tejon Street interchange safety improvement project. The drainage issues related to that project are discussed in *Nevada / Tejon I-25 Interchange, CDOT Project No. SP 0252-342, Final Hydraulics Report,* prepared January 2001. I-25 north of this project was reconstructed as part of the Bijou Street to Fillmore Street safety improvement project. The drainage issues related to that project are discussed in *Final Hydrology and Hydraulics Report for Interstate Highway 25 Improvements, Bijou Street to Fillmore Street, Southbound, Colorado Springs, Colorado, CDOT Project SP 0252-306,* prepared March 1998.

FLOOD HISTORY

CDOT Region 2 design and maintenance staff and the City of Colorado Springs staff have been contacted regarding flood history in the project area. Apparently the only documented flooding history in the project area is related to general flooding along Monument Creek, Fountain Creek, and Bear Creek. There is also recollection of localized flooding of I-25 and local streets adjacent to the highway. This past flooding has apparently occurred on an isolated basis every few years, usually in association with intense, localized thunderstorms.

The most significant local flooding problem in the area appears to be at the I-25 depression under Bijou Street, where the capacity of the storm drainage lift station has often been exceeded. New larger capacity pumps were installed at the lift station in the Fall of 1993, however flooding of this depression occurred soon after in the Summer of 1994, when the capacity of the new pumps was exceeded. Since then, the capacity of the pumps has also been exceeded several more times. The pumps do not operate occasionally, due to power failures during storms.

Local flooding has also been observed frequently along Colorado Avenue west of I-25 between Spruce Street and Chestnut Street, and in the low area of Cucharras Street between Walnut Street and Chestnut Street. Local flooding has also occurred occasionally in the low area where Bijou Street turns into Kiowa Street to the east of I-25.

HYDROLOGIC ANALYSIS

Drainage Basin Description

The drainage basins tributary to the project reach of I-25 slope generally from northwest to southeast, from about elevation 6140 a half mile west of the Bijou Street interchange to about elevation 5925 just west of the highway at the south end of the project. The terrain of the area consists of moderate to steep mesas with moderately sloping drainageways. There are several significant existing culverts, storm sewers, and channels adjacent to or across I-25 along the project reach that carry runoff to Monument Creek and Fountain Creek. The areas of the drainage basins vary from less than one acre to about 82 acres. The drainage basins were delineated based on project mapping, City of Colorado Springs F.I.M.S. mapping, and extensive field observation. The overall project drainage basins are shown on the Drainage Basin Map.

Most of the drainage basin areas are fully developed as single-family residential, and neighborhood and commercial business landuses. Only small isolated open undeveloped areas remain, that are covered with natural range grasses and scattered stands of native shrubs. There are no reservoirs or detention areas that significantly affect runoff. Existing landuses and cover conditions for the drainage basins were based on the extensive field investigation. Future landuses for areas that are currently undeveloped were based on adjacent landuse trends and review of City landuse mapping.

Soils information from *Soil Survey of El Paso County Area, Colorado,* June 1981, prepared by the Soils Conservation Service (S.C.S.) was reviewed. The natural soils are sandy, gravelly loams and clay loams over sandstone and shale bedrock from the Chaseville-Midway complex, Ellicott loamy coarse sand, Heldt clay loam, Razor-Midway complex, and Torrifluvents loamy soils classifications. These soils classifications vary within the S.C.S. Hydrologic Soils Groups A through D.

Design Frequency

The proposed cross drainage and parallel drainage facilities for this interstate highway in an urban area are based on the major storm, 100-year return frequency. Storm drainage systems were designed to pickup the 100-year discharges from the offsite areas west of I-25 before they reach the highway.

Design Criteria

Peak design discharges were estimated for each offsite drainage basin based on existing development, and anticipated future development for those areas that are currently undeveloped. Peak design discharges were estimated for the onsite drainage basins of I-25 based on the future eight-lane roadway with auxiliary lanes full width roadway section. The Rational Method was used to estimate the peak design discharges. Area, height, and length information was measured on the basin mapping. Weighted runoff coefficients were based on criteria from the CDOT *Drainage Design Manual,* 1995. The time of concentration for each drainage basin was estimated considering overland flow time, channel flow time, and storm sewer flow time. Rainfall intensity-duration-frequency information was taken from the City of Colorado Springs / El Paso County *Drainage Criteria Manual,* which is based on the National Oceanic and Atmospheric Administration *NOAA Atlas 2, Precipitation-Frequency Atlas of the Western United States, Volume III-Colorado,* 1973. The peak discharges were routed through the basins using time of concentration. The runoff coefficient table; overland, channel, and pipe flow velocity curves; and the rainfall intensity-duration-frequency curves are included in the Appendix.

Peak Design Discharges

The peak design discharges estimated for the various basins were used for the preliminary design of the proposed storm drainage improvements. The preliminary hydrology calculations are included in the Appendix.

HYDRAULIC ANALYSIS

Design Criteria

The preliminary design of the significant proposed local storm drainage improvements has been done based on simple culvert calculations, hydraulic gradient analysis, and inlet capacity curves. Friction losses for the storm sewers and culverts were calculated based on Manning's equation, and minor losses were calculated based on design curves from the City of Colorado Springs / El Paso County *Drainage Design Manual.* The 10-year water surface elevation of Monument Creek and Fountain Creek was used as the tailwater for the outfall of each of the systems, because the drainage area ratios of the tributary basin area was so small relative to the drainage basin of the receiving stream, based on Federal Highway Administration (FHWA) guidelines. Inlet control calculations were also done for each storm sewer and culvert entrance. Allowable headwater depths were based on inlet grate elevations or channel overflow elevations. A ponding depth of one foot was used for sizing area inlets. Minor storm drainage improvements were only conceptually designed at this time because of the preliminary status of the roadway design. The various design and capacity curves used in the hydraulic analysis are included in the Appendix.

Existing Drainage Improvements

As mentioned previously, there are several significant existing culverts, storm sewers, and channels adjacent to or across I-25 along the project reach that carry runoff to Monument Creek, Fountain Creek, and Bear Creek. An existing grass and riprap lined channel drains southerly along the west side of the highway from about 700 feet south of Cimarron Street to outfall in Bear Creek. The existing storm sewer in Chestnut Street daylights in Cucharras Street, then drains east to an existing culvert crossing of I-25 that outfalls in Monument Creek. The existing storm sewer in Walnut Street turns and crosses the highway between Colorado Avenue and Cucharras Street to outfall in Monument Creek. The existing storm sewer in Spruce Street turns and crosses under the I-25 bridge over Colorado Avenue to outfall in Monument Creek. The existing storm sewer in Kiowa Street crosses the highway to outfall in Monument Creek. The existing storm sewer for the highway depression under Bijou Street flows to the lift station and outfalls to Monument Creek just south of Bijou Street.

There are also numerous existing curb inlets, area inlets, and embankment protectors that drain the existing highway, medians, and roadside areas. These inlets are connected to the existing storm sewers and culverts, or cross the highway in small pipes.

Proposed Drainage Improvements

The improvements planned for the highway will have a new horizontal alignment, a new vertical profile, increased superelevation, and a wider cross section in compliance with current highway standards. This will require reconstruction of the existing significant local storm drainage facilities along the highway. These existing facilities do not have sufficient capacity to carry the design runoff discharges expected and will be enlarged as necessary.

Most of the of the existing storm sewer systems extend west of the highway varying distances into the adjacent development. The City uses a design policy to size storm sewer systems for the initial storm, 10-year return frequency. Many of the existing storm sewer systems do not appear to have sufficient capacity, based on field observation. Additional inlets will be constructed for these systems west of the highway to pickup the difference between the 100-year peak discharge and the capacity of the existing system. A stubout that is sized for the 10-year peak discharge will connect to the enlarged crossings under the new highway with the existing storm sewer systems, to allow enlargement of the existing systems in the future if desired..

The alignment of the new widened highway will be shifted to the west, south of Cimarron Street, to minimize impacts to the Fountain Creek floodplain. The existing grass and riprap lined channel that drains southerly along the west side of the highway to Bear Creek will be eliminated because the highway must be aligned so far to the west there will no longer be adequate space for an open channel. Some of the remaining space on the west side of the new highway alignment must be reserved for an underground electric conduit run that will be needed to replace the existing overhead electric lines in the area. The existing channel will be replaced with a new storm sewer along the west side of the highway that will continue to drain the low point just north of Abbott Lane to Bear Creek, and a new culvert crossing the highway about 950 feet south of Cimarron Street to drain the existing channel from the west to Monument Creek rather than to Bear Creek. The separate system is needed to drain the low point just north Abbott Lane, because the 100-year water surface of Fountain Creek at the outfall of the system that drains the channel from the west (further to the north) is higher than the elevation of the low point just north of Abbott Lane.

A new storm sewer will be constructed under the existing Midland Railroad crossing bridge to outfall in Monument Creek. It will eliminate the existing culvert crossing at Cucharras Street and the existing storm sewer crossing between Colorado Avenue and Cucharras Street. This alignment will allow the new crossing of I-25 under the existing bridge to be constructed without impacting traffic on the highway. The existing bridge will then be removed as part of the project. The new storm sewer will extend north along the west side of the highway to Cucharras Street where a large area inlet will be located at the low point. A stubout will be provided to the west in Cucharras Street for future extension and connection to the existing Chestnut Street storm sewer, and a stubout will be constructed to the north along the west side of the highway to connect to the existing Walnut Street storm sewer. The 100-year water surface of Monument Creek at the outfall of this system is about two feet higher than the existing ground on the west side of the highway where Spruce Street turns into Cucharras Street. This will allow water to back up through the new system to the west side of the highway during the 100-year discharge on Monument Creek. This is the same condition that currently occurs with the existing system that drains the area.

A new storm sewer trunkline will be constructed along the east side of the highway from an outfall about 325 feet south of Colorado Avenue to the I-25 depression under Bijou Street. The location of the outfall for the new trunkline will provide a gravity flow system from the depression into Monument Creek, and will eliminate the need for the existing storm drainage lift station at the depression. The trunkline will follow the alignment of the existing trail along the west side of Monument Creek to minimize impacts to the existing flagstone slope paving along the west bank of the creek. A new storm sewer lateral crossing at Colorado Avenue will be connected to this trunkline, and will replace the existing undersized storm sewer crossing at that location. This storm sewer lateral will extend under the highway to Spruce Street where a large area inlet will be constructed in a new low point west of the highway. A stubout will be constructed to the north to connect to the existing Spruce Street storm sewer. The existing storm sewer crossing at Kiowa Street will also be replaced with a new storm sewer lateral connected to the new trunkline. A large area inlet will be constructed on this lateral on the west side of the highway at the low point of Kiowa Street.

When the existing I-25 / Bijou Street interchange depression was built in the late 1950's, the roadway low point was constructed at an elevation that was about the same as the adjacent bed of Monument Creek. The shale bedrock is only about two to three feet below that elevation. A steel sheet piling cofferdam was constructed to divert much of groundwater around the depressed area. A corrugated metal pipe underdrain system was constructed inside the cofferdam to carry groundwater inside the cofferdam to the storm drainage lift station. These improvements did not remove the groundwater from the depressed area sufficiently. During construction large aggregate and concrete pavement pads below the northbound and southbound lanes were added to adequately stabilize the subgrade of the highway pavement. When the highway is reconstructed the cofferdam will be extended to include the entire new roadway within the depressed area. A new underdrain system connected to the new gravity flow trunkline will be constructed within the enlarged cofferdam. It is also anticipated further roadway subgrade improvements will be required in the depressed area. These subgrade improvements will be identified during final design when more extensive soils and groundwater information is obtained.

The Cimarron Street improvements will meet the existing roadway at the existing bridge over the Union Pacific Railroad. The new roadway will slope westerly toward Fountain Creek. New inlets will be constructed to pick up runoff from the new roadway just to the east of the new Cimarron Street bridge over Fountain Creek.

Bijou Street will be aligned west of I-25 to the Spruce Street intersection. The inlet at the northeast corner of the intersection will be reconstructed to fit the new curb and gutter. The Bijou Street / Kiowa Street curves east of the Bijou Street bridge over Monument Creek and the Union Pacific Railroad will also be realigned. Some of the existing inlets and connecting pipes at this location will be replaced as required to fit the new street alignment, and the new profile will be designed to fit some of the existing inlets where the roadway alignment is unchanged.

Numerous inlets with connecting pipes and embankment protectors will be needed to drain the medians, median barriers, and roadside areas along the reconstructed highway. Storm sewer systems will also be needed to drain the areas of the two interchanges. These minor local storm drainage improvements have been laid out conceptually.

The new significant local storm drainage facilities will cross existing sanitary sewers at several locations. The preliminary design of these drainage facilities has provided adequate clearance at these crossing locations.

The preliminary hydraulic calculations for the significant local storm drainage facilities are included in the Appendix. The proposed significant local storm drainage facilities crossing and adjacent to the highway, the conceptual minor local storm drainage improvements for the highway and the interchange areas, and the preliminary cofferdam and underdrain improvements at the Bijou Street depression are shown on the Drainage & Utility Plans included in the Appendix.

EROSION CONTROL DURING CONSTUCTION, PERMANENT WATER QUALITY IMPROVEMENTS, AND WETLANDS DISTURBANCE AND MITIGATION

A Storm Water Management Plan and erosion control improvement plans will be included with the final design to meet NPDES permit requirements. These plans will be designed to minimize erosion, sedimentation, and pollution of storm water during and after construction of the project.

Temporary erosion control measures such as surface roughening, check dams, storm drain inlet protection, silt fences, slope drains, sediment basins, stabilized construction entrances, concrete waste control structures, spill control, groundwater control, timely reseeding and sodding, and soil retention blankets will designed for erosion control during construction. Permanent erosion control improvements such as riprap protection, drop structures, embankment protectors, slope paving, and permanent seeding will be also be designed for long-term erosion control.

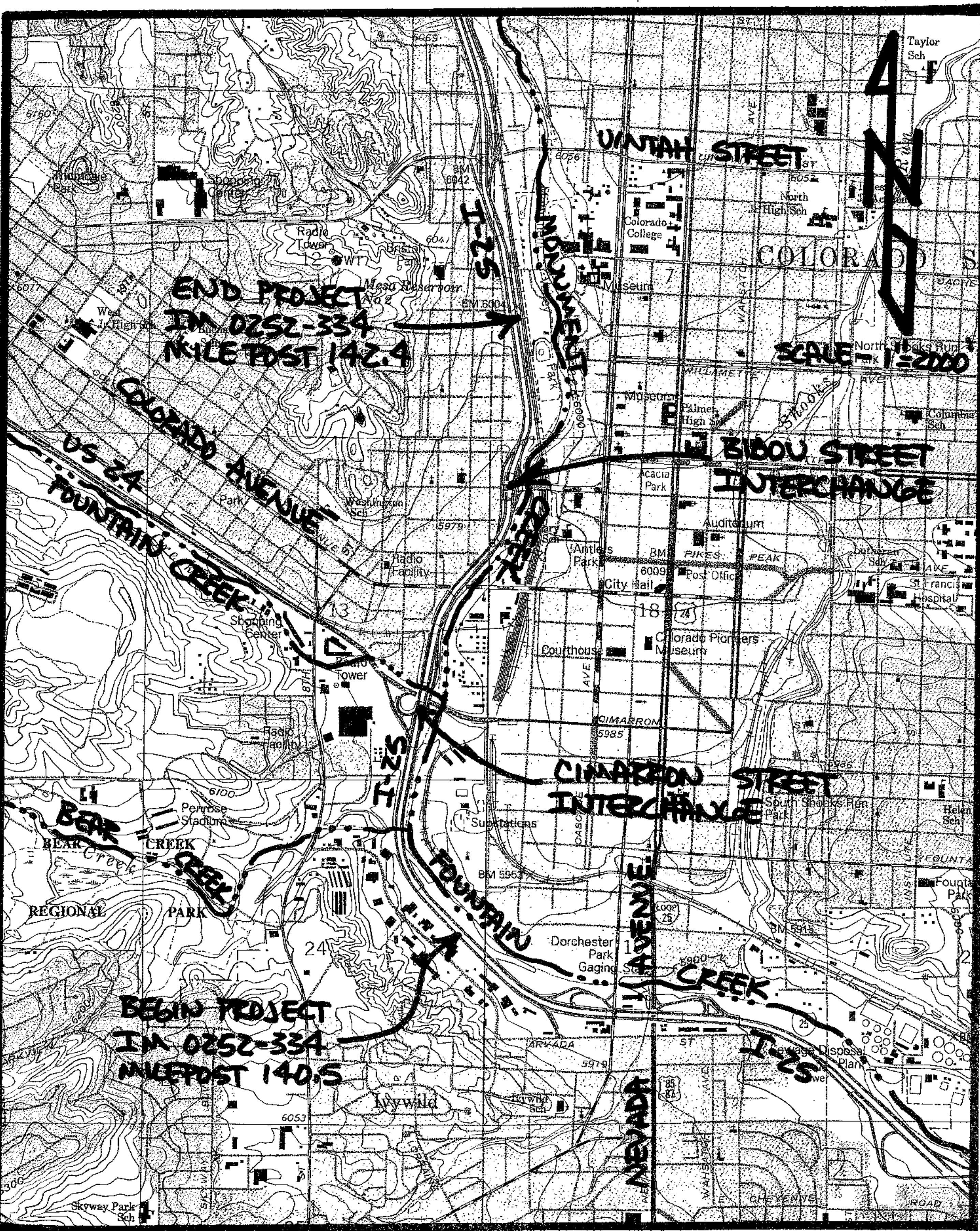
Final design will also include permanent water quality best management practice improvements. Since the corridor of the project is very narrow between Monument Creek and Fountain Creek on the east and the existing development on the west, these improvements will most likely be structural elements incorporated into the storm sewers and culverts. Grass swales with sediment traps, grass buffer strips, infiltration trenches, and extended dry detention basins may be practical in the open areas of interchanges, especially at Cimarron Street, and any other open areas where there will be excess right-of-way.

Wetland disturbance and mitigation plans for areas along Monument Creek, Fountain Creek, and Bear Creek will be included in final design. A 404 Permit will be processed through the US Army Corps of Engineers for the wetland filling and mitigation, to comply with the environment assessment for the overall I-25 Corridor. If required, a Section 401 water quality certificate will be processed through the Colorado Department of Health. Other drainage related permits required, will be processed through local agencies, as needed.

SUMMARY

The preliminary design of the local storm drainage improvements for planned improvement project for Interstate Highway 25 at the Cimarron Street (US Highway 24) and Bijou Street interchanges is in general conformance with CDOT and City of Colorado Springs / El Paso County design criteria. The proposed improvements maintain existing drainage patterns as closely as possible. Final detailed hydrology and hydraulic analyses will be included with the final design of the project, as the final roadway alignment, cross-section, profile, and area grading are completed.

APPENDIX



I-25/CIMARRON/BIJOU INTERCHANGE

CDOT PROJECT IM 0252-334

PROJECT LOCATION MAP

HYDROLOGIC DESIGN INFORMATION

Table 7.4 Recommended Runoff Coefficients and Percent Impervious

Land Use or Surface Characteristics	**Percent Impervious**	**Frequency**			
		2	5	10	100
Business:					
Commercial Areas	95	.87	.87	.88	.89
Neighborhood Areas	70	.60	.65	.70	.80
Residential:					
Single-Family		.40	.45	.50	.60
Multi-Unit (detached)	50	.45	.50	.60	.70
Multi-Unit (attached)	70	.60	.65	.70	.80
½ Acre Lot or Larger		.30	.35	.40	.60
Apartments	70	.65	.70	.70	.80
Industrial:					
Light Areas	80	.71	.72	.76	.82
Heavy Areas	90	.80	.80	.85	.90
Parks, Cemeteries:	7	.10	.10	.35	.60
Playgrounds:	13	.15	.25	.35	.65
Schools:	50	.45	.50	.60	.70
Railroad Yard Areas:	40	.40	.45	.50	.60
Undeveloped Areas:					
Historic Flow Analysis, Greenbelt, Agricultural:	2	See	Lawns		
Offsite Flow Analysis: (when land use not defined)	45	.43	.47	.55	.65
Streets:					
Paved	100	.87	.88	.90	.93
Gravel	13	.15	.25	.35	.65
Drive and Walks:	96	.87	.87	.88	.89
Roofs:	90	.80	.85	.90	.90
Lawns, Sandy Soil:	0	.00	.01	.05	.20
Lawns, Clayey Soil:	0	.05	.10	.20	.40

Note: These Rational Formula coefficients may not be valid for large basins.

Source: Urban Storm Drainage Criteria Manual (UDFCD, 1969).

where:

T_c = time of concentration, in minutes, at the first design point
L = basin length in feet

A minimum T_c is to be 5 minutes in urban areas and 10 minutes in rural areas.

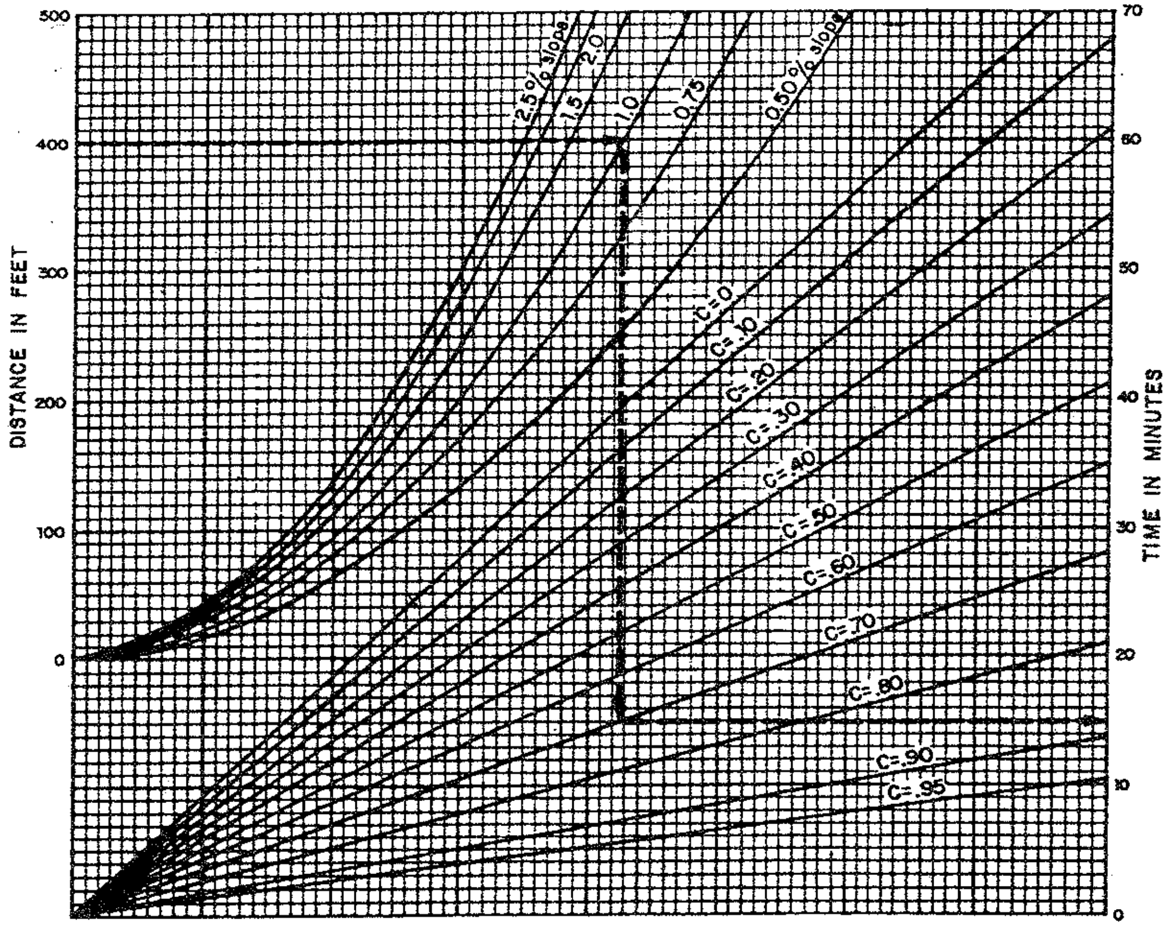


Figure 7-1 Time of Concentration for Overland Flow

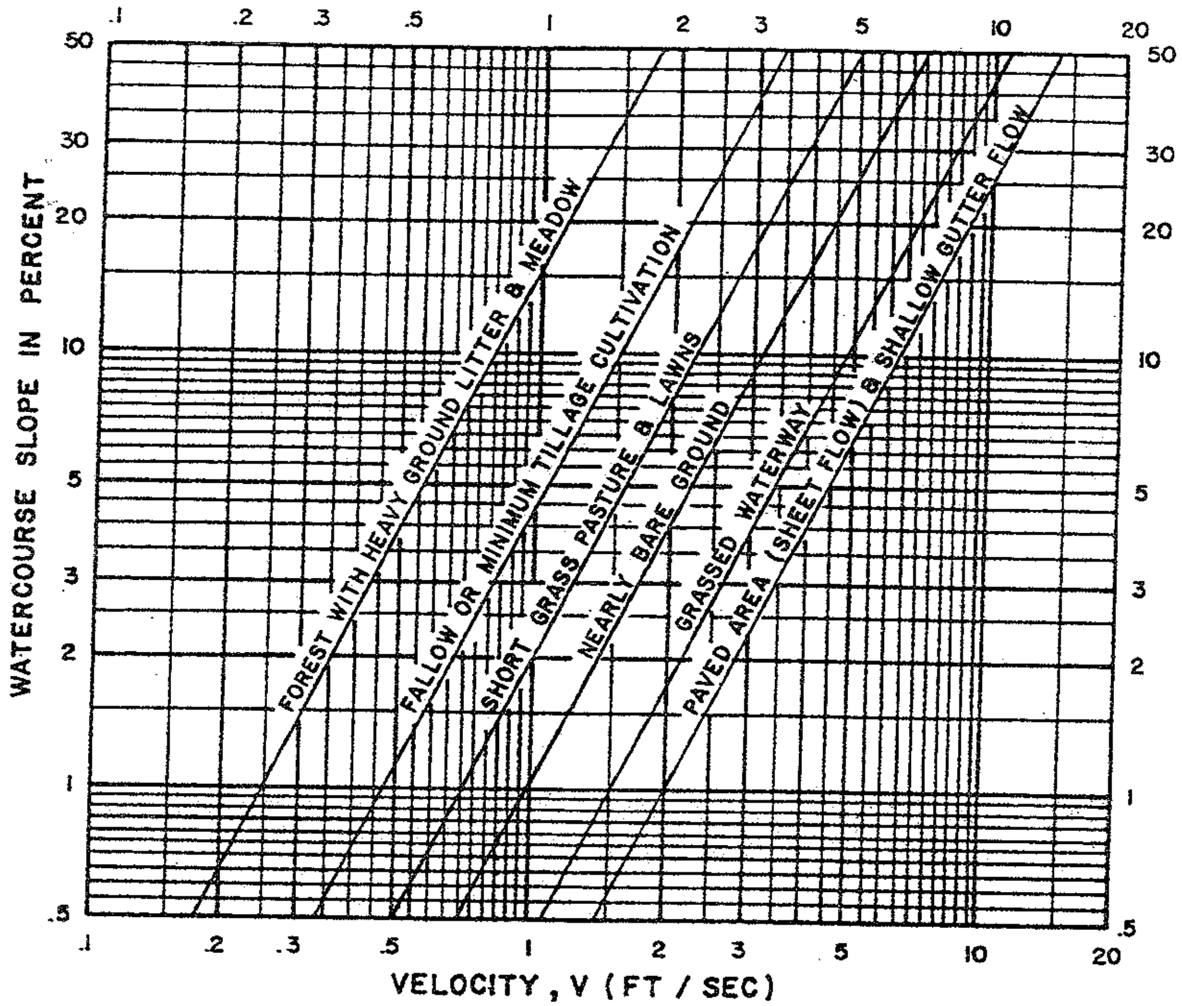
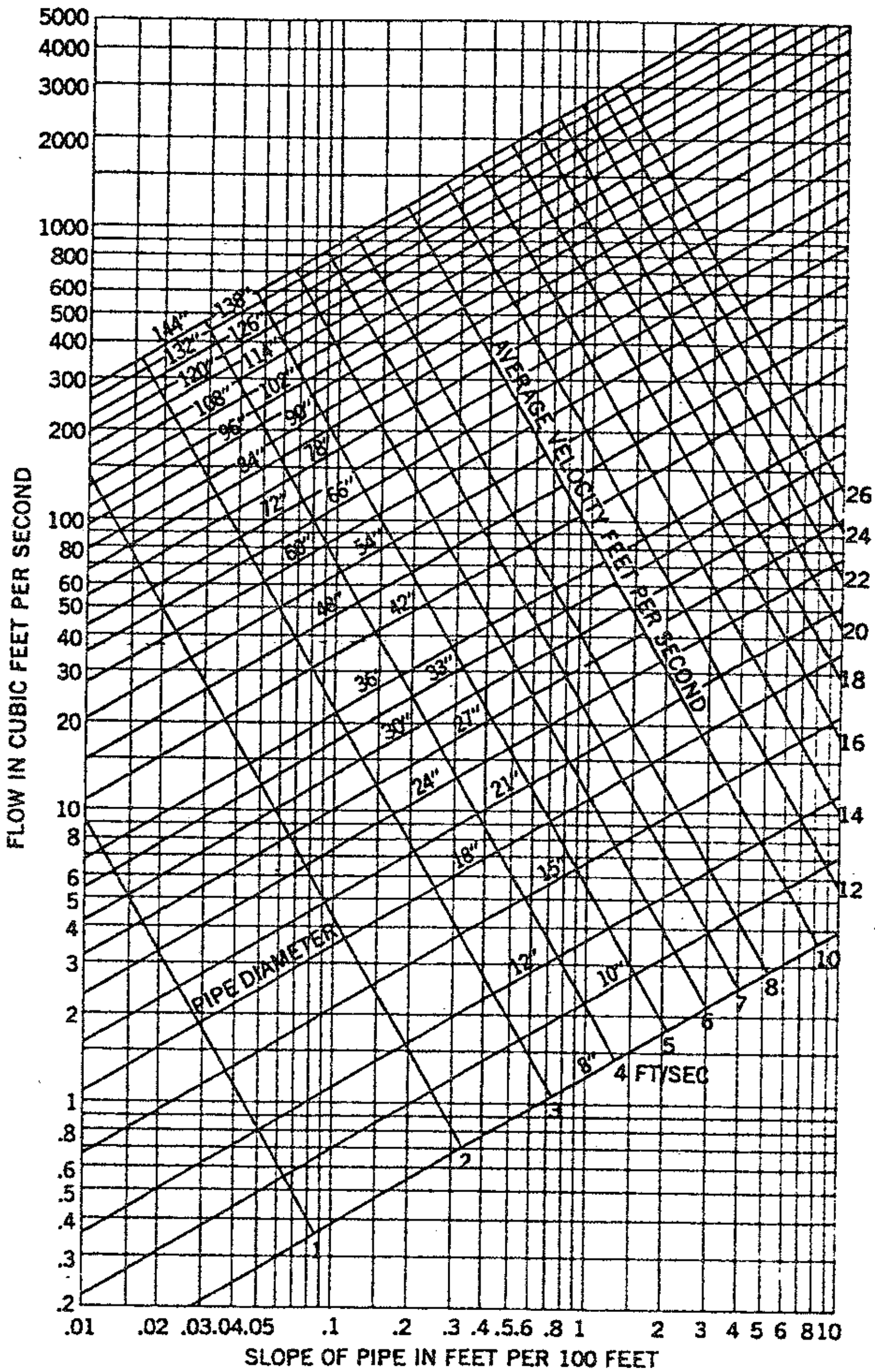
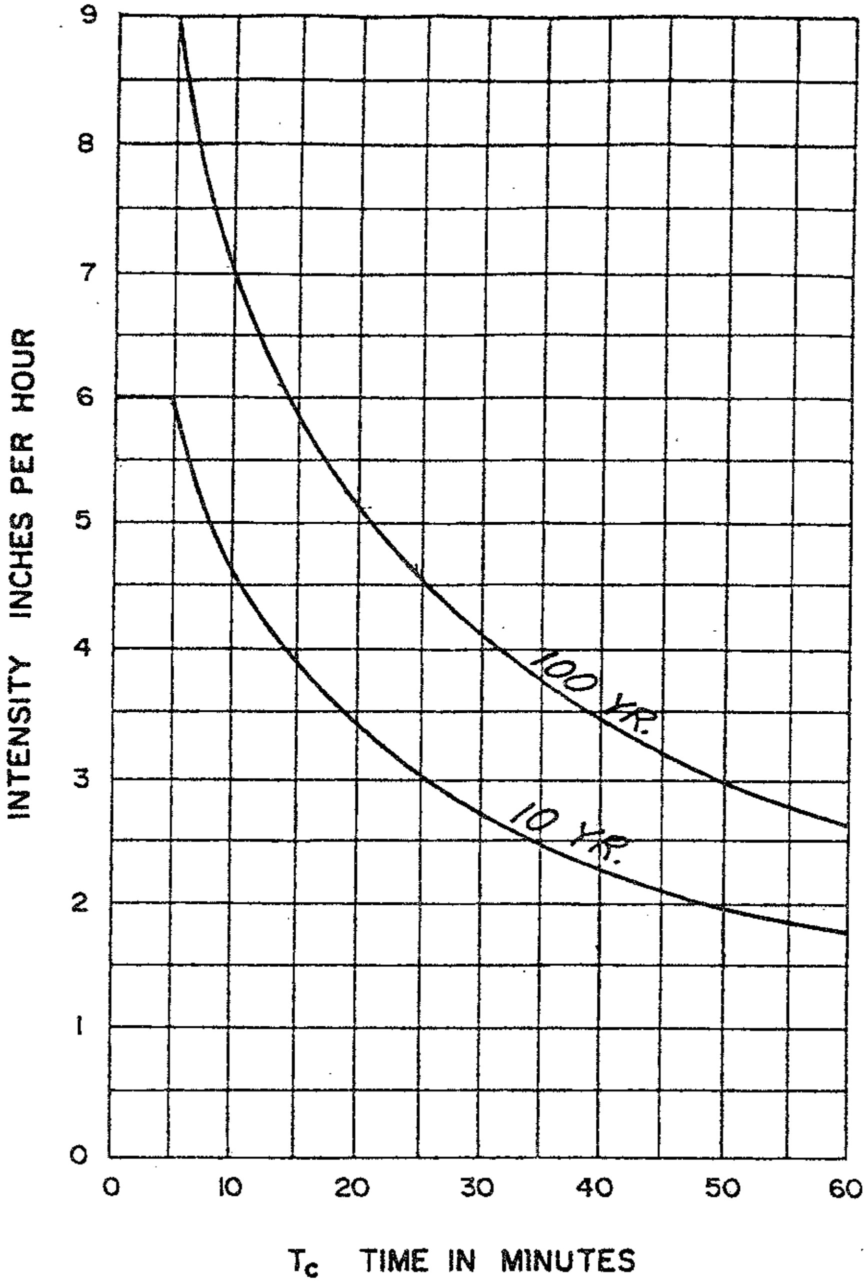


Figure 7-2 Velocities for Estimation of Time of Concentration

FIGURE 5

FLOW FOR CIRCULAR PIPE FLOWING FULL
BASED ON MANNING'S EQUATION n=0.013





RE: Based upon Pikes Peak area council of governments/ areawide urban runoff control manual.

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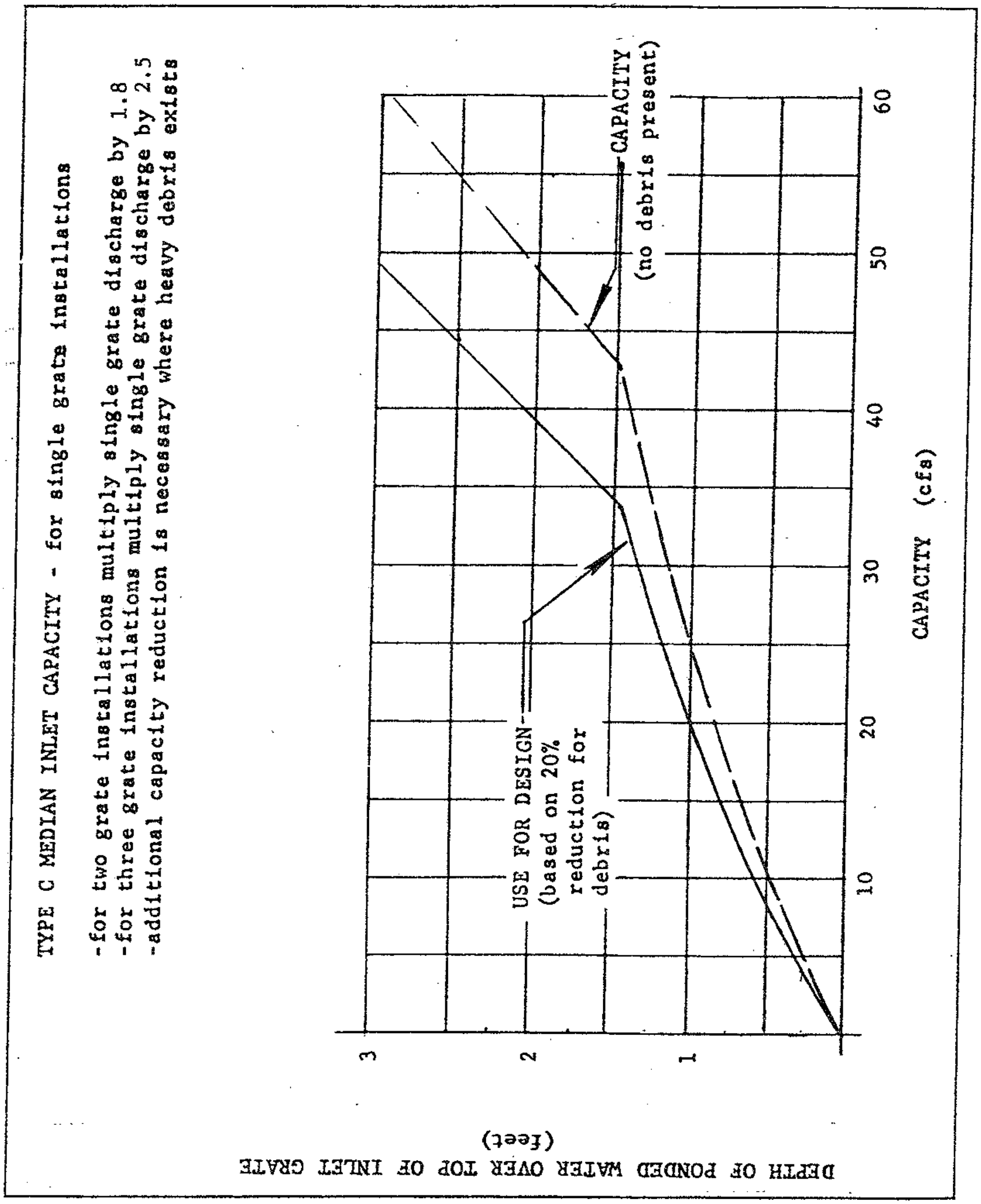
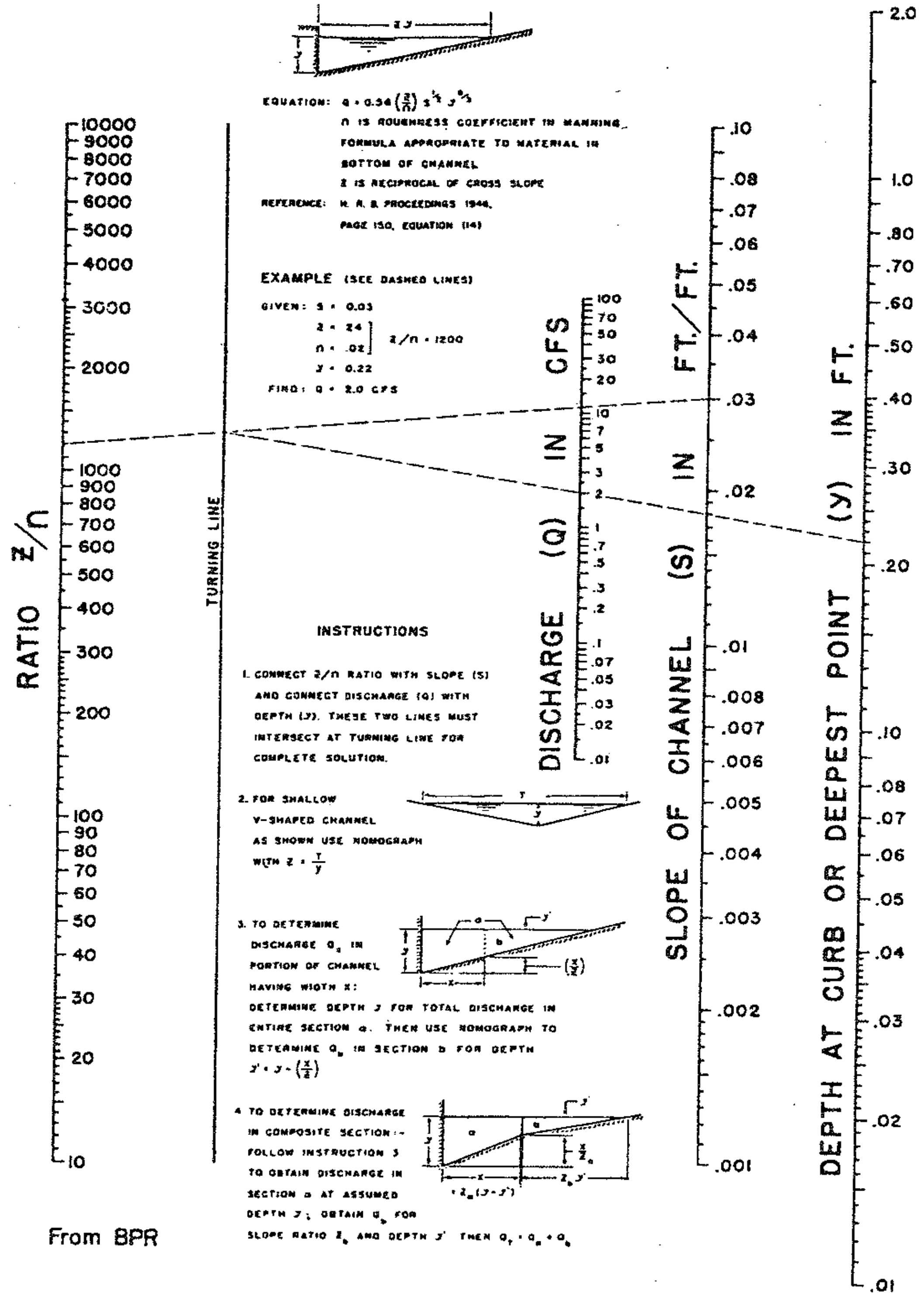
Drainage Criteria Manual

Storm Rainfall
Time Intensity-Frequency Curves

Date
OCT. 1987

Figure
5 - 1


TYPE C MEDIAN INLET CAPACITY - for single grate installations
-for two grate installations multiply single grate discharge by 1.8
-for three grate installations multiply single grate discharge by 2.5
-additional capacity reduction is necessary where heavy debris exists
CAPACITY
(no debris present)
USE FOR DESIGN
(based on 20%
reduction for
debris)
10
20
30
40
50
60
CAPACITY (cfs)
1
2
3
DEPTH OF PONDED WATER OVER TOP OF INLET GRATE
(feet)



NONOGRAPH FOR FLOW IN TRIANGULAR GUTTERS
(From U.S. Dept. of Commerce, Bureau of Public Roads, 1965)

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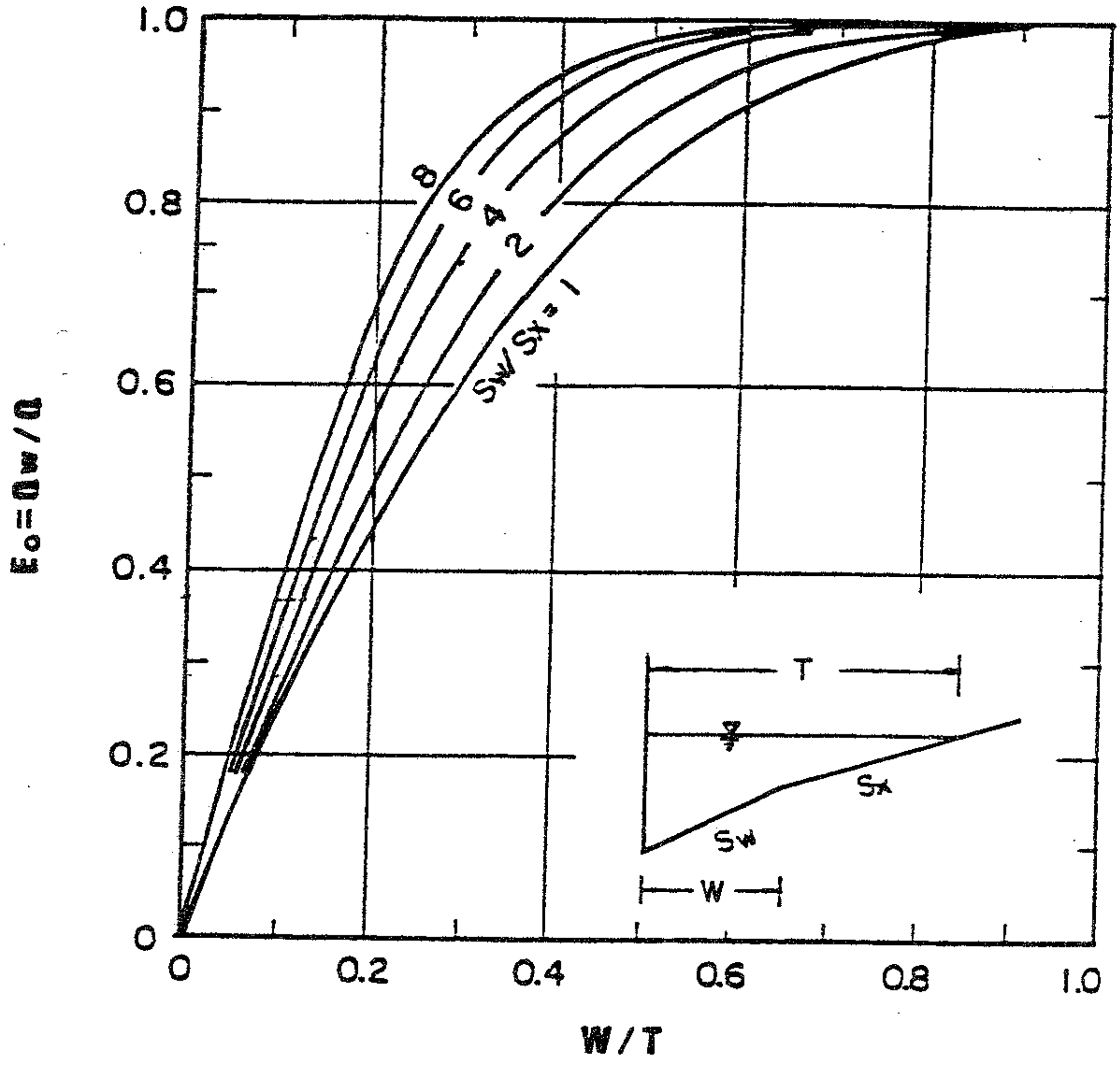
Drainage Criteria Manual

NOMOGRAPH FOR FLOW IN TRIANGULAR GUTTERS.

Date: OCT. 1987

Figure 7 - 2



REFERENCE : FHWA Hydraulic Engineering Circular No. 12

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Drainage Criteria Manual

Date
OCT. 1987

Ratio of Frontal Flow to Gutter Flow

Figure
7 - 3

HYDROLOGIC CALCULATIONS

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CK. | PROJ. Cimarron/Bijou | SHEET 1
DATE May 8, 2003 | SUBJ. Prelim Hydrology | OF

Basin A - A = 11.0 Ac

$C_{10} = (0.20)(0.15)+(0.05)(0.70)+(0.75)(0.90) = 0.74$
(20% open + 5% neighborhood, business + 75% highway)
$C_{100} = (0.20)(0.30)+(0.05)(0.80)+(0.75)(0.93) = 0.80$

TC ⇒ 100' overland paved @ 2.0%± ⇒ $\frac{1.8(1.1-0.90)\sqrt{100}}{\sqrt[3]{2.0}} = 3$

1000' grass-swale @ 1.8% $\left(\frac{5991-5973}{1000}\right)$ ⇒ v = 2.0 fps ⇒ $\frac{1000}{(2.0)(60)} = 8$

11 min

$Q_{10} = (0.74)(4.5)(11.0) = 37$ cfs

$Q_{100} = (0.80)(6.8)(11.0) = 60$ cfs ⇒ New storm sewer in I-25 at Bijou

Basin B - A = 5.5 Ac

$C_{10} = (0.85)(0.70)+(0.15)(0.90) = 0.73$
(85% neighborhood business + 15% highway)
$C_{100} = (0.85)(0.80)+(0.15)(0.93) = 0.82$

TC ⇒ 250' overland paved @ 0.5%± ⇒ $\frac{1.8(1.1-0.90)\sqrt{250}}{\sqrt[3]{0.5}} = 7$

⇒ 300' street @ 2.0%± ⇒ v = 2.8 fps ⇒ $\frac{300}{(2.8)(60)} = 2$

9 min

$Q_{10} = (0.73)(4.7)(5.5) = 19$ cfs

$Q_{100} = (0.82)(7.2)(5.5) = 32$ cfs ⇒ New storm sewer in I-25 at Bijou

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CK. | PROJ. Cimarron/Bijou | SHEET 2
DATE May 8, 2003 | SUBJ. Prelim Hydrology | OF

Σ Basins A and B - A = 16.5 Ac

$C_{10AV} = [(0.74)(11.0) + (0.73)(5.5)] / 16.5 = 0.74$

$C_{100AV} = [(0.80)(11.0) + (0.82)(5.5)] / 16.5 = 0.81$

$\Sigma TC \Rightarrow TC$ at Basin A = 11 min

425' - 42" RCP @ 0.5% ± ⇒ V = 7 fps ⇒ $\frac{425}{(7)(60)} = 1$
(new in I-25)

12 min

$\Sigma Q_{10} = (0.74)(4.3)(16.5) = 53$ cfs

$\Sigma Q_{100} = (0.81)(6.5)(16.5) = 87$ cfs ⇒ New storm sewer on east side I-25 Bijou to Colorado

Basin C-1 - A = 34.9 Ac

$C_{10} = (0.05)(0.15) + (0.75)(0.50) + (0.20)(0.70) = 0.52$
(5% open + 75% single family + 20% neighborhood business)

$C_{100} = (0.05)(0.30) + (0.75)(0.60) + (0.20)(0.80) = 0.63$

TC ⇒ 200' overland paved @ 2.5% $\left(\frac{6103-6098}{200}\right) \Rightarrow \frac{1.8(1.1-0.90)\sqrt{200}}{\sqrt[3]{2.5}} = 4$

⇒ 500' grass swale @ 10.8% $\left(\frac{6098-6044}{500}\right) \Rightarrow$ V = 5.0 fps ⇒ $\frac{500}{(5.0)(60)} = 2$

⇒ 1750' street @ 3.8% $\left(\frac{6044-5978}{1750}\right) \Rightarrow$ V = 3.9 fps ⇒ $\frac{1750}{(3.9)(60)} = 7$

⇒ 575' - 18" RCP @ 0.9% $\left(\frac{5978-5973}{575}\right) \Rightarrow$ V = 5.5 fps ⇒ $\frac{575}{(5.5)(60)} = 2$
(Ex in Spruce)

15 min

$Q_{10} = (0.52)(3.9)(34.9) = 71$ cfs in enlarged existing storm sewer in Spruce

$Q_{100} = (0.63)(5.8)(34.9) = 128$ cfs (71 cfs in enlarged existing storm sewer in Spruce
57 cfs bypass South in Spruce to Basins C-3 and C-4)

COMP. [signature] | **WILSON & COMPANY** | LOC. I-25 | FILE X031000320
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DATE May 8, 2003 | SUBJ. Prelim Hydrology | OF

<u>Basin C-2 - A=14.5 Ac</u>

$C_{10} = (0.95)(0.50) + (0.05)(0.70) = 0.51$
(95% single family + 5% neighborhood business)
$C_{100} = (0.95)(0.60) + (0.05)(0.80) = 0.61$

$TC \Rightarrow$ 150' overland grass @ 5.3% $\left(\frac{6000-5992}{150}\right) \Rightarrow \frac{1.8(1.1-0.15)\sqrt{150}}{\sqrt[3]{5.3}} = 12$

$\Rightarrow$ 75' grass swale @ 5.3% $\left(\frac{5992-5988}{75}\right) \Rightarrow v = 3.5\,fps \Rightarrow \frac{75}{(3.5)(60)} = 1$

$\Rightarrow$ 1175' street @ 1.6% $\left(\frac{5988-5969}{1175}\right) \Rightarrow v = 2.6\,fps \Rightarrow \frac{1175}{(2.6)(60)} = \underline{8}$

21 min

$Q_{10} = (0.51)(3.3)(14.5) = 24\,cfs$ in existing storm sewer east in Pikes Peak

$Q_{100} = (0.61)(5.0)(14.5) = 44\,cfs$ (24 cfs in existing storm sewer east in Pikes Peak, 20 cfs bypass south in Walnut to Basin E-1)

<u>Basin C-3 - A=2.5 Ac</u>

$C_{10} = (0.50)(0.50) + (0.50)(0.70) = 0.60$
(50% single family + 50% neighborhood business)
$C_{100} = (0.50)(0.60) + (0.50)(0.80) = 0.70$

$TC \Rightarrow$ 150' overland grass @ 2.7% $\left(\frac{5977-5973}{150}\right) \Rightarrow \frac{1.8(1.1-0.15)\sqrt{150}}{\sqrt[3]{2.7}} = 15$

$\Rightarrow$ 625' street @ 0.5% $\left(\frac{5973-5970}{625}\right) \Rightarrow v = 1.4\,fps \Rightarrow \frac{625}{(1.4)(60)} = \underline{7}$

22 min

$Q_{10} = (0.60)(3.3)(2.5) = 5\,cfs$ in existing storm sewer in Spruce

$Q_{100} = (0.70)(4.9)(2.5) = 9\,cfs$ (5 cfs in existing storm sewer in Spruce, 4 cfs bypass west in Pikes Peak to Basin E-1)

Basin C-4 – A = 6.5 Ac

$C_{10} = (0.15)(0.15) + (0.60)(0.70) + (0.25)(0.90) = 0.67$
(15% open + 60% neighborhood business + 25% highway)
$C_{100} = (0.15)(0.30) + (0.60)(0.80) + (0.25)(0.93) = 0.76$

TC ⇒ 100' overland paved @ 6.0% $\left(\frac{6001-5995}{100}\right) \Rightarrow \frac{1.8(1.1-0.90)\sqrt{100}}{\sqrt[3]{6.0}} = 2$

⇒ 500' street @ 0.8% $\left(\frac{5974-5970}{500}\right) \Rightarrow v = 1.8$ fps $\Rightarrow \frac{500}{(1.8)(60)} = 5$

⇒ 150' – 24" RCP @ 0.5%± ⇒ v = 5.0 fps $\Rightarrow \frac{150}{(5.0)(60)} = 1$

8 min

$Q_{10} = (0.67)(4.9)(6.5) = 21$ cfs in existing storm sewer in Spruce

$Q_{100} = (0.76)(7.4)(6.5) = 37$ cfs (21 cfs in existing storm sewer, 16 cfs bypass west in Pikes Peak to Basin E-1)

Σ at Basin C-4 – A = 58.4 Ac

$C_{10AV} = [(0.52)(34.9) + (0.51)(14.5) + (0.60)(2.5) + (0.67)(6.5)] / 58.4 = 0.54$

$C_{100AV} = [(0.63)(34.9) + (0.61)(14.5) + (0.70)(2.5) + (0.76)(6.5)] / 58.4 = 0.64$

ΣTC ⇒ TC at Basin C-2 = 21 min

⇒ 500' – 24" Av RCP @ 0.5%± in Pikes Peak ⇒ v = 5.0 fps± $\Rightarrow \frac{500}{(5.0)(60)} = 2$

23 min

$\Sigma Q_{10} = (0.54)(3.2)(58.4) = 101$ cfs in enlarged existing storm sewer in Spruce

$\Sigma Q_{100} = (0.64)(4.7)(58.4) = 176$ cfs
− 40 (20 cfs bypass to Basin E-1, 4 cfs bypass to Basin E-1, 16 cfs bypass to Basin E-1)
136 cfs ⇒ New storm sewer crossing of I-25 at Colorado (101 cfs in enlarged existing storm sewer in Spruce, 35 cfs ⇒ New area inlet in Spruce btwn Pikes Peak and Colorado)

Σ Basins A, B, and Σ Basin at C-4 – A = 74.9 Ac

$C_{10Av} = [(0.74)(16.5) + (0.54)(58.4)] / 74.9 = 0.58$

$C_{100Av} = [(0.81)(16.5) + (0.64)(58.4)] / 74.9 = 0.68$

Σ TC ⇒ TC at Σ at Basin C-4 = 23 min

⇒ 500'± – 48" RCP @ 3.2% ± Av ⇒ V = 21 fps ⇒ $\frac{500}{(21)(60)} = \underline{1}$
(In splice and under I-25 at Colorado)

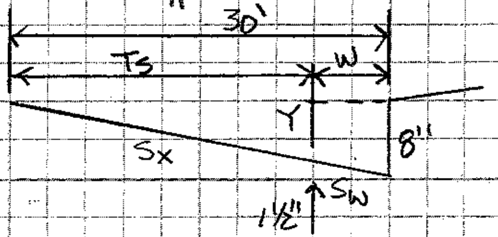
24 min

$\Sigma Q_{10} = (0.58)(3.1)(74.9) = 135$ cfs

$Q_{100} = (0.68)(4.6)(74.9) = 234$ cfs
– 40 (20 cfs bypass to Basin E-1, 4 cfs bypass to Basin E-1, 16 cfs bypass to Basin E-1)
194 cfs ⇒ New storm sewer on east side I-25 Colorado to outfall to south

Basin D-1

100-Year Bypass on Northside of Colorado from West of 8th Street



$Y = 6.5" = 0.54'$
$W = 2.0'$ $T_S = 28.0'$
$S_x = Y/T_S = 0.54/28.0 = 0.0193$
$S_W = 0.125/2.0 = 0.0625$
$Z = 1/S_x = 1/0.0193 = 51.8$
$n = 0.016$
$Z/n = 51.8/0.016 = 3228$

$\Rightarrow Q_S = 50\text{cfs}$ $S_W/S_x = \frac{0.0625}{0.0193} = 3.2$ $W/T_S = \frac{2}{28} = 0.07$

$\Rightarrow E_0 = 0.22$ $Q_T = \frac{Q_S}{1-E_0} = \frac{50}{1-0.22} = 64\text{cfs}$ 100-Year Bypass east on northside of Colorado ⇒ Remainder will overtop Colorado and flow south

$\Rightarrow A = 56.0\text{ AC}$

$C_{10} = (0.15)(0.15) + (0.55)(0.50) + (0.30)(0.70) = 0.51$
(15% open + 55% single family + 30% neighborhood business)

$C_{100} = (0.15)(0.30) + (0.55)(0.60) + (0.30)(0.80) = 0.62$

$T_C \Rightarrow$ 150' overland grass @ 13.3% $\left(\frac{6134-6114}{150}\right) \Rightarrow \frac{1.8(1.1-0.15)\sqrt{150}}{\sqrt[3]{13.3}} = 9$

$\Rightarrow$ 1100' grass swale @ 5.2% $\left(\frac{6114-6057}{1100}\right) \Rightarrow V = 3.4\text{fps} \Rightarrow \frac{1100}{(3.4)(60)} = 5$

$\Rightarrow$ 2500' street @ 3.4% $\left(\frac{6057-5971}{2500}\right) \Rightarrow V = 3.6\text{fps} \Rightarrow \frac{2500}{(3.6)(60)} = 12$

$\Rightarrow$ 500' - 30" RCP @ 0.5% ± $\Rightarrow V = 6.0\text{fps} \Rightarrow \frac{500}{(6.0)(60)} = \underline{1}$

27 min

$Q_{10} = (0.51)(2.9)(56.0) = 83\text{cfs}$ in enlarged existing storm sewer in Chestnut

$Q_{100} = (0.62)(4.3)(56.0) = 149$
$\underline{+64}$ (bypass from west of 8th street on northside Colorado)
213 cfs (83 cfs in enlarged existing storm sewer in Chestnut, 130 cfs bypass east in Colorado and alley north of Colorado to Basin E-1)

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Basin D-2 ⇒ A = 10.2 Ac

$C_{10} = (0.30)(0.50) + (0.70)(0.70) = 0.64$
(30% single family + 70% neighborhood business)
$C_{100} = (0.30)(0.60) + (0.70)(0.80) = 0.74$

TC ⇒ 50' overland grass @ 6.0% $\left(\frac{5996-5993}{50}\right) \Rightarrow \frac{1.8(1.1-0.15)\sqrt{50}}{\sqrt[3]{6.0}} = 7$

⇒ 625' street @ 0.8% $\left(\frac{5993-5988}{625}\right) \Rightarrow V = 1.8 fps \Rightarrow \frac{625}{(1.8)(60)} = 6$

⇒ 950' - 24" Ave RCP @ 2.9% $\left(\frac{5988-5960}{950}\right) \Rightarrow V = 12.0 fps \Rightarrow \frac{950}{(12.0)(60)} = 1$

14 min

$Q_{10} = (0.64)(4.0)(10.2) = 26 cfs$ in existing storm sewer in Chestnut/Cucharras

$Q_{100} = (0.74)(6.0)(10.2) = 45 cfs$

Σ at Basin D-2 ⇒ A = 66.2 Ac

$C_{10AV} = [(0.51)(56.0) + (0.64)(10.2)] / 66.2 = 0.53$

$C_{100AV} = [(0.62)(56.0) + (0.74)(10.2)] / 66.2 = 0.64$

ΣTC ⇒ TC at Basin D-1 = 27 min

⇒ 450' - 36" RCP @ 2.7% $\left(\frac{5972-5960}{450}\right) \Rightarrow V = 15.5 fps \Rightarrow \frac{450}{(15.5)(60)} = 1$
(In Chestnut btwn Colorado and Cucharras)

28 min

$\Sigma Q_{10} = (0.53)(2.7)(66.2) = 95 cfs$ in enlarged existing and future storm sewer in Cucharras

$\Sigma Q_{100} = (0.64)(4.3)(66.2) = 182 cfs$
+ 64 cfs (bypass on north side Colorado from west of 8th street)
− 130 cfs (bypass to Basin E-1)

116 cfs (95 cfs in enlarged existing/future storm sewer in Cucharras - stub out from new storm sewer crossing of I-25 at Cucharras, 16 cfs bypass in Cucharras to Basin D-3)

Basin D-3 ⇒ A = 3.9 AC

$C_{10} = 0.70$ and $C_{100} = 0.80$ (Neighborhood business)

TC ⇒ 175' overland, paved @ 1.1% $\left(\frac{5965-5963}{175}\right) \Rightarrow \frac{1.8(1.1-0.90)\sqrt{175}}{\sqrt[3]{1.1}} = 5$

⇒ 525' street @ 0.4% $\left(\frac{5963-5961}{525}\right) \Rightarrow v = 1.4$ fps $\Rightarrow \frac{525}{(1.4)(60)} = \underline{6}$

11 min

$Q_{10} = (0.70)(4.5)(3.9) = 12$ cfs in new storm sewer crossing of I-25 at Cuchanas

$Q_{100} = (0.80)(6.9)(3.9) = 22$ cfs
+ 2 cfs (bypass from Basin E-2)

24 cfs in new storm sewer crossing of I-25 at Cuchanas

Basin D-4 ⇒ A = 1.9 AC

$C_{10} = (0.10)(0.15) + (0.90)(0.70) = 0.65$
(10% open + 90% neighborhood business)

$C_{100} = (0.10)(0.30) + (0.90)(0.80) = 0.75$

TC ⇒ 50' overland paved @ 1.0% ± $\Rightarrow \frac{1.8(1.1-0.90)\sqrt{50}}{\sqrt[3]{1.0}} = 3$

⇒ 550' street @ 0.4% $\left(\frac{5662-5660}{550}\right) \Rightarrow v = 1.4$ fps $\Rightarrow \frac{550}{(1.4)(60)} = \underline{7}$

10 min

$Q_{10} = (0.65)(4.6)(1.9) = 6$ cfs in new storm sewer crossing of I-25 at Cuchanas

$Q_{100} = (0.75)(7.0)(1.9) = 10$ cfs
+ 2 cfs (bypass from Basin E-3)

12 cfs in new storm sewer crossing of I-25 at Cuchanas

Σ at Basin D-4 ⇒ A = 72.0 Ac

$C_{10AV} = [(0.53)(66.2) + (0.70)(3.9) + (0.65)(1.9)] / 72.0 = 0.54$

$C_{100AV} = [(0.64)(66.2) + (0.80)(3.9) + (0.75)(1.9)] / 72.0 = 0.65$

ΣTC ⇒ ΣTC at Basin D-2 = 28 min

⇒ 375' – 54" RCP @ 0.5% ± ⇒ V = 8.0 fps ⇒ $\frac{375}{(8.0)(60)} = 1$
(future storm sewer in Cuchallas)

29 min

$\Sigma Q_{10} = (0.54)(2.7)(72.0) = 105$ cfs in new storm sewer crossing of I-25 at Cuchallas)

$\Sigma Q_{100} = (0.65)(4.1)(72.0) = 192$ cfs
+ 64 cfs (bypass on northside Colorado from west of 8th Street
+ 4 cfs (2 cfs bypass from Basin E-2, 2 cfs bypass from Basin E-3)
– 130 cfs (bypass to Basin E-1)

130 cfs in new storm sewer crossing of I-25 at Cuchallas)

Basin E-1 ⇒ A = 8.2 Ac

$C_{10} = 0.70$ and $C_{100} = 0.80$ (neighborhood business)

TC ⇒ 100' overland paved @ 1.0% ± ⇒ $\frac{1.8(1.1-0.90)\sqrt{100}}{\sqrt[3]{1.0}} = 4$

⇒ 600' street @ 0.4% ± ⇒ $\left(\frac{5969-5967}{600}\right)$ ⇒ V = 1.4 fps ⇒ $\frac{600}{(1.4)(60)} = 7$

11 min

$Q_{10} = (0.70)(4.5)(8.2) = 26$ cfs in existing storm sewer in Walnut

$Q_{100} = (0.80)(6.9)(8.2) = 45$ cfs
+ 130 cfs (bypass from Basin D-1)
+ 40 cfs (20 cfs bypass from Basin C-2, 4 cfs bypass from Basin C-3, 16 cfs bypass from Basin C-4)

215 cfs (26 cfs in existing storm sewer, 189 cfs bypass in Walnut to Σ at Basin E-3)

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Basin E-2 ⇒ A = 0.6 Ac

C_{10} = 0.70 and C_{100} = 0.80 (neighborhood business)

TC ⇒ 50' overland paved @ 2.0% ± ⇒ $\frac{1.8(1.1-0.90)\sqrt{50}}{\sqrt[3]{2.0}}$ = 2

⇒ 375' street @ 0.4% $\left(\frac{5970-5969}{375}\right)$ ⇒ v = 1.4 fps ⇒ $\frac{375}{(1.4)(60)}$ = 4

6 min

Q_{10} = (0.70)(5.6)(0.6) = 2 cfs in existing storm sewer in Walnut

Q_{100} = (0.80)(8.5)(0.6) = 4 cfs (2 cfs in existing storm sewer in Walnut, 2 cfs bypass in Walnut to Basin D-3)

Basin E-3 ⇒ A = 0.8 Ac

C_{10} = (0.10)(0.15) + (0.20)(0.70) + (0.70)(0.90) = 0.79
(10% open + 20% neighborhood business + 70% highway)

C_{100} = (0.10)(0.30) + (0.20)(0.80) + (0.70)(0.93) = 0.84

TC ⇒ 100' overland paved @ 1.0% $\left(\frac{5981-5980}{100}\right)$ ⇒ $\frac{1.8(1.1-0.90)\sqrt{100}}{\sqrt[3]{1.0}}$ = 4

⇒ 700' street @ 1.7% $\left(\frac{5980-5968}{700}\right)$ ⇒ v = 2.6 fps $\frac{700}{(2.6)(60)}$ = 4

8 min

Q_{10} = (0.79)(4.9)(0.8) = 3 cfs in existing storm sewer in Walnut

Q_{100} = (0.84)(7.4)(0.8) = 5 cfs (3 cfs in existing storm sewer in Walnut, 2 cfs bypass in Walnut to Basin D-4 and E-3)

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Σ at Basin E-3 ⇒ A = 9.6 Ac

$C_{10AV} = [(0.70)(8.2) + (0.70)(0.6) + (0.79)(0.8)]/9.6 = 0.71$

$C_{100AV} = [(0.80)(8.2) + (0.80)(0.6) + (0.84)(0.8)]/9.6 = 0.80$

ΣTC ⇒ TC at Basin E-1 = 11 min

⇒ 300' - 24" RCP @ 0.5%± ⇒ v = 5.0 fps ⇒ $\frac{300}{(5.0)(60)} = \underline{1}$
(existing storm sewer in Walnut)

12 min

$Q_{10} = (0.71)(4.3)(9.6) = 29$ cfs in existing and new storm sewer in Walnut

$Q_{100} = (0.80)(6.5)(9.6) = 50$ cfs
+130 cfs (bypass from Basin D-1)
+ 40 cfs (20 cfs bypass from Basin C-2, 4 cfs bypass from Basin C-3, 16 cfs bypass from Basin C-4)
220 cfs (29 cfs in existing storm sewer, 191 cfs bypass to Σ at Basins D-4 and E-3)

Σ at Basins D-4 and E-3 ⇒ A = 81.6 Ac

$C_{10AV} = [(0.54)(72.0) + (0.71)(9.6)]/81.6 = 0.56$

$C_{100AV} = [(0.65)(72.0) + (0.80)(9.6)]/81.6 = 0.67$

ΣTC ⇒ ΣTC at Σ at Basin D-4 = 29 min

$\Sigma Q_{10} = (0.56)(2.7)(81.6) = 123$ cfs in new storm sewer crossing of I-25 at Cuchara

$\Sigma Q_{100} = (0.67)(4.1)(81.6) = 224$ cfs
+ 40 cfs (20 cfs bypass from Basin C-2, 4 cfs bypass from Basin C-3, 16 cfs bypass from Basin C-4)

264 cfs in new storm sewer crossing of I-25 at Cuchara

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Basin F ⇒ A = 15.9 Ac

$C_{10} = 0.50$ and $C_{100} = 0.60$ (single family)

$TC \Rightarrow 100'$ overland grass @ 8.0% $\left(\frac{6252-6244}{100}\right) \Rightarrow \frac{1.8(1.1-0.15)\sqrt{100}}{\sqrt[3]{8.0}} = 9$

$\Rightarrow 2450'$ sheet @ 4.3% $\left(\frac{6244-6138}{2450}\right) \Rightarrow V = 4.1$ fps $\Rightarrow \frac{2450}{(4.1)(60)} = 10$

$\Rightarrow 400'$ – 33" Ave RCP @ 1.5% $\left(\frac{6138-6132}{400}\right) \Rightarrow V = 11.0$ fps $\Rightarrow \frac{400}{(11.0)(60)} = \underline{1}$

20 min

$Q_{10} = (0.50)(3.4)(15.9) = 27$ cfs in existing storm sewer to Bear Creek

$Q_{100} = (0.60)(5.1)(15.9) = 49$ cfs (27 cfs in existing storm sewer, 22 cfs bypass east on Rio Grande to Basin G-1)

Basin G-1 ⇒ A = 19.9 Ac

$C_{10} = (0.50)(0.70) + (0.50)(0.70) = 0.70$
(50% future apartments + 50% future neighborhood business)

$C_{100} = (0.50)(0.80) + (0.50)(0.80) = 0.80$

T_C ⇒ 150' overland grass @ 6.7% $\left(\frac{6130-6120}{150}\right) \Rightarrow \frac{1.8(1.1-0.15)\sqrt{150}}{\sqrt[3]{6.7}} = 11$

⇒ 225' grass swale @ 3.6% $\left(\frac{6120-6112}{225}\right) \Rightarrow V = 2.9$ fps $\Rightarrow \frac{225}{(2.9)(60)} = 1$

⇒ 1725' street @ 3.7% $\left(\frac{6112-6049}{1725}\right) \Rightarrow V = 3.9$ fps $\Rightarrow \frac{1725}{(3.9)(60)} = 7$

19 min

$Q_{10} = (0.70)(3.5)(19.9) = 49$ cfs ⇒ future Enlarged Storm Sewer to Bear Creek

$Q_{100} = (0.80)(5.2)(19.9) = 83 + 21$ (Bypass from Basin F) $- 49$ (Future Enlarged Storm Sewer to Bear Creek) $= 55$ cfs to east on Rio Grande

Basin G-2 ⇒ A = 3.1 Ac

$C_{10} = (0.50)(0.70) + (0.50)(0.70) = 0.70$
(50% future apartments + 50% future neighborhood business)

$C_{100} = (0.50)(0.80) + (0.50)(0.80) = 0.80$

T_C ⇒ 150' overland grass @ 4.7% $\left(\frac{6084-6077}{150}\right) \Rightarrow \frac{1.8(1.1-0.15)\sqrt{150}}{\sqrt[3]{4.7}} = 13$

⇒ 350' grass swale @ 4.9% $\left(\frac{6077-6060}{350}\right) \Rightarrow V = 3.4$ fps $\Rightarrow \frac{350}{(3.4)(60)} = 2$

15 min

$Q_{10} = (0.70)(3.9)(3.1) = 8$ cfs ⇒ Future Enlarged Storm Sewer to Bear Creek

$Q_{100} = (0.80)(5.8)(3.1) = 14 - 8$ (Future Enlarged Storm Sewer to Bear Creek) $= 6$ cfs to east on Rio Grande

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Ext Basin G-2 ⇒ A = 23.0 Ac

$C_{10AV} = 0.70$ and $C_{100} = 0.80$

ETC ⇒ Tc at G-1 = 19 min

⇒ 575' Street @ 2.8% ⇒ V = 3.3 fps ⇒ $\frac{575}{(3.3)(60)} = 3$

22 min

$EQ_{10} = (0.70)(3.3)(23.0) = 53$ cfs ⇒ Future Enlarged Storm Sewer to Bear Creek

$EQ_{100} = (0.80)(4.9)(23.0) = 90 + 21$ (Bypass from Basin F) − 53 (Future Enlarged Storm Sewer to Bear Creek) = 58 cfs to east on Rio Grande

Basin H ⇒ A = 6.6 Ac

$C_{10} = (0.50)(0.70) + (0.50)(0.70) = 0.70$
(50% future apartments + 50% future neighborhood business)
$C_{100} = (0.50)(0.80) + (0.50)(0.80) = 0.80$

TC ⇒ 150' overland grass @ 4.7% $\left(\frac{6084-6077}{150}\right)$ ⇒ $\frac{1.8(1.1-0.15)\sqrt{150}}{\sqrt[3]{4.7}} = 13$

400' street @ 4.5% $\left(\frac{6033-6015}{400}\right)$ ⇒ V = 4.2 fps ⇒ $\frac{400}{(4.2)(60)} = 2$

15 min

$Q_{10} = (0.70)(3.9)(6.6) = 18$ cfs ⇒ Future Enlarged Storm Sewer to Bear Creek

$Q_{100} = (0.80)(5.8)(6.6) = 31 + 58$ (Bypass from Ext Basin G-2) − 18 (Future Enlarged Storm Sewer to Bear Creek) = 72 cfs to east on Rio Grande

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Basin I-1 ⇒ A = 1.9 Ac

$C_{10} = (0.50)(0.70) + (0.50)(0.70) = 0.70$
(50% future apartments + 50% future neighborhood business)

$C_{100} = (0.50)(0.80) + (0.50)(0.80) = 0.80$

TC ⇒ 150' overland grass @ 4.7% $\left(\frac{6060-6053}{150}\right) \Rightarrow \frac{1.8(1.1-0.15)\sqrt{150}}{\sqrt[3]{4.7}} = 13$

125' grass swale @ 2.4% $\left(\frac{6053-6050}{125}\right) \Rightarrow V = 2.3\text{ fps} \Rightarrow \frac{125}{(2.3)(60)} = 1$

450' street @ 7.1% $\left(\frac{6012-5980}{450}\right) \Rightarrow V = 5.3\text{ fps} \Rightarrow \frac{450}{(5.3)(60)} = 1$

15 min

$Q_{10} = (0.70)(3.9)(1.9) = 5\text{ cfs}$

$Q_{100} = (0.80)(5.8)(1.9) = 9 + 72$ (Bypass from Basin H) $= 81\text{ cfs}$

⇒ Existing flow split at high point at north side of Rio Grande and 8th street intersection ⇒ Approx 50% flow each way on 8th street ⇒ 41 cfs bypass north on 8th street to Basin I-2

Basin I-2 ⇒ A = 25.7 Ac

$C_{10} = 0.70$ and $C_{100} = 0.80$ (Existing and future neighborhood business and apartments)

TC ⇒ 100' overland grass @ 2.0% ± ⇒ $\frac{1.8(1.1-0.15)\sqrt{200}}{\sqrt[3]{2.0}} = 14$

⇒ 2150' street @ 6.4% $\left(\frac{6114-5977}{2150}\right) \Rightarrow V = 5.1\text{ fps} \Rightarrow \frac{2150}{(5.1)(60)} = 7$

21 min

$Q_{10} = (0.70)(3.3)(25.7) = 59\text{ cfs}$

$Q_{100} = (0.80)(5.0)(25.7) = 103\text{ cfs}$

Σ at Basin I-2 ⇒ A = 27.6 Ac

$C_{10AV} = 0.70$ and $C_{100AV} = 0.80$

ΣTC ⇒ TC at Basin I-2 = 21 min

$\Sigma Q_{10} = (0.70)(3.3)(27.6) = 64$ cfs in existing stormsewer in Moreno)

$\Sigma Q_{100} = (0.80)(5.0)(27.6) = 110$ cfs
+ 41 cfs (bypass from Basin I-1)

151 cfs (64 cfs in existing stormsewer in Moreno, 87 cfs bypass in Moreno to Basin I-3)

Basin I-3 ⇒ A = 13.0 Ac

$C_{10} = 0.70$ and $C_{100} = 0.80$ (neighborhood business)

TC ⇒ 300' overland paved @ 1.3% $\left(\frac{5985-5975}{475}\right) \Rightarrow \frac{1.8(1.1-0.90)\sqrt{300}}{\sqrt[3]{1.3}} = 4$

⇒ 475' street @ 1.3% $\left(\frac{5975-5969}{475}\right) \Rightarrow V = 2.3$ fps $\Rightarrow \frac{475}{(2.3)(60)} = 3$

⇒ 600' Ave 36" RCP @ 2.5% $\left(\frac{5969-5954}{600}\right) \Rightarrow V = 15.0$ fps $\Rightarrow \frac{600}{(15.0)(60)} = 1$

8 min

$Q_{10} = (0.70)(4.9)(13.0) = 45$ cfs

$Q_{100} = (0.80)(7.4)(13.0) = 77$ cfs

Σ at Basin I-3 ⇒ A = 40.6 Ac

$C_{10AD} = 0.70$ and $C_{100AD} = 0.80$

ΣTC ⇒ TC at Σ at Basin I-2 = 21 min

⇒ 825' ave 36" RCP @ 2.8% $\left(\frac{5977-5954}{825}\right)$ ⇒ V = 15.5 fps ⇒ $\frac{825}{(15.5)(60)} = \underline{1}$

22 min

$\Sigma Q_{10} = (0.70)(3.3)(40.6) = 94$ cfs in existing open channel east of Moreno

$\Sigma Q_{100} = (0.80)(4.9)(40.6) = 159$ cfs
+ 41 (bypass from Basin I-1)
200 cfs in existing open channel east of Moreno

Basin I-4 ⇒ A = 12.8 Ac

$C_{10} = (0.75)(0.15) + (0.25)(0.70) = 0.29$
(75% open, nursery + 25% neighborhood business)
$C_{100} = (0.75)(0.30) + (0.25)(0.80) = 0.43$

TC ⇒ 100' overland grass @ 2.0% ± ⇒ $\frac{1.8(1.1-0.15)\sqrt{200}}{\sqrt[3]{2.0}} = 14$

⇒ 1325' grass swale @ 1.4% $\left(\frac{5963-5945}{1325}\right)$ ⇒ V = 1.8 fps ⇒ $\frac{1325}{(1.8)(60)} = \underline{12}$

26 min

$Q_{10} = (0.29)(3.0)(12.8) = 11$ cfs

$Q_{100} = (0.43)(4.4)(12.8) = 24$ cfs

Σ at Basin I-4 ⇒ A = 53.4 Ac

$C_{10AV} = [(0.70)(40.6) + (0.29)(12.8)]/53.4 = 0.60$

$C_{100AV} = [(0.80)(40.6) + (0.43)(12.8)]/53.4 = 0.71$

ΣTC ⇒ TC at Basin I-4 = 26 min

$\Sigma Q_{10} = (0.60)(3.0)(53.4) = 96$ cfs in new storm sewer crossing of I-25 at Moreno

$\Sigma Q_{100} = (0.71)(4.4)(53.4) = 167$ cfs
+ 41 cfs (bypass from Basin I-1)

208 cfs in new storm sewer crossing of I-25 at Moreno

Basin J-1 ⇒ A = 10.7 Ac

$C_{10} = (0.90)(0.70) + (0.10)(0.90) = 0.72$
(90% neighborhood business + 10% highway)

$C_{100} = (0.90)(0.80) + (0.10)(0.93) = 0.81$

TC ⇒ 75' overland paved @ 2.0% ± ⇒ $\frac{1.8(1.1-0.90)\sqrt{75}}{\sqrt[3]{2.0}} = 2$

⇒ 1200' street @ 2.3% $\left(\frac{5979-5952}{1200}\right)$ ⇒ v = 3.0 fps ⇒ $\frac{1200}{(3.0)(60)} = 7$

9 min

$Q_{10} = (0.72)(4.7)(10.7) = 36$ cfs

$Q_{100} = (0.81)(7.2)(10.7) = 62$ cfs in new storm sewer to Bear Creek along westside of I-25

Basin J-2 ⇒ A = 6.2 Ac

$C_{10} = (0.80)(0.70) + (0.20)(0.90) = 0.74$
(80% neighborhood business + 20% highway)
$C_{100} = (0.80)(0.80) + (0.20)(0.93) = 0.83$

TC ⇒ 325' overland paved @ 1.0% ± ⇒ $\frac{1.8(1.1-0.90)\sqrt{325}}{\sqrt[3]{1.0}} = 6$

⇒ 300' street @ 1.3% $\left(\frac{5970-5966}{300}\right)$ ⇒ v = 2.3 fps ⇒ $\frac{300}{(2.3)(60)} = 2$

⇒ 375' grass swale @ 1.0% ± ⇒ v = 1.5 fps ⇒ $\frac{375}{(1.5)(60)} = 4$

12 min

$Q_{10} = (0.74)(4.3)(6.2) = 20$ cfs

$Q_{100} = (0.83)(6.5)(6.2) = 33$ cfs in swale along west side of I-25 to Bear Creek

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Basin K ⇒ A = 25.0 Ac

$C_{10} = (0.20)(0.15) + (0.80)(0.88) = 0.73$
(20% open + 80% business, commercial)
$C_{100} = (0.20)(0.30) + (0.80)(0.89) = 0.77$

TC ⇒ 150' overland grass @ 22.7% $\left(\frac{6088-6054}{150}\right) \Rightarrow \frac{1.8(1.1-0.15)\sqrt{150}}{\sqrt[3]{22.7}} = 7$

⇒ 400' grass swale @ 3.5% $\left(\frac{6054-6040}{400}\right) \Rightarrow v = 2.8\ fps \Rightarrow \frac{400}{(2.8)(60)} = 2$

$Q_{10} = (0.73)(3.8)(25.0) = 69\ cfs$ (existing storm sewer to Bear Creek)

$Q_{100} = (0.77)(5.7)(25.0) = 110\ cfs$ (69 cfs in existing storm sewer to Bear Creek, 41 cfs bypass to Basin L-2)

Basin L-1 ⇒ A = 32.0 Ac

$C_{10} = (0.20)(0.15) + (0.80)(0.88) = 0.73$
(20% open + 80% business, commercial)
$C_{100} = (0.20)(0.30) + (0.80)(0.89) = 0.77$

TC ⇒ 50' overland grass @ 2% ± $\Rightarrow \frac{1.8(1.1-0.15)\sqrt{50}}{\sqrt[3]{2.0}} = 10$

3200' street @ 5.7% $\left(\frac{6112-5930}{3200}\right) \Rightarrow v = 4.7\ fps \Rightarrow \frac{3200}{(4.7)(60)} = 11$

21 min

$Q_{10} = (0.73)(3.3)(32.0) = 77\ cfs$ (existing storm sewer in Motor City Drive)

$Q_{100} = (0.77)(5.0)(32.0) = 123\ cfs$ (77 cfs in existing storm sewer in Motor City Drive, 46 cfs bypass east to Basin L-2 thru Basin

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Basin L-2 ⇒ A = 18.1 Ac

$C_{10} = (0.10)(0.15) + (0.80)(0.88) + (0.10)(0.90) = 0.81$
(10% open + 80% business, commercial + 10% highway)

$C_{100} = (0.10)(0.30) + (0.80)(0.89) + (0.10)(0.93) = 0.84$

TC ⇒ 200' overland paved @ 2% ± ⇒ $\frac{1.8(1.1-0.90)\sqrt{200}}{\sqrt[3]{2.0}} = 4$

2100' paved swale @ 1.5% $\left(\frac{5951-5919}{2100}\right)$ ⇒ V = 2.4 fps ⇒ $\frac{2100}{(2.4)(60)} = \underline{15}$

19 min

$Q_{10} = (0.81)(3.5)(18.1) = 51$ cfs

$Q_{100} = (0.84)(5.2)(18.1) = 79$ cfs (existing culvert crossing of I-25)

Σ at Basin L-2 ⇒ A = 50.1 Ac

$C_{10AV} = [(0.73)(32.0) + (0.81)(18.1)] / 50.1 = 0.76$

$C_{100AV} = [(0.77)(32.0) + (0.84)(18.1)] / 50.1 = 0.80$

ΣTC ⇒ TC at Basin L-1 = 21 min

⇒ 800' - 30" RCP Ave @ 1.4% $\left(\frac{5930-5919}{800}\right)$ ⇒ V = 10 fps ⇒ $\frac{800}{(10)(60)} = \underline{1}$

22 min

$\Sigma Q_{10} = (0.76)(3.2)(50.1) = 122$ cfs

$\Sigma Q_{100} = (0.80)(4.8)(50.1) = 192$ cfs
+ 15 cfs (bypass from Basin M-1)
+ 41 cfs (bypass from Basin K)

248 cfs (existing culvert crossing of I-25)

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Basin M-1 ⇒ A = 6.5 Ac

$C_{10} = (0.10)(0.15) + (0.90)(0.88) = 0.81$
(10% open + 90% business, commercial)
$C_{100} = (0.10)(0.30) + (0.90)(0.89) = 0.83$

TC ⇒ 50' overland grass @ 40.0% $\left(\frac{5973-5953}{50}\right)$ ⇒ $\frac{1.8(1.1-0.15)\sqrt{50}}{\sqrt[3]{40.0}} = 4$

700' paved swale @ 4.6% $\left(\frac{5953-5921}{700}\right)$ ⇒ V = 4.3 fps ⇒ $\frac{700}{(4.3)(60)} = 3$

7 min

$Q_{10} = (0.81)(5.2)(6.5) = 27$ cfs (existing storm sewer south in Motor City Drive)
$Q_{100} = (0.83)(7.8)(6.5) = 42$ cfs (27 cfs in existing storm sewer south in Motor City Drive, 15 cfs bypass east to Basin L-2)

Basin M-2 ⇒ A = 37.6 Ac

$C_{10} = (0.15)(0.15) + (0.20)(0.50) + (0.20)(0.70) + (0.45)(0.88) = 0.66$
(15% open + 20% single family + 20% apartments + 45% business, commercial)
$C_{100} = (0.15)(0.30) + (0.20)(0.60) + (0.20)(0.80) + (0.45)(0.89) = 0.73$

TC ⇒ 50' overland grass @ 2.0% ± ⇒ $\frac{1.8(1.1-0.15)\sqrt{50}}{\sqrt[3]{2.0}} = 10$

1700' street @ 3.1% $\left(\frac{6087-6034}{1700}\right)$ ⇒ V = 3.5 fps ⇒ $\frac{1700}{(3.5)(60)} = 8$

1100' - 30" RCP Ave @ 10.3% $\left(\frac{6034-5921}{1100}\right)$ ⇒ V = 26 fps ⇒ $\frac{1100}{(26)(60)} = 1$

19 min

$Q_{10} = (0.66)(3.5)(37.6) = 87$ cfs (existing storm sewer crossing I-25)
$Q_{100} = (0.73)(5.2)(37.6) = 143$ cfs

Σ at Basin M-2 ⇒ A = 44.1 Ac

$C_{10AV} = [(0.81)(6.5) + (0.66)(37.6)] / 44.1 = 0.68$

$C_{100AV} = [(0.83)(6.5) + (0.73)(37.6)] / 44.1 = 0.74$

ΣTC ⇒ TC at Basin M-2 = 19 min

$\Sigma Q_{10} = (0.68)(3.5)(44.1) = 105$ cfs (existing storm sewer crossing I-25)

$\Sigma Q_{100} = (0.74)(5.2)(44.1) = 170$ cfs (105 cfs in existing storm sewer crossing I-25, 15 cfs bypass to Basin L-2, 50 cfs bypass south in Motor City Drive to Basin N)

Basin N ⇒ A = 25.4 Ac

$C_{10} = (0.10)(0.15) + (0.10)(0.50) + (0.80)(0.88) = 0.77$
(10% open + 10% single-family + 80% business, commercial)

$C_{100} = (0.10)(0.30) + (0.10)(0.60) + (0.80)(0.89) = 0.80$

TC ⇒ 200' overland grass @ 8.5% $\left(\frac{6047-6030}{200}\right)$ ⇒ $\frac{1.8(1.1-0.15)\sqrt{200}}{\sqrt[3]{8.5}} = 12$

⇒ 175' grass swale @ 28.0% $\left(\frac{6030-5981}{175}\right)$ ⇒ V = 8 fps ⇒ $\frac{175}{(8)(60)} = 1$

⇒ 1000' paved swale/street @ 6.3% $\left(\frac{5981-5918}{1000}\right)$ ⇒ V = 5.1 fps ⇒ $\frac{1000}{(5.1)(60)} = 3$

⇒ 300' - 30" RCP @ 1.0% $\left(\frac{5918-5915}{300}\right)$ ⇒ V = 8 fps ⇒ $\frac{300}{(8)(60)} = 1$

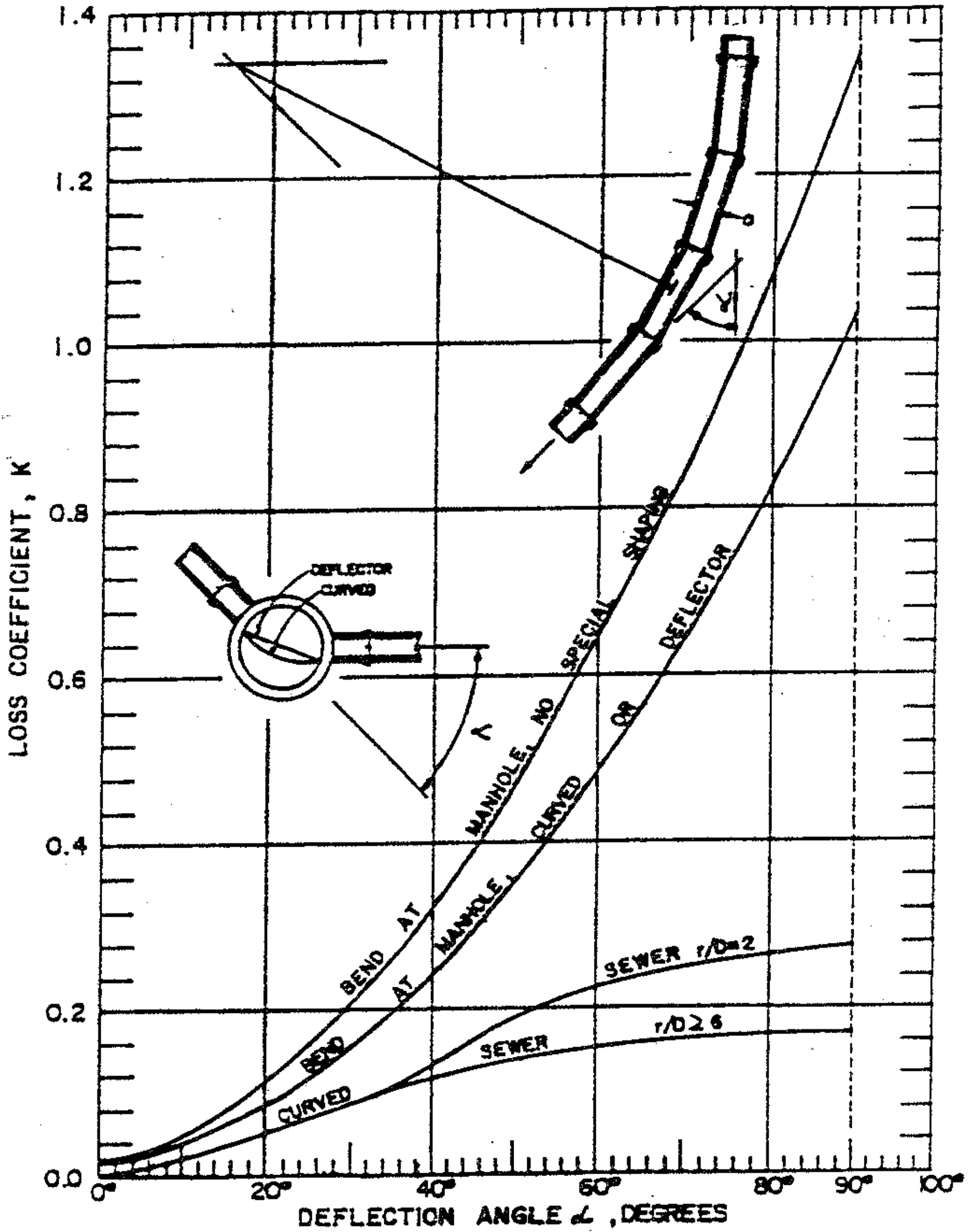
17 min

$Q_{10} = (0.77)(3.7)(25.4) = 72$ cfs

$Q_{100} = (0.80)(5.5)(25.4) = 112$ cfs
+ 50 cfs (bypass from Basin M-2)

162 cfs (existing storm sewer crossing I-25)

HYDRAULIC DESIGN INFORMATION



SEWER BEND LOSS COEFFICIENT

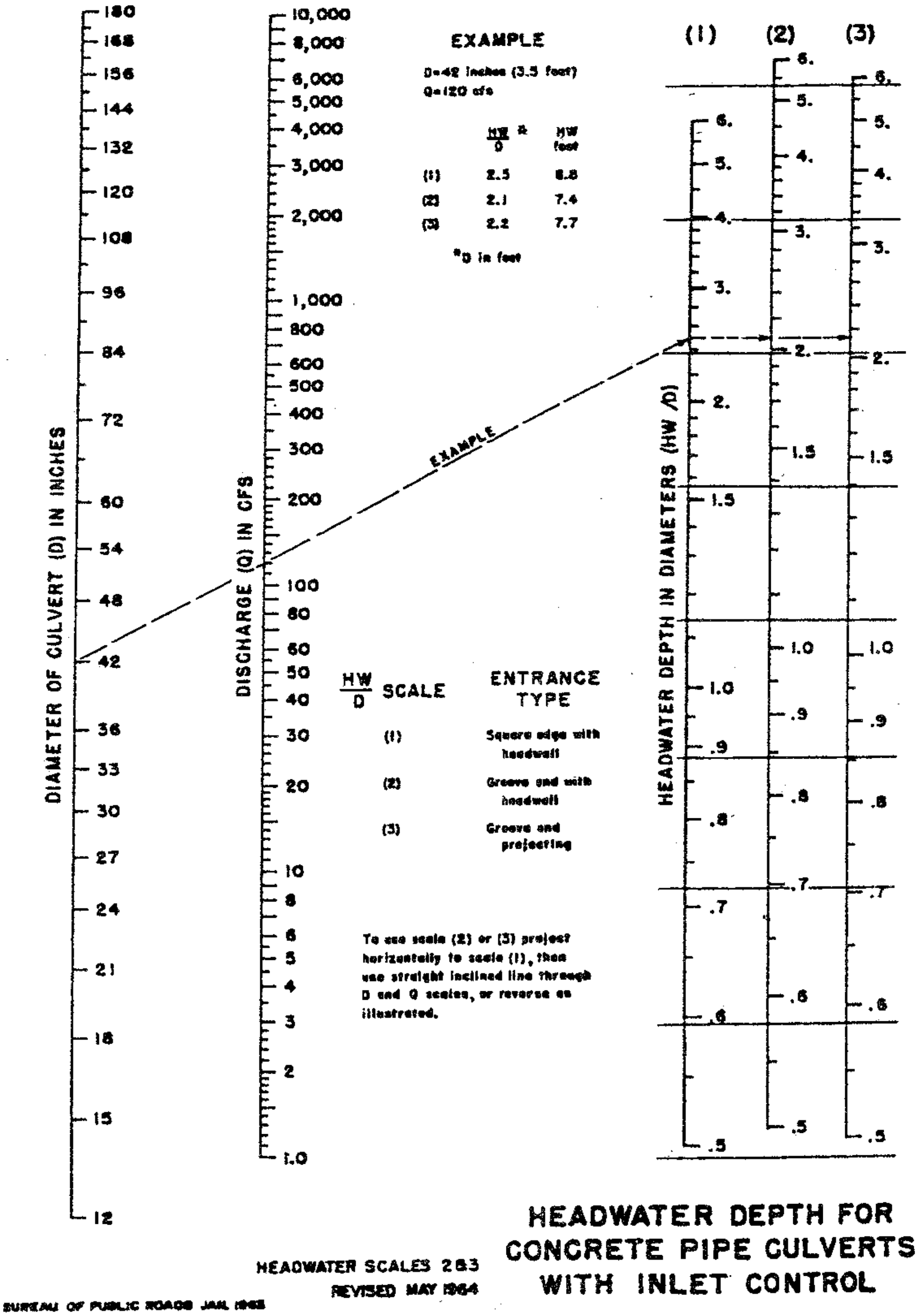
1-15-69
Denver Regional Council of Governments

HDR Infrastructure, Inc.
A Centerra Company

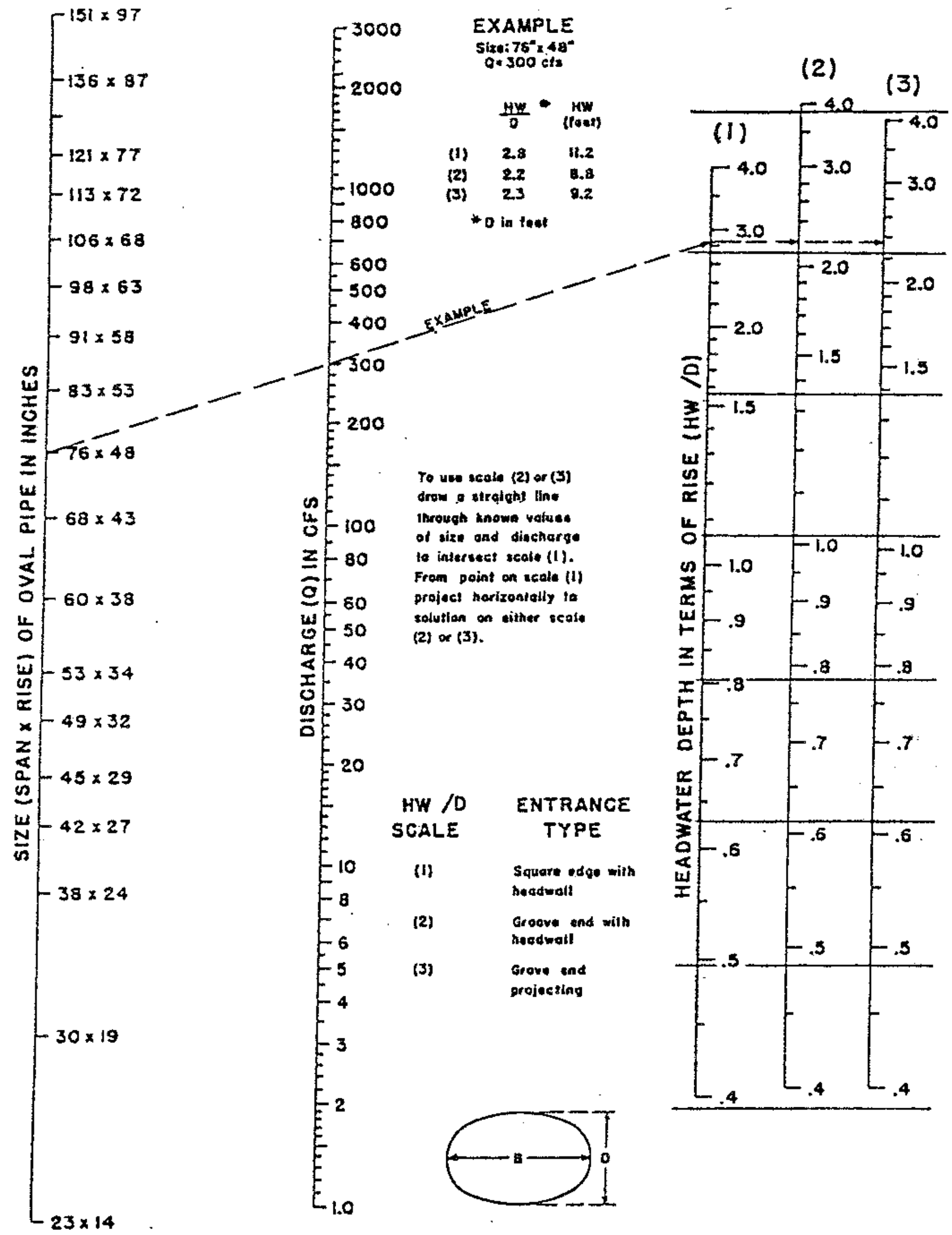
The City of Colorado Springs / El Paso County
Drainage Criteria Manual

Date
OCT. 1987

Figure
8 - 13



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL



HEADWATER DEPTH FOR OVAL CONCRETE PIPE CULVERTS LONG AXIS HORIZONTAL WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

HYDRAULIC CALCULATIONS

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CK. | PROJ. Cimarron/Bijou | SHEET 1

DATE June 23, 2003 | SUBJ. Prelim Hydraulics | OF

496+09 ⇒ A = 44 Ac Q_{10} = 105 cfs Q_{100} = 105 cfs AHW = 6'

⇒ Ex 2-45" x 29" HERCP storm sewer @ 1.1% ±

HW/D = 1.5 HW = (1.5)(2.4) = 3.6' Q_f = 140 cfs

496+59 ⇒ Superelevated roadway draining to median barrier

⇒ Ex 18" RCP @ 0.9% w/ Vane Grate Inlet (Double) at 300' to 350' spacing
constructed as part of Nevada/Tejon project

501+30 and 501+40 ⇒ A = 50 Ac Q_{10} = 125 cfs Q_{100} = 250 cfs AHW = 6'

⇒ Ex 48" WSP @ 1.0% ± w/ wingwalls ⇒ Q = 100 cfs

HW/D = 1.3 HW = (1.3)(4.0) = 5.2' Q_f = 150 cfs

Ex 60" RCP @ 0.5% w/ wingwalls ⇒ Q = 150 cfs
constructed as part of Nevada/Tejon project

HW/D = 1.2 HW = (1.2)(5.0) = 6.0'

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CK. | PROJ. Cimarron/Bijou | SHEET 2

DATE June 24, 2003 | SUBJ. Prelim Hydraulics | OF

505+11 ⇒ Superelevated roadway draining to median barrier

⇒ 18" RCP w/ Vane Grate Inlet (Double) at 300' to 350' spacing

508+30 and 509+90 ⇒ Superelevated roadway draining to median barrier

⇒ Ex 18" RCP w/ New Vane Grate Inlet (Double) at 150' to 200' spacing

512+94, 515+98, and 520+33 ⇒ Superelevated roadway draining to median barrier

⇒ 18" RCP w/ Vane Grate Inlet (Double) at 300' to 350' spacing

519+03 to 520+03 ⇒ Bear Creek ⇒ A = 10.7 sq mi Q_{10} = 1140 cfs Q_{100} = 4140 cfs

⇒ Mainline Bridge spans floodplain

519+72 to 529+78 ⇒ Basin J-1 ⇒ A = 11 Ac Q_{10} = 36 cfs Q_{100} = 62 cfs

AHW = 5943.5 (4.5') HG at outlet = 5934.5 + 3.5 (full flow) = 5938.0

⇒ 1035' - 42" RCP @ 0.4%

⇒ $V_f = \frac{62}{9.6} = 6.5$ fps $S_f = \left[\frac{(185)(0.013)^2}{(3.5)^{4/3}}\right]\frac{6.5^2}{64.4} = 0.0039$

$h_f = (0.0039)(1035) = 4.0'$ 10° bend ⇒ $h_b = 0.1\left(\frac{6.5^2}{64.4}\right) = 0.1'$

HG at Inlet = 5938.0 + 4.0 + 0.1 = 5942.1 (3.1')

⇒ HW/D = 1.2 HW = (1.2)(3.5) = 4.2'

523+67 ⇒ Superelevated roadway draining to median barrier

⇒ 18" RCP w/ Vane Grate Inlet (Double) at 300' to 350' spacing

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CK. | PROJ. Cimarron/Bijou | SHEET 3

DATE June 24, 2003 | SUBJ. Prelim Hydraulics | OF

529+18 to 533+47 ⇒ ℄ at Basin I-4 ⇒ A = 53 Ac Q_{10} = 96cfs Q_{100} = 208cfs

AHW = 5948.0 (10') Fountain Creek 10-Year WS = 5937.0

⇒ 615' - 60" RCP @ 0.9%

$\Rightarrow v_f = \frac{208}{19.6} = 10.6 fps \quad S_f = \left[\frac{(185)(0.013)^2}{(5.0)^{4/3}}\right]\frac{10.6^2}{64.4} = 0.0064$

$h_f = (0.0064)(615) = 3.9'$ 48° bend ⇒ $h_b = 0.45\left(\frac{10.6^2}{64.4}\right) = 0.8'$

HG at Inlet = 5937.0 + 3.9 + 0.8 = 5941.7 (3.7')

⇒ HW/D = 1.7 HW = (1.7)(6.0) = 8.5'

⇒ Inlet Special (15 - Type C)

537+74 to 539+96 ⇒ Fountain Creek ⇒ A = 358 sq mi Q_{10} = 9200 cfs Q_{100} = 42200 cfs

⇒ SH 24/Cimarron Bridge spans floodplain

Cimarron/I-25 Interchange ⇒ Miscellaneous storm sewers for SH24/Cimarron ramp intersections

538+39 to 543+57 (Mainline),
540+51 to 543+08 (NE Ramp),
541+68 to 544+20 (NW Ramp) ⇒ Fountain Creek ⇒ A = 120 sq mi Q_{10} = 4400 cfs Q_{100} = 20500 cfs

⇒ Mainline, NE Ramp, and NW Ramp Bridges span floodplain

543+77, 547+22, 550+68 ⇒ Super-elevated roadway draining to median barrier

⇒ 18" RCP w/ Vane Grate Inlet (Double) at 300' to 350' spacing

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CK. | PROJ. Cimarron/Bijou | SHEET 4

DATE June 25, 2003 | SUBJ. Prelim Hydraulics | OF

550+80 to 551+24 ⇒ Σ at Basins D-4 and E-3 ⇒ A=82Ac Q_{10}=123cfs Q_{100}=264cfs

AHW=5964.0(7.4') Monument Creek 10-Year WS=5957.0

⇒ 500'-91"x58" HERCP @ 0.5%

⇒ $v_f = \frac{264}{29.5} = 8.9$ fps $S_f = \left[\frac{(29)(0.013)^2}{(29.5/19.7)}\right]\frac{8.9^2}{64.4} = 0.0035$

$h_f = (0.0035)(500) = 1.8'$

45°, 57°, and 57° Bends ⇒ $h_b = (0.4+0.6+0.6)\frac{8.9^2}{64.4} = 2.0'$

HG at Inlet = 5957.0+1.8+2.0 = 5960.8 (4.2')

⇒ HW/D = 1.4 HW=(1.4)(4.8)=6.7'

⇒ Inlet Special (15-Type C)

⇒ Σ at Basin D-4 ⇒ A=72Ac Q_{10}=105cfs

54" RCP Stubout @0.5%± in Cucharras Q_f=150cfs

551+24 to 554+88 ⇒ Σ at Basin E-3 ⇒ A=10Ac Q_{10}=29cfs

⇒ 395'-36" RCP @0.5% connection to existing storm sewer in Walnut

Q_f=50cfs

553+39 and 557+29 ⇒ Superelevated roadway draining to median barrier

⇒ 18" RCP w/Vane Grate Inlet (Double) at 300' to 350' spacing

<u>555+44 to 560+04</u> ⇒ Σ Basins A, B, and Σ at Basin C-4 ⇒ A = 75 Ac

Q_{10} = 135 cfs Q_{100} = 194 cfs

AHW = 5961.0 (8.4')   Monument Creek 10-Year WS = 5958.9

⇒ 475' - 66" RCP @ 0.5%

⇒ $v_f = \frac{194}{23.8} = 8.2$ fps $S_f = \left[\frac{(185)(0.013)^2}{(5.5)^{4/3}}\right]\frac{8.2^2}{64.4} = 0.0034$

$h_f = (0.0034)(475) = 1.6'$ 45° Bend ⇒ $h_b = 0.4\left(\frac{8.2^2}{64.4}\right) = 0.4'$

HG at MH = 5958.7 + 1.6 + 0.4 = 5960.9 (8.3')

⇒ HW/D = 1.2   HW = (1.2)(5.5) = 6.6'

<u>560+04 to 560+87</u> ⇒ Σ at Basin C-4 ⇒ A = 58 Ac Q_{10} = 101 cfs Q_{100} = 136 cfs

AHW = 5975.0 (9.5')   D/S HG = 5960.9

⇒ 210' - 48" RCP @ 5.4%

⇒ $V_f = \frac{136}{12.6} = 10.8$ fps $S_f = \left[\frac{(185)(0.013)^2}{(4.0)^{4/3}}\right]\frac{10.8^2}{64.4} = 0.0089$

$h_f = (0.0089)(210) = 1.9$

70° and 30° Bends ⇒ $h_b = (0.70 + 0.25)\frac{10.8^2}{64.4} = 1.7'$

HG = 5960.9 + 1.9 + 1.7 = 5964.5 (−1.0')

⇒ HW/D = 1.9   HW = (1.9)(4.0) = 7.6'

⇒ Inlet Special (6 - Type C)

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CK. — PROJ. Cimarron / Bijou — SHEET 6

DATE June 26, 2003 — SUBJ. Prelim Hydraulics — OF

<u>560+04 to 572+81</u> ⇒ Σ Basins A and B ⇒ A = 17 Ac Q_{10} = 53 cfs Q_{100} = 87 cfs

AHW = 5976.2 (15.1') D/S HG = 5960.9

⇒ 1535' - 54" RCP @ 0.5%

$V_f = \frac{87}{15.9} = 5.5$ fps $S_f = \left[\frac{(185)(0.013)^2}{(4.5)^2}\right]\frac{5.5^2}{64.4} = 0.0020$

$h_f = (0.0020)(1535) = 3.1'$

10°, 20°, and 95° Bends ⇒ $h_b = (0.05 + 0.15 + 1.15)\frac{5.5^2}{64.4} = 0.6'$

HG at MH = 5960.9 + 3.1 + 0.6 = 5964.6 (3.5')

⇒ HW/D = 1.0 HW = (1.0)(4.5) = 4.5'

<u>563+71, 566+71, and 569+78</u> ⇒ Superelevated roadway draining to median barrier

⇒ 18" RCP w/ Vane Grate Inlet (Double) at 300' to 350' spacing

<u>570+17 to 572+81</u> ⇒ Basin B ⇒ A = 6 Ac Q_{10} = 19 cfs Q_{100} = 32 cfs

AHW = 5974.0 (7.2') D/S HG = 5965.6 (4.5')

⇒ 345' - 30" RCP @ 1.0%

$V_f = \frac{32}{4.9} = 6.5$ fps $S_f = \left[\frac{(185)(0.013)^2}{(2.5)^{4/3}}\right]\frac{6.5^2}{64.4} = 0.0060$

$h_f = (0.0060)(345) = 2.1'$ 75° Bend ⇒ $h_b = 0.74\left(\frac{6.5^2}{64.4}\right) = 0.5'$

HG at Inlet = 5965.6 + 2.1 + 0.5 = 5968.2 (1.4')

⇒ HW/D = 1.4 HW = (1.4)(2.5) = 3.5'

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CK. — PROJ. Cimarron/Bijou — SHEET 7

DATE June 26, 2003 — SUBJ. Prelim Hydraulics — OF

572+81 to 576+12 ⇒ Basin A ⇒ A = 11 Ac Q_{10} = 37 cfs Q_{100} = 60 cfs

AHW = 5968.8 (4.9')   D/S HG = 5965.6 (4.5')

⇒ 415' - 42" RCP @ 0.5%

$V_f = \frac{60}{9.6} = 6.3$ fps $S_f = \left[\frac{(185)(0.013)^2}{(3.5)^{4/3}}\right]\frac{6.3^2}{64.4} = 0.0036$

$h_f = (0.0036)(415) = 1.5'$

2-90° Bends $h_b = (1.05 + 1.05)\frac{6.3^2}{64.4} = 1.3'$

HG at Inlet = 5965.6 + 1.5 + 1.3 = 5968.4 (4.5')

⇒ HW/D = 1.2   HW = (1.2)(3.5) = 4.2'

575+55 to 576+85 ⇒ Monument Creek ⇒ A = 238 sq mi Q_{10} = 11500 cfs Q_{100} = 32000 cfs

⇒ Bijou Bridge spans floodplain

Bijou/I-25 Interchange ⇒ Miscellaneous storm sewers for Bijou ramps

581+84 to 586+22 ⇒ A = 177 Ac Q_{10} = 250 cfs Q_{100} = 465 cfs

⇒ Ex 6'x4' CBC storm sewer @ 0.4% constructed as part of I-25 N.B. project

586+12 ⇒ A = 56 Ac Q_{10} = 85 cfs Q_{100} = 175 cfs

⇒ Ex 91" x 58" HERCP storm sewer @ 0.4% constructed as part of I-25 S.B and N.B. projects

⇒ Superelevated roadway draining to open median

New Inlet Type C in median connected to existing pipe

COMP. WMA

CK.

DATE June 26, 2003

WILSON & COMPANY

LOC. I-25

PROJ. Cimarron / Bijou

SUBJ. Prelim Hydraulics

FILE X03100320

SHEET 8

OF

590+12 ⇒ A = 39 Ac Q_{10} = 65 cfs Q_{100} = 100 cfs

⇒ Ex 42" RCP storm sewer @ 1.1% constructed as part of I-25 S.B. and N.B. projects

⇒ Superelevated roadway draining to open median

Existing Inlet Type C connected to existing pipe

593+09 ⇒ A = 7 Ac Q_{10} = 15 cfs Q_{100} = 40 cfs

⇒ Ex 36" RCP storm sewer @ 0.7% constructed as part of I-25 S.B. and N.B. projects

⇒ Superelevated roadway draining to open median

Existing Inlet Type C connected to existing pipe

596+52 ⇒ A = 33 Ac Q_{10} = 55 cfs Q_{100} = 90 cfs

⇒ Ex 42" RCP storm sewer @ 2.0% constructed as part of I-25 S.B. and N.B. projects

603+38 ⇒ A = 38 Ac Q_{10} = 55 cfs Q_{100} = 100 cfs

⇒ Ex 42" RCP storm sewer @ 1.4% constructed as part of I-25 S.B. and N.B. projects

COMP. WHD | **WILSON & COMPANY** | LOC. I-25 | FILE X031000320

CK. | PROJ. Cimarron/Bijou | SHEET 9

DATE June 26, 2003 | SUBJ. Prelim Hydraulics | OF

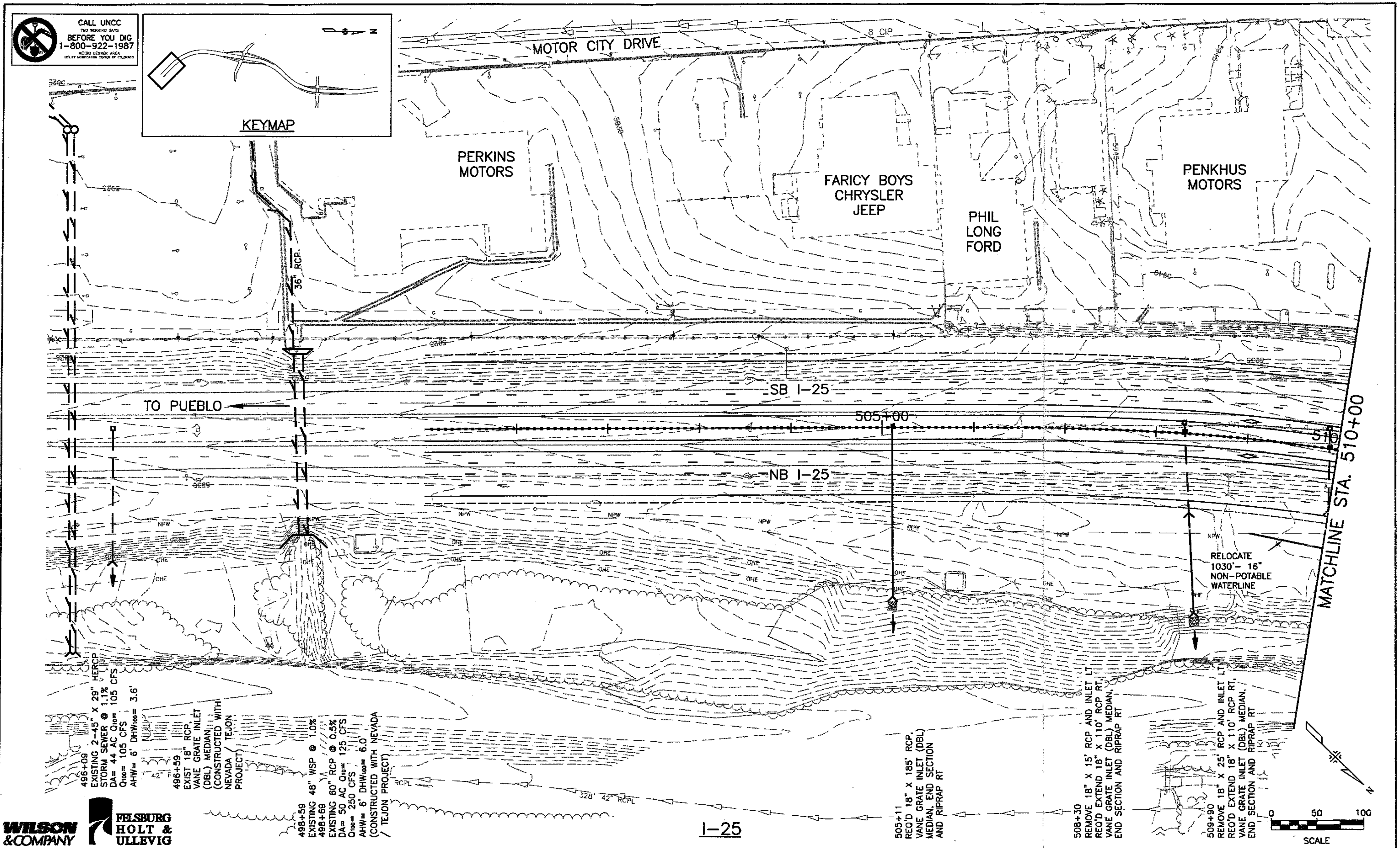
Cimarron east of Fountain Creek Bridge ⇒ 2 - New Inlet Type R L10
w/18" RCP U/S of Bridge

Bijou/Spruce Intersection ⇒ Extend 18" RCP w/ New Inlet Type R L10
to fit new curb & gutter

Bijou/Kiowa/Sierra Madre/Westview ⇒ Extend 24" RCP w/New Inlet Type R L20
to fit new curb & gutter

⇒ New curb & gutter to fit 4 Ex
C.O. Inlets

DRAINAGE BASIN MAP AND DRAINAGE &UTILITY PLANS



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Detailer: MAB
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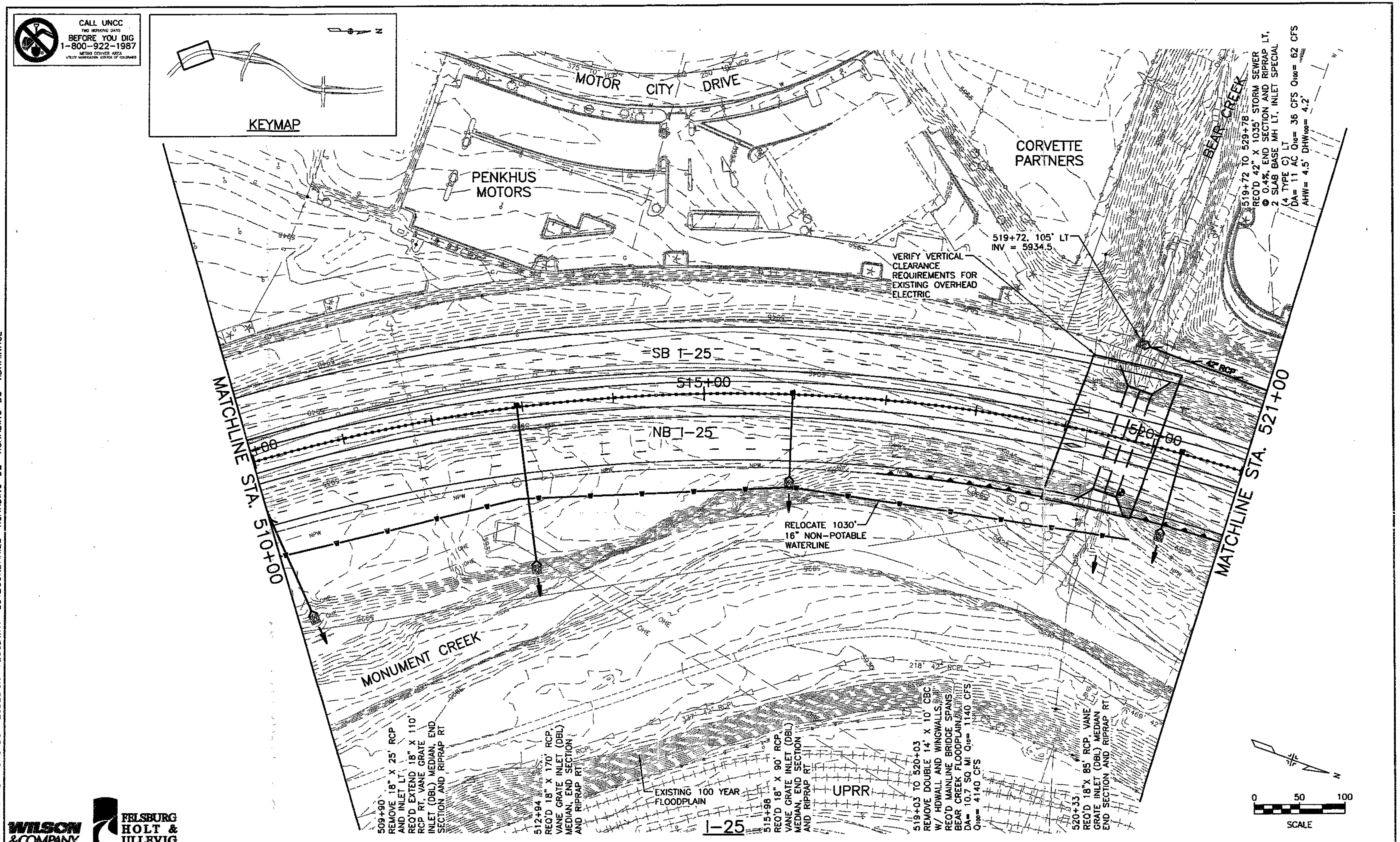

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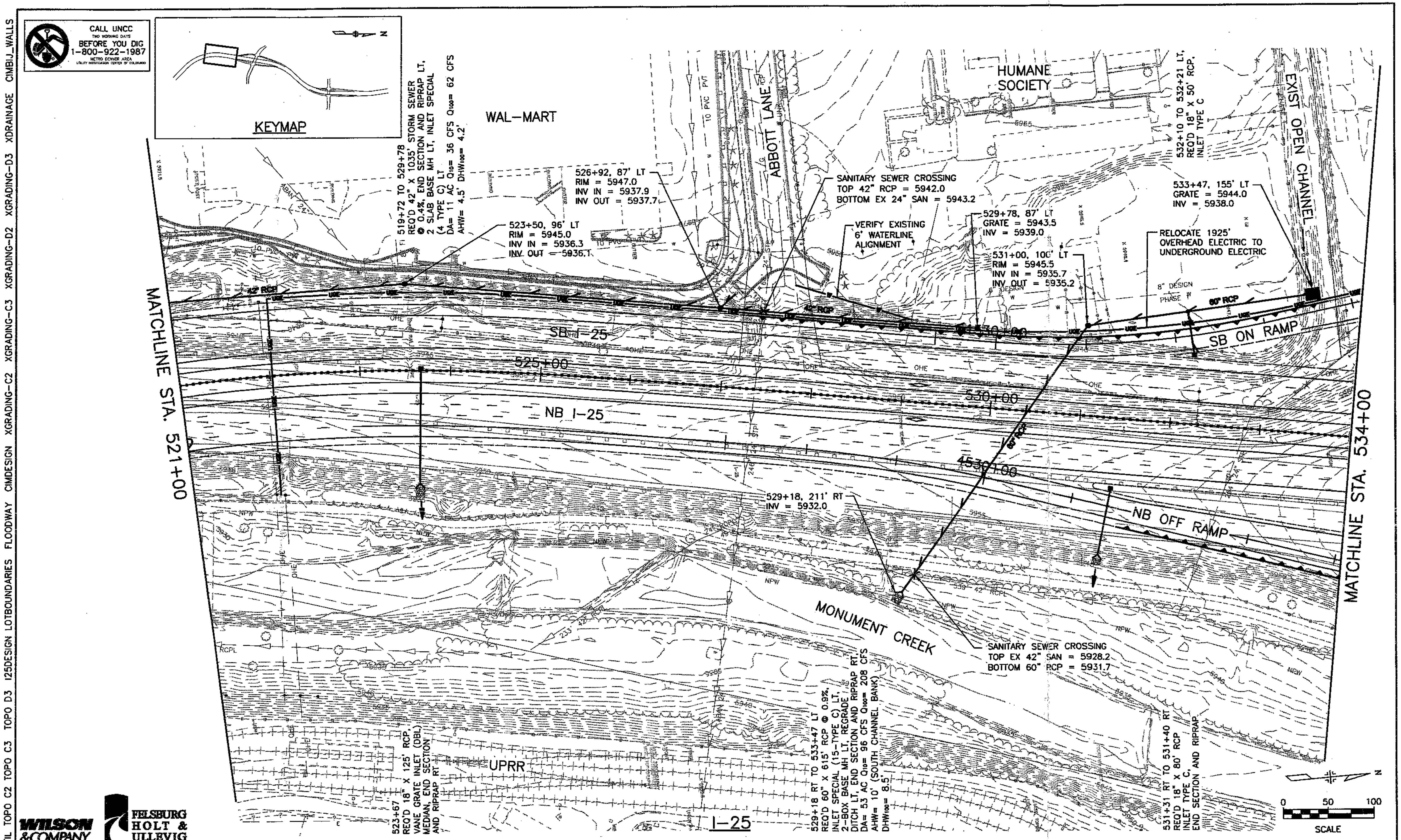

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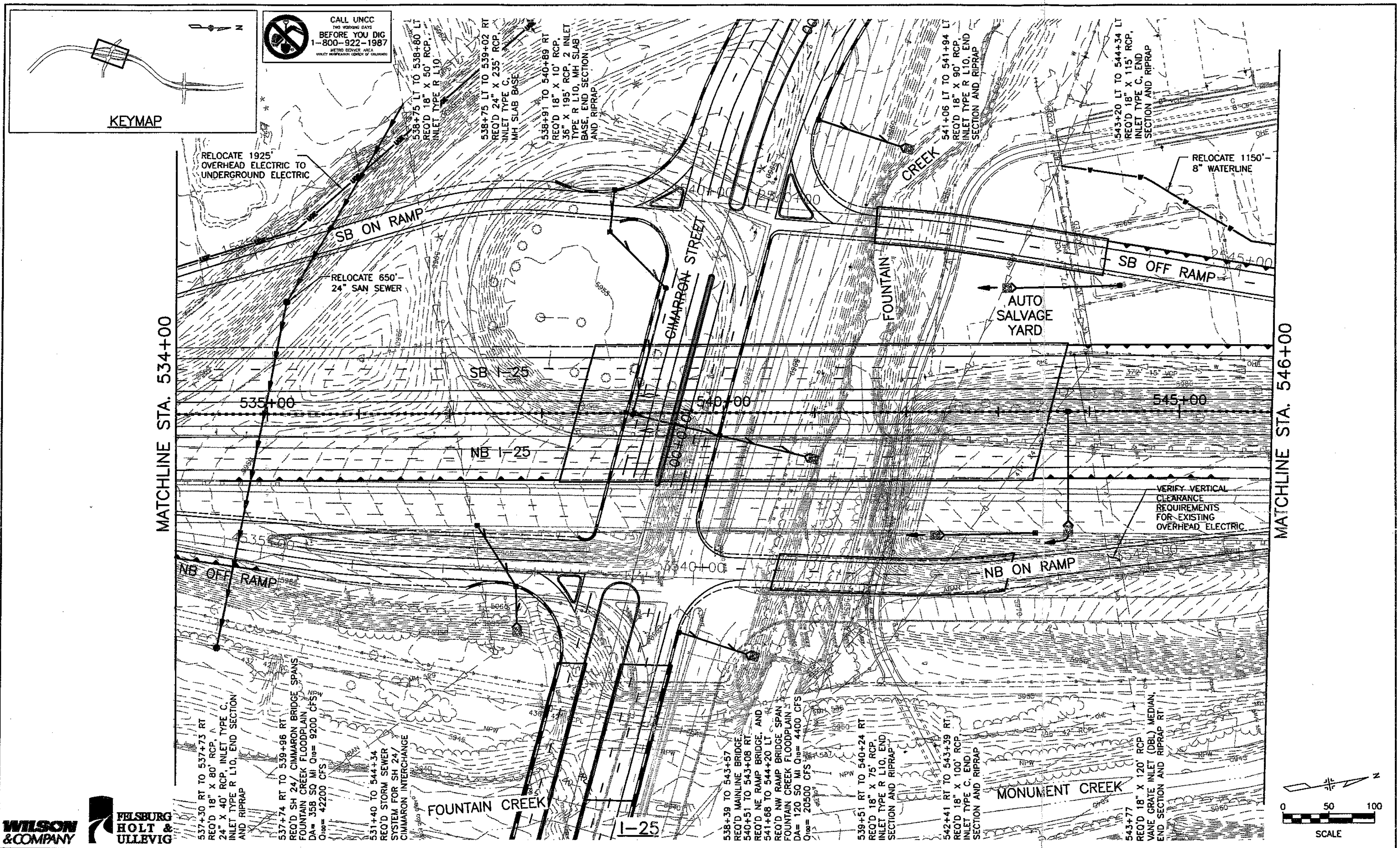

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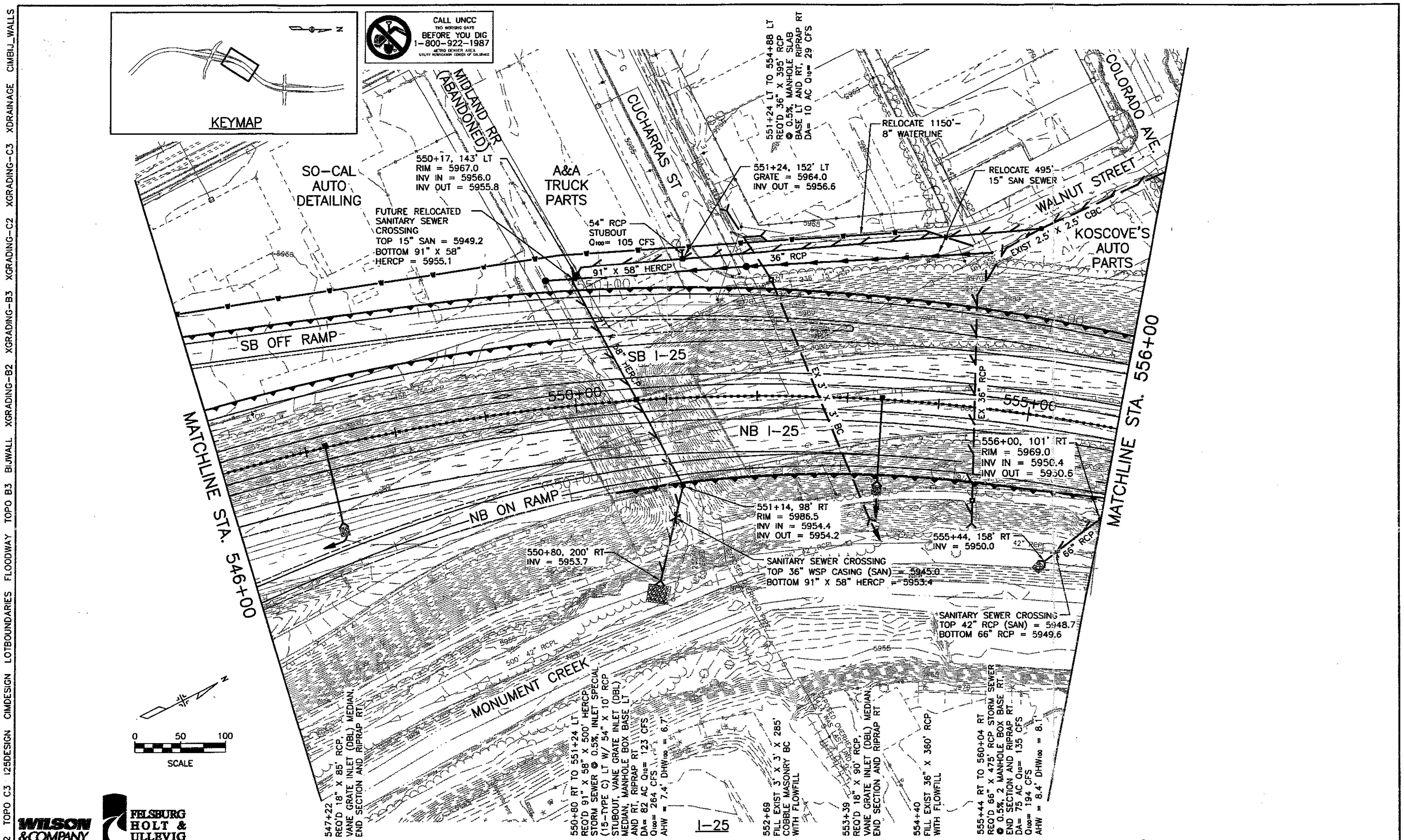

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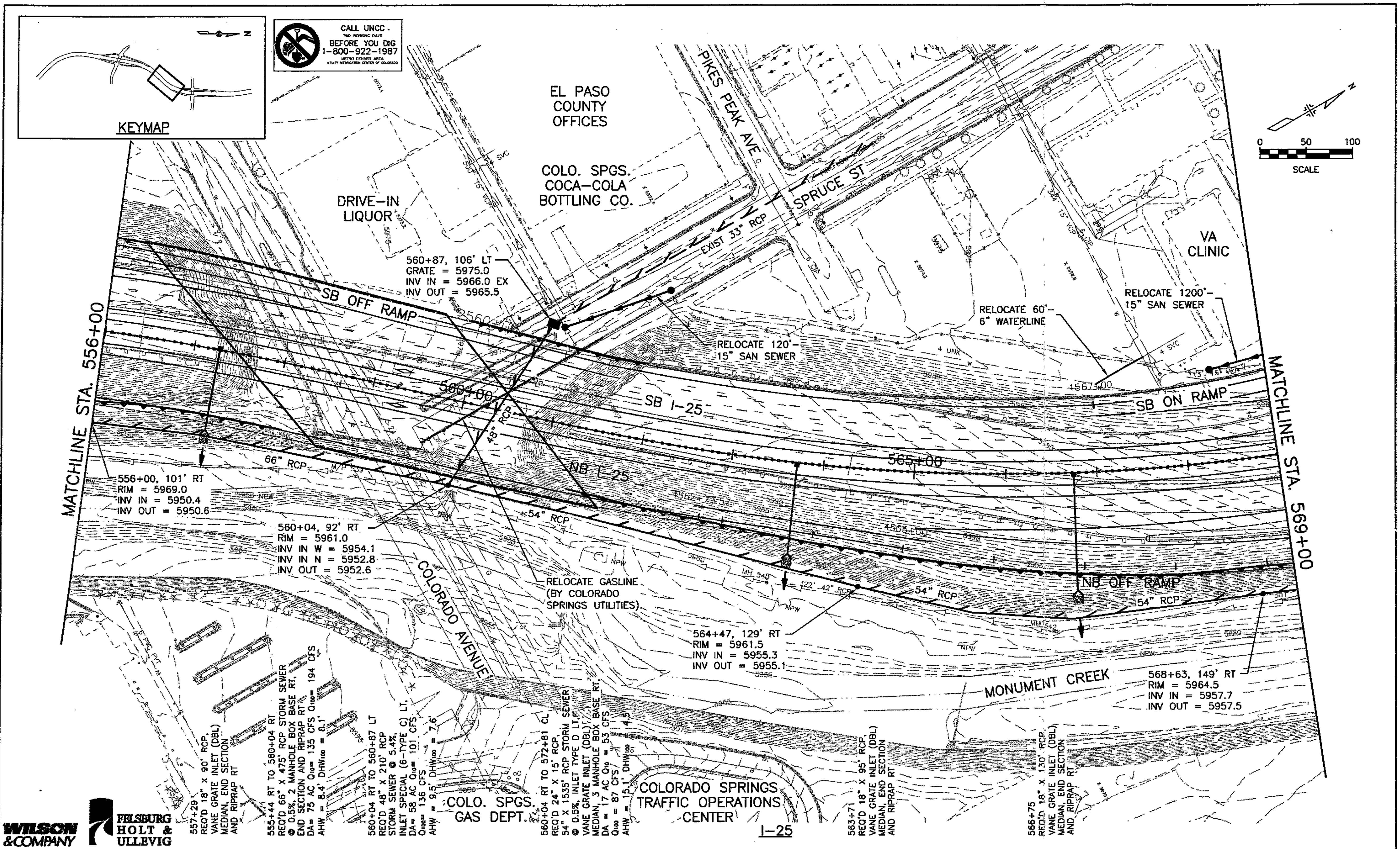

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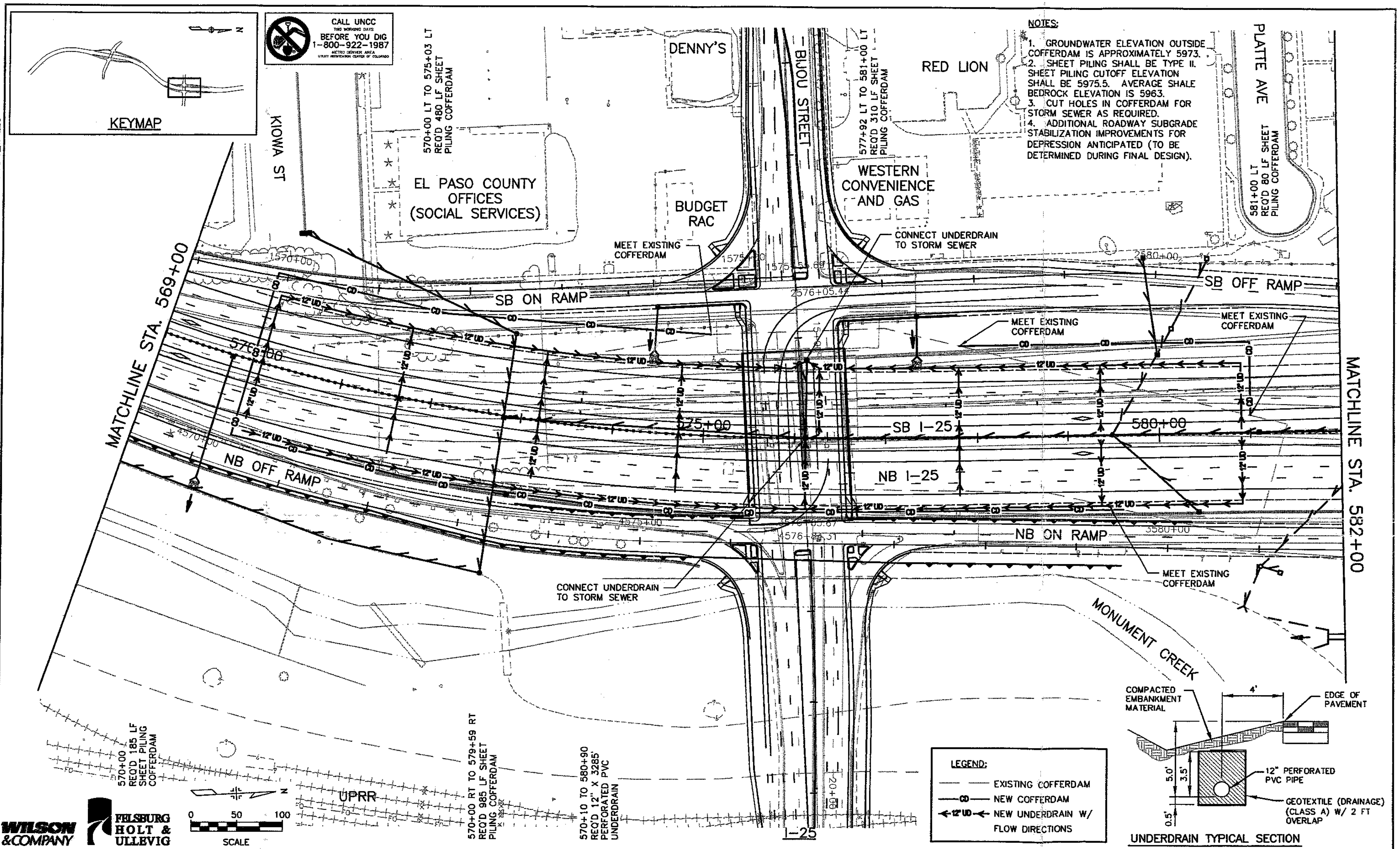

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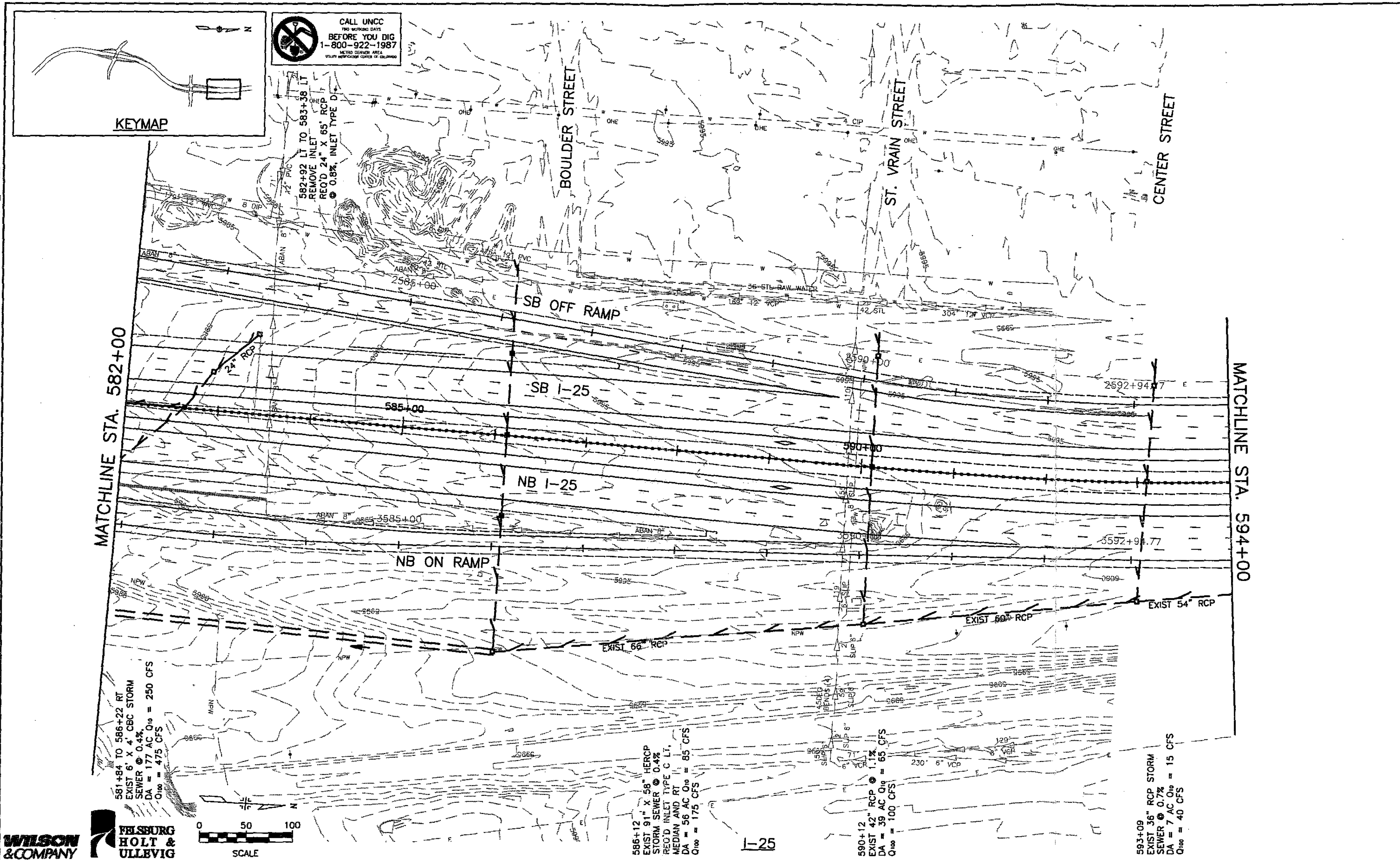

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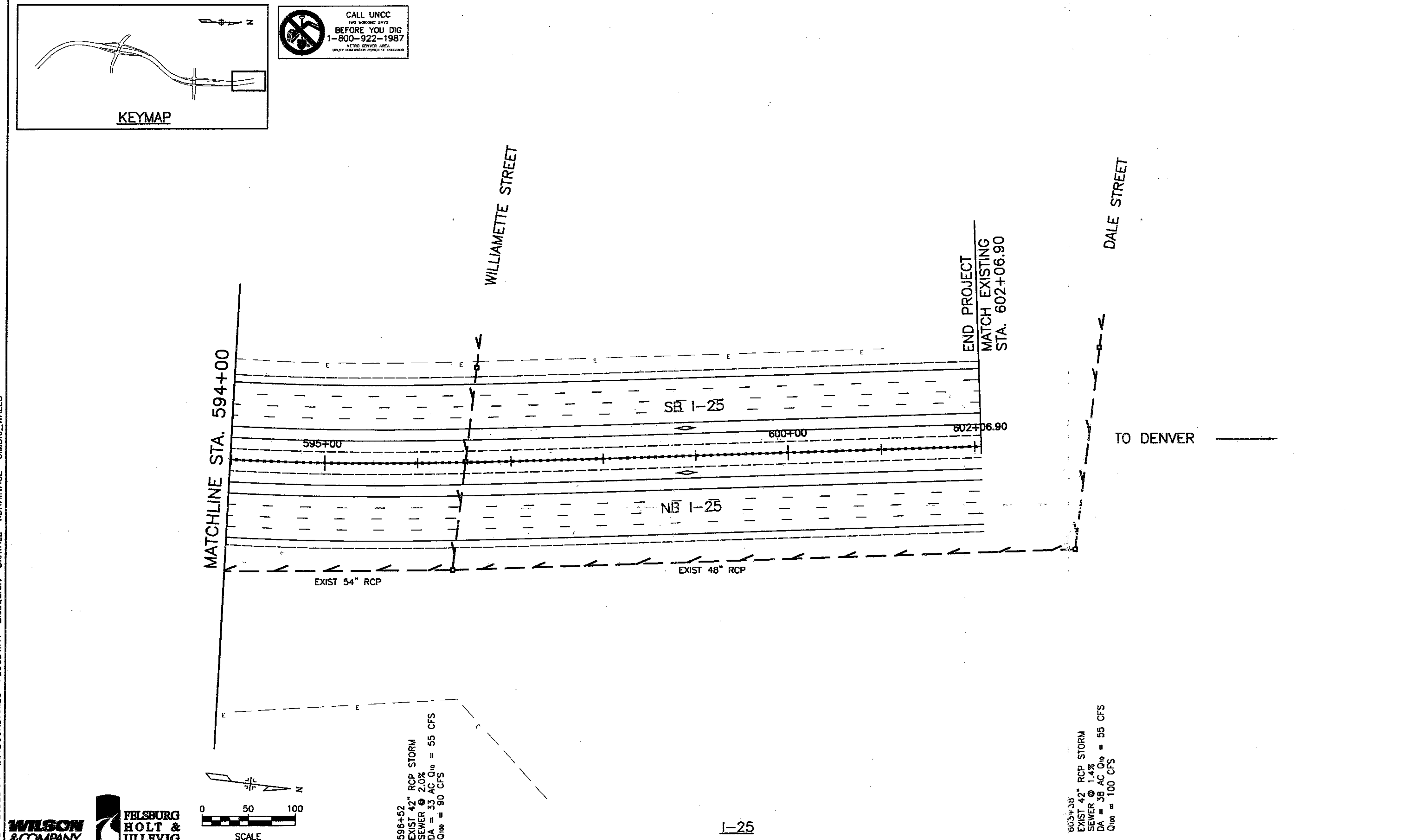

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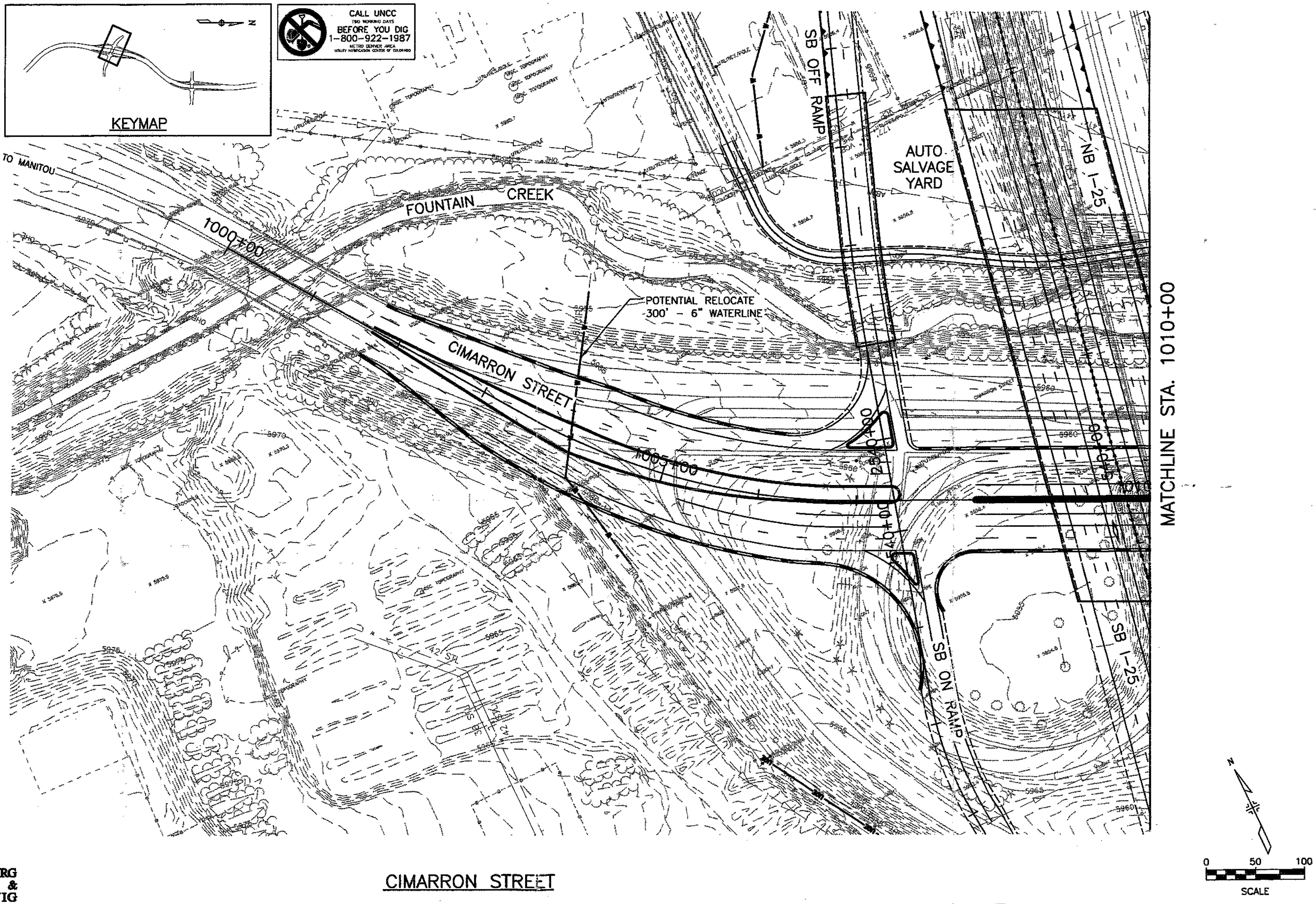

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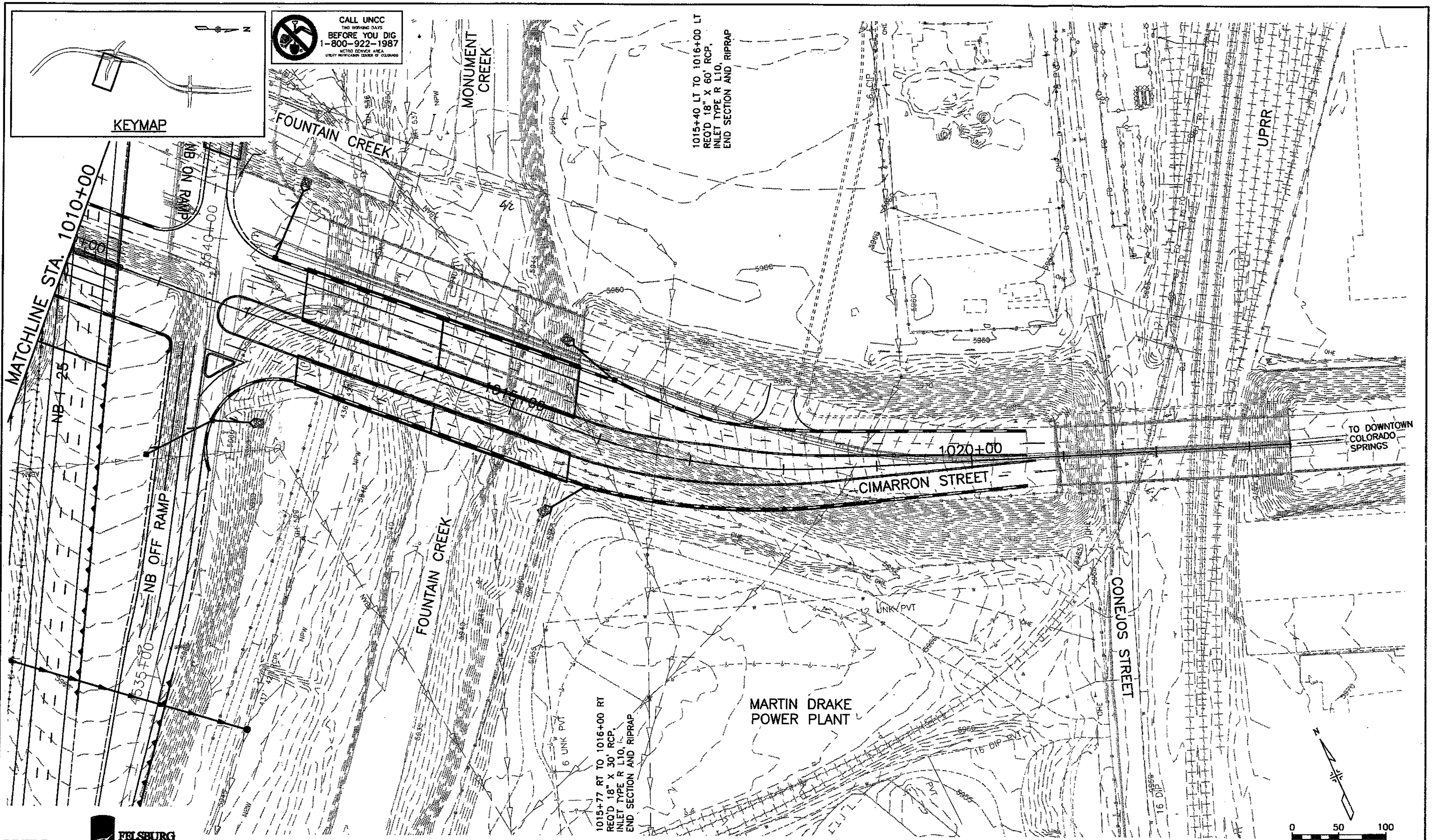

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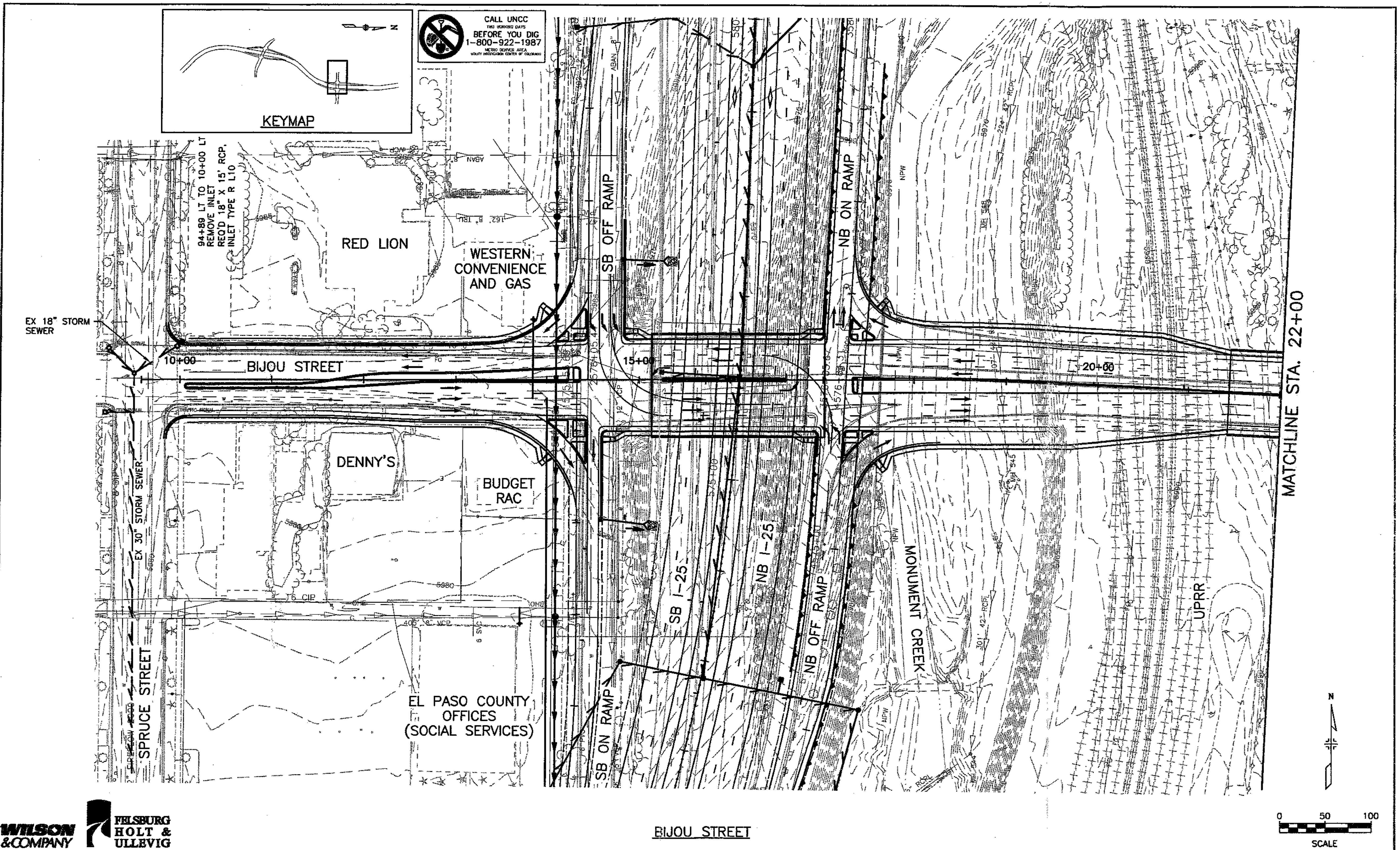

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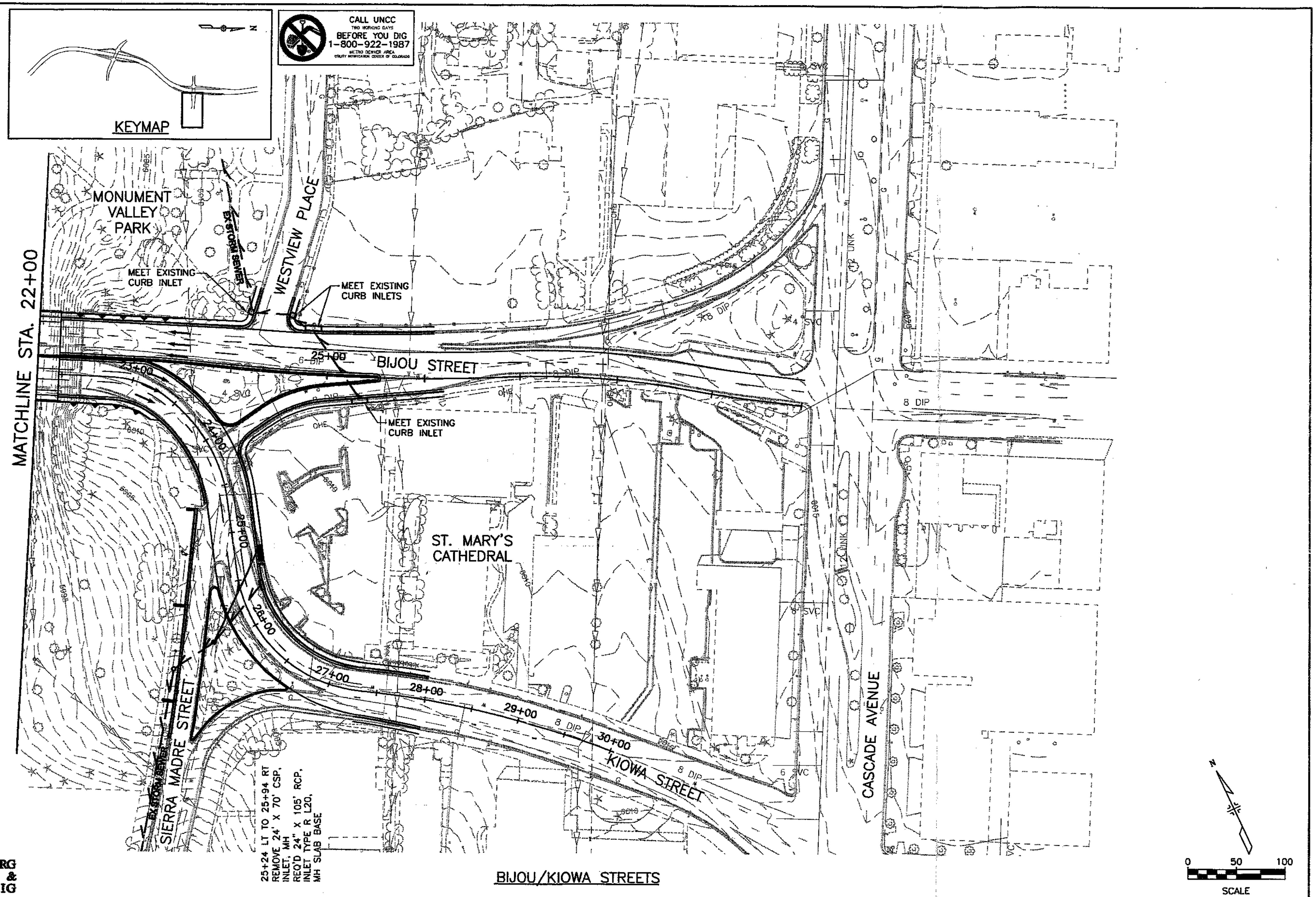

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