Little Shooks Run Outfall Systems Plan

Final Report

Prepared for

City of Colorado Springs

CITY OF COLORADO SPRINGS

July 2018

JACOBS ch2m

5555 Tech Center Drive Suite 212
Colorado Springs, CO 80919
Phone: (719) 633-8805
Fax: (719) 633-235

Transmittal Letter

JACOBS ch2m

CH2M
5555 Tech Center Drive
Suite 212
Colorado Springs, CO
80919-2372
719-477-4956
719-634-9951

July 27, 2018

Project Number: 691414

City of Colorado Springs
Tim Biolchini, P.E.
Senior Civil Engineer
Public Works/City Engineering
30 S. Nevada Ave, Suite 401
Colorado Springs, CO 80903

Subject: Draft Little Shooks Run Outfall Systems Plan

Dear Mr. Biolchini,
CH2M Engineers Inc. is pleased to submit the Draft Little Shooks Run Outfall System Plan. The Little Shooks Run watershed is comprised of 1.67 square miles (1068 acres) of urbanized land extending east from the confluence of Shooks Run at Kiowa Street to the eastern limits at the intersection of East Platte Avenue and Circle Drive. This watershed has been previously studied in the *Shooks Run Master Drainage Basin Study (Karcich & Weber, 1972)* and subsequently in the *Drainage Basin Planning Study, Shooks Run (Wilson and Company, 1993 and Shooks Run Drainage Basin Planning Study (DBPS) (CH2M, 2016))*. However, this outfall system of the Shooks Run Basin has never been studied in its entirety and is defined by several smaller drainage studies and improvement projects completed by developers. This new report provides a detailed EPA-SWMM hydrologic model that identifies the magnitude and volume of flow through the Little Shooks Run watershed, including all storm drainage pipes 30" and greater in size based on the recently revised City of Colorado Springs hydrologic criteria and work completed as part of *the Shooks Run DBPS (CH2M, 2016*). These reports will provide guidance and aid planning officials in evaluating beneficial projects to address and ease flooding issues throughout the watershed.

Sincerely,

Alan Turner, P.E. No. 38982

CH2M is now Jacobs

c: Richard Mulledy/City of Colorado Springs

PAGE INTENTIONALLY LEFT BLANK

Contents

Table of Tables

Table of Figures

Appendices

Acronyms, Abbreviations, and Definitions

Acronym	Definition	Page
AICP	American Institute of certified Planners	11
ASPRS	American Society of Photogrammetry and Remote Sensing	10
ATAC	Active Transportation Advisory Committee	11
AVE	Avenue	47
BGEPA	Bald and Golden Eagle Protection Act	37
BLVD	Boulevard	48
CAD	Computer Aided Design	31
CDA	Colorado Department of Agriculture	35
CFM	Certified Floodplain Manager	11
CFR	Code of Federal Regulations	37
CHI	Computational Hydraulics International	49
CMP	Corrugated Metal Pipe	19
COS	City of Colorado Springs	9
CPW	Colorado Parks and Wildlife	37
CSU	Colorado State University	37
DBPS	Drainage Basin Planning Study	9
DCM	City of Colorado Springs Drainage Criteria Manual	10
DFIRM	Digital Flood Insurance Rate Map	10
EPA	Environmental Protection Agency	3
EPA-SWMM	A dynamic rainfall–runoff–subsurface runoff simulation model used for single-event to long-term (continuous) simulation of the surface/subsurface hydrology quantity and quality from primarily urban/suburban areas. The United States Environmental Protection Agency developed the EPA-SWMM software.	10
FEMA	Federal Emergency Management Agency	9
FHAD	Flood Hazard Area Delineation	9
FHU	Felsburg, Holt & Ullevig	11
FIMS	Facilities Information Management System	10
FIPS	Federal Information Processing Standard	10
FLO-2D	FLO-2D is a flood routing model that simulates channel flow, unconfined overland flow, and street flow over complex topography. The software is proprietary and is developed by FLO-2D.	9
GIS	Geographic Information System	10
GPS	Global Positioning System	
GUI	Graphical User Interface	27

Acronym	Definition	Page
HARN	High Accuracy Reference Network - A HARN is a statewide or regional upgrade in accuracy of NAD 83 coordinates using Global Positioning System (GPS) observations	10
HEC	Hydrologic Engineering Center	10
HEC-HMS	The Hydrologic Modeling System (HEC-HMS) is designed to simulate the complete hydrologic processes of dendritic watershed systems. The software includes many traditional hydrologic analysis procedures such as event infiltration, unit hydrographs, and hydrologic routing. The United States Army Corps of Engineers developed the software.	10
HEC-RAS	HEC-RAS allows you to perform one-dimensional steady flow, unsteady flow, sediment transport/mobile bed computations, and water temperature modeling. The United States Army Corps of Engineers developed the software.	10
HMS	Hydrologic Modeling System	10
MBTA	Migratory Bird Treaty Act	37
NAD83	North American Datum of 1983. The North American Datum of 1983 (NAD 83) is the horizontal control datum for the United States, Canada, Mexico, and Central America, based on a geocentric origin and the Geodetic Reference System 1980. This datum, NAD 83, is the current geodetic reference system. NAD 83 is based on the adjustment of 250,000 points, including 600 satellite Doppler stations, which constrain the system to a geocentric origin.	10
NAVD88	North American Vertical Datum of 1988. The North American Vertical Datum of 1988 (NAVD88) is the vertical control datum of orthometric height established for vertical control surveying in the United States of America based upon the General Adjustment of the North American Datum of 1988.	10
NEP	Nonessential Experimental Population	38
NGVD29	National Geodetic Survey of 1929. The Sea Level Datum of 1929 became the *National Geodetic Vertical Datum of 1929* on May 10, 1973. (Geodetic Glossary, pp. 57) The Sea Level Datum of 1929 is a vertical control datum in the United States by the general adjustment of 1929.	10
NOAA	National Oceanic and Atmospheric Administration	27
NRCS	National Resource Conservation Service	10
NRHP	National Register of Historic Places	47
OAHP	The Colorado Office of Archaeology and Historic Preservation	47
PCSWMM	A powerful GIS engine works seamlessly with the latest GIS data formats, and provides intelligent tools for streamlining model development, optimization, and analysis in a comprehensive range of applications. Software is proprietary and was developed by Computational Hydraulics International	9
PMJM	Preble's Meadow Jumping Mouse	38
PPRBD	Pikes Peak Regional Building Department	9
RAS	River Analysis System	10
RCB	Reinforced Concrete Box	19
RCP	Reinforced Concrete Pipe	20
SWMM	Stormwater Management Model	3

Acronym	Definition	Page
UDFCD	Urban Drainage and Flood Control District	13
USACE	United States Corps of Engineers	9
USC	United States Code	37
USFWS	United States Fish and Wildlife Service	37
VERTCON	Program VERTCON computes the modeled difference in orthometric height between the North American Vertical Datum of 1988 (NAVD88) and the National Geodetic Vertical Datum of 1929 (NGVD29) for a given location specified by latitude and longitude. The National Oceanic and Atmospheric administration created the program	10
YMCA	Young Men's Christian Association	11
YWCA	Young Women's Christian Association	47

Introduction

Contract Authorization

The Little Shooks Outfall Systems Plan (OSP) report was prepared as part of the Little Shooks Run Drainage Basin Planning Study authorized by the City of Colorado Springs (City) under agreement number R008233 Task Order 2017-001 executed on February 21, 2017. This agreement authorizes CH2M Engineers, Inc (Engineer) to complete a baseline hydrology analysis, alternatives analysis, and conceptual design of selected issues throughout the Little Shooks Run basin as defined by the City. In addition, the hydrologic and hydraulic analysis will provide a baseline for the City to understand future drainage needs of the basin.

Purpose and Scope of Study

The scope of this project is to perform an Outfall Systems Plan (OSP) for the Little Shooks Run Watershed. The scope for the project consists of hydrologic analysis, hydraulic analysis, alternatives evaluation for selected issues within the basin defined by the City, and conceptual design of the selected alternatives in the Little Shooks Run Basin. This Report documents the hydrologic analysis and identification of flooding related issues throughout the basin and will be used by the City to prioritize projects throughout the basin to address undersized infrastructure and flooding issues.

The Little Shooks Run drainage basin has been studied as a part of larger DBPS studies including the Shooks Run Master Drainage Basin Study (Karcich and Weber, Inc., 1972), the Shooks Run Drainage Basin Planning Study (DBPS) (Wilson and Company, 1993) and the Drainage Basin Planning Study, Shooks Run (CH2M, 2016). However, there is no specific study of the Little Shooks Run Basin storm drain system. Over the years, individual studies for storm drain expansions have formed the backbone of the design in the area. The purpose of this project is to create the Baseline Hydrology for the entire Little Shooks Run Basin and look holistically at the Storm Drain system to identify problems areas and develop solutions that are within compliance with the current City of Colorado Springs Drainage Criteria Manual (DCM). The focus on the alternatives analysis and conceptual design was for selected issues in the basin including inlet placement along the main Little Shooks Run Outfall Pipe, heaved and damaged sections of the Little Shooks Run outfall pipe, and drainage issues near Pitkin Street and Boulder Street.

Planning Process

Multiple goals for the Little Shooks Run Outfall Systems Plan study define the planning process. The defined goals for the study are below.

1. Develop a revised Hydrologic/Hydraulic model for the Little Shooks Run storm drain system that utilizes the City of Colorado Springs revised hydrology guidelines and update land use to reflect the current conditions. This model will include the 2-, 5-, 10-, 25-, 50-, 100-, and 500-Year return period flows;
2. Identify flooding problems and undersized infrastructure, this will be analyzed by developing a coupled 2D and 1D model of the existing infrastructure utilizing Flood Modeller and EPA-SWMM;
3. Develop Alternatives to for three specific problems within the basin;
    - Flooding Issues at Pitkin Street and Boulder Street
    - Additional Inlets along the Little Shooks Run Outfall Pipe
    - Repair or rehabilitation alternative for buckled sections of the 9-foot x 14-foot Little Shooks Run Outfall Pipe
4. Complete a preliminary level design (30%) For the three specific issues defined above.

The process began by completing a revised hydrologic analysis which meet the updated City's DCM. The 2016 Shooks Run DBPS (CH2M, 2016) became the base model to initially identify sub-basin boundaries and general overland flow paths. To isolate the Little Shooks Run Basin storm water infrastructure, sub-basins were further sub-divided based on the storm drain system, inlets, and overland flow paths. By looking at both routing elements and overland flow paths, the model provided additional resolution on flooding issues and to provide a comprehensive analysis of the capacity of the Little Shooks Run drainage system. A PCSWMM model (which runs the EPA-SWMM 5.0.011 Engine) was created based on the revised hydrologic data, basin delineations and routing elements that exist within the watershed. This PCSWMM model was used to develop the 5-year (minor storm return period) for the analysis of the hydraulic capacity of the storm drainage infrastructure and the 100-year (major storm) hydraulic capacity of street conveyance as required by City of Colorado Springs DCM.

Beyond the revised hydrology and hydraulic analysis of the storm drain system for the watershed, the major goal of the project is to develop alternatives for the three-specific flooding and infrastructure problems identified by the City. This effort will culminate in a preliminary design for solutions that will help rehabilitate the storm drainage infrastructure or improve flooding problems in the basin.

This report differs from a tradition DBPS because it focuses on one major collection system for a broader drainage basin, in this case Shooks Run. This analysis will provide revised hydrology and hydraulics for the existing collection system, and will help to identify undersized infrastructure and flooding issues, but differs in the fact that the alternatives and conceptual design were focused on three specific issues. It is the intent of this report to compliment the broader Shooks Run DBPS, while providing a basis for the improvements to the infrastructure as redevelopment and maintenance allows.

Agency Jurisdictions

The Little Shooks Run Watershed exists entirely within the City of Colorado Springs. Future re-development in the Little Shooks Run Basin will be located within and managed by the City of Colorado Springs.

General Basin Description

The Little Shooks Run Watershed is located entirely within the City of Colorado Springs in El Paso County Colorado and includes portions of East Colorado Springs including Memorial Hospital and the Olympic Training Center. The study area is bounded on the North by East Uintah Street and East Boulder Street, the east by Circle Drive, the west by Shooks Run and the south by Pikes Peak Avenue. See **Figure 2.1** for a Vicinity Map.

The Little Shooks Run Watershed has a total drainage area of 1.67 square miles (1068 acres). This represents approximately 21.5% of the entire Shooks Run Basin (7.77 Sq. mi.) and contains over 11.5 miles of storm drain system and currently does not have any open channel conveyance elements inside the basin. Within the Little Shooks Run Watershed, the highest elevation is 6266 in the norther portion of the watershed near the intersection of East San Miguel and Iowa Avenue and the lowest elevation is 5964 at the confluence Shooks Run in the southwest corner of the basin. The average watershed slope is approximately 1.7 percent. The general flow of water within the basin is south until the flow reaches the southern portion of the basin where flow turns and flows due west discharging to Shooks Run near Kiowa Street.

Mapping and Surveys

CH2M collected elevation data from the City of Colorado Springs for the Little Shooks Run Project. This elevation data was created from elevation points and break lines from imagery captured in 2011 with an accuracy that meets the American Society of Photogrammetry and Remote Sensing (ASPRS) Class 1 National Map Accuracy Standards to perform mapping at the scale of 1" = 100' for 2' contours. The Vertical Datum of this data is the North American Vertical Datum

of 1988 (NAVD88) and the Horizontal Datum is NAD83 HARN State Plane Colorado Central, Federal Information Processing Standard (FIPS) 0502 feet. This data was created in 2011 from Light Detection and Ranging (LiDAR) data and provided by Colorado Springs Utilities.

Data Collection

CH2M worked with the City to collect as-builts, utility information and GIS data to complete the Little Shooks Run OSP. **Table 1-1, Data Collected for Project**, describes the pertinent information gathered to determine the hydrology for the watershed reported in this report.

Table 1-1

Data Collected for Project

Document Type	Description	Date	Author
2011 2 Foot Contour Data (NAVD88)	FIMS Contour Data	Received 4/7/2017	Colorado Springs Utility
2008 Aerial Image	Aerial Raster	Received 4/7/2017	City of Colorado Springs
GIS Parcel Data	County Parcel Data	10/22/2013	El Paso County
GIS Buildings	City Building Data (GIS)	Received 4/7/2017	City of Colorado Springs
NRCS Web Soil Survey	Soil Classification	Downloaded 4/7/2017	NRCS
GIS Database	FIMS Data (Utilities, Storm, Roadway)	Received 4/7/2017	Colorado Springs Utilities
As-Builts	Shooks Run Drainage Improvements Kiowa to Pikes Peak	Received 5/16/2017	City of Colorado Springs
As-Builts	6011-02, 6910-04, 7109-14, 8402-2, 8812-03, 8812-17, 8812-19, 8812-20, 8812-21, 8811-22, 8812-23, 8812-24, 8812-25, J-20, k-19, k-20, i-19, i-20,	Received 5/16/2017	City of Colorado Springs

Computer Models

A hydrologic and hydraulic model for the Little Shooks Run watershed was developed using the Environmental Protection Agencies (EPA) Storm Water Management Model Version 5.1.011 engine(EPA-SWMM) to simulate the rainfall-runoff process and generate flood hydrographs for select storm events. This model was selected due to the urbanization of the watershed and extensive storm drain network that was modeled to replicate the correct routing of the flows. The Little Shooks run EPA-SWMM model was based on the EPA-SWMM model developed for the Shooks Run DBPS (CH2M, 2016). The model from the Shooks Run DBPS was simplified to focus on the Little Shooks Run Basin and then expanded to include all storm drains greater than 30" in diameter. In addition, the sub-basin boundaries originally found in the Shooks Run DBPS (CH2M, 2016) were further sub-divided to reflect the increased storm drain complexity and to focus design points on key problem areas. Results from that comparison can be found in **Appendix A**. Facilities Information Management System (FIMS) topographic data, City of Colorado Springs Land Use Data, National Resource Conservation Service (NRCS) soils Data and FIMS storm drain information was used to complete the hydrologic analysis.

To further understand the exchange of flow between the subsurface network and the overland flow paths, a 2D model was built using Flood Modeller (CH2M). Flood Modeller 2D models utilizes surface elevation and can integrate with EPA SWMM to provide a 1D-2D linked model that can communicate directly with SWMM. As the subsurface drainage system reaches capacity and begin to flood junction nodes, flow is routed out of SWMM and onto the 2D model. As flow is routed over the 2D model, flow that has diverted out of the 1D system as the opportunity to flow back into the 1D system based on modeled inlets.

Applicable Criteria and Standards

The criteria and standards set forth in the City of Colorado Springs Drainage Criteria Manual (DCM), Volume 1 was applied to the entirety of the Little Shooks Run OSP. The Little Shooks Run OSP was prepared in accordance with the policies and procedures established in the DCM.

Acknowledgements

This Study was completed with support and input from a variety of individuals representing the City of Colorado Springs. The key participants in the development of the Outfall Systems Planning Study are shown in **Table 1-2, Acknowledgements**.

Table 1.2

Acknowledgements

Project Participant	Function	Affiliation
Aaron Egbert P.E.	Project Manager	City of Colorado Springs Engineering
Tim Biolchini, P.E.	Project Manager	City of Colorado Springs Engineering
Brian Kelley, P.E.	Engineering's Program Manager	City of Colorado Springs Engineering
Beau Thompson	Project Engineer	City of Colorado Springs Engineering
Jon Adair	Project Engineer	City of Colorado Springs Engineering
Alan Turner, P.E., CFM	Project Manager	CH2M
Myles Gardner	Project Engineer	CH2M
Will McGoey	Project Engineer	CH2M
Bryan Schafroth	CAD	CH2M
Jeremy Quan	GIS	CH2M

Basin Characteristics

Study Area

The Little Shooks Run Subwatershed is one of the major tributaries of the Shooks Run Watershed and is located within the City of Colorado Springs in El Paso County Colorado. The study area is bounded on the north by East Uintah St. and E. Boulder St., the east by N Circle Drive, and the west by Shooks Run and the south by East Pikes Peak Ave. See **Figure 2.1** for a Vicinity Map and **Figure 2-2** for a Watershed Map. The watershed is located entirely within the City of Colorado Springs jurisdictional boundaries and contains a mixture of single and multi-family residential properties and commercial development.

The Shooks Run Watershed has a total drainage area of 7.77 square miles (4,970 acres), the Little Shooks Run contributes 1.67 square miles (1068 acres). Within the Little Shooks Run Watershed, the highest elevation is 6266 in the north portion of the watershed and the lowest elevation is 5964 at the confluence with Shooks Run in the southwest. The average watershed slope is approximately 1.71 percent. The general flow of water within the basin is south until the flow reaches the southern portion of the basin where flow turns and flows due west toward Shooks Run. Both the subsurface drainage and the overland paths outfall into Shooks Run near E Kiowa Street.

Climate, Geology and Environmental

Climate

The climate of the region is classified as a mid-latitude steppe, with total annual precipitation averaging 16.2 inches annually. Eighty percent of the region's precipitation comes in the growing season from March to October. Monsoon moisture in the form of thunderstorms in July and August contributes the most. Winter is the driest season of the year. The mean annual snowfall in the region is 84 inches with the peak amount in March.

Geology and Vegetation

The general land use throughout the watershed is classified as a highly-urbanized area with an average impervious of 67.79 percent. The Little Shooks Run drainage is fully contained in storm drains or is characterized by flow in the street section. The full system passes through a heavily developed part of Colorado Springs. The vegetation in the basin is typically residential lawns and landscaping. There are no identified wetlands in the basin as there are no open channels or detention areas.

The geology of the Little Shooks Run basin is comprised primarily of Blakeland Loamy Sand (46%) and Bresser Sandy Loam (43%). Other soils located in the area include Chaseville Gravelly Sandy Loam, Nelson-Tassel Fine Sandy Loams, Truckton Sandy Loam on the southern boundary of the watershed and Ascalon Sandy Loam on the Northern edge of the watershed.

Bresser Sandy Loam has a hydrologic soil classification of C while Blakeland Loamy Sand has a hydrologic soil classification of A making infiltration rates in the basin low in the western portion of the basin and high in the eastern portion of the basin. See **Table 2-1** for Hydrologic Soil Group Parameters. **Figure A-1** in Appendix A displays the hydrologic soil groups located in the basin, while **Figure A-2** displays the Web Soil Service information from the NRCS for the basin.

Existing and Proposed Land Use

The Little Shooks Run project area is a highly-urbanized watershed. Aerial imagery reinforces the fact that the project area is highly urbanized with very few areas available for future development. Thus, the future conditions land use is assumed to be

TABLE 2-1

Hydrologic Soil Group Parameters

Soils Group	Infiltration Rate(in/hr)	Relative Runoff Potential
A	>0.30	Low
B	0.15-.30	Moderate
C	0.05-0.15	High
D	0-0.05	Very High

the same as the existing conditions land use. To develop impervious values for the hydrologic analysis, parcel data information was collected from El Paso County. The parcel data contained two fields related to land use: Zone Code and Use Description. The Zone Code generally but not always indicated the type of land use. The Use Description also generally but not always indicated the type of land use. A summary of the Zone Codes and Use Descriptions is provided in **Appendix A, Table A-1**. Land use was then assigned to the parcels based on the Zone Code and Use Description. In cases where the Zone Code and Use Description contradicted each other, the Use Description overrides. Parcels that did not contain a land use were assigned a Land use based on aerial review and consideration of neighboring land use. The land use was assigned a percent impervious based on the Runoff Coefficients for Rational Method (Urban Drainage and Flood Control District (UDFCD), 2001). **Table 2-2** presents the land use and corresponding percent impervious values for the Shooks Run Watershed.

Table 2-2

Land Use with Assigned Percent Impervious

Land Use	Percent Impervious
Business Commercial Areas	95
Residential 1/8 Acre or less	65
Residential 1/8 Acre to 1/3 Acre	40
Residential greater than 1/3 Acre	30
Limited Industrial Areas	80
Heavy Industrial Areas	90
Parks and Cemeteries	7
Playgrounds	13
Pasture/Meadow/Vacant	0
Paved Streets	100

The distribution of the percent imperviousness within the Little Shooks Run Watershed is presented in **Appendix A,** Figure A-2.

Major Drainageways and Structures

Irrigation Facilities

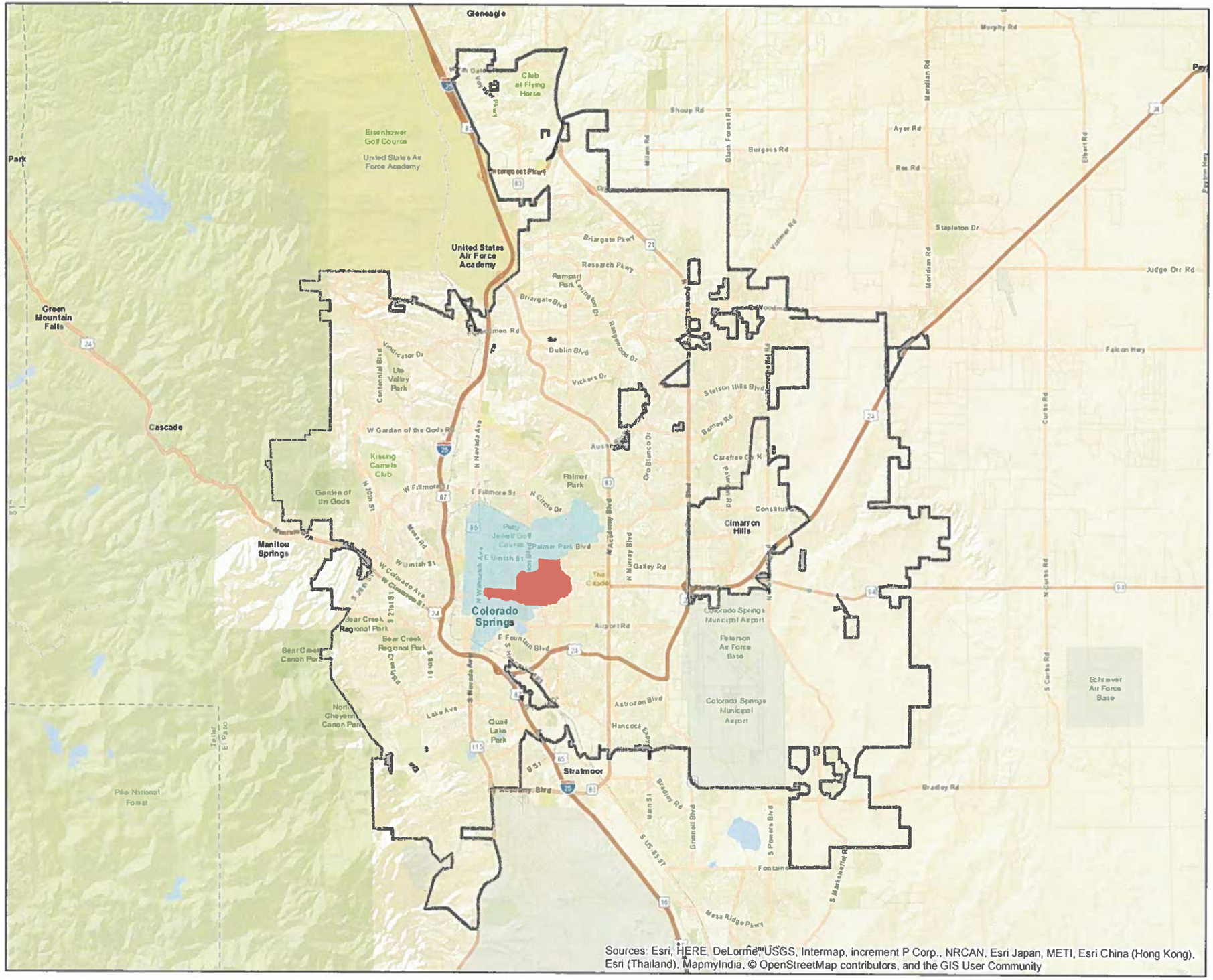
There are no recorded irrigation facilities still active in the Little Shooks Run Watershed. The El Paso Canal, a water supply canal developed for the City of Colorado Springs in the early 1900's, runs through the Shooks Run watershed and has since been abandoned. This irrigation system terminated at Boulder Park in a reservoir for storing flows from the canal. The park was originally part of the Colorado Springs Company (headed by General William J. Palmer), was one of the city's earliest reservoirs, and held a million gallons of water. Constructed in 1874, it fed the El Paso Canal, which followed a serpentine path through the Shooks Run Watershed, to, and through the North End. The Reservoir in the City and the Canal were decommissioned in 1908 and no longer transport water through the watershed. This system is located just to the north of the Little Shooks Run watershed and does not impact drainage or hydrology in Little Shooks Run.

Detention Storage Sites

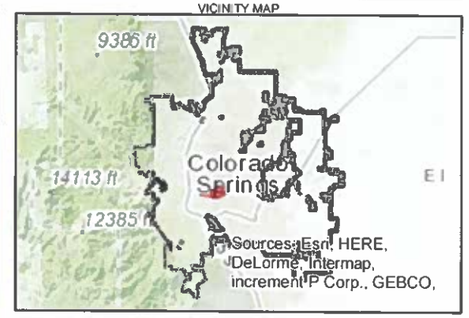
There are several small detention facilities constructed by developments throughout the Little Shooks Run Basin. However, a review of these facilities indicates that none of the detention in the basin is owned or maintained by the City of Colorado Springs. There are no existing detention facilities were modeled as part of the hydrology or hydraulics for the Little Shooks Run Basin.

Flood History

The Little Shooks Run basin has flooded several times in the past but there is very little documented information surrounding flooding in the basin. Flooding has occurred during heavy thunderstorms that inundate the storm drain system and localized flooding caused by blocked inlets. This last happened in August of 2016 when 2 feet of hail fell and clogged the inlets to the Little Shooks Run Drainage System, causing property flooding at several locations including Logan Street and Willow Street.



VICINITY MAP



LEGEND

- COLORADO SPRINGS
- Little Shooks Run Watershed
- Shooks Run Watershed

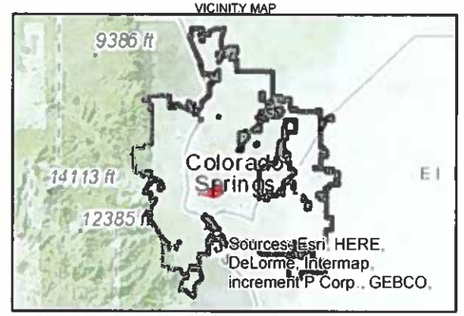
N

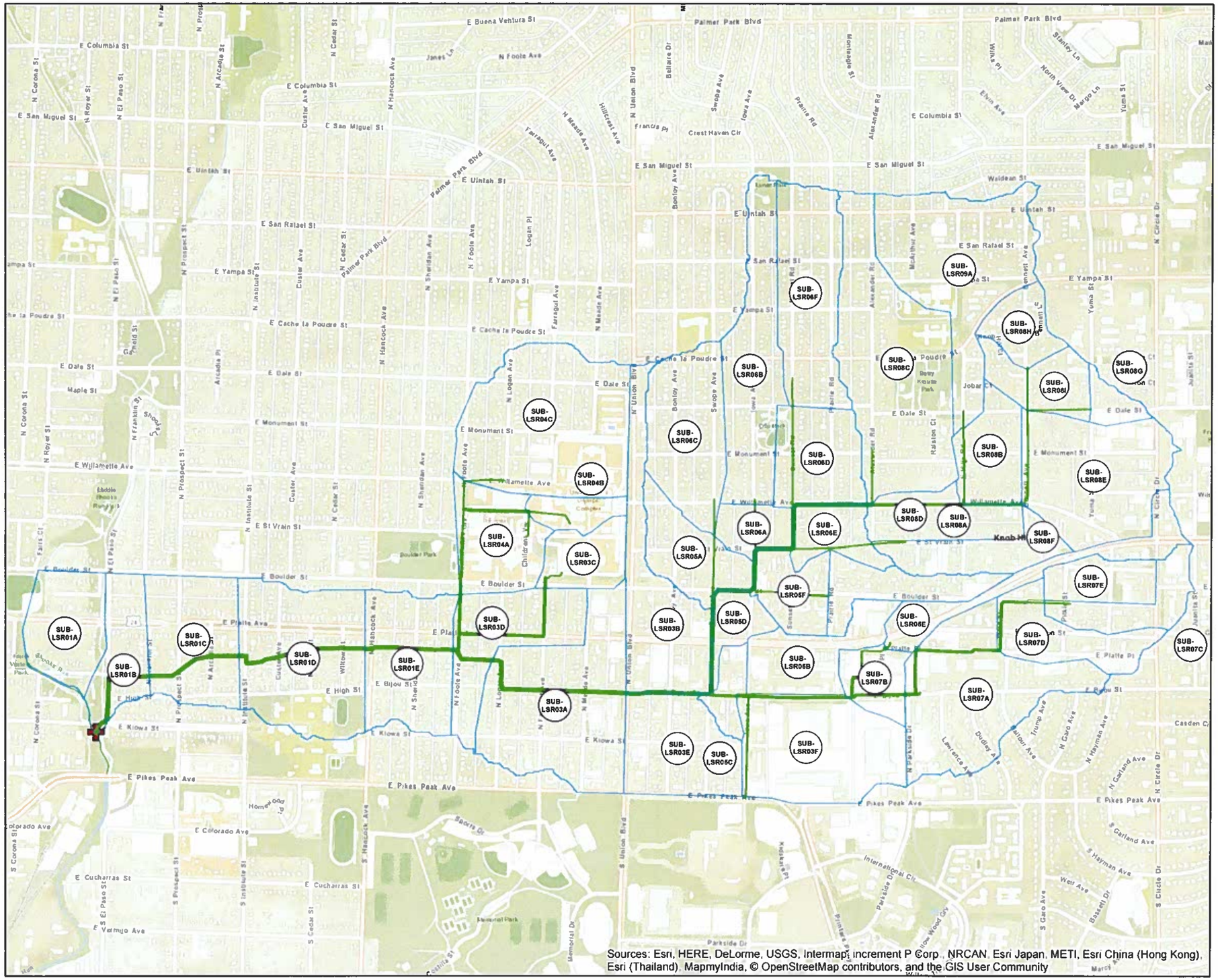
0 0.5 1 2
Miles

FIGURE 2-1
Little Shooks Run Vicinity Map
Little Shooks Run Outfall Systems Plan
Little Shooks Run Outfall Systems Plan

ch2m

VICINITY MAP





LEGEND

Little Shooks Run Watershed

Existing Storm Drain

- < 18"
- 18" to 45"
- 45" to 60"
- 60" to 108"
- 108" to 240"

Outfall

N

0 250 500 1,000
Feet

FIGURE 2-2
Little Shooks Run Watershed Map
Little Shooks Run Outfall Systems Plan
Little Shooks Run Outfall Systems Plan

ch2m

Hydrologic and Hydraulic Analysis

Overview

A hydrologic and hydraulic analysis for the Little Shooks Run watershed, as depicted in Figure 2-2, was performed to determine the peak flow rates and volumes for the 2-, 5-, 10- and 100-year return period storm events as well as the routing for those flows through the storm drain network and the overland flow paths. The analysis utilized existing land use conditions, which is assumed to be similar to future land use conditions because the basin is fully developed. The information derived from the hydrologic and hydraulic analysis will be later used to identify problem areas within the Little Shooks Run watershed and to develop alternative drainage plans to:

1. Improve the flooding conditions that are experienced by properties and roadways adjacent to the stormwater infrastructure.
2. Provide recommendations and conceptual design for areas of flooding that do not meet City Criteria. Specifically, the information will be used to help the City place additional inlets to relieve flooding, provide rehabilitation to damaged infrastructure and provide recommendations to relieve flooding near Pitkin St. and E. Boulder St.

The Little Shooks Run EPA-SWMM model was based on the EPA-SWMM model developed for the Shooks Run DBPS (CH2M, 2016). The model from the 2016 Shooks Run DBPS was truncated to focus on the Little Shooks Run Basin and then expanded to include all storm drains greater than 30" in diameter. In addition, the sub-basin boundaries originally found in the Shooks Run DBPS (CH2M, 2016) were further sub-divided to reflect the increased storm drain complexity and to focus design points on key problem areas.

Due to the uncertainty of the surface flow patterns throughout the Little Shooks Run watershed, a comprehensive two-dimensional model was created to identify the major surface flow patterns for the entire sub-basin. The selected two-dimensional model was CH2M's Flood Modeller. This model was created using the 2011 2-foot contour data to create a 5-foot digital elevation grid. The 2D model grid was linked to the EPA-SWMM model that was developed for hydrology and hydraulic routing of storm flows for the Little Shooks Run watershed. Linking the two models allowed for the loading of the 2D model with flooding hydrographs from the EPA SWMM Model for manholes where subsurface system was insufficient to convey the flows. This model allowed the project team to identify local flow paths within the watershed boundary and understand the existing inlet capacity, and provide recommendations for upsized pipe infrastructure and additional inlet capacity to reduce the overland street conveyance to within City criteria.

Major Basins and Sub-basins

The existing storm drainage system that exists in the project area created a challenge for developing subwatershed boundaries. Previous studies delineated watershed boundaries based primarily upon topography with secondary considerations being the storm drain network.

For this study, sub-basins from the 2016 Shooks Run DBPS were used as a base model. Sub-basins were further subdivided based upon the subsurface drainage system and to develop design points for key problem areas. This approach resulted in 41 sub-basins that varied in size from 10 acres to 50 acres, with an average size of 28 acres. Model parameters were determined utilizing the topographic mapping, land use mapping and zoning provided by the City.

Design Rainfall

The 2-, 5-, 10-, and 100-year, 1- and 24-hour design point rainfall depths used in the hydrologic analysis were obtained from the National Oceanic and Atmospheric Administration (NOAA) 14 Atlas. Per Chapter 6, Section 2.0 in the Colorado Springs Design Criteria Manual (CSDCM 2014), the 2-hour thunderstorm distribution and point rainfall depths were developed from the NOAA 14 1-hour Point rainfall values. The 2-hour design thunderstorm was developed for the City of Colorado Springs in the Carlton 2011 study. No areal adjustment was needed based on the small size (less than 10 square miles) of the watershed. **Table 3-1** presents totals, in inches, for the 2- and 24-hour design point rainfall depths.

Table 3-1
Point Rainfall Table

Storm Frequency	*2-Hour Point Rainfall Values (inches)	24-Hour Point Rainfall Values (inches)
2-year	1.05	1.90
5-year	1.35	2.42
10-year	1.63	2.92
25-year	2.08	3.72
50-year	2.45	4.42
100-year	2.86	5.19
500-year	3.96	7.30

* = 2-Hour point rainfall depths were developed using the NOAA 14 1-hour rainfall depths distributed across the 2-hour frontal storm distribution.

The 24-hour rainfall depths were distributed across the NRCS Type II Distribution, while the 2-hour rainfall depths were developed per CSDCM (2014) criteria using the thunderstorm distribution defined in the criteria.

Hydrograph Routing and Hydraulics

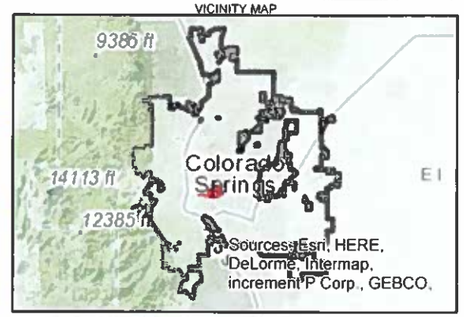
To fully understand the complexity of the Little Shooks Run watershed, the routing of the storm runoff through the basin was handled by two models simultaneously. The runoff hydrographs were developed and routed through the system using PCSWMM. PCSWMM is a graphical user interface that sits on top of the EPA-SWMM engine and allows the user to input GIS information directly into an EPA-SWMM Model. **Figure 3-1**, provides a schematic of the PCSWMM model define the extents of the sub-basin and collection network modeled.

Flow routing within the SWMM model utilized conduit elements for the storm drain system. To build the conduit database, City provided GIS shapefiles were used as a basis and missing information was either supplemented or inferred from As Built. Conduits greater than 30" were incorporated into the 1D Model. Conduits were connected via junction nodes. One of the significant changes from the 2016 DPBS model was the removal of diversion nodes and overland flow paths from the SWMM model. These junction nodes were programed to have the ability to discharge excess flow out of the SWMM model and subsequently picked up and routed in the 2D Flood Modeller model.

To capture the hydraulic routing of flow escaping the subsurface system, a 2-dimensional model was built using CH2M's Flood Modeller program. Flood Modeller 2D models utilizes topographic data and can integrate with the EPA SWMM engine to provide a 1D-2D linked model that can communicate simultaneously. The 2D model was created using 2011 2-foot LiDAR data provided by the City and was summarized using a 5' x 5' grid cell size.

To understand the exchange of flow back and forth between the surface and subsurface system, inlet information gathered from the City's GIS data was also taken into consideration. Inlet GIS information summarized and grouped based on location, type, and outlet into the main drainage system. To model the number of inlets, individual weirs were modeled in the 2D model at the appropriate junction locations. These weirs varied in length and allowed the model to exchange flow back and forth between models but also understand the effects of cogging on the inlets and how that relates to the flood risk. Figure 3-2, provides a schematic of the PCSWMM model with the defined links to the 2D model domain.

VICINITY MAP



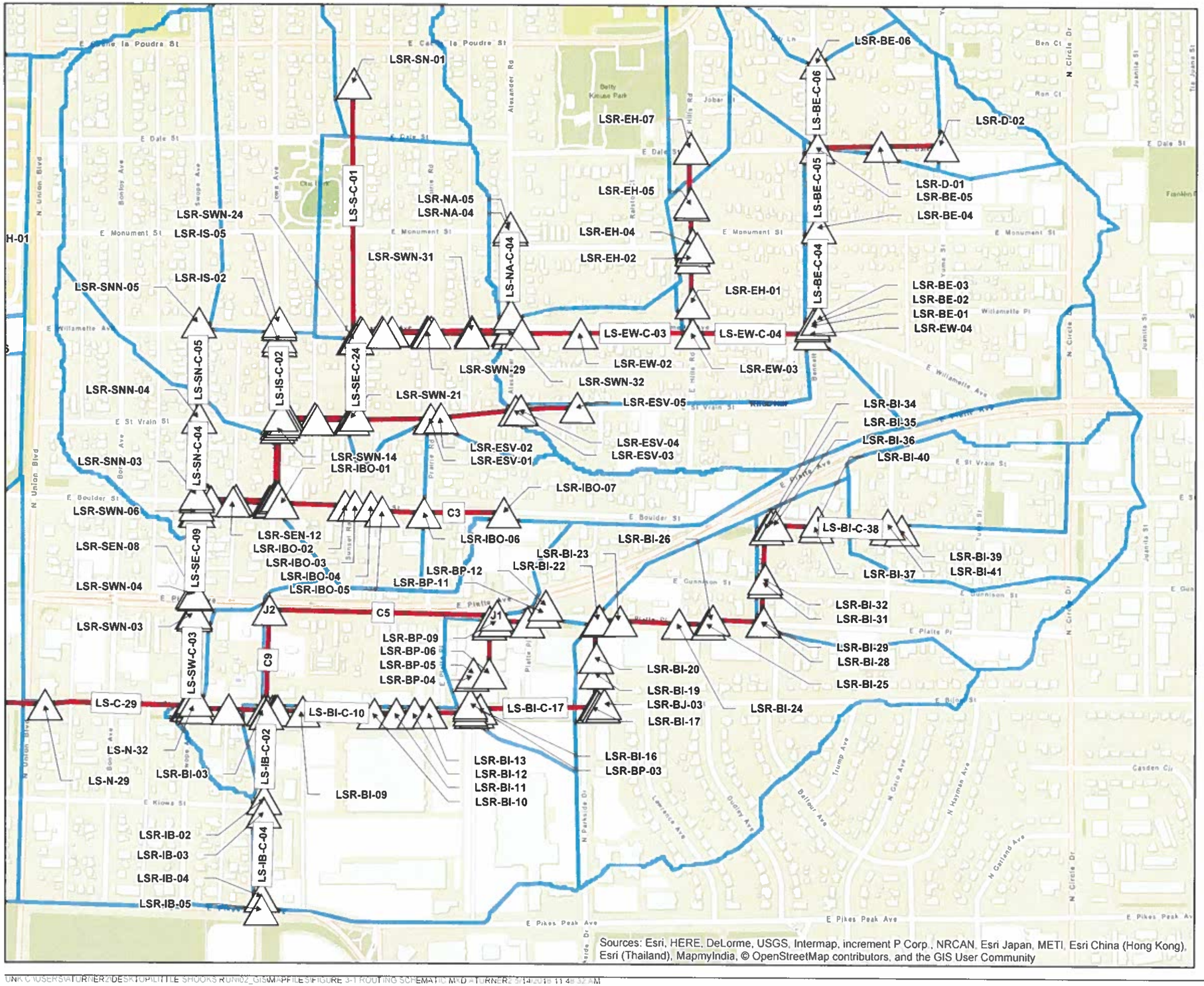
LEGEND

- Junctions
- Outfalls
- Conduits
- COLORADO SPRINGS
- Little Shooks Run Watershed

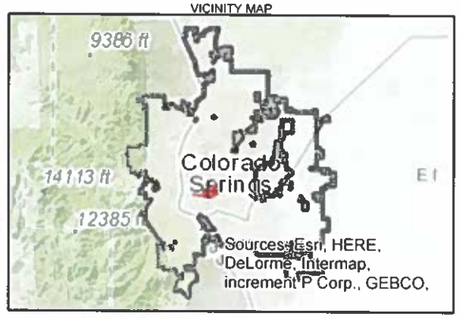
0 250 500 Feet

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

FIGURE 3-1
Little Shooks Run Routing Scematic
Little Shooks Run Outfall Systems Plan
Little Shooks Run Outfall Systems Plan



VICINITY MAP



LEGEND

- Junctions
- Outfalls
- Conduits
- COLORADO SPRINGS
- Little Shooks Run Watershed

N

0 250 500

Feet

FIGURE 3-1
Little Shooks Run Routing Scematic
Little Shooks Run Outfall Systems Plan
Little Shooks Run Outfall Systems Plan

ch2m

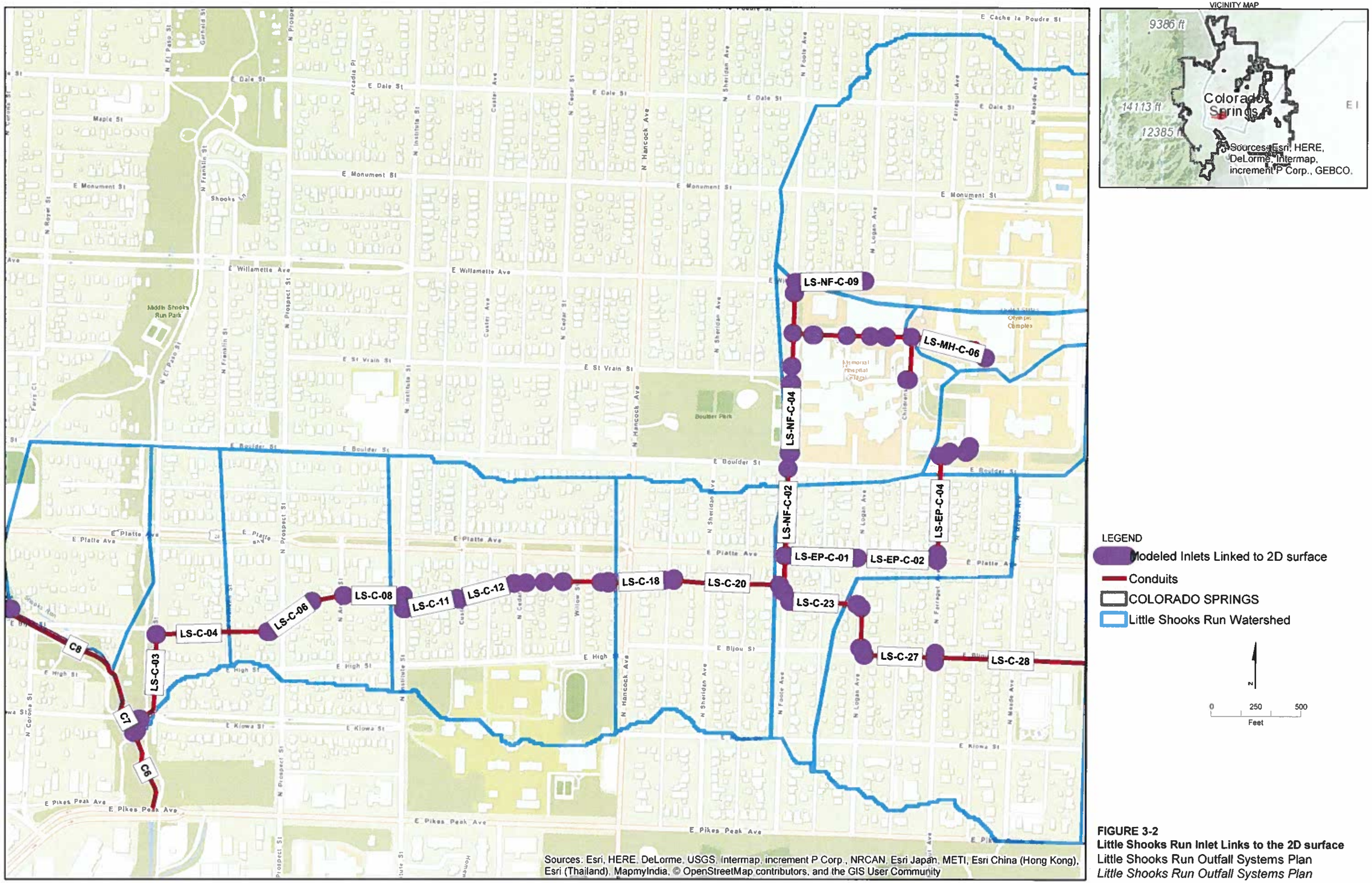
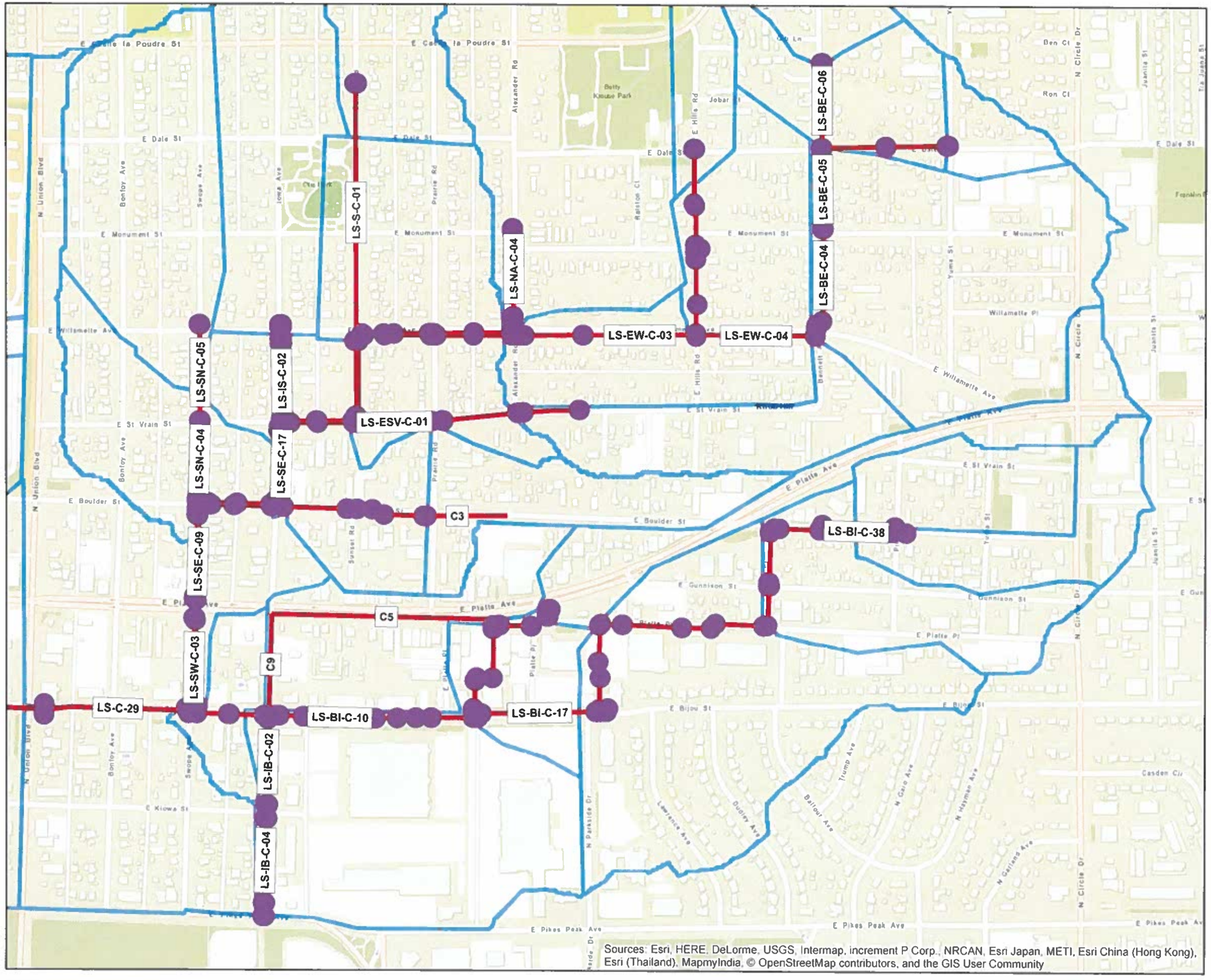
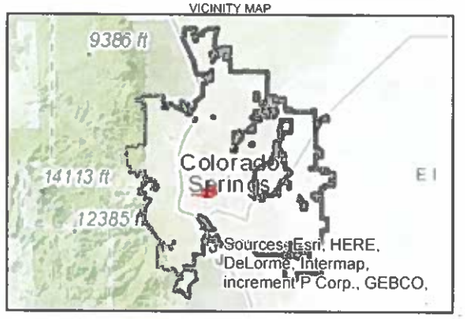


FIGURE 3-2
Little Shooks Run Inlet Links to the 2D surface
Little Shooks Run Outfall Systems Plan
Little Shooks Run Outfall Systems Plan



VICINITY MAP



LEGEND

- Modeled Inlets Linked to 2D surface
- Conduits
- COLORADO SPRINGS
- Little Shooks Run Watershed

N

0 250 500
Feet

FIGURE 3-2
Little Shooks Run Inlet Links to the 2D surface
Little Shooks Run Outfall Systems Plan
Little Shooks Run Outfall Systems Plan

PAGE INTENTIONALLY LEFT BLANK

Hydraulic Results and Problem Areas

To understand the extent of the flooding impacts, the 2-hour storm duration for the 5- and 100-year storm provided the largest peak flows for the basin and were analyzed per the City of Colorado Springs DCM for storm drain capacity and surface flooding. The 2-hour storm is designed to replicate the intense thunderstorms typical of the Colorado Springs area during the spring and summer months and is determined using the NOAA 14 1-hour point rainfall depths. These thunder storms typically last 2 hours and exhibit very intense rain during a small duration of the storm event.

While no single junction locations were selected to report out for results, 6 areas of concern and flooding locations were identified from the 1D and 2D models, see **Figure 4-1** for locations of problem areas in the watershed:

7' x 12' Culvert at North Cedar Street

Along the mainstem of the storm sewer network, a 9 [ft] x 14 [ft] Arch pipe acts as the primary conduit running from the confluence with Shooks Run up to Swope Avenue. Near its intersection with North Cedar Street, just south of East Platte Avenue, a section of the arch pipe was replaced in 1997 with a 7' x 12' Reinforced Concrete Box Culvert. Upon inspection of this culvert, concrete transitions were modeled to relieve the abrupt transitions between concert box culvert and corrugated steel arch better representing the hydraulic conditions in the pipe. Hydraulic modeling efforts showed that under the design storm (2HR-5YR) for existing conditions, the culvert transition cause a reduction in conveyance capacity and causing minor flooding around the area. This was dependent upon the existing flooding at the two upheaval sections, 400-700 feet upstream and further described below. If the upstream pipe upheavals remain unfixed, the flooding issues at the box are relieved because of lost flow upstream. If the upheavals are fixed flooding may become an issue around North Cedar Street.

Little Shooks Run Main Pipe Upheavals

There are two sections of the system where the invert of the Plate Arch culvert has heaved. The first section occurs underneath the alley between North Hancock Avenue and Willow Street and is approximately 42' in length. The second section occurs underneath the alley between North Sheridan Avenue and North Hancock Avenue and is approximately 52' in length.

Both upheavals have reduced the capacity of the storm drain and cause flooding upstream. To model the existing conditions, both sections of pipe were modeled to have lost 3 feet from the invert of the culvert, therefore, conduits for these two sections were modeled as a 6 [ft] x 14 [ft] Arch Pipe with a 3-foot inlet and outlet offset.

Due to the reduction in conveyance, two junctions upstream see flowrates of 575 cfs spilling out the underground storm drain system (approximately 10.0 [ac-ft] of volume is discharged to the surface during the 5-yr design storm). Flow later has a chance to reenter the system as flow is intercepted by inlets downstream of the blockage.

Boulder Park Flooding

At the intersection of East Boulder Street and North Foote Avenue, directly adjacent to Boulder Park and the Memorial Hospital, A small section of 42-inch reinforced concrete pipe, approximately 88 ft is undersized and causes flow that cannot be contained in the storm drain system to spill into Boulder Park. Upstream of the 42-inch storm drain the pipe increase in size to a 54-inch pipe, downstream of the 42-inch pipe is a 48-inch pipe. The undersized and miss matched infrastructure is causing the flooding problem although the storm drain system through Memorial Hospital and the Olympic Training Center have been recently improved. Approximately 0.13 [ac-ft] of water is discharged from the subsurface system where it flows into Boulder Park and subsequently ponds in the north-west corner of the park.

Flooding at East Bijou Street and North Logan Ave

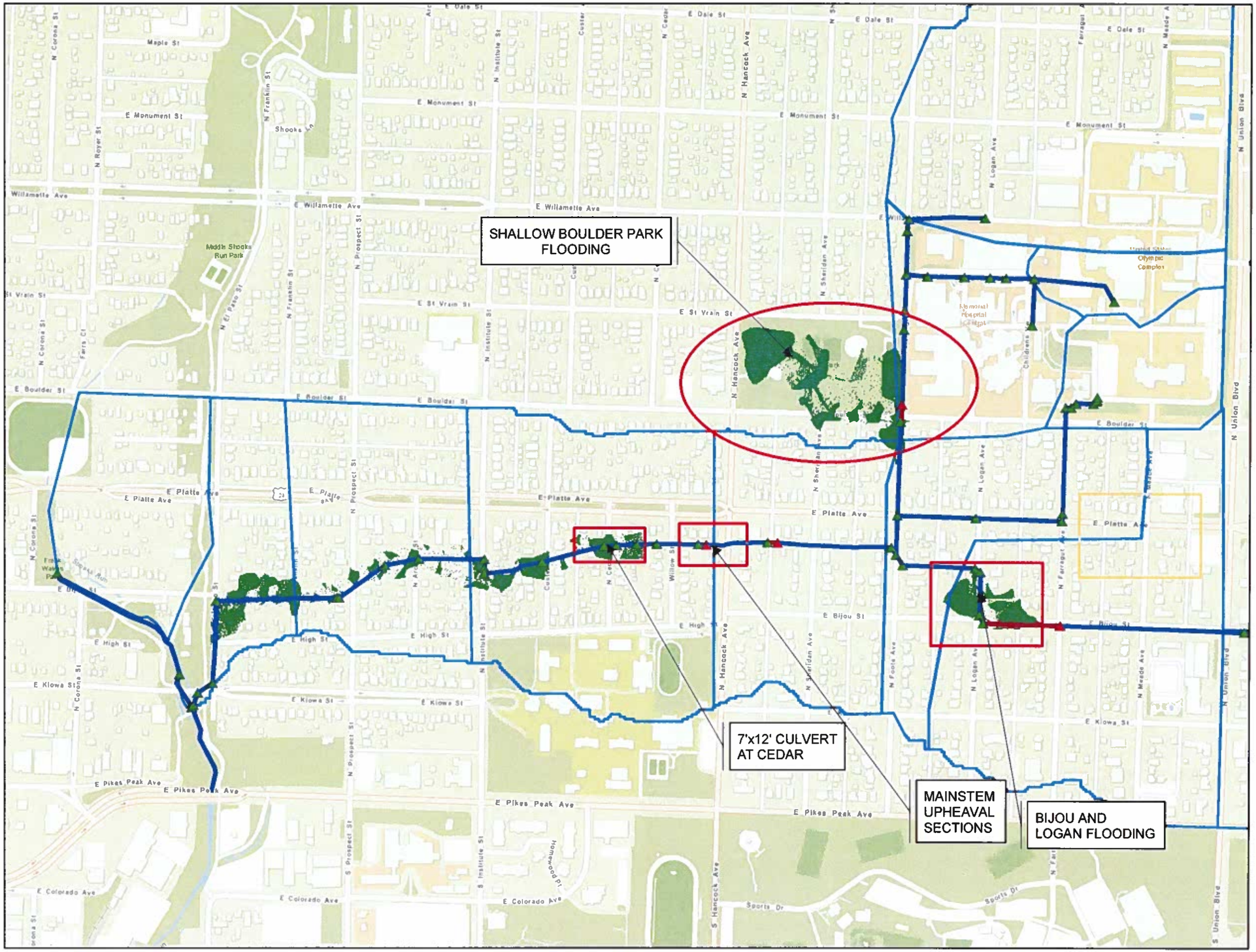
Reports of flooding near the intersection of East Bijou Street and North Logan Avenue have been reported and passed along to the team. A review of the results of the modeling in this area show that the dual 90-degree bends along the mainstem Little Shooks Run Storm Drain are contributing to the majority of the flooding at Farragut Avenue. The bends in the Mainstem storm drain cause friction and bend losses in the pipe system that reduce the capacity of the Little Shooks Run storm drain causing water to leave the underground storm drain system and flow along the roadways in the area. The flooding is compounded due to the localized slump reaching from North Logan Avenue to Farragut Avenue. Approximately 1 [ac-ft] of volume is discharged to the surface during the 5-year design storm.

Swope Avenue Culverts.

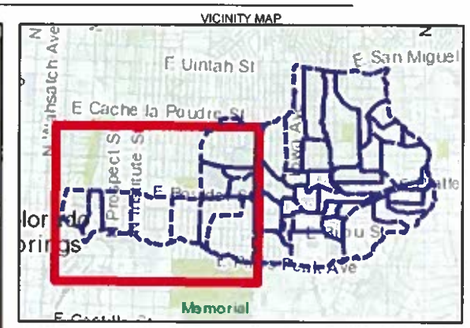
One of the more moderate flooding issue occurs along the twin 66" storm drains that make a series of 90-degree bends as they work their way from East Bijou Street and Swope Avenue up to their divergence at the intersection of East Willamette Avenue and Alexander Road. Modeling shows that due to the lack of capacity in the twin lines and the sequential bends, cause multiple flooding points to occur. The topography in the vicinity helps direct overland flow along the storm drain alignment, allowing inlets downstream to intercept flow where the subsurface system has capacity. Approximately 1.2 [ac-ft] of water is discharged from the subsurface system during the design storm.

Flooding at East Boulder Street and North Pitkin Avenue.

Multiple accounts of flooding over the past few years have been reported to the City. Upon detailed investigation of the hydraulics of this area, the subsurface drainage system is not adequate to effectively covey flow from this area. The existing infrastructure consists of an 18" RCP with a very mild slope. The lack of subsurface conveyance capacity and the localized depression cause a circular flow path and prolonged flooding, see Figure 4-2 for a description of flooding occurs in the area. Approximately 0.87 [ac-ft] of water is ultimately ponded on the surface until the subsurface drainage system can drain the area. See + for the drainage patterns around Boulder Street and Pitkin Street.



VICINITY MAP



LEGEND

- JUNCTION
- FLOODING JUNCTIONS

Conduits

- <92% FULL
- FLOODING
- Little Shooks Run Sub-Basins

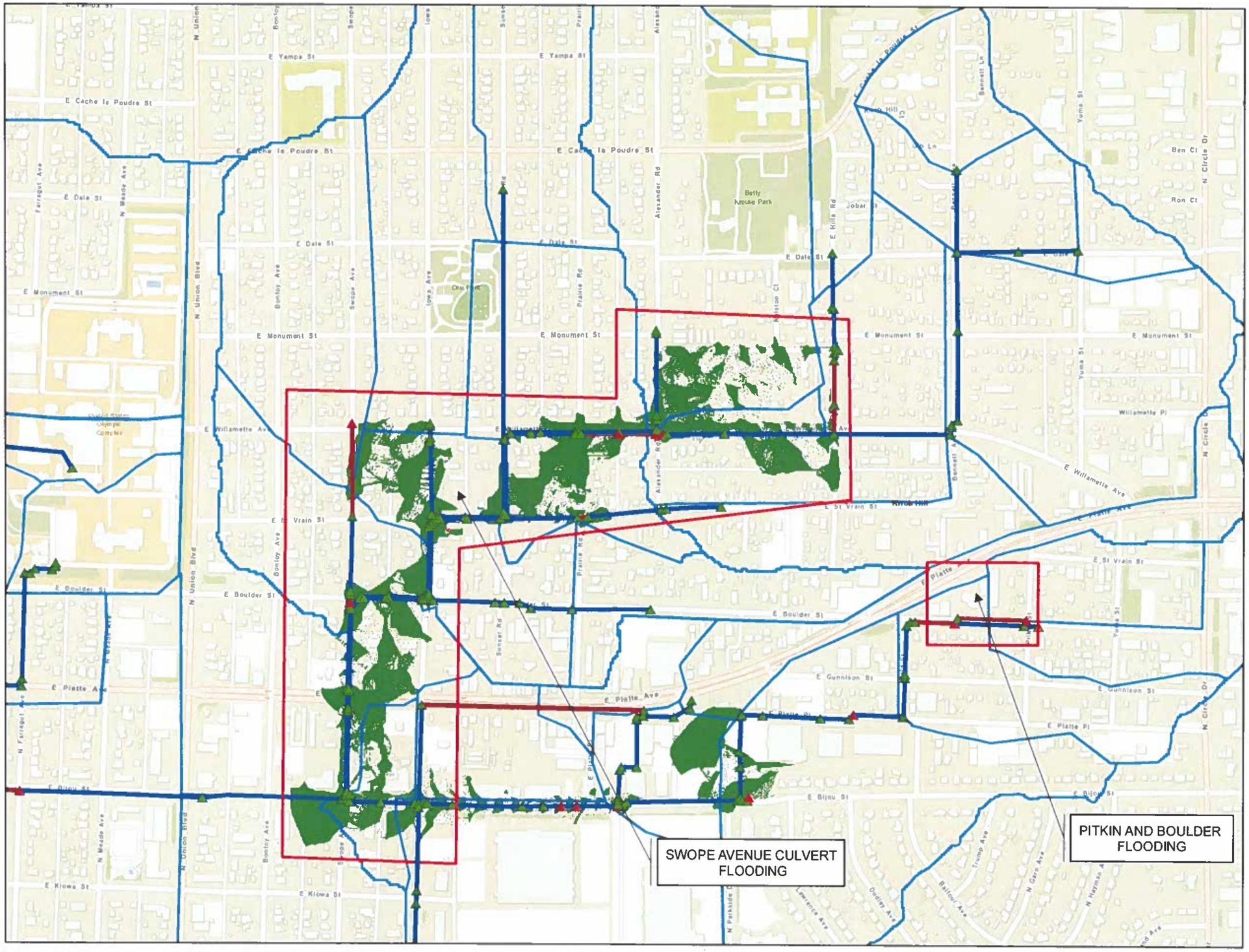
FLOODING DEPTH

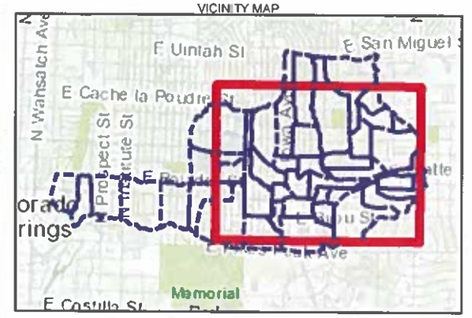
- <0.5 [ft]
- 0.5-1.00 [ft]
- 1.00-2.00 [ft]
- >2.00 [ft]

N

0 500 1,000 Feet

FIGURE 4-1
EXISTING CONDITIONS PROBLEM AREAS
LITTLE SHOOKS RUN OSP
2HR-5YR DESIGN STORM





LEGEND

- JUNCTION
- FLOODING JUNCTIONS

Conduits

- <92% FULL
- FLOODING
- Little Shooks Run Sub-Basins

FLOODING DEPTH

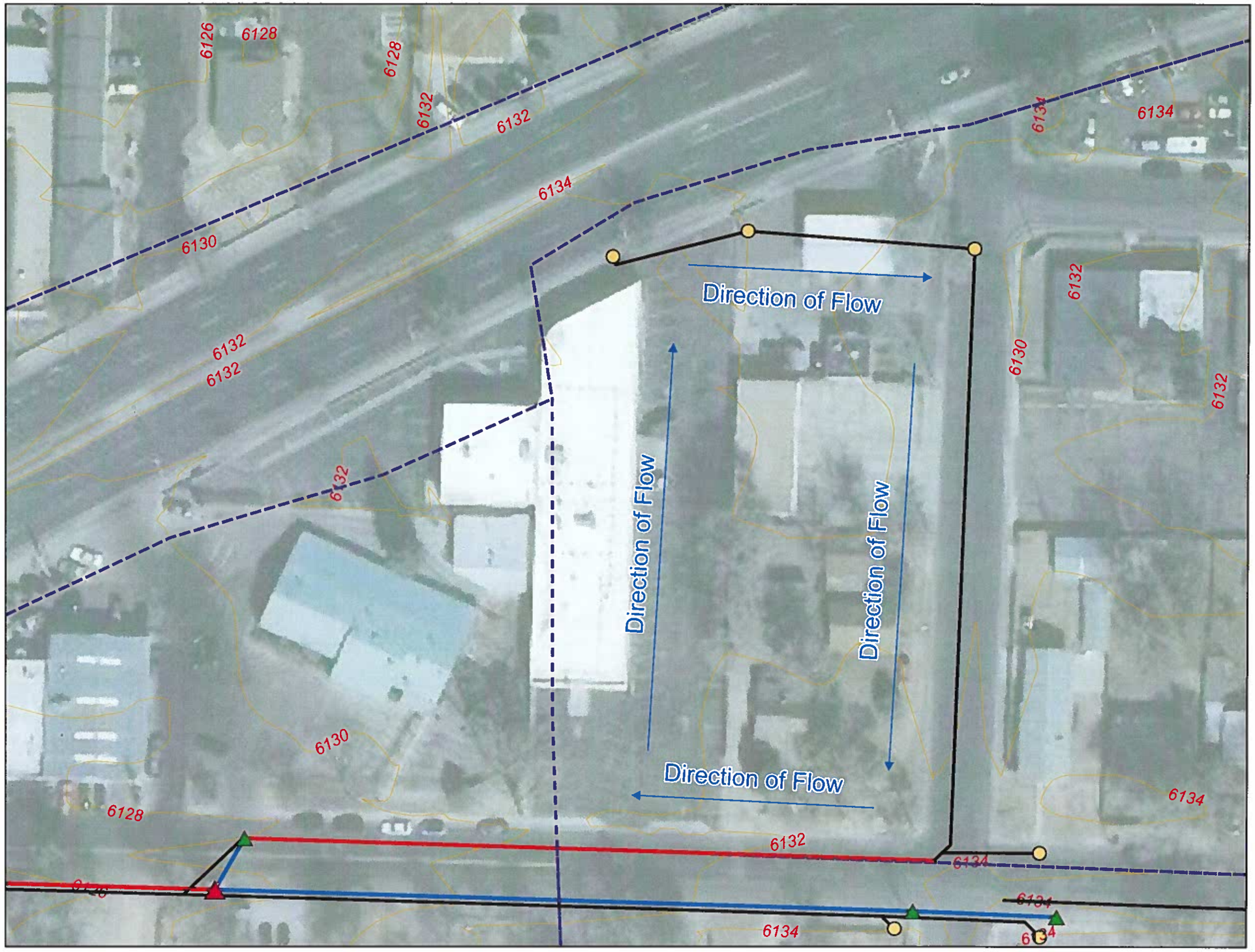
- <0.5 [ft]
- 0.5-1.00 [ft]
- 1.00-2.00 [ft]
- >2.00 [ft]

N

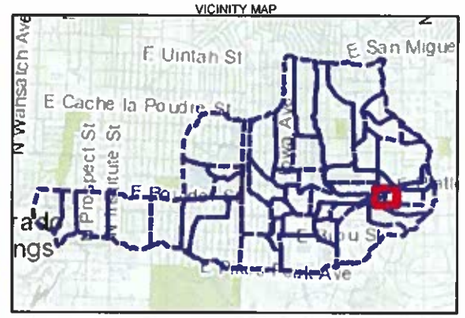
0 500 1,000 Feet

FIGURE 4-1
EXISTING CONDITIONS
PROBLEM AREAS
LITTLE SHOOKS RUN OSP
2HR-5YR DESIGN STORM

ch2m



VICINITY MAP



L E G E N D

Junctions
- Visible
- Flooded

Conduits
- Visible
- Flooded
- Subcatchments
- Outfall
- Inlets
- Pipe Network
- Contours

N

FIGURE 4-2
BOULDER ST. FLOODING
LITTLE SHOOKS RUN OSP
2HR-05YR DESIGN STORM

ch2m

Little Shooks Run Outfall Pipe Conditions Assessment

Conditions Assessment Introduction

As part of the alternatives analysis for the Little Shooks Run Basin, the 9-foot by 14-foot corrugated metal out fall pipe was inspected and the conditional of the pipe was analyzed to determine if the existing pipe had suffered corrosion or was still within specification for strength and thickness. This was completed for two reasons.

1. To determine if the pipe in the areas of the two structural heaves would have sufficient structural strength to be rehabilitated;
2. To determine the potential remaining life span and structural integrity of the visibly corroded section of pipe under Institute Avenue.

Alan Turner and Craig VanHorn performed an inspection the Little Shooks Run 9-foot by 14-foot culvert on the morning of October 10, 2017. The scope of the inspection included visual inspection of the culvert and ultrasonic thickness measurements of two sections of culvert that has heaved. In addition, ultrasonic thickness measurements and visual inspection of a corroded section of the culvert under North Institute Street was performed. Over 140 ultrasonic thickness measurements were obtained during the inspection.

Approach

The ultrasonic thickness measurements were obtained at clocked positions above the spring line of the culvert, approximately six inches above the concrete floor, and at approximately ten feet intervals along the length of the culvert extending beyond the heaved or corroded sections by at least ten feet. This approach will map out an area of a pipe/culvert to identify any trends or anomalies in the culvert.

Observations

Heaved Sections

The ultrasonic thickness measurements did not reveal any trend or anomaly in the culvert wall thickness. All thickness measurements in the heaved sections were within the error of the specified thickness of the plate with the exception of a few outlier points that indicate localized corrosion spots that would not affect the overall integrity of the pipe or errant measurements that could be ignored.

Visual inspection revealed that there was some buckling of the culvert at the bottom radius approximately three inches above the concrete floor, see Figure 5-1 below. In addition to the buckling, there were some areas near the bottom of the culvert that had localized through wall corrosion, see figure 5-2 below.

Corroded Section Under North Institution Street

Through wall corrosion is apparent throughout the section of pipe that is beneath North Institute Street. Based on the corrosion patterns the corrosion on the inside of the pipe, the corrosion appears to have initiated on the external surfaces. Once through wall corrosion had been obtained, then corrosive constituents from the external surfaces caused corrosion to occur on the interior surfaces. The exact cause of corrosion on the exterior surfaces cannot be determined without further investigation. However, crystals have formed where there is through wall corrosion which would suggest that road salts, e.g. magnesium chloride, could be present in the soils. It was also observed that a sewer line with manhole runs adjacent to the culvert, on the side which has more corrosion. There may be a correlation with the location of the manhole from the sewer line and the corrosion of the culvert but a more extensive investigation would be required to confirm.

The ultrasonic thickness measurements suggest that the pipe is heavily corroded in some areas. Ultrasonic thickness measurements obtained adjacent to areas that had through wall corrosion suggests that the corrosion is occurring on a broader scale that what can be observed from inside the pipe.

Conclusions and Recommendations

Heaved Sections

The heaved sections of the culvert did not show any significant deterioration or corrosion on the external surfaces (soil side). These sections of culvert, above the spring line, do not need any type of rehabilitation during the repairs of the heaved bottom.

Corroded Section Under Institution

This section of culvert has significant corrosion relative to the rest of the culvert. It is recommended to replace this section of culvert within the next 5 years or sooner to avoid catastrophic failure. An investigation should be completed to determine the cause of corrosion so the source of corrosion can be mitigated properly for the installation of the new culvert.

Tabulated Ultrasonic Thickness Data

Location:	Heave Section of Little Shooks Run Pipe West of Hancock Street
Measurements Taken By	Craig VanHorn, Alan Turner
Date	10/16/2017
Measurement Notes:	Measurements were taken from Upstream to Downstream (East to West)
Pipe Thickness Specification	.1084" for 12 Gauge Galvanized Corrugated steel
Maximum Thickness Tolerance	.1174" for 12 Gauge Galvanized Corrugated steel
Minimum Thickness Tolerance	.0994" for 12 Gauge Galvanized Corrugated steel

Measurement Location around Circumference of Pipe	Measurement Locations Along Flowline of pipe					
	10' Upstream of Heave (inches)	At Start of Heave (inches)	Middle of Heave (inches)	At End of Heave (inches)	10' Downstream of end of Heave (inches)	20' Downstream of End of Heave (inches)
7:00	.117/.128	0.126	0.117	0.087	0.109	0.115
9:00 (Spring Line of Pipe)	0.105	0.109	0.113	0.104	0.116	0.118
10:30	0.113	0.110	0.115	0.117	0.117	0.119
12:00	0.118	0.113	0.113	0.115	0.117	0.118
1:30	0.111	0.113	0.115	.124?	0.118	0.114
3:00 (Spring line of Pipe)	0.108	0.107	0.105	0.114	0.117	0.111
5:00	0.119	0.118	0.119	0.107	0.118	.126/.119

Notes

1. Bottom of east side of heave has a thickness of 0.0108"
2. Bottom of east side of heave has a thickness of 0.091", 0.100", 0.109", 0.103"
3. 9' DS of the heave on the north side some buckling has occurred at corner radius of pipe. Buckling seen through heave section as well.

Location:	Heave Section of Little Shooks Run Pipe Under Hancock Street
Measurements Taken By	Craig VanHorn, Alan Turner
Date	10/16/2017
Measurement Notes:	Measurements were taken from Upstream to Downstream (East to West)
Pipe Thickness Specification	.1084" for 12 Gauge Galvanized Corrugated steel
Maximum Thickness Tolerance	.1174" for 12 Gauge Galvanized Corrugated steel
Minimum Thickness Tolerance	.0994" for 12 Gauge Galvanized Corrugated steel

Measurement Location around Circumference of Pipe	Measurement Locations Along Flowline of pipe						
	10' Upstream of E. Hancock Inlets (inches)	Start of Bulge (inches)	US of Sanitary Crossing (inches)	DS of Sanitary Crossing (inches)	US of W. Hancock Inlet (inches)	Middle of Small Bulge (inches)	10' DS of Heave (inches)
7:00	0.117	0.114	0.096	0.119	0.119	0.119	0.111
9:00 (Spring Line of Pipe)	0.117	0.113	0.104	0.106	0.117	0.105	0.118
10:30	0.117	0.112	0.119	0.118	0.120	0.113	.123?
11:00	0.119	0.117	0.117	0.112	.118/.096? (pit)	0.117	0.120
1:00	.120?	0.115	0.118	0.119	0.117	0.114	.122/.124
1:30	0.117	0.115	0.118	0.118	0.118	0.116	0.124
3:00 (Spring line of Pipe)	0.117	0.100	0.109	0.108	0.118	0.113	0.118
5:00	0.116	0.108	0.098	0.118	0.111	0.116	0.113

Location:	Corroded Pipe Under Institute
Measurements Taken By	Craig VanHorn, Alan Turner
Date	10/16/2017
Measurement Notes:	Measurements were taken from Upstream to Downstream (East to West)
Pipe Thickness Specification	.1084" for 12 Gauge Galvanized Corrugated steel
Maximum Thickness Tolerance	.1174" for 12 Gauge Galvanized Corrugated steel
Minimum Thickness Tolerance	.0994" for 12 Gauge Galvanized Corrugated steel

Measurement Location around Circumference of Pipe	Measurement Locations Along Flowline of pipe					
	10' Upstream of E. Institute Inlets (inches)	DS Side of E. Institute Inlets* (inches)	Mid of Corroded Area (inches)	US Side of W. Institute Inlets (inches)	10' DS of Corroded Area (inches)	20' DS of Corroded Area (inches)
7:00	.112/.063 (Visual Corrosion)	.119/.088	0.107	0.115	0.087	0.114/.098
9:00 (Spring Line of Pipe)	0.104	0.104	0.076	0.106	0.107	Not tested
10:30	0.111	0.102	0.104	0.110	.110/.107	Not tested
11:00	0.115	0.102	0.102	0.110	0.117	Not tested
1:00	0.094	0.106	0.081	0.100	0.114	Not tested
1:30	0.093	.100/.098	0.107	0.103	0.112	Not tested
3:00 (Spring line of Pipe)	0.105	0.098	0.112	0.109	0.115	Not tested
5:00	0.118	US .084/@.061/DS .111	0.109	0.103	.112/.112	Not tested

Notes:

* Measurements taken adjacent to rusted rib located under the approximate separation of concrete curb/road asphalt interface.

Thickness near spring line under NE inlets some buckling evident see picture below.

Thickness at rust spots is generally through wall but some measure 0.055" to 0.081"

Approximately half of plates are exhibiting rust on the north side of the pipe. A quarter of plates on the south side are showing corrosion.

Overall areas that are corroded have lost about 1/3 of the thickness of the pipe.

It appears about 1/4 of the pipe has some sort of through wall corrosion.

Salts are evident upstream and downstream of the site through all bolt holes.

Selected Inspection Photographs

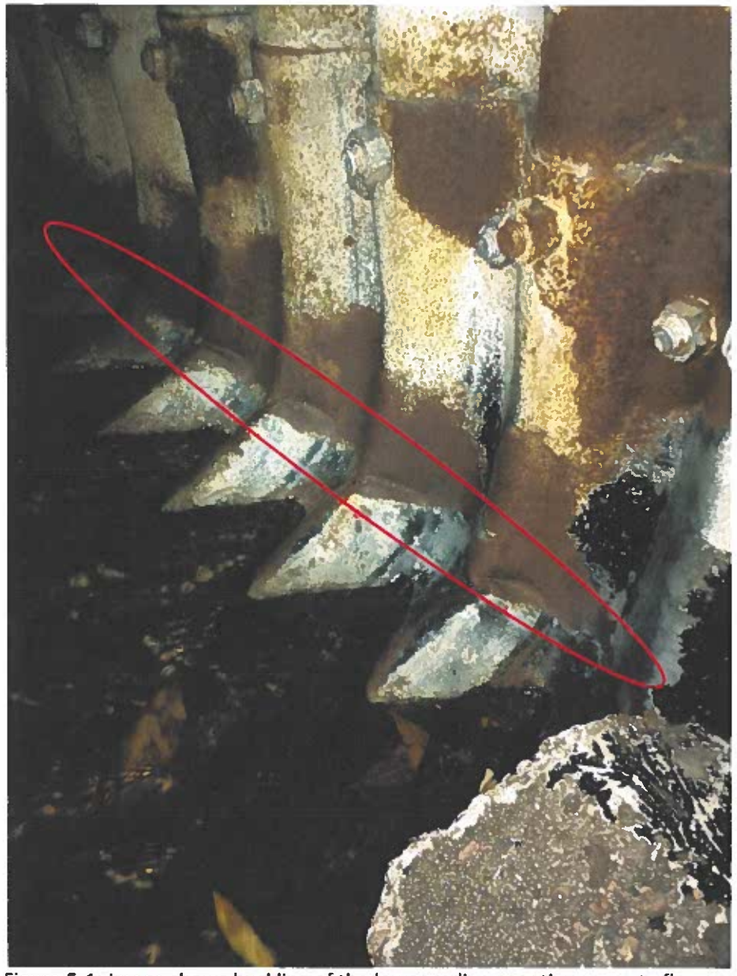


Figure 5-1: Image shows buckling of the lower radius near the concrete floor.

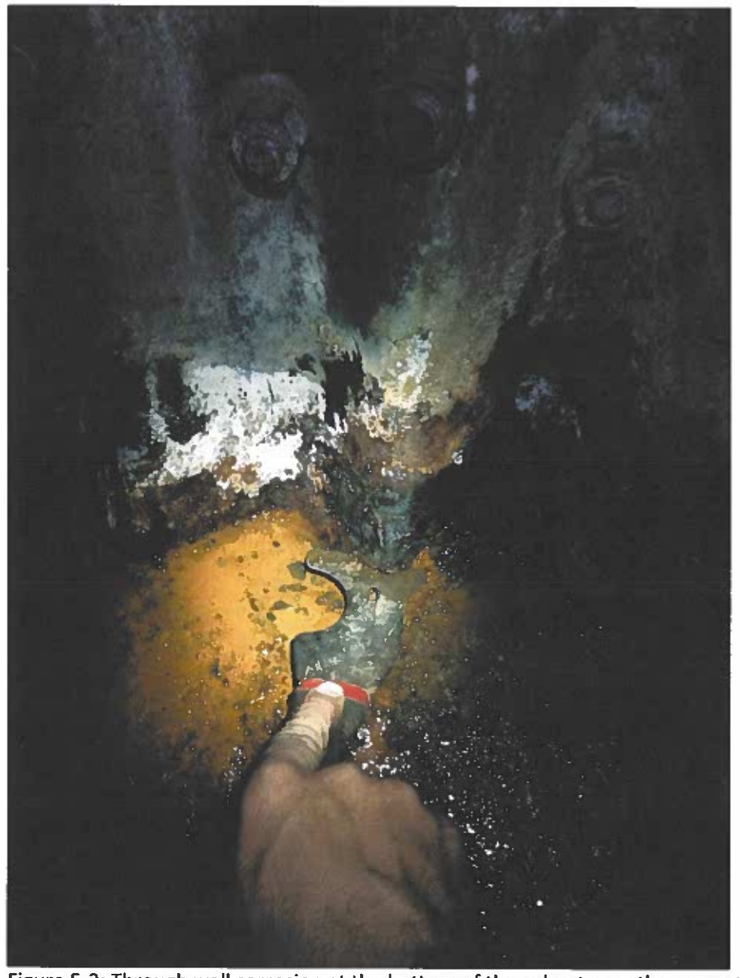


Figure 5-2: Through wall corrosion at the bottom of the culvert near the concrete floor.

PAGE INTENTIONALLY LEFT BLANK

Alternatives Evaluation

Overview

After brief discussions with the City of Colorado Springs, key improvements were identified and selected for further alternatives analysis. Critical improvements encompass repairs to the upheaval sections of the mainstem; consider viable storage options and drainage improvement options to relieve flooding concerns at Pitkin and Boulder Street; and identify locations where additional inlets are needed throughout the basin.

Project Prioritization

Due to the limited funding available to the City, proposed alternatives were prioritized based on the needs of the system and the flooding severity. Ranked results are shown in the list below in order from highest to lowest priority.

1. Mainstem Pipe Upheavals Sites – approximately 10 [ac-ft] of runoff escapes the subsurface system during the existing conditions
2. Additional Inlets along Mainstem – Additional Inlets placed throughout the watershed greatly reduce flooding by allowing storm runoff to reenter the subsurface system
3. Flooding concerns at East Boulder Street and North Pitkin Avenue – While this problem area does not contribute the greatest degree of flooding, it does experience a sustained ponding condition severely impacting local residents and businesses
4. Swope Avenue Storm Drains – Approximately 1.2 [ac-ft] of runoff escapes the subsurface system during the existing conditions and does not have a chance to reenter the subsurface system until the overland flow paths intersect with the mainstem
5. 7' x 12' Reinforced Concrete Box Culvert at North Cedar Street – After improvements have fixed the Mainstem upheavals, this section of pipe begins to constrict flow and limit capacity.

Proposed Alternatives

Heaved Sections

Two Upheavals Site: One between Willow Street and Hancock Ave and one between North Hancock Avenue and North Sheridan Avenue. A full suite of alternatives was considered for the damaged sections of the outfall pipe. The alternatives reviewed for the heaved section of the pipe were handled in two phases.

1. Phase 1 look at a suite of options for the replacement or repair of the culvert
2. Once an alternative was selected a structural assessment was made to understand if the selected alternative would be appropriate for the repair for the heaved sections.

Table 6-1 below, includes a list of all the alternatives reviewed, including cost, for Phase 1.

Table 6-1
Alternatives Analyzed

Alternative	Description	Approximate Cost
Open Cut Replacement	Remove existing damaged pipe and replace with Concrete Reinforced Box Culvert	$809,000
Fiber Reinforced Geopolymer	Remove the damaged section of the floor and replace with reinforced concrete. Add reinforced gepolymer for additional structural integrity.	$534,000
Replace Concrete Floor	Remove damage section of the CMP and replace the floor with reinforced concrete.	$348,000

A memorandum was prepared for the City on the various alternatives, the pros and cons and approximate costs. It was decided to repair the damage in place by removing and rehabilitating the bottom of the 9-foot x 14-foot CMP. For a more detailed description of the alternatives analysis please see **Appendix B** for the memorandum submitted to the City entitled *Alternatives for the repair of the Little Shooks Run 9' x 14' Plate Arch Storm Sewer System* delivered to the City on June 26, 2017.

Additional Inlets

Additional Inlets placed throughout the watershed reduce flooding by allowing storm runoff to reenter the subsurface system. This provides the most cost-effective way of utilizing existing infrastructure to its greatest potential. As part of the alternatives analysis for the basin, the coupled 1-D and 2-D model was utilized to identify areas where water was ponding throughout the Little Shooks Run Basin. These areas were reviewed to understand if the area had sufficient storm drain capacity to accept additional flow if additional inlets were added to reduce the surface flooding. Through this analysis, several areas were identified where surface flooding could be relieved by the addition of inlets. These areas had excess storm drain capacity and were sump areas that show water collection ion the modeling that is support by information from the surrounding community. Additional areas where inlets would be most effective are as follows:

1. Downstream of the 7-foot x 12-foot culvert, 3-4 sets of inlets along the mainstem would help get flow back into the subsurface drainage system. Ideally, one set would be located between N Institute St and N Cedar St. The other two or three would be located between N. Arcadia St and N. El Paso St.
2. One to two groupings of inlets along the mainstem near N. Logan Ave will drastically improve ponding conditions caused by the sequential ninety-degree bends in the mainstem.
3. Two groupings of inlets between Swope Avenue and North Meade Ave would aid the existing infrastructure in getting overland flow from the Swope Avenue culverts into the main stem.
4. One grouping of inlets between Iowa Avenue and E. Platte Place will capture flow coming from the west and spilling near E. Platte Place.
5. Flooding at East Bijou Street and North Logan Ave. - Due to the flooding at Farragut Avenue, approximately 1 [ac-ft] of water is discharged onto the surface and subsequently ponds near Logan Avenue causing additional damage to adjacent properties. In an attempt to decrease the ponding depth in this area, the City has installed six additional inlets between North Logan and Farragut Avenue. While these increases aid in the capture of flow back into the subsurface system, additional inlets between Logan and Foote are recommended.

Appendix B includes information from the City on additional inlets added to the Shooks Run Basin

Flooding at East Boulder Street and North Pitkin Avenue.

Flooding has been identified by the City and surrounding community near Pitkin Street and East Boulder Street. This became a priority for the City to review and propose alternatives to attempt to minimize or reduce the frequency of flooding in the Area. A review of the hydraulics at the project site show a complex drainage problem. A review of the existing conditions modeling supplemented by field reconnaissance quickly reveals the existing storm drain consists of undersized infrastructure that is draining a 34 [ac] sub-basin with 66% imperviousness. During the design storm (2HR-5YR), the watershed generates a peak flow rate of 57 cfs. The existing infrastructure (18" RCP) can only handles 16 cfs, leaving 41 cfs on the street where approximately 0.87 [ac-ft] of water ponds, causing damage to the adjacent properties. As proposed alternatives, increasing the undersized infrastructure as well as adding an underground storage facility to capture excess flows were investigated. Underground storage under the Springs Palace Event Center parking lot, underground storage near the intersection of Pitkin and Boulder was considered and analyzed as a viable alternative. To relieve the flooding to the adjacent properties, a 0.9 [ac-ft] underground detention facility was examined and designed to understand the cost and constructability of the detention facility.

Beyond adding detention to the area, which is in a natural sump (See Figure 4-2 for the existing conditions hydraulics), the project team examined the potential for adding additional pipe capacity in the streets and providing additional storm storage capacity on the street surface through the modification of the street crown, increase height of the curbs and improved inlet capacity.

Ultimately, the expense of constructing and underground storage system that would contain the 5-year flow but not mitigate larger storms was determined to be unfeasible. Instead, additional inlet capacity was added to Pitkin Street as well as increased gutter capacity, improved storm drain grates and improved drainage to existing infrastructure through the addition of concrete cross pans and modification of the road crown were completed to help alleviate but not eliminate 5-year storm flows.

Appendix B includes information on the underground detention systems and potential costs for the Boulder and Pitkin Improvements.

Swope Avenue Storm Drain

One of the more moderate flooding issues within the Little Shooks Rub basin are the twin 66" storm drains that make a series of ninety-degree bends as they work their way from East Bijou Street and Swope Avenue up to their divergence at the intersection of East Willamette Avenue and Alexander Road. Approximately 1.2 [ac-ft] of water is discharged from the subsurface system during the design storm.

Due to shear flooding severity as a result of undersized infrastructure and poor alignment, upsizing any single portion of the lines do little to improve the flooding hazards. Capturing flow as it works its way downstream does however limit the extent of damage. See Section 6.3.2 for additional Inlet locations to limit flooding hazards.

7' x 12' RCBC at North Cedar Street

Modeling efforts during the existing conditions analysis showed that under the design storm (2HR-5YR), the Culverts do not cause a reduction in conveyance capacity. This was largely depended upon flooding at the two upheaval sections, 400-700 feet upstream which were limiting the flow that could get to this section of pipe in the existing conditions model.

Under the proposed conditions, when the two upheaval sections of pipe are fixed and the upstream and capacity is restored, this section of pipe begins to limit the flow rate downstream allowing flow to escape to the surface. In its present form, the change in conveyance from the existing Arch to the concrete box and back to the Arch causes an expansion and contraction of flow, reducing the culverts efficiency. Storms greater than the 2HR-5YR event will begin to cause minor surface discharges which will continue along the pipe until intercepted by downstream inlet banks. Additional inlet capacity downstream of the culverts, as described in 6.3.2 could help to collect water that escapes the pipe in the downstream direction without additional need for storm drain improvements.

Selected Plan and Conceptual Design

Overview

Of the problem areas prioritized by the City. Three locations were moved forward for conceptual design. This included:

1. Mainstem Pipe Upheavals Sites – approximately 10 [ac-ft] of runoff escapes the subsurface system during the existing conditions
2. Additional Inlets along Mainstem – Additional Inlets placed throughout the watershed greatly reduce flooding by allowing storm runoff to reenter the subsurface system
3. Flooding concerns at East Boulder Street and North Pitkin Avenue – While this problem area does not contribute the greatest degree of flooding, it does experience a sustained ponding condition severely impacting local residents and businesses

Of the three projects moved forward for conceptual design, the mainstem upheavals and the flooding concerns at East Boulder Street and North Pitkin Avenue were taken to 30% design drawings which in turn were constructed by the City. The upheaval section of the Little Shooks Run Pipe began construction in March of 2018 with a projected completion date of May 2018. The construction of the Boulder and Pitkin improvements began in September of 2017 and were completed in November of 2017.

The City chose to take the recommendations for inlet placement for the basin and contract directly with an on-call construction company with the City to install the inlets throughout the basin. Additional information is provided below for the Boulder and Pitkin flood improvement projects and the Little Shooks Run Outfall Pipe Rehabilitation.

Boulder Street and Pitkin Avenue

Through the alternative selection process, it was determined that flooding issues around Boulder and Pitkin would be addressed through the improvement of the street conveyance and providing additional inlet capacity and increasing the height of the gutters to help alleviate street flooding and to reconfigure the street crown to help water drain to existing infrastructure. These improvements will help to provide additional conveyance and storage for the 5-year minor storm but will not provide substantial improvements for the major flood which will continue to inundate the surrounding area before it can drain. The conceptual design drawings and engineers cost estimate can be found in **Appendix C.**

Little Shooks Run 9-ft x 14-ft Rehabilitation Project

Through the alternative selection process, it was decided that a rehabilitation of the heaved sections of the 9-foot x 14-foot instead of replacing the culvert. The rehabilitation will include removing the bottom damaged heaved section of the 9-foot x 14-foot CMP. This will be accomplished within the pipe which will be braced from the inside. The bottom will be replaced with reinforced concrete, with the invert of the pipe matching the exiting upstream and downstream inverts. The conceptual design drawings and engineers cost estimate can be found in **Appendix C**.

PAGE INTENTIONALLY LEFT BLANK

References

City of Colorado Springs. 2014. *Drainage Criteria Manual*.

Computational Hydraulics International (CHI). (2011, January). *PCSWMM Version 2011*. Ontario, Canada: Computational Hydraulics International (CHI).

Conrad Land Survey Co. March 1973. *Drainage Report for Dyer Subdivision.*

Denver Engineering Corporation. October 1972. *Madison/Wahsatch Drainage Improvements Final Drainage Study.*

Donell Jeffries. September 1983. *Drainage Study of Country Club Place.*

Drexel-Barrell. June 1990. *Master Drainage Development Plan for the Houck Estate at Union Boulevard and Fillmore Street, Colorado Springs, Colorado.*

El Paso County. 2008. *All-Hazards Pre-Disaster Mitigation Plan.*

HJ Kraettli and Sons. September 1978. *Drainage Plan for Country Club Acres.*

JR Engineering Ltd. October 1988. *Lower Cragmor Master Drainage Plan.*

Karcich and Weber, Inc. April 1971. *Drainage Plan for Highland Acres Subdivision.*

Karcich and Weber, Inc. April 1972. *Palmer Park Area Master Drainage Report.*

Leigh Whitehead and Associates. February 1988. *Drainage Report & Plan East Pikes Peak Avenue Subdivision.*

Peak Engineering Co. April 1973. *Ocho Caballos Subdivision No. 1 Drainage Report.*

Pikes Peak Regional Building Department. Website. *Significant Flood Events in the Pikes Peak Region throughout the Past Century.*

National Oceanic and Atmospheric Administration (NOAA). 1973. *Precipitation Frequency Atlas of the Western United States, Volume III – Colorado*. NOAA Atlas 2, Silver Springs, MD.

National Oceanic and Atmospheric Administration (NOAA). 2013. "NOAA Atlas 14 Precipitation-Frequency Atlas of the United States, Volume 8, Version 2.0: Midwestern States."

Trico Colorado. May 1977. *Drainage Report for Country Club Park Subdivision.*

Urban Drainage and Flood Control District. (2013). Urban Storm Drainage Criteria Manual Volume 1, 2, &3. Denver, CO: Urban Drainage and Flood Control District.

U.S. Army Corps of Engineers (USACE). 2010a. *Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) User's Manual*, Version 3.5. Davis, CA. August.

U.S. Environmental Protection Agency. (2011, April). *EPA Storm Water Management Model (SWMM) Version 5.0.022*. Washington DC, District of Columbia, USA: U.S. Environmental Protection Agency.

U.S. Department of Interior. 1948. *Floods in Colorado*.

William P. Weber and Associates. August 1980. *Printers Park Master Drainage Report.*

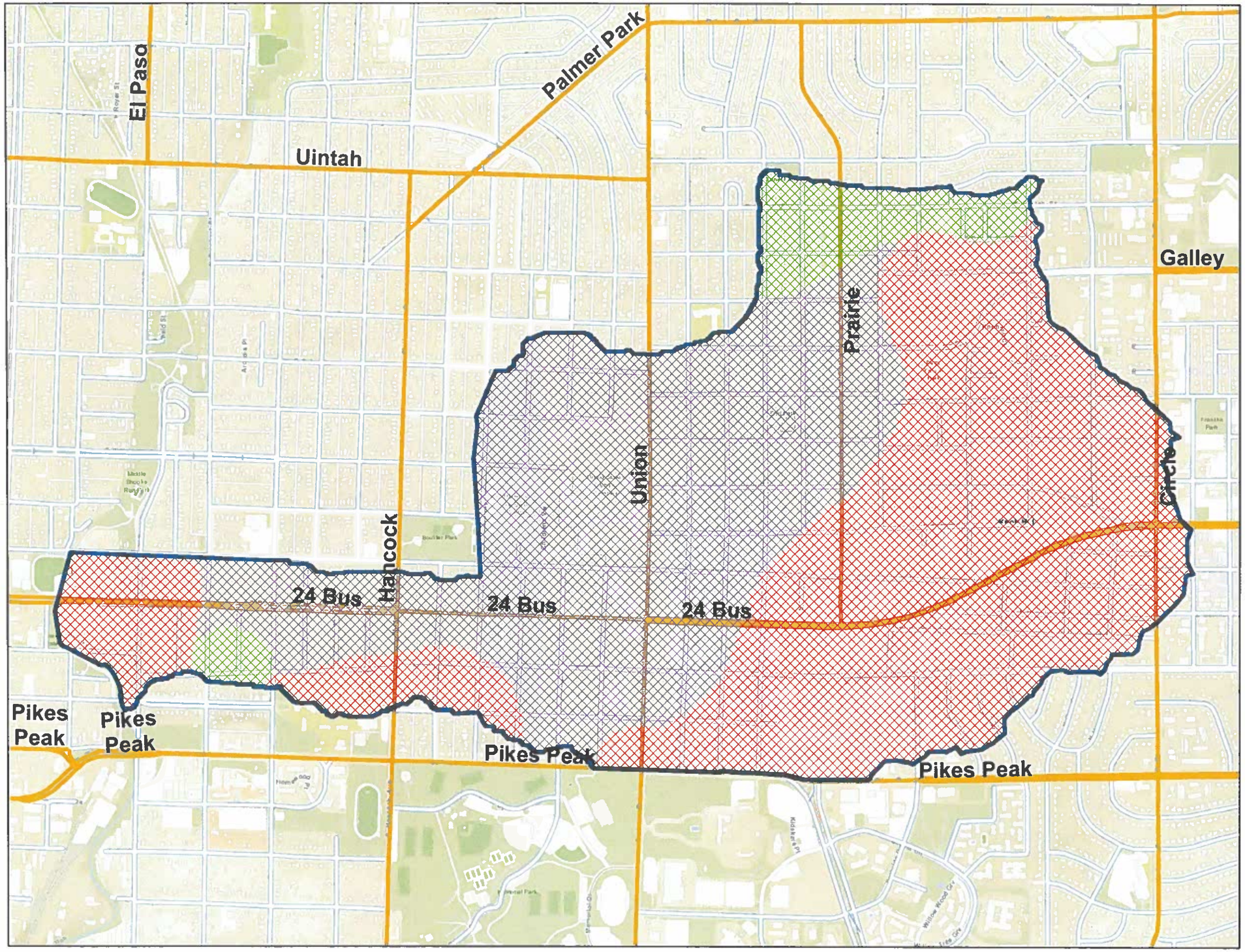
William P. Weber and Associates. October 1980. *Drainage Report for Shooks Run Industrial Park Subdivision.*

Wilson and Company. 1993. *Drainage Basin Planning Study, Shooks Run*.

PAGE INTENTIONALLY LEFT BLANK

Appendix A
Hydrologic and Hydraulic Analysis

PAGE INTENTIONALLY LEFT BLANK



LEGEND

Little Shooks Run Watershed

HYDSG

- A
- B
- C
- D
- Water

N

0 2,000 Feet

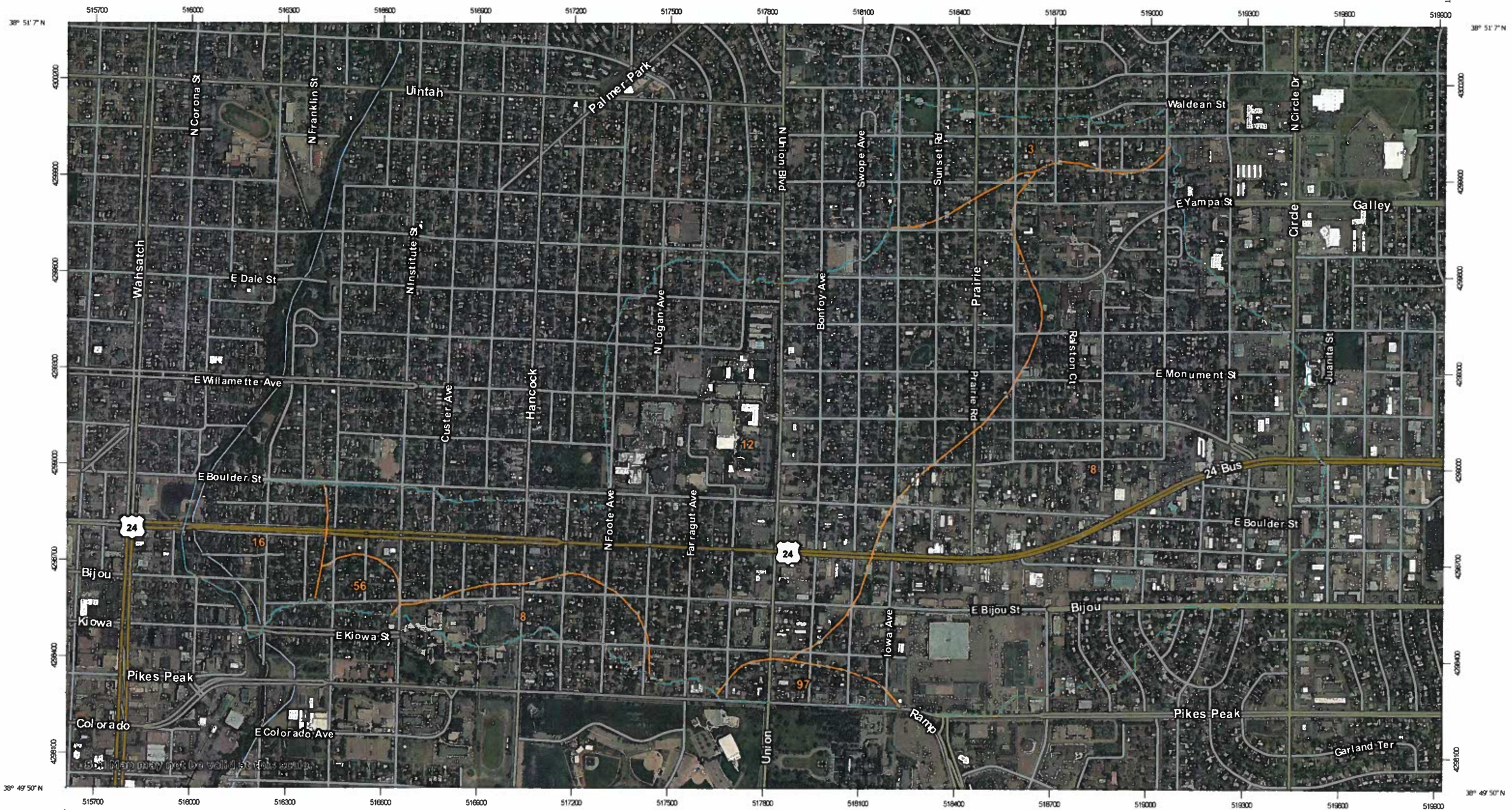
Figure A-1
Little Shooks Run Soils Map
Little Shooks Run Outfall Systems Plan

May, 2018

CH2MHILL

C:\USERS\ATURNER2\DESKTOP\LITTLE SHOOKS RUN\FINAL_DELIVERABLE\GIS\FIGURE_A-1_SOILS_MAP.MXD ATURNER2 5/14/2018 4:38:31 PM

Soil Map—El Paso County Area, Colorado
(Little Shooks Run Soils Data)



Map Scale: 1:11,600 if printed on B landscape (17" x 11") sheet.

N

Meters: 0 150 300 600 900

Feet: 0 500 1000 2000 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

Natural Resources Conservation Service

Web Soil Survey
National Cooperative Soil Survey

5/14/2018

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 15, Oct 10, 2017

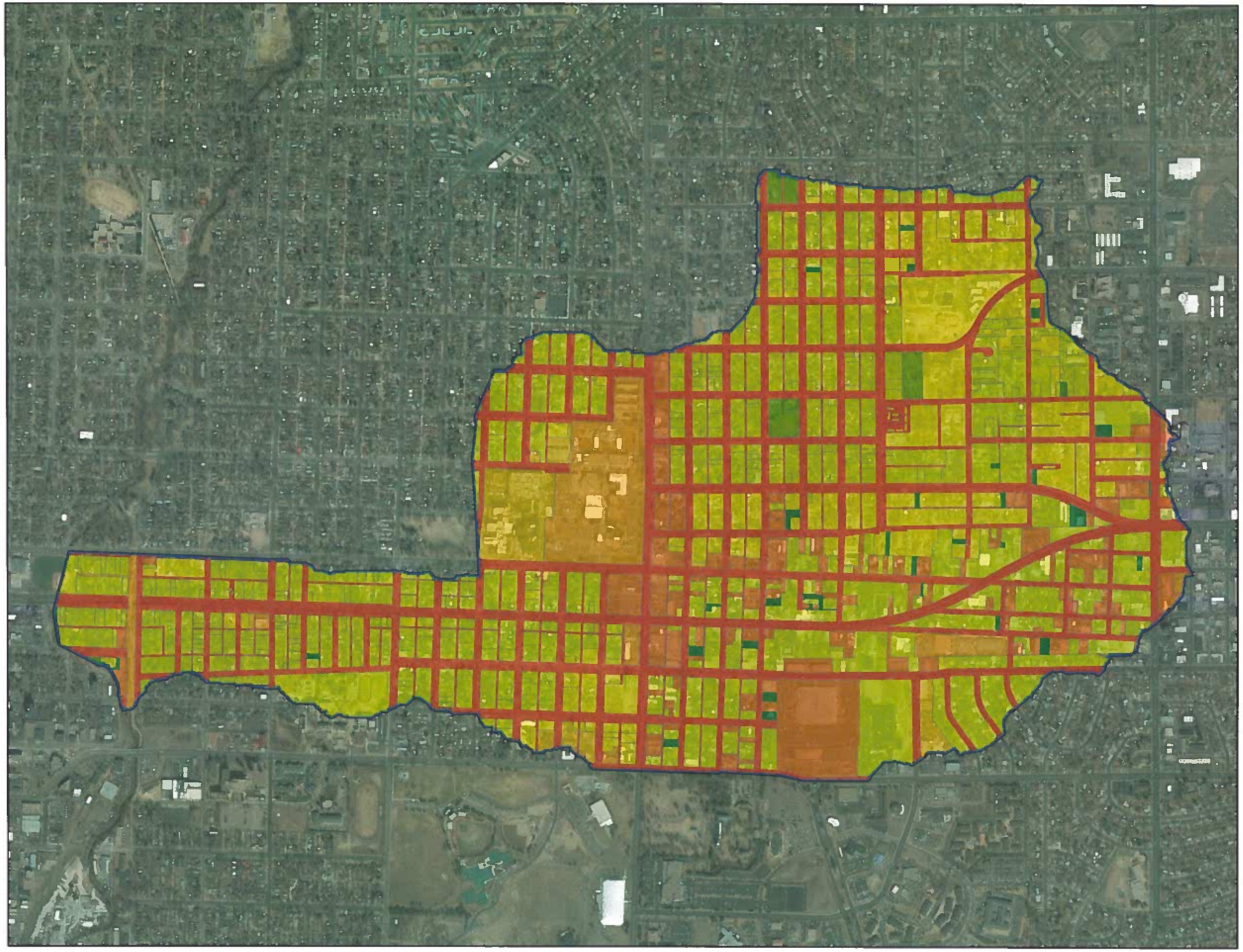
Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 3, 2014—Jun 17, 2014

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
3	Ascalon sandy loam, 3 to 9 percent slopes	47.2	5.2%
8	Blakeland loamy sand, 1 to 9 percent slopes	413.5	45.4%
12	Bresser sandy loam, cool, 3 to 5 percent slopes	386.8	42.4%
16	Chaseville gravelly sandy loam, 1 to 8 percent slopes	39.8	4.4%
56	Nelson-Tassel fine sandy loams, 3 to 18 percent slopes	9.7	1.1%
97	Truckton sandy loam, 3 to 9 percent slopes	14.6	1.6%
Totals for Area of Interest		**911.6**	**100.0%**



LEGEND

Percent Impervious

- 2
- 7
- 13
- 25
- 40
- 65
- 80
- 90
- 95
- 100

Little Shooks Run Watershed

N

0 1,000 Feet

Figure A-2
Little Shooks Run Landuse/Percent Impervious Map
Little Shooks Run Outfall Systems Plan

May, 2018

CH2MHILL

C:\USERS\ATURNER2\DESKTOP\LITTLE SHOOKS RUN\FIGURE_A-2_LANDUSE_MAP.MXD ATURNER2 5/14/2018 4:48:22 PM

Table A-1 Zone Code Descriptions

ZONE CODE	DESCRIPTION	ENTITY
A	Agricultural	Colorado Springs
APD	Airport planned development	Colorado Springs
AO-CAD	Commercial Airport Overlay	Colorado Springs
C-5	Intermediate Business	Colorado Springs
C-6	General business	Colorado Springs
DFOZ	Design Flexibility Overlay	Colorado Springs
FBZ-CEN	Form Based-Central	Colorado Springs
FBZ-COR	Form Based-Corridor	Colorado Springs
FBZ-T1	Form Based-Transition Sector 1	Colorado Springs
FBZ-T2A	Form Based-Transition Sector 2A	Colorado Springs
FBZ-T2B	Form Based-Transition Sector 2B	Colorado Springs
HP	Historic Preservation Overlay	Colorado Springs
HR	High Rise Overlay	Colorado Springs
HS	Hillside Area Overlay	Colorado Springs
M-1	Light Industrial	Colorado Springs
M-2	Heavy Industrial	Colorado Springs
MU-NC	Mixed Use-Neighborhood Center	Colorado Springs
MU-CC	Mixed Use-Commercial Center	Colorado Springs
MU-R/EC	Mixed Use-Regional/Employment Center	Colorado Springs
NP	Navigation Preservation Overlay	Colorado Springs
OC	Office Complex	Colorado Springs
OR	Office Residential	Colorado Springs
P	Planned Provisional overlay	Colorado Springs
PBC	Planned business center	Colorado Springs
PCR	Planned cultural Resort	Colorado Springs
PF	Public Facilities	Colorado Springs
PIP-1	Planned Industrial Park	Colorado Springs
PIP-2	Planned Industrial Park	Colorado Springs
PK	Public Parks	Colorado Springs
PUD	Planned Unit Development	Colorado Springs
R	Estate Single-family Residential	Colorado Springs
R-1 6000 (R-1 6)	Single-family Residential	Colorado Springs
R-1 9000 (R-1 9)	Single-family Residential	Colorado Springs
R-2	Two-family Residential	Colorado Springs
R-4	Multi-family Residential	Colorado Springs
R-5	Multi-family Residential	Colorado Springs
SS	Streamside Overlay zone	Colorado Springs
SU	Special Use	Colorado Springs
TND	Traditional Neighborhood Development	Colorado Springs
UV	Use Variance Overlay	Colorado Springs
A-1	Agricultural obsolete	El Paso County
A-5	Agricultural	El Paso County
A-35	Agricultural	El Paso County
C-1	Commercial obsolete	El Paso County
C-2	Commercial obsolete	El Paso County
CAD-O	Commercial Airport District	El Paso County
CC	Commercial Community	El Paso County

Table B-1 Zone Code Descriptions

ZONE CODE	DESCRIPTION	ENTITY
CN	Commercial Neighborhood	El Paso County
CO	Commercial Office	El Paso County
CR	Commercial Regional	El Paso County
CS	Commercial Service	El Paso County
F	Forest & Recreation obsolete	El Paso County
F-5	Forestry and Recreation	El Paso County
GA-O	General Aviation Overlay District	El Paso County
I-1	Research and Development	El Paso County
I-2	Limited Industrial	El Paso County
I-3	Heavy Industrial	El Paso County
HR-O	High Rise Overlay District	El Paso County
HWT	Hazardous Waste Transfer, Storage, Treatment Facility	El Paso County
MHP	Mobile Home Park	El Paso County
MHP-R	Mobile Home Park Rural	El Paso County
MHS	Mobile Home Subdivision	El Paso County
NBD	Neighborhood Business obsolete	El Paso County
OA-CGM	Airport Zone obsolete	El Paso County
OA-G	Airport-General Aviation District obsolete	El Paso County
O-HR	High Rise Zone obsolete	El Paso County
PBC	Planned Business Center obsolete	El Paso County
PBD	Planned Business obsolete	El Paso County
PBP	Planned Business Park obsolete	El Paso County
PHID	Planned Heavy Industrial obsolete	El Paso County
PID	Planned Industrial obsolete	El Paso County
POC	Planned Office Complex obsolete	El Paso County
PUD	Planned Unit Development	El Paso County
R	Residential obsolete	El Paso County
R&D	Research and Development obsolete	El Paso County
R-1	Residential obsolete	El Paso County
R-2	Residential obsolete	El Paso County
R-3	Residential obsolete	El Paso County
R-4	Planned Development obsolete	El Paso County
RLUP-O	Rural Land Use Plan Overlay District	El Paso County
RM-12	Residential Multi-Dwelling	El Paso County
RM-30	Residential Multi-Dwelling	El Paso County
RR-0.5	Residential Rural	El Paso County
RR-1	Rural Residential obsolete	El Paso County
RR-2	Rural Residential obsolete	El Paso County
RR-2.5	Residential Rural	El Paso County
RR-3	Rural Residential obsolete	El Paso County
RR-5	Residential Rural	El Paso County
RS-5000	Residential Rural	El Paso County
RS-6000	Residential Suburban	El Paso County
RS-20000	Residential Suburban	El Paso County
R-T	Residential-Topographic	El Paso County
RVP	Recreational Vehicle Park	El Paso County
RVS	Recreational Vehicle Subdivision	El Paso County

Table B-1 Zone Code Use Descriptions

LANDUSE DESCRIPTION
ALL OTHER EXEMPT
CHARITABLE
CODE 200 AT PRESENT WORTH
COMMERCIAL CONDO
CONDOMINIUM
COUNTY
DUPLEXES & TRIPLEXES
EXEMPT GVT. LEASED
FEDERAL
HOMEOWNERS ASSOCIATION
INDUSTRIAL CONDOMINIUMS
LODGING
MANUFACTURING PROCESSING
MERCHANDISING
MULTI_UNIT (9 & UP)
MULTI-UNITS (4-8)
OFFICES
POLITICAL SUBDIVISION
RECREATION
RELIGIOUS WORSHIP
RES LAND AT RES RATE
RESIDENTIAL CHARITABLE
RESIDENTIAL COUNTY
RESIDENTIAL POLITICAL SUB
RESIDENTIAL PRIVATE SCHOOLS
RESIDENTIAL RELIGIOUS PURPOSES
SCHOOLS-PRIVATE
SINGLE FAMILY RES.
SPECIAL PURPOSE
VACANT COMMERCIAL LOTS
VACANT INDUSTRIAL LOTS
VACANT LAND = 1 AND < 5 ACRES
VACANT RESIDENTIAL LOTS
WAREHOUSE/STORAGE

Appendix B
Alternatives Analysis

PAGE INTENTIONALLY LEFT BLANK

Little Shooks Run Outfall Systems Plan

Alternatives for the repair of the Little Shooks Run 9' x 14' Plate Arch Storm Sewer System

PREPARED FOR:	City of Colorado Springs
COPY TO:	File
PREPARED BY:	CH2M
DATE:	June 26, 2017
PROJECT NUMBER:	691414
REVISION NO.:	Draft

1.0 Introduction

An alternatives analysis was performed to determine the cost and feasibility of trenchless rehabilitation versus tradition trench and replacement for one section of the Little Shooks Run 9'x14' Plate Arch Culvert that has experienced severe corrosion and two sections of the Little Shooks Run 9'x14' Plate Arch that have experienced significant upheaval.

The first section of heaved pipe is located under the alley between North Hancock Avenue and Willow Street and is approximately 42' long. The second section of heaved pipe is located under the alley between North Sheridan Avenue and North Hancock Avenue and is approximately 52' long. The section of pipe that has experienced severe corrosion, which is approximately 30' in length, is located under North Institute Street.

Both trenchless rehabilitation solutions and traditional cut and repair open trench options are being considered as a viable rehabilitation approaches to the issues currently facing the repair of the Little Shooks Run Plate Arch Culvert. Both methods of repair, trenchless and conventional, are being investigated for a number of reasons.

1. To identify the potentially most cost effective repair technique.
2. Current Right-of-way (ROW) along the corridor varies from 20' to 40' with residential and business structures in close proximity to the pipeline making traditional open cut construction difficult, favoring an insitu solution.
3. Unknown geotechinical conditions surrounding the pipe corridor and unknown cause of the failure of the current Little Shooks Run Pipe.

This memorandum outlines the potential repair options, provides highlevel cost estimates, quantifies the pros and cons of each alternative and provides a recommendation for next steps. To determine the feasibility of any rehabilitation method it will be necessary to complete a survey of these locations to determine the precise location and length of each failure and complete a series of geotechnical borings to determine the cause of heaving of the existing Arch CMP.

2.0 Available Data

The City of Colorado Springs provided data for the horizontal location of the Little Shooks Run storm drain system. In addition the City provided utility information, ROW information, parcel data and landuse data. This information was provided to CH2M as a combination of GIS data and As-Builts information. The GIS data provided information for the horizontal location of the storm drain system and utilities. However, it did not contain essential geometric data for the storm drain system, such as inverts, slope, and dimensions of the pipe.

As-Builts were gathered to determine the inverts, slopes, and dimensions of the storm drain system. However, the As-Builts were not continuous or complete for the entire system and the vertical datum of the As-Builts was unable to be determined making the use on invert information unreliable. For this memorandum, the profile of the system was determined using the invert of the system at its discharge location into Shooks Run, which was determined from the topographical survey data provided by the City of Colorado Springs (2011 2-foot contour information and recent As-Built information from the Shooks Run reconstruction from Platte Avenue to Kiowa Street), as the reference point. From the reference point, As-Built data was utilized, where available, to develop the profile of the system based on the designed slope from the As-Builts. In areas where As-Built data was not available, it was assumed that the slope of the pipe matched surrounding As-Built Information and that the profile of storm drain was built per City criteria. Prior to final design the system will need to be surveyed to ensure accurate construction information.

3.0 Field Walk Results

Given the limited information the City of Colorado Springs possessed for the Little Shooks Run Storm Sewer System, a field walk was conducted to determine the condition of the system and to locate problem areas that would require rehabilitation.

During this field walk the following problem areas were observed:

Corrosion (See Figure 1 and Figure 2):

Under North Institute Street there is a section of the system, approximately 30' in length, that has experienced corrosion. If left unchecked this could cause future stability issues with the pipe. Upon review of field walk photographs CH2M pipe experts concluded that the corrosion may be caused by Magnesium Chloride seepage from winter de-icing operations and is becoming more common as liquid deicers and magnesium chloride is used.

Upheaval (See Figures 3 through Figure 6):

There are two sections of the system where, for reasons unknown at this time, the invert of the Plate Arch culvert has heaved. The first section occurs underneath the alley between North Hancock Avenue and Willow Street and is approximately 42' in length. The second section occurs underneath the alley between North Sheridan Avenue and North Hancock Avenue and is approximately 52' in length.

As mentioned above, in order to more accurately diagnose problem areas and provide appropriate solutions, a survey of the system will be necessary. Given the limited geotechnical information and the problems with the system observed, which hint at geotechnical issues, it is recommended that borings be performed and analyzed at each of these areas to have a better understanding of the cause.

Figure 1
Corrosion Along Little Shooks Run Pipe under North Institute

Figure 2
Corrosion Experienced

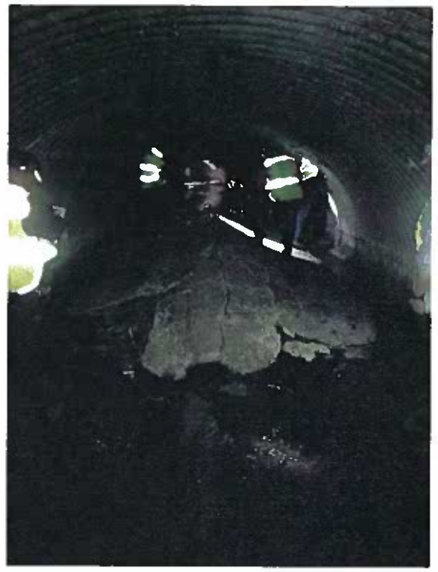


Figure 3
Upheaval between Willow and Hancock

Figure 4
Upheaval Between Willow and Hancock, Plate Arch and Concrete Flood Heaved but Intact

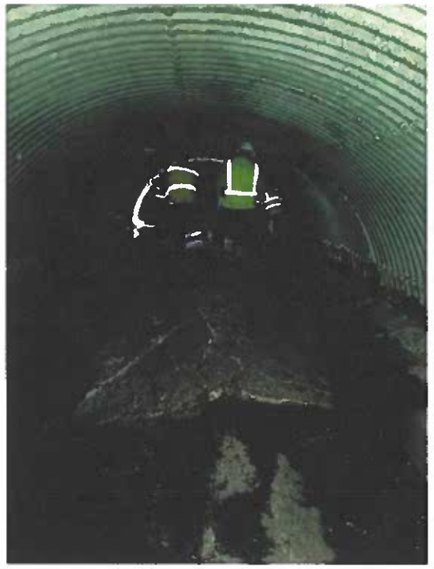


Figure 5
Second Upheaval Section

Figure 6
Second Upheaval Section, Arch CMP and Concrete Floor Heaved

4.0 Potential Trenchless Alternatives for Rehabilitation

Based on the results of the field walk, the data collected, and limited geotechnical information, trenchless reconstruction may not be feasible due to the structural requirements of the large diameter pipe. However, there are some insitu options that are preliminarily feasible based on the areas of concern listed below:

4.1 Corrosion Under North Institute (See Figure 1 and Figure 2):

1. A fiber-reinforced polymer (FPR) based, trenchless technology method for the repair, strengthening and retrofit of corrosion-damaged and distressed large-diameter pipes is a potential solution. This method would require manned entry into the pipe where shotcrete would be placed to fill the space between corrugations and create a smooth surface for the placement of FPR at approximately one inch thick. This solution would create a structural repair to the pipe as the repair would no longer rely on the steel plate arch for stability.
2. An epoxy trenchless technology method is another potential solution should there be no structural damage. This method would include the following:
   - Sand Blast clean the surface of the pipe;
   - Solvent clean to remove soluble salts;
   - Spray/apply two coats of epoxy;

4.2 Upheaval Sections (Figures 3 through Figure 6):

1. A fiber-reinforced geopolymer based, trenchless technology method is proposed solution. This method would require manned entry and would be a fully structural repair. This method would include the following:
   - Cut and remove the bottom of the pipe and concrete floor (pipe would be required to be stabilized with bracing in the floor to prevent failure of the Plate Arch);
   - Place concrete in removed bottom of floor to match upstream and downstream inverts;
   - Spray the entire rehabilitated section of the pipe with geopolymer to a thickness of approximately two inches;
   - Recommended to spray an extra 15-20' upstream and downstream of rehabilitated area to prevent infiltration of water into repair;
2. A secondary in-situ repair would be a partial structural repair very similar to the geopolymer repair described above that includes the following:
   - Cut and remove the bottom of the pipe and concrete floor;
   - Rehabilitate with metal like material to spray against;
   - Pour in concrete floor to match upstream and downstream characteristics;

Given the recommendation to spray an additional length upstream and downstream of the rehabilitated area, for the purposes of estimating cost the approximate length of the first upheaval was increased from 42' to 50' and the approximate length of the second upheaval was increased from 52' to 60'.

These are preliminary alternatives and may change as information is developed about the geotechnical conditions surrounding the pipes and additional survey data which will help inform the project team of the appropriate solution for the repair of the Little Shooks Run Plate Arch Pipe.

5.0 Conventional Rehabilitation Alternatives

Conventional rehabilitation alternatives were identified and analyzed for rehabilitation for the sections of the Plate Arch Pipe within the Little Shooks Run Storm Drain System that have been discussed in this technical memorandum. For the purposes of this technical memorandum, open cut replacement was evaluated for the above-mentioned sections of the Plate Arch pipe that require rehabilitation.

In 1997 a non-trenchless rehabilitation was performed just downstream of the first upheaval located between Willow and Hancock. A 12' x 7' Reinforced Concrete Box Culvert (RCBC) was constructed in place of the existing Plate Arch Pipe. Analysis of this section indicates that it has conveyance capacity for the minor storm event but becomes surcharged during larger events due to the smaller cross sectional areas that the existing Plate Arch Pipe.

The approximate cross-sectional area of the Plate Arch pipe, 14' x 9', is 99 square feet (SF). Therefore, a 12' x 8' RCBC is being recommended for the rehabilitation of these sections as its cross-sectional area is approximately 96 SF. Despite having a smaller cross-sectional area, the change in Manning's roughness coefficient allows the 12' x 8' RCBC to convey the same amount of flow as the existing Plate Arch Pipe.

This open cut rehabilitation method would require the following:

- Excavating around the sections needing rehabilitation;
- Shoring of the trench due to limited space and proximity to residential homes;
- dewatering;
- Removing and replacing existing sections of pipe with RCBC;
- Backfilling with approved material;

6.0 Qualitative Assessment of all Pipe Rehabilitation Alternatives

Each alternative evaluated has pros and cons for the rehabilitation of the Little Shooks Run Drainage System. Table 1 and table 2 below provides a qualitative assessment of the differing alternatives.

Table 1 - Comparison Table for Corrosion Rehabilitation

Conventional Alternative		Pros	Cons	Cost
1	Open Cut Replacement	• Maintains/increases original pipe flow capacity • Mitigates risk accepted with trenchless method • Accommodates installation along existing alignment • Structural repair	• Requires large amount of excavation • Requires larger construction area in a site with limited area • Dewatering -contingency for large storm events would be required or construction in the winter time • Traffic impacts • Cost	$262,000
Trenchless Alternatives		**Pros**	**Cons**	**Cost**
1	Fiber-Reinforced Polymer	• Used for large diameter pipes • Maintains/increases original pipe flow capacity • Accommodates installation along existing alignment • No excavation necessary • Structural repair • Cost	• Requires confined space entry and air monitoring • Access Could be problematic and may require moving material from pipe entrance if inlet cannot be used. • Dewatering- would have to demobilize from the pipe if there are large storm events (removal of all construction materials)	$200,000
2	Epoxy and Fiberglass	• Used for large diameter pipes • Maintains/increases original pipe flow capacity • Accommodates installation along existing alignment • No excavation necessary • Cost	• Requires confined space entry and air monitoring • Access Could be problematic and may require moving material from pipe entrance if inlet cannot be used • Dewatering- would have to demobilize from the pipe if there are large storm events (removal of all construction materials) • Not a structural repair	$65,600

Table 2 - Comparison Table for Upheaval Rehabilitation

Conventional Alternative		Pros	Cons	Cost
1	Open Cut Replacement	• Maintains/increases original pipe flow capacity • Accommodates installation along existing alignment • Structural repair	• Requires large amount of excavation • Requires larger construction area in a site with limited area • Traffic impacts • Dewatering -contingency for large storm events would be required or construction in the winter time. • Cost	50' Length: $372,000 60' Length: $437,000
Trenchless Alternatives		**Pros**	**Cons**	**Cost**
1	Fiber-Reinforced Geopolymer	• Used for large diameter pipes • Maintains/increases original pipe flow capacity • Accommodates installation along existing alignment • Minimal change to geometry of storm sewer system • Minimal impact to surface • Structural repair • Cost	• Requires confined space entry and air monitoring • Access Could be problematic and may require moving material from pipe entrance if inlet cannot be used. • Dewatering- would have to demobilize from the pipe if there are large storm events (removal of all construction materials) • Requires bracing after bottom of pipe is cut • Potential of pipe caving with construction crew inside	50' Length: $244,000 60' Length: $290,000
2	Replace Concrete Floor	• Maintains/increases original pipe flow capacity • Accommodates installation along existing alignment • Minimal change to geometry of storm sewer system • Minimal impact to surface • Structural Repair • Cost	• Requires confined space entry and air monitoring • Access Could be problematic and may require moving material from pipe entrance if inlet cannot be used. • Dewatering- would have to demobilize from the pipe if there are large storm events (removal of all construction materials) • Requires bracing after bottom of pipe is cut • Potential of pipe caving with construction crew inside	50' Length: $164,000 60' Length: $184,000

7.0 Summary, Recommendations and Next steps.

There are a limited number of opportunities to repair or rehabilitate the Little Shooks Run Plate Arch Culvert in areas where it has been damaged. There is the traditional remove and replace option and two insitu options, fiber wrap and geopolymer, that could be utilized to repair the pipe. Due to limited information on the geotechinical conditions surrounding the pipe and with the need to further inspect and evaluate the pipes structural stability and develop additional information about the invert and location of the failures through survey, the project team is making the following reccomendations.

7.1 Corrosion Under North Institute

The corrosion under North Institute lends itself to an insitu repair utilizing both fiber reinforcement and epoxy coating to extend the life of the pipe. It would be proposed to use Fiberwrap to fix areas that have been fully corroded and compromised while epoxy alone could be used to protect intact portions of the pipe. This would provide a cost effective alternative to replacement. It is recommended that the area be surveyed to understand the full location and length of the issue and to have the structural integrity of the pipe inspected to better understand the current condition of the pipe and to target the appropriate solutions for rehabilitation.

7.2 Upheaval Sections

Discussions with Fiberwrap have removed this alternative for the repair option for the =heaved sections as the fiberglass would not provide adequate structural support for the area. However, geopolymers, removal and replacement of the upheaved sections and full replacement are viable. There is risk in completing a partial replacement of only the bottom as removing the bottom of the pipe could cause structural instability and collapse. Careful bracing will be required to prevent structural failures.

At this time the project team is recommending that the area be surveyed to understand the full location and length of the issue and to have the structural integrity of the pipe inspected as well as removing a section of the pipe to understand what the conditions are under the heaved section of the pipe.

Kumar & Associates, Inc.
Geotechnical and Materials Engineers
and Environmental Scientists

6735 Kumar Heights
Colorado Springs, CO 80918
phone: (719) 632-7009
fax: (719) 632-1049
email: kacolospgs@kumarusa.com
www.kumarusa.com

ACEC MEMBER

Office Locations: Denver (HQ), Colorado Springs, Fort Collins, Glenwood Springs, Parker, and Summit County, Colorado

September 22, 2017

Mr. Tim Biolchini, PE
Water Resources Engineering Division
City of Colorado Springs
30 S. Nevada Avenue, Suite 401
Colorado Springs, Colorado 80901

Subject: Results of Subsurface Exploration, Little Shooks Run Culvert, Vicinity of Hancock Avenue and Platte Avenue, Colorado Springs, Colorado

Project No. 17-2-192

Dear Mr. Biolchini:

This report presents the results of a subsurface study adjacent to and within the Little Shooks Run Culvert, in Colorado Springs, Colorado. The study was conducted in general accordance with the scope of work in our proposal C17-230, dated July 25, 2017, to provide information on the subsurface conditions at the requested locations.

FIELD EXPLORATION

The field exploration of subsurface conditions consisted of drilling 3 borings at the approximate locations shown on the attached Fig. 1. The field exploration was completed on September 12th and 14th, 2017, using a conventional 2WD truck mounted drill rig for Boring 1 (in roadway), and hand auger equipment for Borings 2 and 3 (in culvert).

Boring 1 was drilled with 4-inch diameter continuous flight solid stem auger. Samples of the soils were taken with a 2-inch I.D. California sampler. The sampler was driven into the various strata with blows from a 140-pound hammer falling 30 inches. Penetration resistance values, when properly evaluated, provide an indication of the relative density or consistency of the soils. Depths at which the samples were taken and the penetration resistance values are shown on the boring log. Borings 2 and 3 were drilled with a 4-inch diameter hand auger, and small disturbed samples of the auger cuttings were collected. Prior to drilling, the corrugated metal floor was cut utilizing a gas powered demo saw. The boring logs are presented on Fig. 2, and the corresponding legend and notes are included on Fig. 3.

LABORATORY TESTING

Samples obtained from the exploratory borings were visually classified in the laboratory by the project engineer and samples were selected for laboratory testing. Laboratory testing included index property tests such as in-situ moisture content and dry unit weight, grain size analysis, Atterberg limits, and swell-consolidation. The testing was conducted in general accordance with recognized test procedures, primarily those of the American Society for Testing of Materials (ASTM). Results of the laboratory testing program are shown on Figs. 2 and 4 thru 7, and are summarized in Table I.

SITE CONDITIONS

The project site is located south of the intersection of E. Platte Avenue and N. Hancock Avenue, as shown on Fig. 1. The Little Shooks Run Culvert flows generally east to west within the study area and consists of a 9'x14' corrugated steel arch culvert. The floor of the culvert is lined with a 2 to 3-inch layer of concrete. In the locations of Borings 2 and 3, the culvert floor has bulged up about 2 to 3 feet, and the concrete lined floor has spalled away within portions of these bulges. Each of these bulged areas had a length of about 50 feet.

SUBSURFACE CONDITIONS

The following subsurface descriptions are of a generalized nature to highlight the major stratification features encountered. The boring logs presented on Fig. 2 should be referenced for more detailed information at each location.

In Roadway

In Boring 1, drilled within the southbound lane of Hancock Avenue and south of the culvert, approximately 9 inches of asphalt was encountered at the surface. The pavement was underlain by a granular fill (Poorly to well-graded sand with silt and silty sand with occasional gravel) to a depth of about 5 feet, followed by a cohesive fill consisting of sandy lean clay and clayey sand, which extended to a depth of about 13.75 feet. Our borings did not determine the exact lateral or vertical extent of the fill. At the 13.75-foot depth, concrete or grout was encountered, and the boring was terminated due to concerns for potential unknown utilities. Sampler penetration blow counts suggest the fill is generally marginally compact to noncompact. Swell-consolidation test results presented on Fig. 4 indicate the tested sample of clayey sand was nonexpansive and moderately compressible when wetted under a 1-ksf surcharge. Groundwater was not encountered at the time of drilling. The boring was backfilled with auger cuttings and the roadway was patched with hot-mix asphalt.

In Culvert

Borings 2 and 3 were drilled within the west and east bulge areas, respectively, at the approximate locations shown on Fig. 1. Below the steel floor in Boring 2, an approximate 3-foot void was found. The subsurface materials that followed included lean clay with sand and clayey sand to a depth of approximately 3.5 feet, followed by weathered claystone which extended to the 4.5-foot depth explored. Ground water was present at about the 3-foot depth (base of void), which corresponds to about what the normal culvert floor elevation would be away from the bulged area.

In Boring 3, below the steel floor, approximately 3 feet of silty sand was encountered, followed by weathered claystone which was present from about 3 to 3.1 feet. We were unable to advance the hand auger deeper due to the wet/caving soils. There was no void found at this location. Ground water was encountered at an approximate depth of 2 feet, which corresponds to a depth of about what the normal culvert floor elevation would be away from the bulged area.

We were unable to collect undisturbed samples of the claystone that could be utilized for swell-consolidation testing due to the drilling and sampling methods within the culvert; however, the claystone appeared to be very moist to wet, suggesting it would have a lower than typical potential for swell. Upon completion of drilling, the in-culvert borings were backfilled with auger cuttings. The holes within the metal floor were plugged at the surface with concrete pieces and covered with a mound of site-mixed concrete.

LIMITATIONS

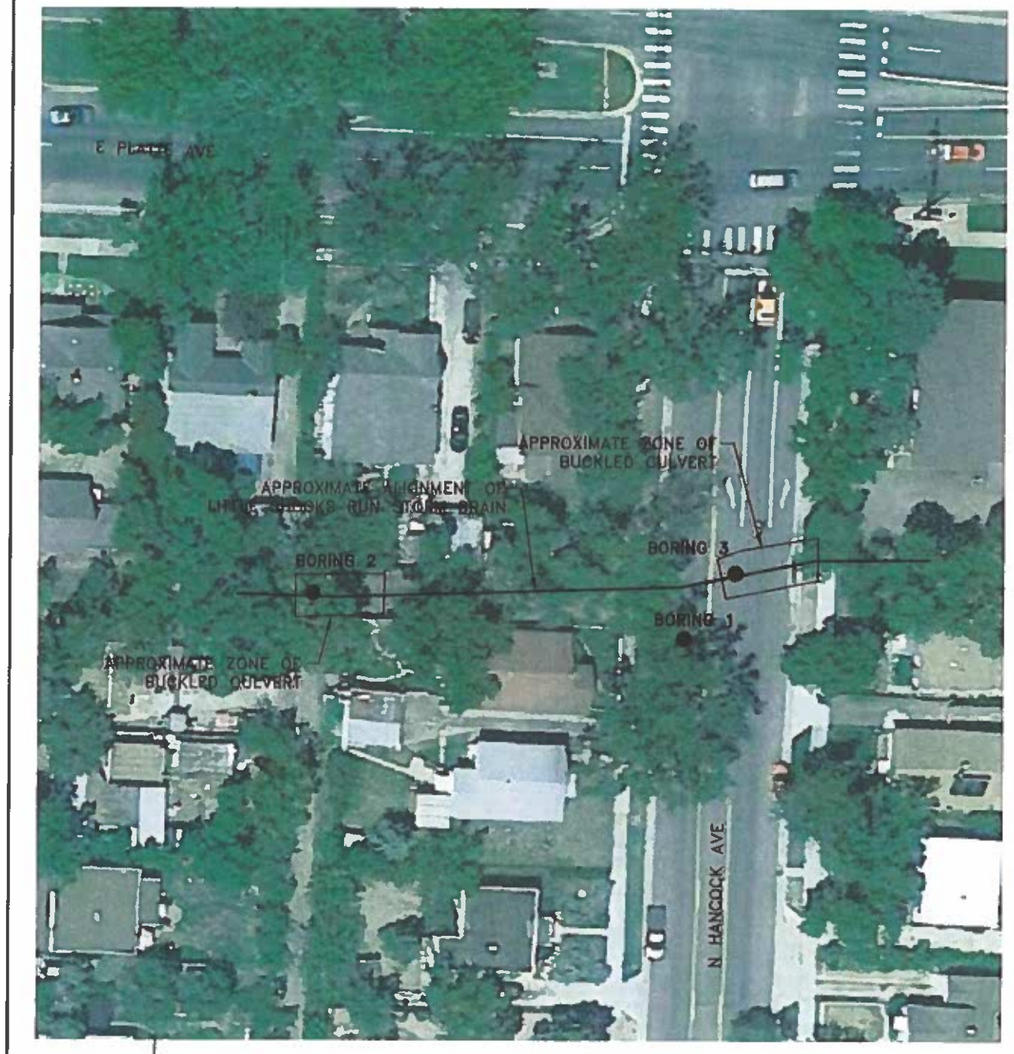
The scope of our study was to provide a report of the subsurface conditions encountered, and the requested scope did not include interpretation or analysis of the data. This study has been conducted in accordance with generally accepted geotechnical engineering practices in this area for use by the client for design purposes. The conclusions submitted in this report are based upon the data obtained from the exploratory borings at the approximate locations indicated on Fig. 1. The nature and extent of subsurface variations across the site may not become evident until excavation is performed. If during construction, soil, rock or water conditions appear to be significantly different from those described herein, this office should be advised so additional subgrade investigation can be performed, if required.

If you have any questions or require any additional information, please do not hesitate to call.

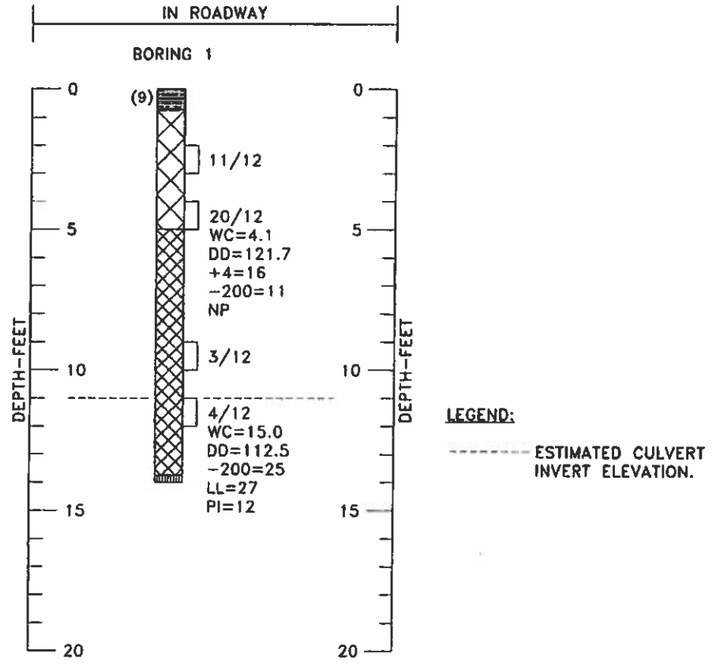
KUMAR & ASSOCIATES, INC.
Duane P. Craft, P.E.

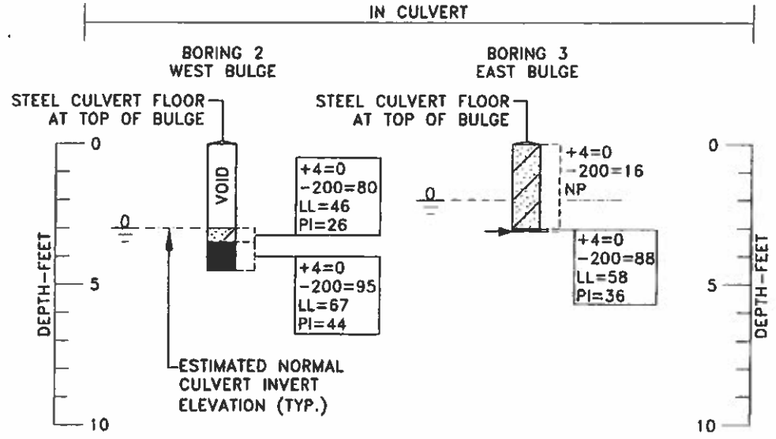
COLORADO REGISTERED
DUANE P. CRAFT
37553
PROFESSIONAL ENGINEER
D.P. Craft 9/22/17

DPC:bj
Reviewed by: AFK
Attachments



17-2-192	Kumar & Associates	LOCATION OF EXPLORATORY BORINGS	Fig. 1





17-2-192	Kumar & Associates	LOGS OF EXPLORATORY BORINGS	Fig. 2

LEGEND

(9) ASPHALT, THICKNESS IN INCHES SHOWN IN PARENTHESES TO LEFT OF THE LOG.

FILL: POORLY TO WELL-GRADED SAND WITH SILT AND OCCASIONAL GRAVEL (SP-SM, SW-SM), AND SILTY SAND (SM), MOIST, REDISH-BROWN.

FILL: SANDY LEAN CLAY (CL) AND CLAYEY SAND (SC), MOIST, GRAY AND BROWN.

CONCRETE OR GROUT (ENCOUNTERED IN TIP OF BORING 1).

LEAN CLAY WITH SAND (CL) AND CLAYEY SAND (SC), WET, TAN AND BROWN.

SILTY SAND (SM), WET, TAN AND BROWN.

WEATHERED CLAYSTONE BEDROCK, HIGH PLASTICITY, BLOCKY, VERY MOIST TO WET, BROWN AND GRAY.

DRIVE SAMPLE, 2-INCH I.D. CALIFORNIA LINER SAMPLE.

DISTURBED BULK SAMPLE.

11/12 DRIVE SAMPLE BLOW COUNT. INDICATES THAT 11 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE THE SAMPLER 12 INCHES.

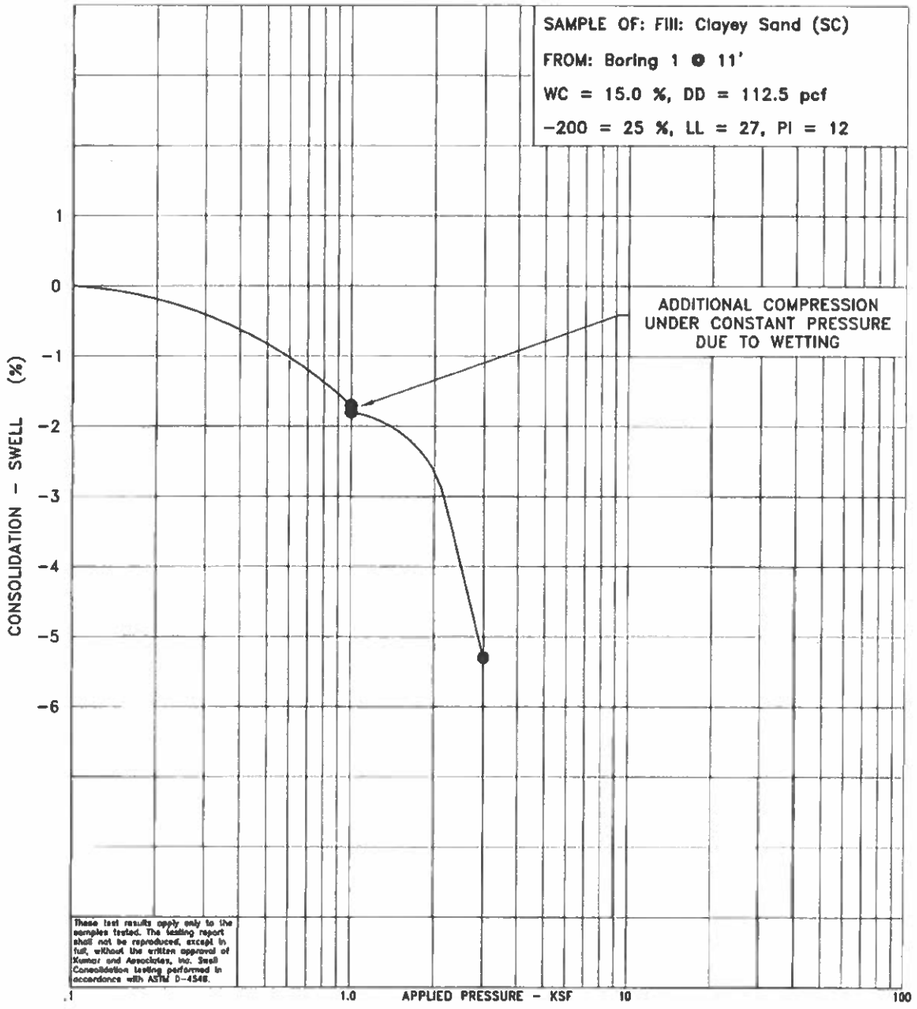
DEPTH TO WATER LEVEL ENCOUNTERED AT THE TIME OF DRILLING.

DEPTH AT WHICH BORING CAVED.

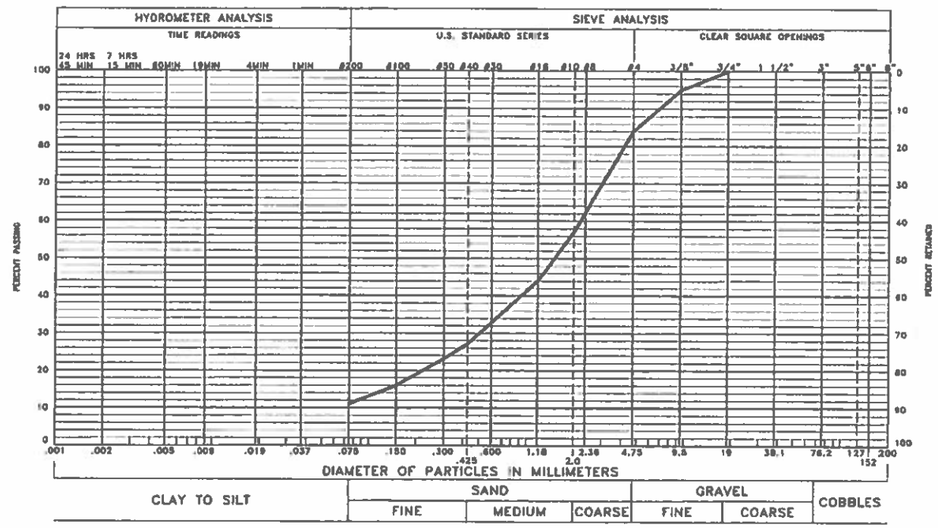
NOTES

1. BORING 1 WAS DRILLED ON SEPTEMBER 12, 2017 WITH A 4-INCH DIAMETER CONTINUOUS FLIGHT POWER AUGER. BORINGS 2 AND 3 WERE DRILLED ON SEPTEMBER 14, 2017 WITH A 4-INCH DIAMETER HAND AUGER.
2. THE LOCATIONS OF THE EXPLORATORY BORINGS WERE MEASURED APPROXIMATELY BY PACING FROM FEATURES SHOWN ON THE SITE PLAN PROVIDED.
3. THE ELEVATIONS OF THE EXPLORATORY BORINGS WERE NOT MEASURED AND THE LOGS OF THE EXPLORATORY BORINGS ARE PLOTTED TO DEPTH.
4. THE LINES BETWEEN MATERIALS SHOWN ON THE EXPLORATORY BORING LOGS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.
5. GROUNDWATER LEVELS SHOWN ON THE LOGS WERE MEASURED AT THE TIME OF DRILLING. FLUCTUATIONS IN THE WATER LEVEL MAY OCCUR WITH TIME.
6. LABORATORY TEST RESULTS:
   - WC = WATER CONTENT (%) (ASTM D 2216);
   - DD = DRY DENSITY (pcf) (ASTM D 2216);
   - +4 = PERCENTAGE RETAINED ON NO. 4 SIEVE (ASTM D 422);
   - -200= PERCENTAGE PASSING NO. 200 SIEVE (ASTM D 1140);
   - LL = LIQUID LIMIT (ASTM D 4318);
   - PI = PLASTICITY INDEX (ASTM D 4318);
   - NP = NON-PLASTIC (ASTM D 4318).

17-2-192	Kumar & Associates	LEGEND AND NOTES	Fig. 3



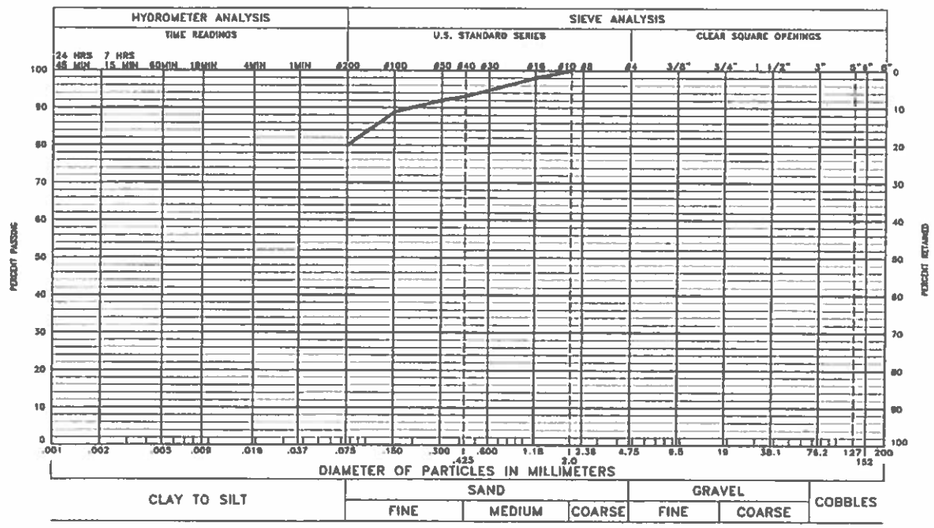
17-2-192	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULT	Fig. 4



GRAVEL 16 % SAND 73 % SILT AND CLAY 11 %

LIQUID LIMIT PLASTICITY INDEX NP

SAMPLE OF: Fill: Well Graded Sand with Silt and Gravel (SW-SM) FROM: Boring 1 @ 4'



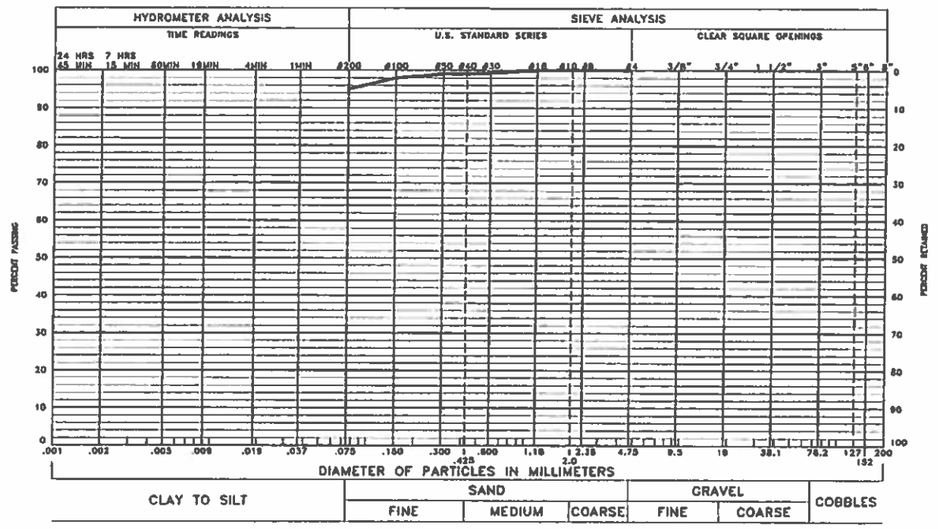
GRAVEL 0 % SAND 20 % SILT AND CLAY 80 %

LIQUID LIMIT 46 PLASTICITY INDEX 26

SAMPLE OF: Lean Clay with Sand (CL) FROM: Boring 2 @ 3'-3.5'

These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D422, ASTM C136 and/or ASTM D1140.

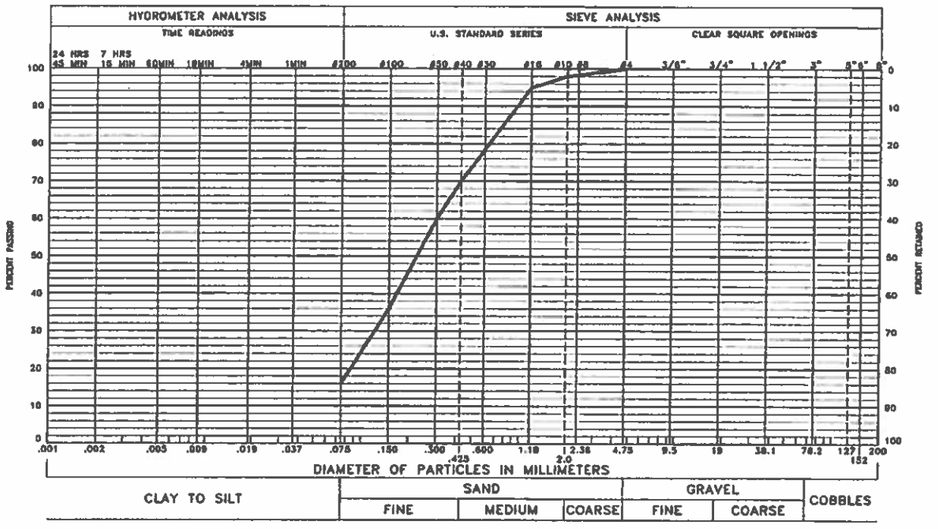
17-2-192	Kumar & Associates	GRADATION TEST RESULTS	Fig. 5



GRAVEL 0 % SAND 5 % SILT AND CLAY 95 %

LIQUID LIMIT 67 PLASTICITY INDEX 44

SAMPLE OF: Weathered Claystone FROM: Boring 2 @ 3.5'-4.5'

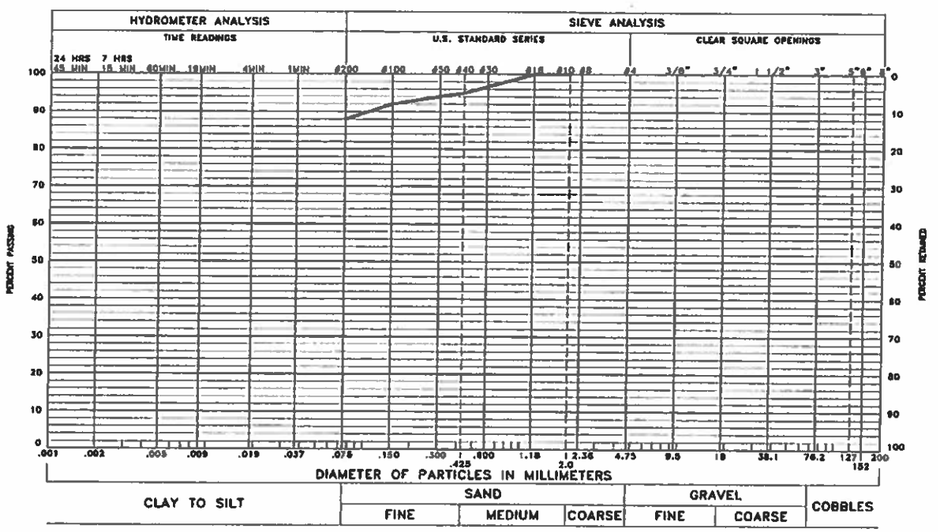


GRAVEL 0 % SAND 84 % SILT AND CLAY 16 %

LIQUID LIMIT PLASTICITY INDEX NP

SAMPLE OF: Silty Sand (SM) FROM: Boring 3 @ 0-3'

17-2-192	Kumar & Associates	GRADATION TEST RESULTS	Fig. 6



GRAVEL 0 % SAND 12 % SILT AND CLAY 88 %

LIQUID LIMIT 58 PLASTICITY INDEX 36

SAMPLE OF: Weathered Claystone FROM: Boring 3 @ 3'-3.1'

17-2-192	Kumar & Associates	GRADATION TEST RESULTS	Fig. 7

Kumar & Associates, Inc.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

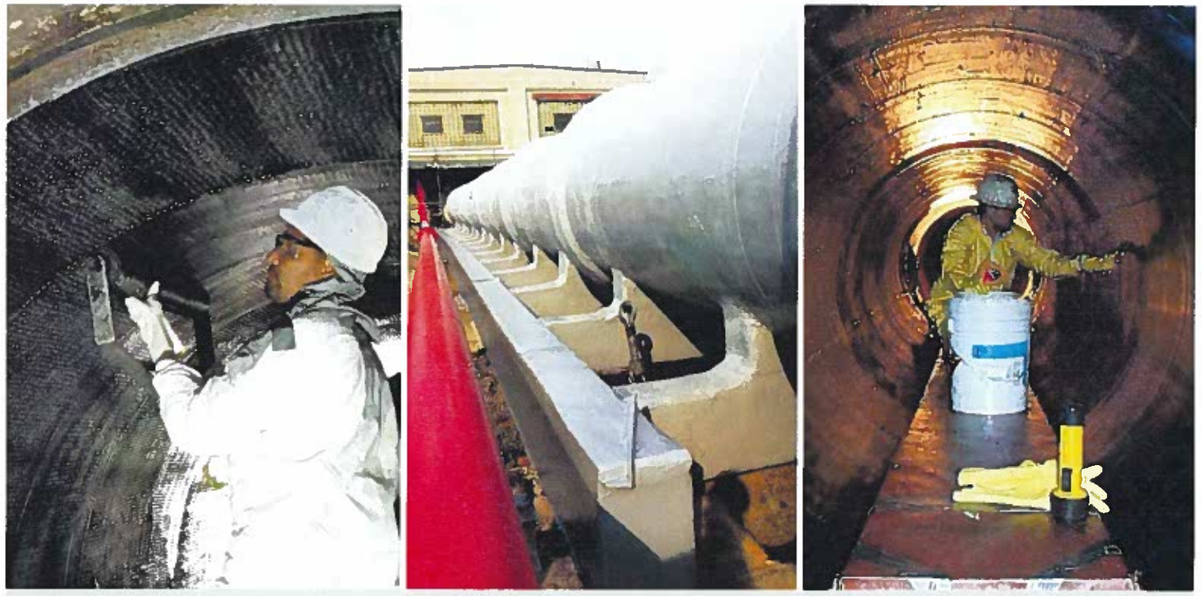
Project No.: 17-2-192
Project Name: Little Shooks Run Culvert
Date Sampled: 9/12/2017 and 9/14/2017
Date Received: 9/12-9/14/2017

SAMPLE LOCATION		DATE TESTED	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	GRADATION		PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		SOIL OR BEDROCK TYPE (Unified Soil Classification)
BORING	DEPTH (ft)				GRAVEL (%)	SAND (%)		LIQUID LIMIT	PLASTICITY INDEX	
1	4	9/19/17	4.1	121.7	16	73	11		NP	Fill: Well Graded Sand with Silt and Gravel (SW-SM)
1	11	9/19/17	15.0	112.5			25	27	12	Fill: Clayey Sand (SC)
2	3-3.5	9/19/17			0	20	80	46	26	Lean Clay with Sand (CL)
2	3.5-4.5	9/19/17			0	5	95	67	44	Weathered Claystone
3	0-3	9/19/17			0	84	16		NP	Silty Sand (SM)
3	3-3.1	9/19/17			0	12	88	58	36	Weathered Claystone

INFRASTRUCTURE SOLUTIONS

PIPELINES

Fiber-reinforced polymer (FRP) structural strengthening for pipelines



FYFE® an AEGION company

FIBRWRAP® an AEGION company

PIPELINES

Structural Strengthening

Since 1988, Fyfe Co. has been a pioneer in the fiber-reinforced polymer (FRP) structural strengthening industry. Fyfe is a world leader in designing and manufacturing specialized carbon, glass, aramid and hybrid fabrics, which are combined with polymers to strengthen a wide range of masonry, concrete, steel and wooden structures.

Through Fibrwrap Construction, Inc., we install Tyfo® Fibrwrap®, our patent-protected FRP composite.

Pipe Rehabilitation

When a pre-stressed concrete cylinder pipe (PCCP), reinforced concrete pipe (RCP) or steel pipe suffers from corrosion, it can experience significant structural loss. The Tyfo® Fibrwrap® system strengthens these pipes and enables them to accommodate increased internal pressure, flexural loads, internal and external loads (i.e. operating pressure, surge pressure, soil loads and traffic loads), traffic and soil loads.

The Tyfo® Fibrwrap® system is a fiber-reinforced polymer liner that can be bonded to either the inside or outside of pipes 30-inches in diameter or greater. Protective coatings can also be applied to address aggressive chemical or environmental exposures. Designed to resist internal and external pressure, the Tyfo® Fibrwrap® system meets NSF Standard 61 requirements and is designed for the life of the structure.

Fibrwrap Construction has used Tyfo® SCH carbon systems to strengthen and protect PCCP, RCP and steel pipe segments, including installations to protect against pipe bursting and provide corrosion mitigation.

Before After

Industrial, Municipal, Power and Storage Facilities

Because of their high strength-to-weight ratio and ease of installation, Tyfo® Fibrwrap® systems are ideal for strengthening industrial structures. Conforming around existing equipment and instrumentation, construction of time-sensitive repairs can be completed with minimal impact to operations, significantly shortening shutdown times.

Fibrwrap Construction professionals are experienced at working in industrial environments, including refineries, water treatment plants, mills, nuclear power plants and manufacturing sites. Our stringent safety plan surpasses the toughest governmental and industrial standards. With the protection of our team's health and safety at the forefront, we maintain one of the best safety records in the industry. Our FRP and other solutions meet a wide range of industrial needs, including:

- Structural upgrades
- Corrosion repair
- High performance coatings
- Concrete repair
- Rapid shutdown turnaround

We complete turnkey repairs quickly with limited service disruption, even during emergency shutdowns.

FRP can be designed to the following codes:

- AWWA M11-water
- AWWA M45-water
- ASME B31.1-power
- ASME PCC-2-industrial
- ASTM F1216

FYFE® an AEGION company

Fyfe Co., LLC
www.fyfeco.com

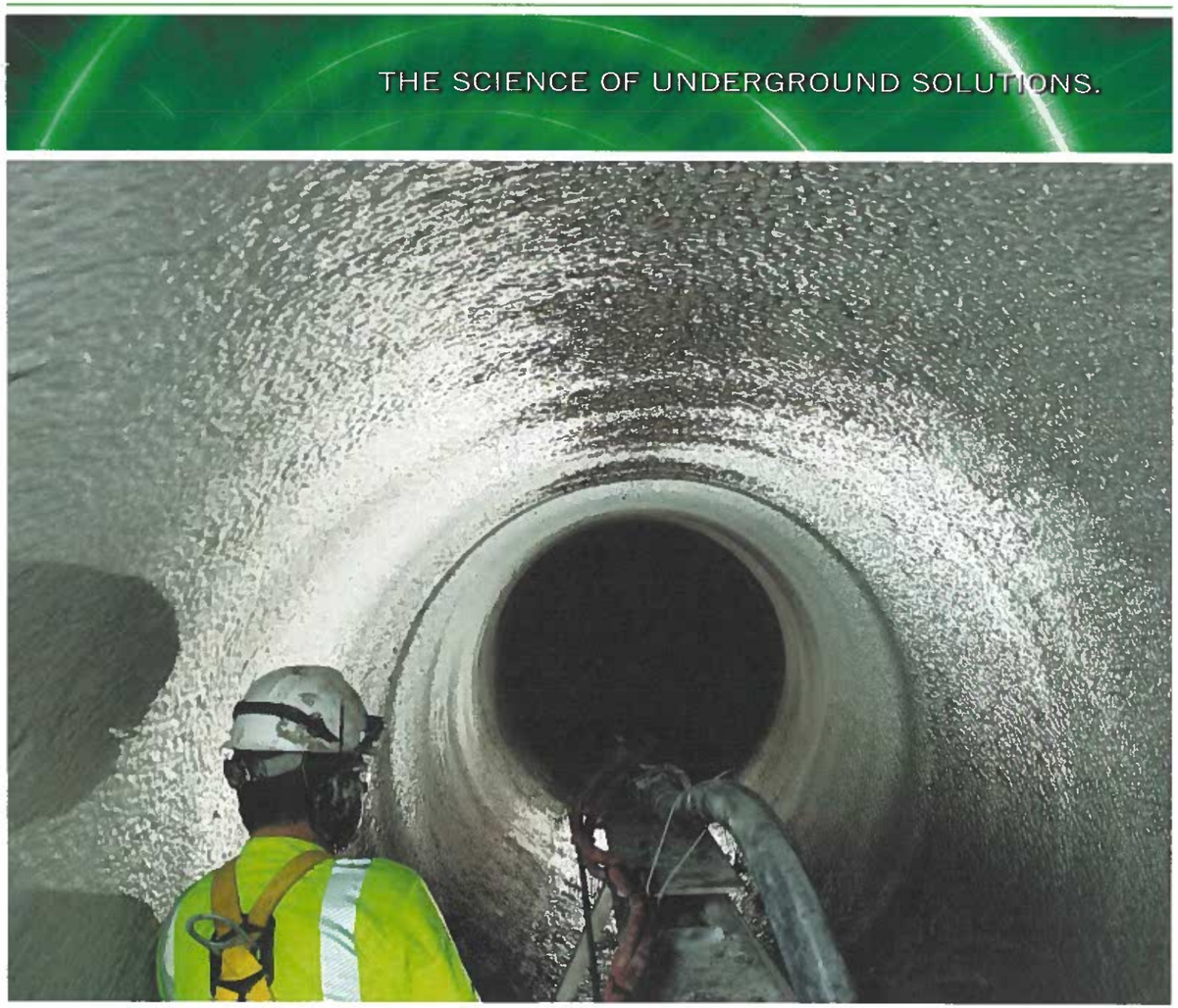
FIBRWRAP® an AEGION company

Fibrwrap Construction Services USA, Inc.
916.379.8955
www.fibrwrap.com

ECOCAST
WITH Milliken GEOPOLYMERS

ADVANCED GEOPOLYMER TECHNOLOGY

Structural Repair
Safe for the Environment
Effective Large Diameter Rehabilitation



ECOCAST

AN ENVIRONMENTALLY FRIENDLY, PRECISION APPLIED, STRUCTURAL LINING SYSTEM

IPR Leads the Market with EcoCast™, the first "Green" Geopolymer

Historically, the industry has focused on four critical performance physical characteristics for the successful application of a geopolymer liner.

- Excellent Bond Strength
- Low Permeability
- High Compressive Strength
- Efficient Constructability

IPR, along with its development partner, Milliken Infrastructure Solutions, LLC adds a fifth crucial element ... it is sustainable. Together we have introduced a proprietary system that combines the most advanced application equipment with a custom formulated geopolymer, specifically designed for consistent application and long-term performance.

EcoCast will successfully restore your concrete, brick, or corrugated metal storm and sewer pipes. It is particularly effective for large diameter pipe sections starting at 36".

IPR EcoCast's geopolymer lining is perfect for pipe segment rehabilitation typically found in and around airports, road and highway overpasses, and municipal sewer applications.

THE ECOCAST SYSTEM IS A TECHNOLOGICAL BREAKTHROUGH IN THE TRADITIONAL PIPELINE REHABILITATION MARKET

EcoCast was developed with the sole purpose of meeting the market's demand for a large diameter, precision applied, environmentally friendly, pipe lining solution.

The end result is the first-ever geopolymer coating centrifugally cast through a state-of-the-art, precision controlled spray system. Unlike traditional, manual "pull through" applications, the EcoCast system's drive train allows the product to be consistently applied to preset coating thickness with each pass. Some of the other features include:

- A true structural repair
- Ability to work with a small footprint (10'-30')
- Can be used to restore round and non-round infrastructure
- Can rehabilitate any structure, decking or headwall
- Can rehabilitate pipes that have separated
- Extremely cost-effective for short segment repairs
- Advanced sealant can be specified for added corrosion protection

Typical Applications


DOT projects: highways and bridge overpasses


Concrete, sanitary and storm sewers


Corrugated metal pipe is the perfect candidate for EcoCast


Airports


Manholes and wet wells

THE ECOCAST ADVANTAGE

- EcoCast liners form an inorganic polymer network for higher resistance to acids and greater surface durability
- Cures quickly, providing shortened by-pass time and allows flows to be re-established much quicker than Portland cement based mortars.
- EcoCast is exceptionally resistant to environmental factors like heat and cold and allows for extended application environments through batch temperature controls
- EcoCast is a high strength fiber reinforced geopolymer specially designed for ease of use with mechanical pumping, spraying and application
- EcoCast is designed to stick and adhere to virtually any surface; unlike traditional cement mortars, the geopolymer is capable of bonding and building to greater thicknesses
- An engineered, 100% fully manufactured product with no added non-contributing fillers
- Qualifies for LEED credits and is styrene free

ECOCAST LINER MATERIAL PROPERTIES

Featuring Milliken Geopolymers

Geopolymers are a high performance fiber reinforced mortar specifically designed for structural rehabilitation. This high strength, ultra-low porosity material is made from natural mineral polymers and recycled industrial waste streams. Geopolymers are designed for use through multiple application techniques including pouring, placing, trowelling, spraying, or centrifugal casting. EcoCast can be used for rehabilitation of pipes and structures in Civil Infrastructure, Oil & Gas and Chemical industries. In addition, it is used to repair tunnels, bridges, and roads as well as to rehabilitate buildings and containment areas.

ECOCAST LINER PERFORMANCE DATA

Test Method	Duration	GeoSpray	Conventional Repair Mortar
Compressive Strength ASTM C-39/C-109	1 Day 28 Days	Min. 2,500 psi / 17 MPa Min. 8,000 psi / 55 MPa	 5,000 psi / 34 MPa
Flexural Strength ASTM C-78	7 Day 28 Days	1,100 psi / 7.6 MPa 1,500 psi / 10.3 MPa	 500 psi / 3.4 MPa
Modulus of Elasticity ASTM C-469	1 Day 28 Days	3,000,000 psi / 20,700 MPa 5,800,000 psi / 40,000 MPa	 3,000,000 psi / 20,700 MPa
Bond Strength to Concrete ASTM C-882	1 Day 28 Days	Min 900 psi / 6.2 MPa Min. 2,500 psi / 17 MPa	 N/A
Set Time ASTM C-807 Initial Cure Time	Initial Set Final Set	60 - 75 Minutes 90 - 110 Minutes	120 Minutes 300 minutes
Freeze Thaw Durability ASTM C-666	300 Cycles	100% Zero loss	80% to 90% 10% to 20% degradation
Shrinkage ASTM C-1090	28 Days	0.00% @ 65% R. H.	0.35% to 0.50% Shrinkage
Tensile Strength ASTM C-496	28 Days	Min. 800 psi / 5.5 MPa	400 psi / 2.7 MPa
Abrasion Resistance ASTM C-1138	5 Cycles @ 28 Day Maturity	2.7% Loss	4.7% Loss
Rapid Chloride Ion Permeability ASTM C-1202	28 Days	Very Low	N/A

The EcoCast Process

Typical condition of a corrugated metal pipe in need of repair

Corroded and damaged pipe is cleaned and patched

EcoCast spin casting sled begins the application process

The proprietary EcoCast system applies the structural geopolymer with a high level of efficiency and precision

ECOCAST* WITH Milliken GEOPOLYMERS

IPR has partnered with Milliken Infrastructure Solutions, LLC to deploy its EcoCast system utilizing Milliken Geopolymers. IPR is the industry's leading full service provider of trenchless underground solutions across the United States.

www.teamipr.com

IPR Locations

IPR SERVICES ALSO INCLUDE:

• TV Inspection & Cleaning • CIPP • Pipe Bursting • Pressure Pipe Applications

OTHER SERVICES:

• Assessment • Design Build • Construction Management • Emergency Services

Made in the USA

*Patent Pending

StormTrap®

MODULAR CONCRETE
STORMWATER MANAGEMENT

COLORADO SPRINGS DETENTION OPTION 1

COLORADO SPRINGS, CO

DESIGN ASSUMPTIONS

COVER:	MIN: 1.00" - MAX: 2.00"
GROUND WATER TABLE:	BELOW INVERT OF SYSTEM
SOIL PRESSURE:	3,000 PSF
LOADING:	HS-20 WHEEL LOADING

SHEET INDEX

JOB SITE INFORMATION

DESCRIPTION

JOB NAME:	COLORADO SPRINGS DETENTION OPTION 1
JOB ADDRESS:	COLORADO SPRINGS, CO
ENGINEERING CO:	CH2M
CONTACT NAME:	
CONTACT PHONE:	720-286-0844
CONTACT FAX:	
STORM TRAP SUPPLIER:	STORMTRAP
CONTACT NAME:	JERAMY SHERWOOD
CONTACT PHONE:	815-955-6655
CONTACT EMAIL:	JSHERWOOD@STORMTRAP.COM
WATER STORAGE REQ'D:	36,000.00 CUBIC FEET
WATER STORAGE PROV:	22,092.32 CUBIC FEET
UNIT HEADROOM:	5'-0" SINGLETRAP
UNIT QUANTITY:	52 UNITS - 52 TOTAL PIECES

StormTrap

PATENTS LISTED AT: [HTTP://STORMTRAP.COM/PATENT/

1287 WINDHAM PARKWAY
ROMEOVILLE, IL 60446
P: 877-867-6872
F: 331-318-5347

ENGINEER INFORMATION:

CH2M

9189 SOUTH JAMAICA STREET
ENGLEWOOD, CO 80112
Phone: 720-286-0844
Fax:

PROJECT INFORMATION:

COLORADO SPRINGS
DETENTION OPTION 1

COLORADO SPRINGS, CO

CURRENT ISSUE DATE:

06-OCT-2017

APPROVED BY:

ISSUED FOR:

PRELIMINARY

REV.:	DATE:	DESC.	BY:
1	06-OCT-2017	ISSUED FOR PRELIMINARY	ADF

SCALE:

SHEET TITLE:

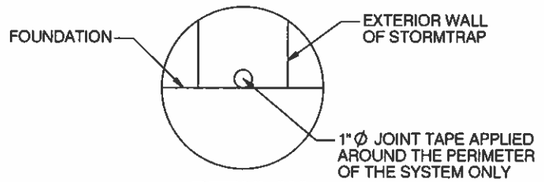
COVER SHEET

SHEET NUMBER:

0.0

STORMTRAP INSTALLATION SPECIFICATION

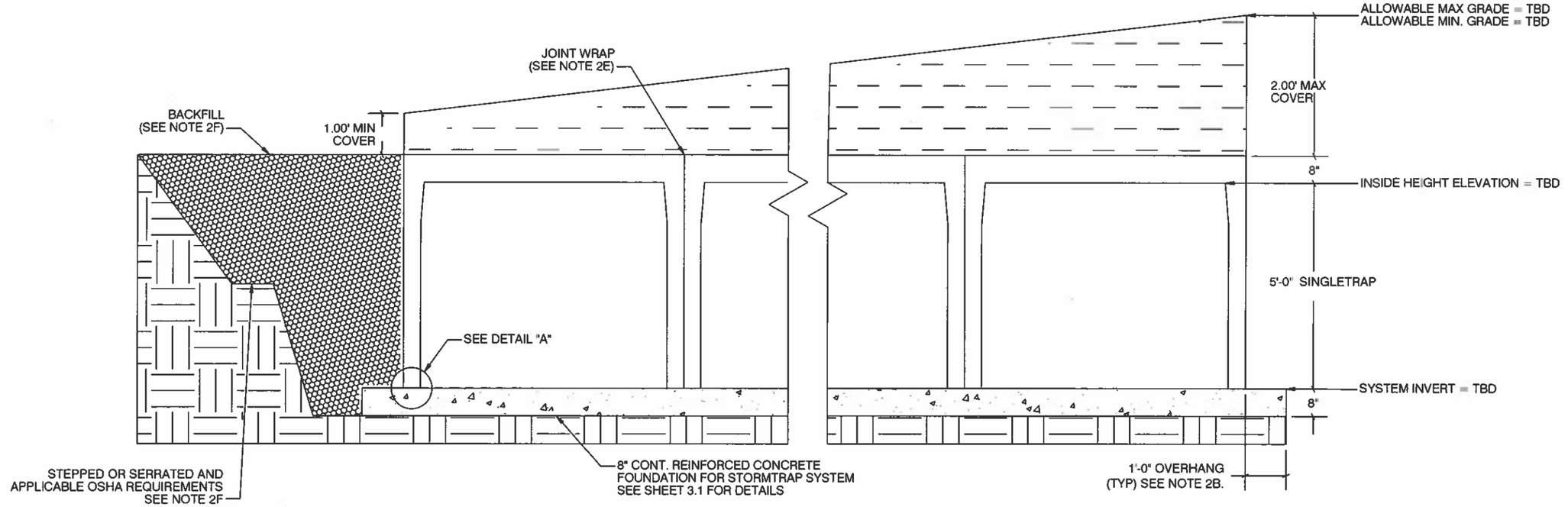
1. STORMTRAP MODULES SHALL BE MANUFACTURED ACCORDING TO SHOP DRAWINGS APPROVED BY THE INSTALLING CONTRACTOR AND ENGINEER. THE SHOP DRAWINGS SHALL INDICATE SIZE AND LOCATION OF ROOF OPENINGS AND INLET/ OUTLET PIPE OPENINGS.
2. STORMTRAP SHALL BE INSTALLED IN ACCORDANCE WITH ASTM C891-09, STANDARD PRACTICE FOR INSTALLATION OF UNDERGROUND PRE-CAST CONCRETE UTILITY STRUCTURES. THE FOLLOWING ADDITIONS AND/OR EXCEPTIONS SHALL APPLY:
   - A. SPECIFICATIONS ON THE ENGINEER'S DRAWINGS SHALL TAKE PRECEDENCE.
   - B. STORMTRAP MODULES SHALL BE PLACED ON LEVEL FOUNDATION (SEE SHEET 3.1) WITH A 1'-0" OVERHANG ON ALL SIDES THAT SHALL BE POURED IN PLACE BY INSTALLING CONTRACTOR.
   - C. THE STORMTRAP MODULES SHALL BE PLACED SUCH THAT THE MAXIMUM SPACE BETWEEN ADJACENT MODULES DOES NOT EXCEED 3/4". IF THE SPACE EXCEEDS 3/4", THE MODULES SHALL BE RESET WITH APPROPRIATE ADJUSTMENT MADE TO LINE AND GRADE TO BRING THE SPACE INTO SPECIFICATION.
   - D. THE PERIMETER HORIZONTAL JOINT OF THE STORMTRAP MODULES SHALL BE SEALED TO THE FOUNDATION WITH PREFORMED MASTIC JOINT SEALER ACCORDING TO ASTM C891-09, 8.8 AND 8.12. SEE DETAIL "A".
   - E. ALL EXTERIOR JOINTS BETWEEN ADJACENT STORMTRAP MODULES SHALL BE SEALED WITH PRE-FORMED, COLD-APPLIED, SELF-ADHERING ELASTOMERIC RESIN BONDED TO A WOVEN HIGHLY PUNCTURE RESISTANT POLYMER WRAP CONFORMING TO ASTM C891-09 AND SHALL BE 0'-8" INTEGRATED PRIMER SEALANT AS APPROVED BY STORMTRAP. THE ADHESIVE EXTERIOR JOINT WRAP SHALL BE INSTALLED ACCORDING TO THE FOLLOWING INSTALLATION INSTRUCTIONS:
     1. USE A BRUSH OR WET CLOTH TO THOROUGHLY CLEAN THE OUTSIDE SURFACE AT THE POINT WHERE THE JOINT WRAP IS TO BE APPLIED.
     2. A RELEASE PAPER PROTECTS THE ADHESIVE SIDE OF THE JOINT WRAP. PLACE THE ADHESIVE TAPE (BUTYL SIDE DOWN) AROUND THE STRUCTURE. REMOVING THE RELEASE PAPER AS YOU GO. PRESS THE JOINT WRAP FIRMLY AGAINST THE STORMTRAP MODULE SURFACE WHEN APPLYING.
   - F. THE FILL PLACED AROUND THE STORMTRAP UNITS MUST BE DEPOSITED ON BOTH SIDES AT THE SAME TIME AND TO APPROXIMATELY THE SAME ELEVATION. AT NO TIME SHALL THE FILL BEHIND ONE SIDE WALL BE MORE THAN 2'-0" HIGHER THAN THE FILL ON THE OPPOSITE SIDE. BACKFILL SHALL BE COMPACTED TO 95% STANDARD PROCTOR DENSITY OR OTHERWISE SPECIFIED BY ENGINEER. CARE SHALL BE TAKEN TO PREVENT ANY WEDGING ACTION AGAINST THE STRUCTURE, AND ALL SLOPES BOUNDING OR WITHIN THE AREA TO BE BACKFILLED MUST BE STEPPED OR SERRATED TO PREVENT WEDGE ACTION. (REFERENCE ARTICLE 502.10 I.D.O.T. S.S.R.B.C.) CARE SHALL ALSO BE TAKEN AS NOT TO DISRUPT THE JOINT WRAP FROM THE JOINT DURING THE BACKFILL PROCESS. BACKFILL MATERIAL SHALL BE CLEAN, CRUSHED, ANGULAR No.5 (AASHTO M43) AGGREGATE.



DETAIL "A"
JOINT TAPE INSTALLATION

STORMTRAP SPECIFICATION

1. TOTAL COVER: MIN. 1.00' MAX. 2.00' CONSULT STORMTRAP FOR ADDITIONAL COVER OPTIONS.
2. CONCRETE CHAMBER DESIGNED FOR AASHTO HS-20 WHEEL LOADING. MIN. SOIL PRESSURE 3,000 PSF.
3. ALL DIMENSIONS AND SOIL CONDITIONS, INCLUDING BUT NOT LIMITED TO GROUNDWATER AND SOIL BEARING CAPACITY ARE TO BE VERIFIED IN THE FIELD BY OTHERS PRIOR TO STORMTRAP INSTALLATION.
4. FOR STRUCTURAL CALCULATIONS THE WATER TABLE IS ASSUMED TO BE BELOW THE SYSTEM INVERT, IF DIFFERENT THAN ASSUMED, CONTACT STORMTRAP.
5. FOR STRUCTURAL CALCULATIONS THE SOIL DENSITY IS ASSUMED TO BE 120 PCF.
6. FOR FLOTATION CALCULATIONS THE WATER TABLE IS ASSUMED TO BE BELOW THE SYSTEM INVERT, IF DIFFERENT THAN ASSUMED, CONTACT STORMTRAP.
7. STORMTRAP IS NOT WATERTIGHT. CONTACT STORMTRAP FOR WATERTIGHT OPTIONS. WATERTIGHT APPLICATION TO BE PROVIDED BY OTHERS.



5'-0" SINGLETRAP

**FOR STRUCTURAL AND FLOTATION CALCULATIONS THE WATER TABLE IS ASSUMED TO BE BELOW THE SYSTEM INVERT, IF DIFFERENT THAN ASSUMED, CONTACT STORMTRAP.

StormTrap
PATENTS LISTED AT: (HTTP://STORMTRAP.COM/PATENT/)
1287 WINDHAM PARKWAY
ROMEOVILLE, IL 60446
P: 877-867-6872
F: 331-318-5347

ENGINEER INFORMATION:

CH2M
9189 SOUTH JAMAICA STREET
ENGLEWOOD, CO 80112
Phone: 720-286-0844
Fax:

PROJECT INFORMATION:

COLORADO SPRINGS DETENTION OPTION 1
COLORADO SPRINGS, CO

CURRENT ISSUE DATE:
06-OCT-2017

APPROVED BY:

ISSUED FOR:
PRELIMINARY

REV.:	DATE:	DESC.	BY
1	06-OCT-2017	ISSUED FOR PRELIMINARY	AD

SCALE:

SHEET TITLE:
SINGLETRAP INSTALLATION SPECIFICATIONS

SHEET NUMBER:
1.0

RECOMMENDED ACCESS OPENING SPECIFICATION

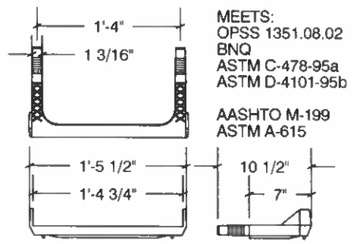
1. TYPICAL ACCESS OPENINGS FOR THE STORMTRAP SYSTEM ARE 2'-0" IN DIAMETER. ACCESS OPENINGS LARGER THAN 2'-0" IN DIAMETER NEED TO BE APPROVED BY STORMTRAP. ALL OPENINGS MUST RETAIN AT LEAST 1'-0" OF CLEARANCE IN ALL DIRECTIONS FROM THE EDGE OF THE STORMTRAP UNITS.
2. PLASTIC COATED STEEL STEPS PRODUCED BY M.A. INDUSTRIES PART #PS3-PFC (SEE DETAIL TO THE RIGHT) ARE PROVIDED INSIDE ANY UNIT WHERE DEEMED NECESSARY. THE HIGHEST STEP IN THE UNIT IS TO BE PLACED A DISTANCE OF 1'-0" FROM THE INSIDE EDGE OF THE STORMTRAP UNITS. ALL ENSUING STEPS SHALL BE PLACED WITH A MAXIMUM DISTANCE OF 1'-4" BETWEEN THEM. STEPS MAY BE MOVED OR ALTERED TO AVOID OPENINGS OR OTHER IRREGULARITIES IN THE UNIT.
3. STORMTRAP LIFTING INSERTS MAY BE RELOCATED TO COINCIDE WITH THE ACCESS OPENING OR THE CENTER OF GRAVITY OF THE UNIT AS NEEDED.
4. STORMTRAP ACCESS OPENINGS MAY BE RELOCATED TO AVOID INTERFERENCE WITH INLET AND/OR OUTLET PIPE OPENINGS SO PLACEMENT OF STEPS IS ATTAINABLE.
5. ACCESS OPENINGS SHOULD BE LOCATED IN ORDER MEET THE APPROPRIATE MUNICIPAL REQUIREMENTS. STORMTRAP RECOMMENDS AT LEAST ONE ACCESS OPENING PER SYSTEM FOR ACCESS AND INSPECTION.
6. USE PRECAST ADJUSTING RINGS AS NEEDED TO MEET GRADE. STORMTRAP RECOMMENDS FOR COVER OVER 2' TO USE PRECAST BARREL OR CONE SECTIONS. (BY OTHERS)

RECOMMENDED PIPE OPENING SPECIFICATION

1. PIPE OPENINGS SHALL MAINTAIN A MINIMUM 1'-0" OF CLEARANCE FROM A VERTICAL EDGE OF THE STORMTRAP UNIT.
2. MAXIMUM OPENING SIZE TO BE DETERMINED BY UNIT HEIGHT. PREFERRED OPENING SIZE Ø36" OR LESS. ANY OPENING NEEDED THAT DOES NOT FIT THIS CRITERIA SHALL BE BROUGHT TO THE ATTENTION OF STORMTRAP FOR REVIEW.
3. CONNECTING PIPES SHALL BE INSTALLED WITH A 1'-0" CONCRETE COLLAR, AND A AGGREGATE CRADLE FOR AT LEAST ONE PIPE LENGTH, AS SHOWN. A STRUCTURAL GRADE CONCRETE OR GROUT WITH A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 3000 PSI SHALL BE USED.
4. THE ANNULAR SPACE BETWEEN THE PIPE AND THE HOLE SHALL BE FILLED WITH NON-SHRINK GROUT.

RECOMMENDED PIPE INSTALLATION INSTRUCTIONS

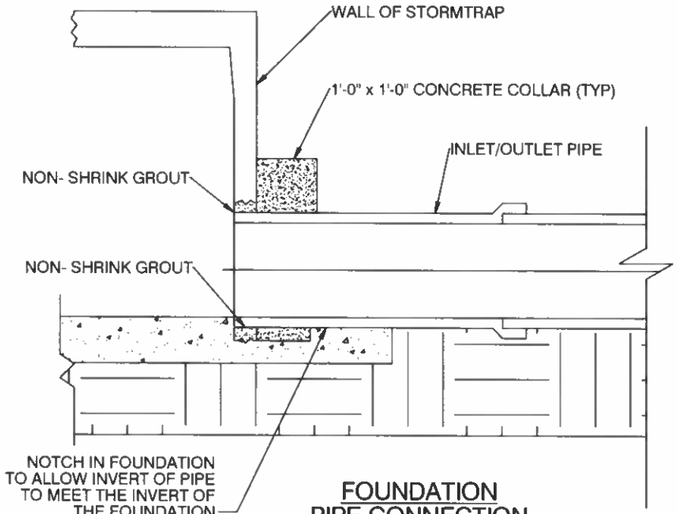
1. CLEAN AND LIGHTLY LUBRICATE ALL OF PIPE TO BE INSERTED INTO STORMTRAP.
2. IF PIPE IS CUT, CARE SHOULD BE TAKEN TO ALLOW NO SHARP EDGES. BEVEL AND LUBRICATE LEAD END OF PIPE.
3. ALIGN CENTER OF PIPE TO CORRECT ELEVATION AND INSERT INTO OPENING.



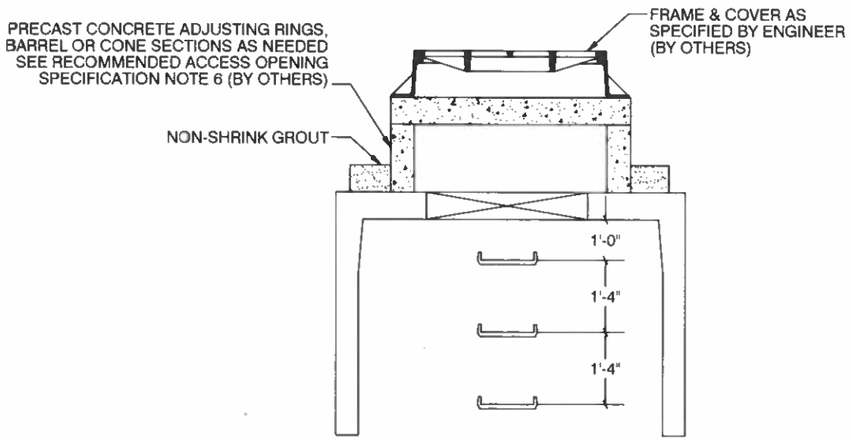
MEETS:
OPSS 1351.08.02
BNQ
ASTM C-478-95a
ASTM D-4101-95b

AASHTO M-199
ASTM A-615

STEP DETAIL



FOUNDATION PIPE CONNECTION



RISER / STAIR DETAIL

StormTrap
PATENTS LISTED AT: [HTTP://STORMTRAP.COM/PATENT/
1287 WINDHAM PARKWAY
ROMEOVILLE, IL 60446
P: 877-867-6872
F: 331-318-5347

ENGINEER INFORMATION:

CH2M

9189 SOUTH JAMAICA STREET
ENGLEWOOD, CO 80112
Phone: 720-286-0844
Fax:

PROJECT INFORMATION:

COLORADO SPRINGS
DETENTION OPTION 1

COLORADO SPRINGS, CO

CURRENT ISSUE DATE:

06-OCT-2017

APPROVED BY:

ISSUED FOR:

PRELIMINARY

REV.:	DATE:	DESC.	BY:
1	06-OCT-2017	ISSUED FOR PRELIMINARY	ADF

SCALE:

SHEET TITLE:

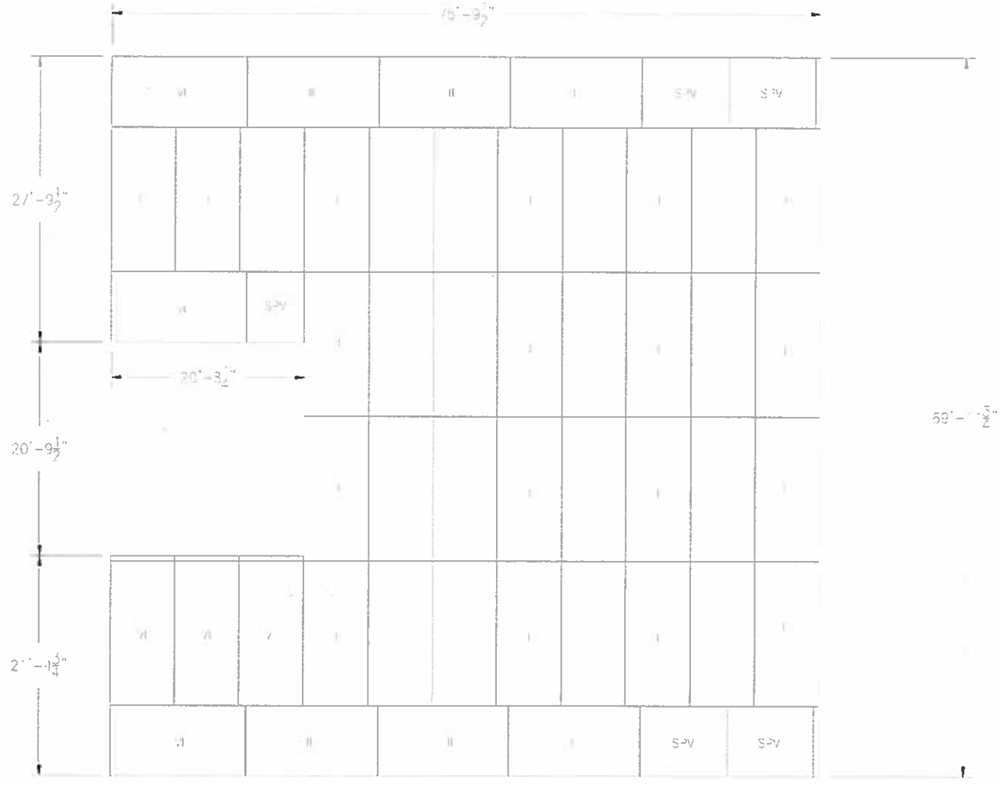
RECOMMENDED SINGLETRAP INSTALLATION SPECIFICATIONS

SHEET NUMBER:

2.0

BILL OF MATERIALS

QTY.	PART NO.	DESCRIPTION	WEIGHT
28	TYPE I	5'-0" SINGLETRAP TYPE I	13555
0	TYPE II	5'-0" SINGLETRAP TYPE II	8685
13	TYPE III	5'-0" SINGLETRAP TYPE III	16025
0	TYPE IV	5'-0" SINGLETRAP TYPE IV	9920
5	SPVI	5'-0" SINGLETRAP TYPE VI	VARIES
6	TYPE VI	5'-0" SINGLETRAP TYPE VI	18495
8	VI PANEL	5'-0" SINGLETRAP TYPE VII	2904
48	JOINT TAPE	JOINT TAPE - 14.5' PER ROLL	
10	JOINT WRAP	JOINT WRAP - 150' PER ROLL	



NOTES:

1. DIMENSION OF STORMTRAP SYSTEM ALLOW FOR A 3/4" GAP BETWEEN EACH UNIT.
2. ALL DIMENSIONS TO BE VERIFIED IN THE FIELD BY OTHERS.
3. SEE SHEET 2 FOR INSTALLATION SPECIFICATIONS.

LAYOUT DETAIL

DESIGN CRITERIA

INSIDE HEIGHT ELEVATION = TBD

ALLOWABLE MIN GRADE = TBD

ALLOWABLE MAX GRADE = TBD

SYSTEM INVERT = TBD

STORMTRAP VOLUME = 22,092.32 C.F. / 0.84 A.F.

StormTrap

PATENTS LISTED AT: [HTTP://STORMTRAP.COM/PATENT/

1287 WINDHAM PARKWAY
ROMEOVILLE, IL 60446
P: 877-867-6872
F: 331-318-5347

ENGINEER INFORMATION:

CH2M

9189 SOUTH JAMAICA STREET
ENGLEWOOD, CO 80112
Phone: 720-286-0844
Fax:

PROJECT INFORMATION:

COLORADO SPRINGS
DETENTION OPTION 1

COLORADO SPRINGS, CO

CURRENT ISSUE DATE:

06-OCT-2017

APPROVED BY:

ISSUED FOR:

PRELIMINARY

REV.:	DATE:	DESC.	BY
1	06-OCT-2017	ISSUED FOR PRELIMINARY	AD

SCALE:

SHEET TITLE:

LAYOUT DETAIL

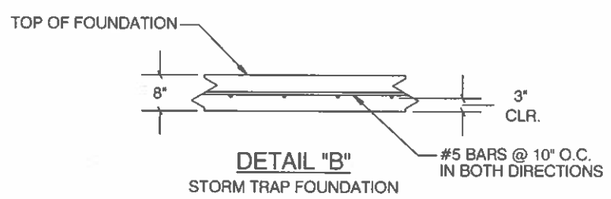
SHEET NUMBER:

3.0

NOTES:

1. DIMENSION OF FOUNDATION MUST HAVE 1'-0" OVERHANG BEYOND EXTERNAL FACE OF UNITS.
2. DIMENSION OF STORMTRAP SYSTEM ALLOW FOR A 3/4" GAP BETWEEN EACH UNIT.
3. ALL DIMENSIONS TO BE VERIFIED IN THE FIELD BY OTHERS.
4. SEE SHEET 2 FOR INSTALLATION SPECIFICATIONS.

CONCRETE FOUNDATION PLAN



DETAIL "B"
STORM TRAP FOUNDATION

NOTES:
1. 4,000 p.s.i. @ 28 DAYS, 5%-8% ENTRAINED AIR, 4" MAX. SLUMP.
2. NET ALLOWABLE SOIL PRESSURE GREATER THAN OR EQUAL TO 2,000 p.s.f.
3. SOIL CONDITIONS TO BE VERIFIED ON SITE BY OTHERS.
4. 1'-0" OVERHANG AROUND OUTSIDE OF SYSTEM.
5. REBAR: ASTM A-615 GRADE 60. BLACK BAR.

StormTrap
PATENTS LISTED AT: (HTTP://STORMTRAP.COM/PATENT/)
1287 WINDHAM PARKWAY
ROMEOVILLE, IL 60446
P: 877-867-6872
F: 331-318-5347

ENGINEER INFORMATION:

CH2M

9189 SOUTH JAMAICA STREET
ENGLEWOOD, CO 80112
Phone: 720-286-0844
Fax:

PROJECT INFORMATION:

COLORADO SPRINGS
DETENTION OPTION 1

COLORADO SPRINGS, CO

CURRENT ISSUE DATE:

06-OCT-2017

APPROVED BY:

ISSUED FOR:

PRELIMINARY

REV.:	DATE:	DESC.	BY:
1	06-OCT-2017	ISSUED FOR PRELIMINARY	ADF

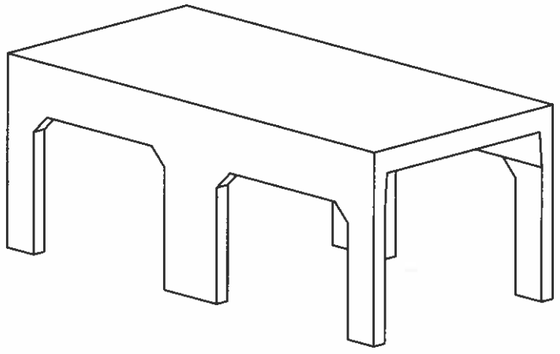
SCALE:

SHEET TITLE:

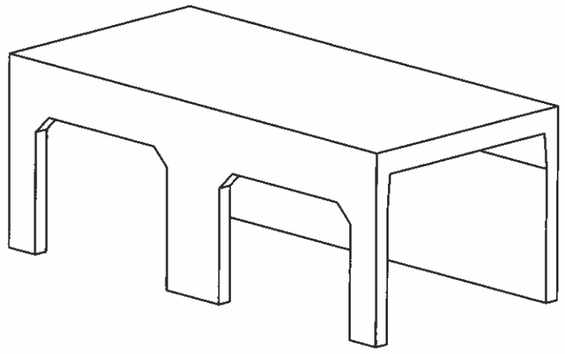
CONCRETE FOUNDATION PLAN

SHEET NUMBER:

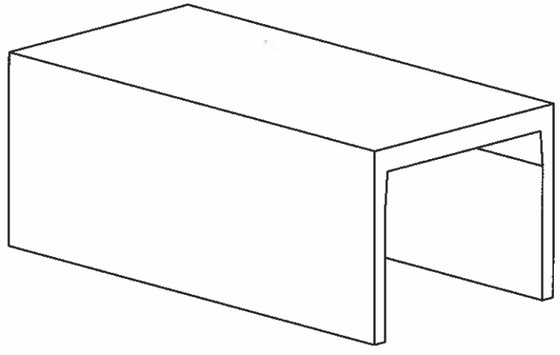
3.1



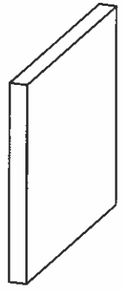
TYPE I



TYPE III



TYPE IV



TYPE VI

StormTrap

PATENTS LISTED AT: [HTTP://STORMTRAP.COM/PATENT/

1287 WINDHAM PARKWAY
ROMEOVILLE, IL 60446
P: 877-867-6872
F: 331-318-5347

ENGINEER INFORMATION:

CH2M

9189 SOUTH JAMAICA STREET
ENGLEWOOD, CO 80112
Phone: 720-286-0844
Fax:

PROJECT INFORMATION:

COLORADO SPRINGS
DETENTION OPTION 1

COLORADO SPRINGS, CO

CURRENT ISSUE DATE:

06-OCT-2017

APPROVED BY:

ISSUED FOR:

PRELIMINARY

REV.:	DATE:	DESC.	BY
1	06-OCT-2017	ISSUED FOR PRELIMINARY	AD

SCALE:

SHEET TITLE:

STANDARD
5'-0" SINGLETRAP
UNIT TYPES

SHEET NUMBER:

4.0

StormTrap®

MODULAR CONCRETE
STORMWATER MANAGEMENT

COLORADO SPRINGS DETENTION OPTION 2

COLORADO SPRINGS,

DESIGN ASSUMPTIONS	
COVER:	MIN: 1'-0" - MAX: 2'-0"
GROUND WATER TABLE:	BELOW INVERT OF SYSTEM
SOIL PRESSURE:	3,000 PSF
LOADING:	HS-20 WHEEL LOADING

SHEET INDEX

JOB SITE INFORMATION

DESCRIPTION

JOB NAME:	COLORADO SPRINGS DETENTION OPTION 2
JOB ADDRESS:	COLORADO SPRINGS,
ENGINEERING CO:	CH2M
CONTACT NAME:	
CONTACT PHONE:	720-286-0844
CONTACT FAX:	
STORM TRAP SUPPLIER:	STORMTRAP
CONTACT NAME:	JERAMY SHERWOOD
CONTACT PHONE:	815-955-6655
CONTACT EMAIL:	JSHERWOOD@STORMTRAP.COM
WATER STORAGE REQ'D:	36,000.00 CUBIC FEET
WATER STORAGE PROV:	28,218.67 CUBIC FEET
UNIT HEADROOM:	5'-0" SINGLETRAP
UNIT QUANTITY:	66 UNITS - 66 TOTAL PIECES

StormTrap

PATENTS LISTED AT: [HTTP://STORMTRAP.COM/PATENT/

1287 WINDHAM PARKWAY
ROMEOVILLE, IL 60446
P: 877-867-6872
F: 331-318-5347

ENGINEER INFORMATION:

CH2M

9189 SOUTH JAMAICA STREET
ENGLEWOOD, CO 80112
Phone: 720-286-0844
Fax:

PROJECT INFORMATION:

COLORADO SPRINGS
DETENTION OPTION 2

COLORADO SPRINGS,

CURRENT ISSUE DATE:

06-OCT-2017

APPROVED BY:

ISSUED FOR:

PRELIMINARY

REV.:	DATE:	DESC.	BY:
1	06-OCT-2017	ISSUED FOR PRELIMINARY	ADF

SCALE:

SHEET TITLE:

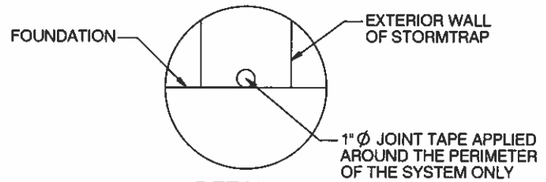
COVER SHEET

SHEET NUMBER:

0.0

STORMTRAP INSTALLATION SPECIFICATION

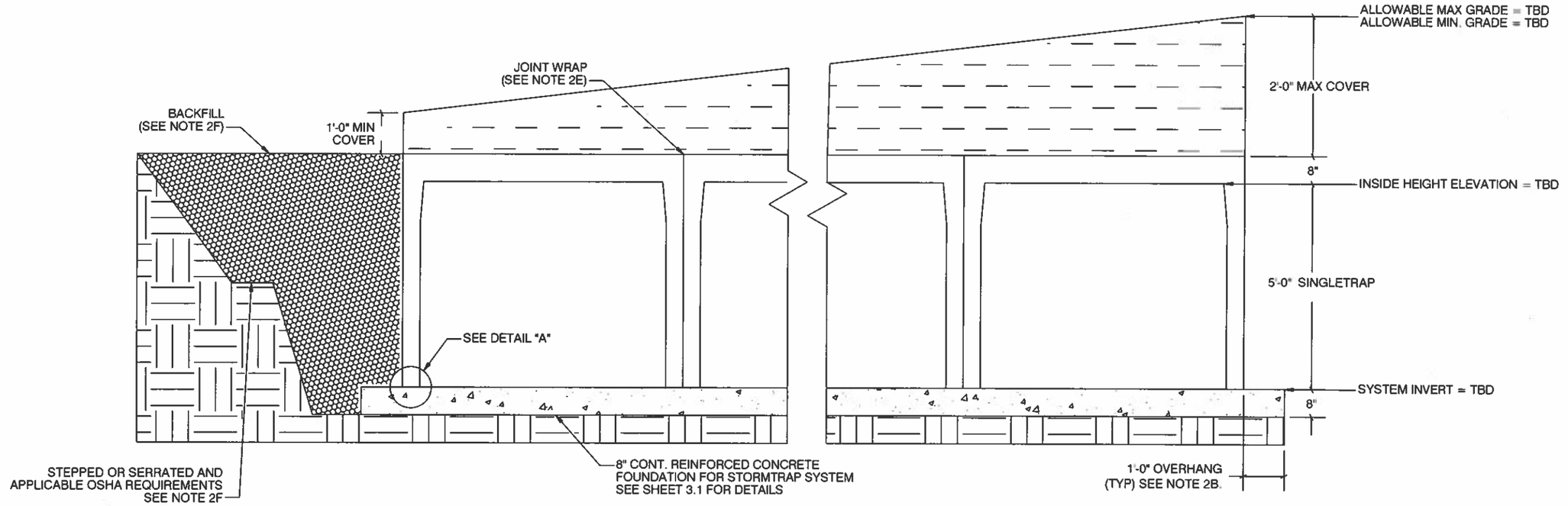
1. STORMTRAP MODULES SHALL BE MANUFACTURED ACCORDING TO SHOP DRAWINGS APPROVED BY THE INSTALLING CONTRACTOR AND ENGINEER. THE SHOP DRAWINGS SHALL INDICATE SIZE AND LOCATION OF ROOF OPENINGS AND INLET/ OUTLET PIPE OPENINGS.
2. STORMTRAP SHALL BE INSTALLED IN ACCORDANCE WITH ASTM C891-09, STANDARD PRACTICE FOR INSTALLATION OF UNDERGROUND PRE-CAST CONCRETE UTILITY STRUCTURES. THE FOLLOWING ADDITIONS AND/OR EXCEPTIONS SHALL APPLY:
   - A. SPECIFICATIONS ON THE ENGINEER'S DRAWINGS SHALL TAKE PRECEDENCE.
   - B. STORMTRAP MODULES SHALL BE PLACED ON LEVEL FOUNDATION (SEE SHEET 3.1) WITH A 1'-0" OVERHANG ON ALL SIDES THAT SHALL BE POURED IN PLACE BY INSTALLING CONTRACTOR.
   - C. THE STORMTRAP MODULES SHALL BE PLACED SUCH THAT THE MAXIMUM SPACE BETWEEN ADJACENT MODULES DOES NOT EXCEED 3/4". IF THE SPACE EXCEEDS 3/4", THE MODULES SHALL BE RESET WITH APPROPRIATE ADJUSTMENT MADE TO LINE AND GRADE TO BRING THE SPACE INTO SPECIFICATION.
   - D. THE PERIMETER HORIZONTAL JOINT OF THE STORMTRAP MODULES SHALL BE SEALED TO THE FOUNDATION WITH PREFORMED MASTIC JOINT SEALER ACCORDING TO ASTM C891-09, 8.8 AND 8.12. SEE DETAIL "A".
   - E. ALL EXTERIOR JOINTS BETWEEN ADJACENT STORMTRAP MODULES SHALL BE SEALED WITH PRE-FORMED, COLD-APPLIED, SELF-ADHERING ELASTOMERIC RESIN BONDED TO A WOVEN HIGHLY PUNCTURE RESISTANT POLYMER WRAP CONFORMING TO ASTM C891-09 AND SHALL BE 0'-8" INTEGRATED PRIMER SEALANT AS APPROVED BY STORMTRAP. THE ADHESIVE EXTERIOR JOINT WRAP SHALL BE INSTALLED ACCORDING TO THE FOLLOWING INSTALLATION INSTRUCTIONS:
     1. USE A BRUSH OR WET CLOTH TO THOROUGHLY CLEAN THE OUTSIDE SURFACE AT THE POINT WHERE THE JOINT WRAP IS TO BE APPLIED.
     2. A RELEASE PAPER PROTECTS THE ADHESIVE SIDE OF THE JOINT WRAP. PLACE THE ADHESIVE TAPE (BUTYL SIDE DOWN) AROUND THE STRUCTURE, REMOVING THE RELEASE PAPER AS YOU GO. PRESS THE JOINT WRAP FIRMLY AGAINST THE STORMTRAP MODULE SURFACE WHEN APPLYING.
   - F. THE FILL PLACED AROUND THE STORMTRAP UNITS MUST BE DEPOSITED ON BOTH SIDES AT THE SAME TIME AND TO APPROXIMATELY THE SAME ELEVATION. AT NO TIME SHALL THE FILL BEHIND ONE SIDE WALL BE MORE THAN 2'-0" HIGHER THAN THE FILL ON THE OPPOSITE SIDE. BACKFILL SHALL BE COMPACTED TO 95% STANDARD PROCTOR DENSITY OR OTHERWISE SPECIFIED BY ENGINEER. CARE SHALL BE TAKEN TO PREVENT ANY WEDGING ACTION AGAINST THE STRUCTURE, AND ALL SLOPES BOUNDING OR WITHIN THE AREA TO BE BACKFILLED MUST BE STEPPED OR SERRATED TO PREVENT WEDGE ACTION. (REFERENCE ARTICLE 502.10 I.D.O.T. S.S.R.B.C.) CARE SHALL ALSO BE TAKEN AS NOT TO DISRUPT THE JOINT WRAP FROM THE JOINT DURING THE BACKFILL PROCESS. BACKFILL MATERIAL SHALL BE CLEAN, CRUSHED, ANGULAR No.5 (AASHTO M43) AGGREGATE.



DETAIL "A"
JOINT TAPE INSTALLATION

STORMTRAP SPECIFICATION

1. TOTAL COVER: MIN. 1'-0" MAX. 2'-0" CONSULT STORMTRAP FOR ADDITIONAL COVER OPTIONS.
2. CONCRETE CHAMBER DESIGNED FOR AASHTO HS-20 WHEEL LOADING.
3. MIN. SOIL PRESSURE 3,000 PSF.
4. ALL DIMENSIONS AND SOIL CONDITIONS, INCLUDING BUT NOT LIMITED TO GROUNDWATER AND SOIL BEARING CAPACITY ARE TO BE VERIFIED IN THE FIELD BY OTHERS PRIOR TO STORMTRAP INSTALLATION.
5. FOR STRUCTURAL CALCULATIONS THE WATER TABLE IS ASSUMED TO BE BELOW THE SYSTEM INVERT, IF DIFFERENT THAN ASSUMED, CONTACT STORMTRAP.
6. FOR STRUCTURAL CALCULATIONS THE SOIL DENSITY IS ASSUMED TO BE 120 PCF.
7. FOR FLOTATION CALCULATIONS THE WATER TABLE IS ASSUMED TO BE BELOW THE SYSTEM INVERT, IF DIFFERENT THAN ASSUMED, CONTACT STORMTRAP.
8. STORMTRAP IS NOT WATERTIGHT. CONTACT STORMTRAP FOR WATERTIGHT OPTIONS. WATERTIGHT APPLICATION TO BE PROVIDED BY OTHERS.



5'-0" SINGLETRAP

**FOR STRUCTURAL AND FLOTATION CALCULATIONS THE WATER TABLE IS ASSUMED TO BE BELOW THE SYSTEM INVERT, IF DIFFERENT THAN ASSUMED, CONTACT STORMTRAP.

StormTrap
PATENTS LISTED AT: [HTTP://STORMTRAP.COM/PATENT/](http://stormtrap.com/patent/)
1287 WINDHAM PARKWAY
ROMEOVILLE, IL 60446
P: 877-867-6872
F: 331-318-5347

ENGINEER INFORMATION:
CH2M
9189 SOUTH JAMAICA STREET
ENGLEWOOD, CO 80112
Phone: 720-286-0844
Fax:

PROJECT INFORMATION:
COLORADO SPRINGS DETENTION OPTION 2
COLORADO SPRINGS,

CURRENT ISSUE DATE:
06-OCT-2017

APPROVED BY:

ISSUED FOR:
PRELIMINARY

REV.:	DATE:	DESC.	BY
1	06-OCT-2017	ISSUED FOR PRELIMINARY	AD

SCALE:

SHEET TITLE:
SINGLETRAP INSTALLATION SPECIFICATIONS

SHEET NUMBER:
1.0

RECOMMENDED ACCESS OPENING SPECIFICATION

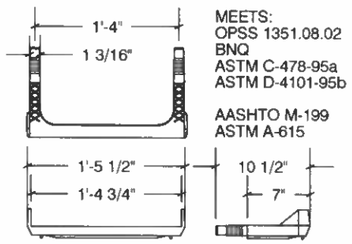
1. TYPICAL ACCESS OPENINGS FOR THE STORMTRAP SYSTEM ARE 2'-0" IN DIAMETER. ACCESS OPENINGS LARGER THAN 2'-0" IN DIAMETER NEED TO BE APPROVED BY STORMTRAP. ALL OPENINGS MUST RETAIN AT LEAST 1'-0" OF CLEARANCE IN ALL DIRECTIONS FROM THE EDGE OF THE STORMTRAP UNITS.
2. PLASTIC COATED STEEL STEPS PRODUCED BY M.A. INDUSTRIES PART #PS3-PFC (SEE DETAIL TO THE RIGHT) ARE PROVIDED INSIDE ANY UNIT WHERE DEEMED NECESSARY. THE HIGHEST STEP IN THE UNIT IS TO BE PLACED A DISTANCE OF 1'-0" FROM THE INSIDE EDGE OF THE STORMTRAP UNITS. ALL ENSUING STEPS SHALL BE PLACED WITH A MAXIMUM DISTANCE OF 1'-4" BETWEEN THEM. STEPS MAY BE MOVED OR ALTERED TO AVOID OPENINGS OR OTHER IRREGULARITIES IN THE UNIT.
3. STORMTRAP LIFTING INSERTS MAY BE RELOCATED TO COINCIDE WITH THE ACCESS OPENING OR THE CENTER OF GRAVITY OF THE UNIT AS NEEDED.
4. STORMTRAP ACCESS OPENINGS MAY BE RELOCATED TO AVOID INTERFERENCE WITH INLET AND/OR OUTLET PIPE OPENINGS SO PLACEMENT OF STEPS IS ATTAINABLE.
5. ACCESS OPENINGS SHOULD BE LOCATED IN ORDER MEET THE APPROPRIATE MUNICIPAL REQUIREMENTS. STORMTRAP RECOMMENDS AT LEAST ONE ACCESS OPENING PER SYSTEM FOR ACCESS AND INSPECTION.
6. USE PRECAST ADJUSTING RINGS AS NEEDED TO MEET GRADE. STORMTRAP RECOMMENDS FOR COVER OVER 2' TO USE PRECAST BARREL OR CONE SECTIONS. (BY OTHERS)

RECOMMENDED PIPE OPENING SPECIFICATION

1. PIPE OPENINGS SHALL MAINTAIN A MINIMUM 1'-0" OF CLEARANCE FROM A VERTICAL EDGE OF THE STORMTRAP UNIT.
2. MAXIMUM OPENING SIZE TO BE DETERMINED BY UNIT HEIGHT. PREFERRED OPENING SIZE Ø36" OR LESS. ANY OPENING NEEDED THAT DOES NOT FIT THIS CRITERIA SHALL BE BROUGHT TO THE ATTENTION OF STORMTRAP FOR REVIEW.
3. CONNECTING PIPES SHALL BE INSTALLED WITH A 1'-0" CONCRETE COLLAR, AND A AGGREGATE CRADLE FOR AT LEAST ONE PIPE LENGTH, AS SHOWN. A STRUCTURAL GRADE CONCRETE OR GROUT WITH A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 3000 PSI SHALL BE USED.
4. THE ANNULAR SPACE BETWEEN THE PIPE AND THE HOLE SHALL BE FILLED WITH NON-SHRINK GROUT.

RECOMMENDED PIPE INSTALLATION INSTRUCTIONS

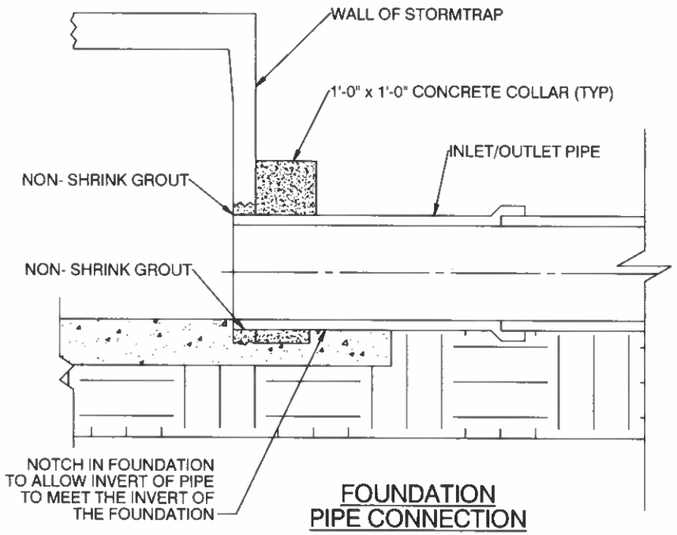
1. CLEAN AND LIGHTLY LUBRICATE ALL OF PIPE TO BE INSERTED INTO STORMTRAP.
2. IF PIPE IS CUT, CARE SHOULD BE TAKEN TO ALLOW NO SHARP EDGES. BEVEL AND LUBRICATE LEAD END OF PIPE.
3. ALIGN CENTER OF PIPE TO CORRECT ELEVATION AND INSERT INTO OPENING.



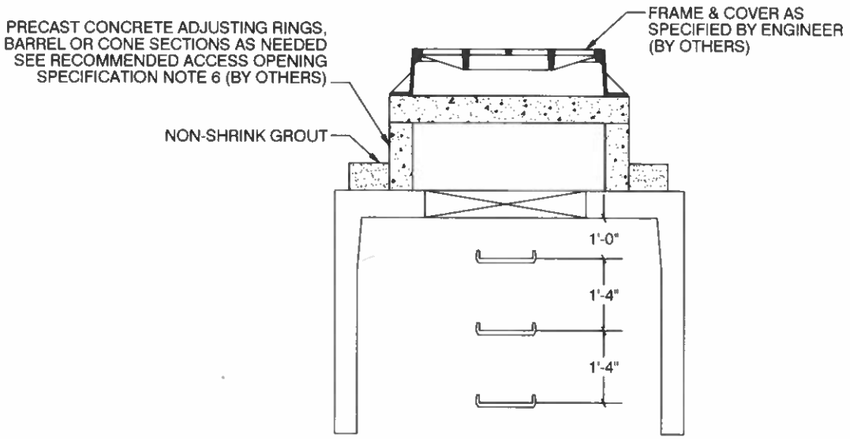
MEETS:
OPSS 1351.08.02
BNQ
ASTM C-478-95a
ASTM D-4101-95b

AASHTO M-199
ASTM A-615

STEP DETAIL



FOUNDATION PIPE CONNECTION



RISER / STAIR DETAIL

StormTrap
PATENTS LISTED AT: (HTTP://STORMTRAP.COM/PATENT/
1287 WINDHAM PARKWAY
ROMEOVILLE, IL 60446
P: 877-867-6872
F: 331-318-5347

ENGINEER INFORMATION:

CH2M

9189 SOUTH JAMAICA STREET
ENGLEWOOD, CO 80112
Phone: 720-286-0844
Fax:

PROJECT INFORMATION:

COLORADO SPRINGS
DETENTION OPTION 2

COLORADO SPRINGS,

CURRENT ISSUE DATE:

06-OCT-2017

APPROVED BY:

ISSUED FOR:

PRELIMINARY

REV.:	DATE:	DESC.	BY:
1	06-OCT-2017	ISSUED FOR PRELIMINARY	ADF

SCALE:

SHEET TITLE:

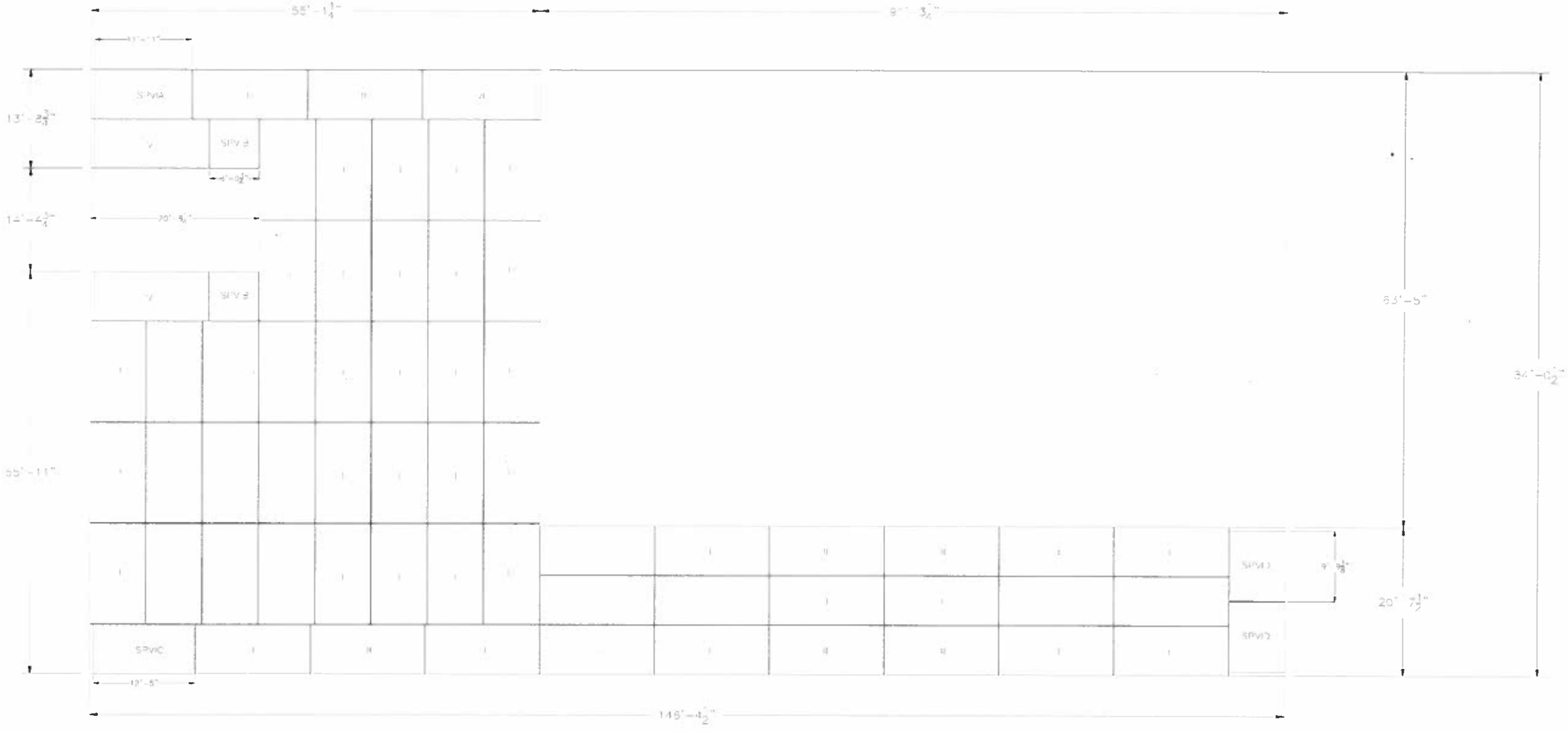
RECOMMENDED SINGLETRAP INSTALLATION SPECIFICATIONS

SHEET NUMBER:

2.0

BILL OF MATERIALS

QTY.	PART NO.	DESCRIPTION	WEIGHT
30	TYPE I	5'-0" SINGLETRAP TYPE I	13305
0	TYPE II	5'-0" SINGLETRAP TYPE II	8375
27	TYPE III	5'-0" SINGLETRAP TYPE III	15465
0	TYPE IV	5'-0" SINGLETRAP TYPE IV	9455
6	SPVI	5'-0" SINGLETRAP TYPE VI	VARIES
3	TYPE VI	5'-0" SINGLETRAP TYPE VI	17620
7	VI PANEL	6" THICK TYPE VI PANEL	2904
56	JOINT TAPE	JOINT TAPE - 14.5' PER ROLL	
13	JOINT WRAP	JOINT WRAP - 150' PER ROLL	



NOTES:

1. DIMENSION OF STORMTRAP SYSTEM ALLOW FOR A 3/4" GAP BETWEEN EACH UNIT.
2. ALL DIMENSIONS TO BE VERIFIED IN THE FIELD BY OTHERS.
3. SEE SHEET 2 FOR INSTALLATION SPECIFICATIONS.

LAYOUT DETAIL

DESIGN CRITERIA

INSIDE HEIGHT ELEVATION = TBD

ALLOWABLE MIN GRADE = TBD

ALLOWABLE MAX GRADE = TBD

SYSTEM INVERT = TBD

STORMTRAP VOLUME = 28,218.67 C.F. / 0.84 A.F.

StormTrap

PATENTS LISTED AT: [HTTP://STORMTRAP.COM/PATENT/]

1287 WINDHAM PARKWAY
ROMEOVILLE, IL 60446
P: 877-867-6872
F: 331-318-5347

ENGINEER INFORMATION:

CH2M

9189 SOUTH JAMAICA STREET
ENGLEWOOD, CO 80112
Phone: 720-286-0844
Fax:

PROJECT INFORMATION:

COLORADO SPRINGS DETENTION OPTION 2

COLORADO SPRINGS,

CURRENT ISSUE DATE:

06-OCT-2017

APPROVED BY:

ISSUED FOR:

PRELIMINARY

REV.:	DATE:	DESC.	BY:
1	06-OCT-2017	ISSUED FOR PRELIMINARY	AD

SCALE:

SHEET TITLE:

LAYOUT DETAIL

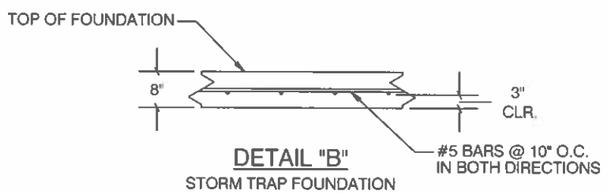
SHEET NUMBER:

3.0

NOTES:

1. DIMENSION OF FOUNDATION MUST HAVE 1'-0" OVERHANG BEYOND EXTERNAL FACE OF UNITS.
2. DIMENSION OF STORMTRAP SYSTEM ALLOW FOR A 3/4" GAP BETWEEN EACH UNIT.
3. ALL DIMENSIONS TO BE VERIFIED IN THE FIELD BY OTHERS.
4. SEE SHEET 2 FOR INSTALLATION SPECIFICATIONS.

CONCRETE FOUNDATION PLAN



DETAIL "B"
STORM TRAP FOUNDATION

NOTES:
1. 4,000 p.s.i. @ 28 DAYS, 5%-8% ENTRAINED AIR, 4" MAX. SLUMP.
2. NET ALLOWABLE SOIL PRESSURE GREATER THAN OR EQUAL TO 2,000 p.s.f.
3. SOIL CONDITIONS TO BE VERIFIED ON SITE BY OTHERS.
4. 1'-0" OVERHANG AROUND OUTSIDE OF SYSTEM.
5. REBAR: ASTM A-615 GRADE 60. BLACK BAR.

StormTrap
PATENTS LISTED AT: [HTTP://STORMTRAP.COM/PATENT/
1287 WINDHAM PARKWAY
ROMEOVILLE, IL 60446
P: 877-867-6872
F: 331-318-5347

ENGINEER INFORMATION:

CH2M

9189 SOUTH JAMAICA STREET
ENGLEWOOD, CO 80112
Phone: 720-286-0844
Fax:

PROJECT INFORMATION:

COLORADO SPRINGS
DETENTION OPTION 2

COLORADO SPRINGS,

CURRENT ISSUE DATE:

06-OCT-2017

APPROVED BY:

ISSUED FOR:

PRELIMINARY

REV.:	DATE:	DESC.	BY:
1	06-OCT-2017	ISSUED FOR PRELIMINARY	ADF

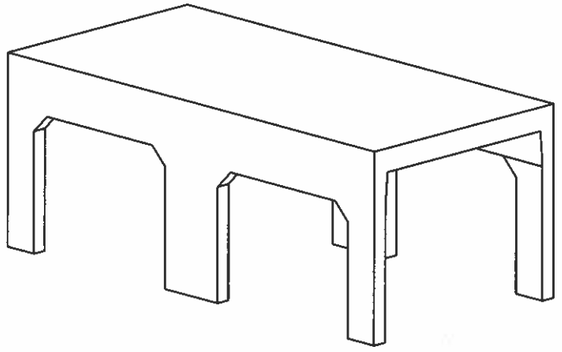
SCALE:

SHEET TITLE:

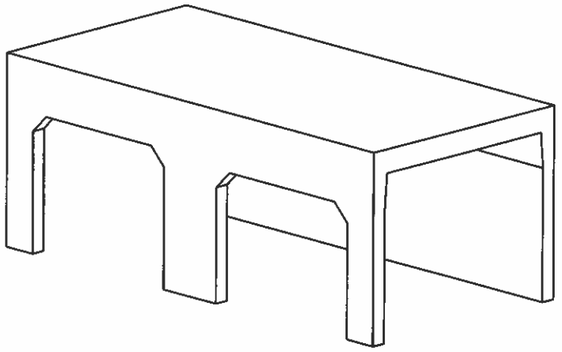
CONCRETE FOUNDATION PLAN

SHEET NUMBER:

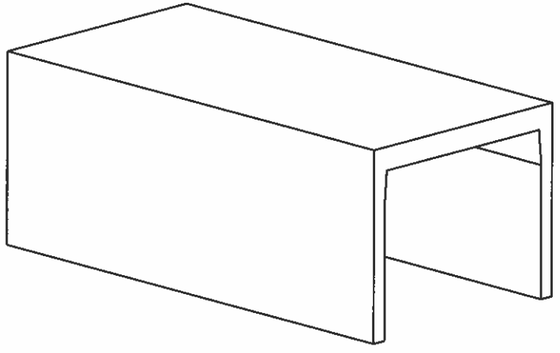
3.1



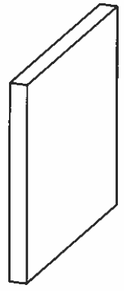
TYPE I



TYPE III



TYPE VI



TYPE VI PANEL

StormTrap

PATENTS LISTED AT: [HTTP://STORMTRAP.COM/PATENT/]

1287 WINDHAM PARKWAY
ROMEOVILLE, IL 60446
P: 877-867-6872
F: 331-318-5347

ENGINEER INFORMATION:

CH2M

9189 SOUTH JAMAICA STREET
ENGLEWOOD, CO 80112
Phone: 720-286-0844
Fax:

PROJECT INFORMATION:

COLORADO SPRINGS
DETENTION OPTION 2

COLORADO SPRINGS,

CURRENT ISSUE DATE:

06-OCT-2017

APPROVED BY:

ISSUED FOR:

PRELIMINARY

REV.:	DATE:	DESC.	BY
1	06-OCT-2017	ISSUED FOR PRELIMINARY	AD

SCALE:

SHEET TITLE:

STANDARD
5'-0" SINGLETRAP
UNIT TYPES

SHEET NUMBER:

4.0

October 12, 2017

LEED Contribution and Water Quality Available Upon Request

CH2M
9189 South Jamaica Street
Englewood, CO 80112

RE: Colorado Springs Detention Option 2 - Colorado Springs,

StormTrap, LLC is pleased to offer the following opinion of cost for the installation of the StormTrap System for the above stated project. Please note that the opinion of cost assumes that all spoil will be left on site and is exclusive of any applicable taxes. *Assumptions used for this project are as follows (see page 2 of the design for complete design criteria): Cover: 6" (Max of 3'-5"); Groundwater: 3'-0" below grade; Loading ASTM C857 HS-20.*

5'- 0" SINGLETRAP
Total Water Storage Provided: 0.65 Acre-Feet or 28,219 C.F.
Footprint (Outside Area): (147 x 85)

66 StormTrap Units (see attached layout)
(StormTrap Units + Delivery + JointTape + JointWrap)

SUB TOTAL FOR MATERIAL AND FREIGHT: **$176,866.00**

Excavation (StormTrap Area + Overdig + The Average Cover + 8 Inch Pad)	2,305	C.Y.	@	$9.00	Per C.Y.	$20,745.00
Install Units (Crane + Labor Costs for Setting Units)	66	Pieces	@	$100.00	Per Piece	$6,600.00
Pad (Forming + Labor + Rebar + Finishing)	6,681	S.F.	@	$9.00	Per S.F.	$60,129.00
Backfill (Filling Overdig w/ 3/4" Stone, to Top of Roof Slab)	398	C.Y.	@	$30.00	Per C.Y.	$11,940.00

SUB-TOTAL FOR INSTALLATION: **$99,414.00**

TOTAL OPINION OF COST FOR MATERIAL AND INSTALLATION: **$276,280.00**

Please feel free to call me if you have any questions.

Sincerely,

Jeramy Sherwood

Jeramy Sherwood

815 941 4549
331 318 5347
www.stormtrap.com
info@stormtrap.com
1287 Windham Parkway
Romeoville, Illinois 60446

October 10, 2017

LEED Contribution and Water Quality Available Upon Request

CH2M
9189 South Jamaica Street
Englewood, CO 80112

RE: Colorado Springs Detention Option 1 - Colorado Springs, CO

StormTrap, LLC is pleased to offer the following opinion of cost for the installation of the StormTrap System for the above stated project. Please note that the opinion of cost assumes that all spoil will be left on site and is exclusive of any applicable taxes. *Assumptions used for this project are as follows (see page 2 of the design for complete design criteria): Cover: 6" (Max of 3'-5"); Groundwater: 3'-0" below grade; Loading ASTM C857 HS-20.*

5'- 0" SINGLETRAP
Total Water Storage Provided: 0.51 Acre-Feet or 22,092 C.F.
Footprint (Outside Area): (76 x 70)

52 StormTrap Units (see attached layout)
(StormTrap Units + Delivery + JointTape + JointWrap)

SUB TOTAL FOR MATERIAL AND FREIGHT: **$143,013.00**

Excavation (StormTrap Area + Overdig + The Average Cover + 8 Inch Pad)	1,722	C.Y.	@	$9.00	Per C.Y.	$15,498.00
Install Units (Crane + Labor Costs for Setting Units)	52	Pieces	@	$200.00	Per Piece	$10,400.00
Pad (Forming + Labor + Rebar + Finishing)	5,170	S.F.	@	$9.00	Per S.F.	$46,530.00
Backfill (Filling Overdig w/ 3/4" Stone, to Top of Roof Slab)	259	C.Y.	@	$30.00	Per C.Y.	$7,770.00

SUB-TOTAL FOR INSTALLATION: **$80,198.00**

TOTAL OPINION OF COST FOR MATERIAL AND INSTALLATION: **$223,211.00**

Please feel free to call me if you have any questions.

Sincerely,

Jeramy Sherwood

Jeramy Sherwood

815 941 4549
331 318 5347
www.stormtrap.com
info@stormtrap.com
1287 Windham Parkway
Romeoville, Illinois 60446

PAGE INTENTIONALLY LEFT BLANK

CITY OF COLORADO SPRINGS
EAST BOULDER ST & PITKIN ST DRAINAGE IMPROVEMENTS
COLORADO SPRINGS, COLORADO
30% PRELIMINARY DESIGN DRAWINGS

NOVEMBER 2017

LOCATION MAP
NTS

N
VICINITY MAP
NTS

SHEET INDEX

AGENCIES

SERVICE	ENTITY	POINT OF CONTACT
PREPARED FOR:	CITY CAPITAL IMPROVEMENTS 30 SOUTH NEVADA AVENUE, SUITE 401 COLORADO SRPINGS. CO 80903	ADAM COPPER, PE (719) 385-XXXX
CIVIL ENGINEER:	CH2M HILL 9189 S JAMAICA ST ENGLEWOOD, CO 80112	ALLEN TURNER, PE (720) 286-4510
ENGINEERING DIVISION:	CITY OF COLORADO SPRINGS 30 S. NEVADA AVE. SUITE 401 COLORADO SPRINGS, CO 80903	MIKE CHAVEZ (719) 385-5408
WATER/WASTEWATER:	SPRINGS UTILITIES 1521 HANCOCK EXPRESSWAY COLORADO SPRINGS, CO 80901	ADAM BAKER (719) 668-4737

REVIEWED BY

CITY ENGINEERING DIVISION

BY: _____
ROADWAY DATE

BY: _____
TRAFFIC DATE

BY: _____
WATER RESOURCE DIVISION DATE

CITY STREETS DIVISION

BY: _____
DATE

SPRINGS UTILITIES WATER/WASTEWATER

BY: _____
DATE

UTILITY NOTIFICATION CENTER
OF COLORADO
CALL BEFORE YOU DIG
811
Call 2 days prior to any digging, grading or excavating for the marking of underground member utilities

DETAILED DRAINAGE CONSTRUCTION PLANS AND SPECIFICATIONS ENGINEERS STATEMENT

THESE DETAILED PLANS AND SPECIFICATIONS WERE PREPARED UNDER MY DIRECTION AND SUPERVISION . SAID DETAILED PLANS AND SPECIFICATIONS HAVE BEEN PREPARED ACCORDING TO THE CRITERIA ESTABLISHED BY THE CITY FOR DETAILED DRAINAGE PLANS AND SPECIFICATIONS, AND SAID PLANS AND SPECIFICATIONS ARE IN CONFORMITY WITH THE MASTER PLAN OF THE DRAINAGE BASIN. SAID DETAILED DRAINAGE PLANS AND SPECIFICATIONS MEET THE PURPOSES FOR WHICH THE DRAINAGE FACILITY(S) IS DESIGNED. I ACCEPT RESPONSIBILITY FOR AMY LIABILITY CAUSED BY ANY NEGLIGENT ACT, ERRORS, OR OMISSIONS ON MY PART IN PREPARATION OF THE DETAILED DRAINAGE PLANS AND SPECIFIATIONS.

ALLEN TURNER, P.E. ######### DATE
FOR AND ON BEHALF OF CH2M ENGINEERS

PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	APVD
DSGN	JM	DR	CHK	BS
			AT.	APVD
				AT.

9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112
ch2m:

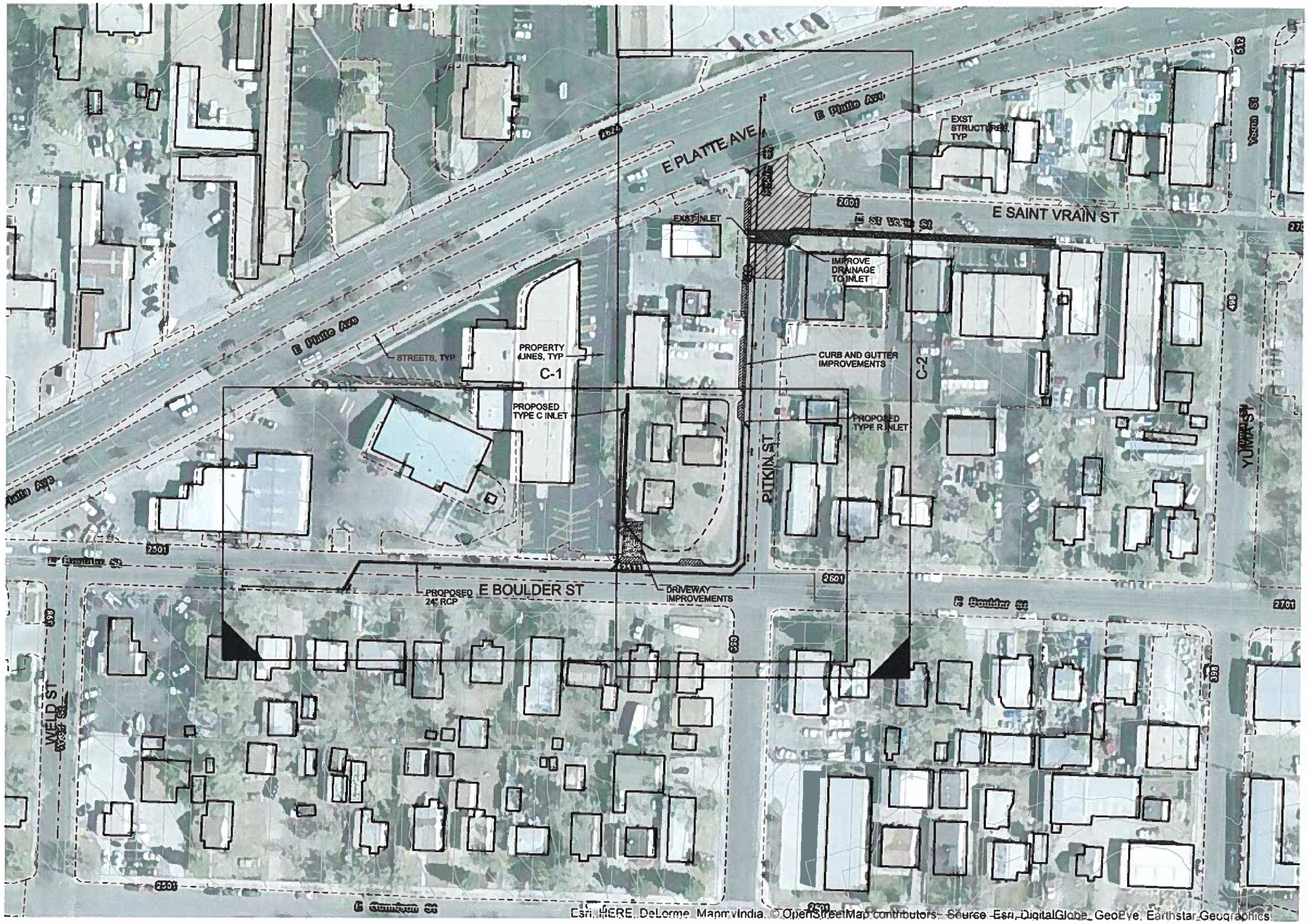
WATER RESOURCES ENGINEERING
COLORADO SPRINGS UTILITIES

LITTLE SHOOKS RUN -BOULDER & PITKIN IMPROVEMENTS
COVER SHEET

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2017
PROJ	691414
DWG	G-1
SHEET	1 of 7

30% DOCUMENT



N

0 50 100 150

Scale in Feet

PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	APVD
DSGN		DR	CHK	APVD
		JM	BS	AT

ch2m:

9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112

WATER RESOURCES ENGINEERING

COLORADO SPRINGS OLYMPIC CITY USA

LITTLE SHOOKS RUN -BOULDER & PITKIN IMPROVEMENTS

OVERALL SITE PLAN AND KEYMAP

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.

DATE	NOVEMBER 2017
PROJ	691414
DWG	G-3
SHEET	2 of 7

30% DOCUMENT

GENERAL SITE NOTES:

1. SOURCE OF TOPOGRAPHY SHOWN ON THE CIVIL PLANS ARE BASE MAPS PROVIDED BY THE CITY OF COLORADO SPRINGS IN 2011 CITY FIMS DATA, NAVD88 STATE PLAN CENTRAL COORDINATE SYSTEM. EXISTING CONDITIONS MAY VARY FROM THOSE SHOWN ON THESE PLANS.
2. THE CONTRACTOR SHALL VERIFY EXISTING CONDITIONS AND ADJUST WORK PLAN ACCORDINGLY PRIOR TO BEGINNING CONSTRUCTION. EXISTING TOPOGRAPHY, STRUCTURES, AND SITE FEATURES ARE SHOWN SCREENED AND/OR LIGHT-LINED. NEW FINISH GRADE, STRUCTURES, AND SITE FEATURES ARE SHOWN HEAVY-LINED UNLESS INDICATED OTHERWISE ON PLANS.
3. MAINTAIN, RELOCATE, OR REPLACE EXISTING SURVEY MONUMENTS, CONTROL POINTS, AND STAKES WHICH ARE DISTURBED OR DESTROYED.
4. PERFORM THE WORK TO PRODUCE THE SAME LEVEL OF ACCURACY AS THE ORIGINAL MONUMENT(S) IN A TIMELY MANNER, AND AT THE CONTRACTOR'S EXPENSE.
5. STAGING AREA SHALL BE FOR CONTRACTOR'S EMPLOYEE PARKING, CONTRACTOR'S TRAILERS AND ON-SITE STORAGE OF MATERIALS. PROVIDE TEMPORARY FENCING AS NECESSARY TO MAINTAIN SECURITY AT ALL TIMES.
6. ELEVATIONS GIVEN ARE TO FINISH GRADE UNLESS OTHERWISE SHOWN.
7. SLOPE UNIFORMLY BETWEEN CONTOURS AND SPOT ELEVATIONS SHOWN.
8. CONTRACTOR SHALL BE RESPONSIBLE FOR IMPLEMENTING AND MAINTAINING EROSION CONTROL DEVICES DURING CONSTRUCTION.
9. CONTRACTOR SHALL TAKE ALL OTHER MEASURES TO POSITIVELY PRECLUDE EROSION MATERIALS FROM LEAVING THE SITE.

ABBREVIATIONS

ACI	AMERICAN CONCRETE INSTITUTE
ACWWA	ARAPAHOE COUNTY WATER AND WASTEWATER AUTHORITY
ADDL	ADDITIONAL
ADJ	ADJACENT
AGGR	AGGREGATE
APVD	APPROVED
AVG	AVERAGE
@	AT
BETW	BETWEEN
BL	BASELINE
BOC	BOTTOM OF CONCRETE
BPS	BEGIN POOL SECTION, LOOKING DOWNSTREAM
BRS	BEGIN RIFFLE SECTION, LOOKING DOWNSTREAM
BVC	BEGINNING OF VERTICAL CURVE
CFS	CUBIC FEET PER SECOND
CCBWQA	CHERRY CREEK BASIN WATER QUALITY AUTHORITY
CIP	CAST IN PLACE
CJ	CONSTRUCTION JOINT
CL	CENTERLINE
CLSM	CONTROLLED LOW STRENGTH MATERIAL
CMP	CORRUGATED METAL PIPE
CONC	CONCRETE
CONDO	CONDOMINIUM
CONT	CONTINUED, CONTINUOUS, CONTINUATION
COORD	COORDINATE
CS	CROSS SECTION
CTR	CENTER
CU FT	CUBIC FOOT
CY, CU YD	CUBIC YARD
DIA	DIAMETER
DT	DETAIL
EA	EACH
ECCV	EAST CHERRY CREEK VALLEY WATER AND SANITATION DISTRICT
EG	EXAMPLE
EL	ELEVATION, EASEMENT LINE
ENGR	ENGINEER
EQ	EQUATION
EQL	EQUAL
ESC	EROSION AND SEDIMENT CONTROL
EXST, EXIST	EXISTING
FIG	FIGURE
FES	FLARED END SECTION
FG	FINISH GRADE
FL	FLOW LINE
FT	FOOT OR FEET
FPS	FEET PER SECOND
G, GND	GROUND
GESC	GRADING, EROSION, AD SEDIMENT CONTROL
GPS	GLOBAL POSITION SYSTEM
HGL	HYDRAULIC GRADE LINE
HGT	HEIGHT
HORIZ	HORIZONTAL
INV EL	INVERT ELEVATION
IN	INCH
INV, INVT	INVERT
IP	INLET PROTECTION
JCT	JUNCTION
L	LENGTH
LAT	LATITUDE
LB	POUND
LB/FT^2	POUNDS PER SQUARE FOOT
LF	LINEAR FEET
LONG	LONGITUDINAL
LT	LEFT
MAX	MAXIMUM
MH	MANHOLE
MIN	MINIMUM
MISC	MISCELLANEOUS
NAVD	NORTH AMERICAN VERTICAL DATUM
N	NORTH
NGVD	NATIONAL GEODETIC VERTICAL DATUM
NIC	NOT IN CONTRACT
NO., #	NUMBER
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
O.F.	OUTSIDE FACE
OPP	OPPOSITE
OZ	OUNCE
PC	POINT OF CURVE
PI	POINT OF INTERSECTION
PL	PROPERTY LINE
POB	POINT OF BEGIN
POE	POINT OF END
PP	POWER POLE
PRC	POINT OF REVERSE CURVE
PRCST	PRECAST
PROP	PROPERTY
PT	POINT OF TANGENCY
PVC	POLYVINYL CHLORIDE
PVI	POINT OF VERTICAL INTERSECTION
PVMT	PAVEMENT
PVT	POINT OF VERTICAL TANGENCY
R OR RAD	RADIUS
RCP	REINFORCED CONCRETE PIPE
REC	RECORDED
REF	REFER OR REFERENCE
REINF	REINFORCED, REINFORCING, REINFORCE
REQD	REQUIRED
RT	RIGHT
S	SLOPE, SOUTH
SB	SEDIMENT BASIN
SCHED	SCHEDULE
SECT	SECTION
SED	SEDIMENTATION
SEMSWA	SOUTHEAST METRO STORMWATER AUTHORITY
SH	SHEET
SPEC, SPECS	SPECIFICATIONS
SQ	SQUARE
SQ FT	SQUARE FOOT, FEET
SQ IN	SQUARE INCH
SQ YD	SQUARE YARD
ST	STORM DRAIN
STA	STATION
STD	STANDARD
STRL	STRUCTURAL
T	SHEAR
T&B	TOP AND BOTTOM
TAN	TANGENT
TB	TOP OF BOULDER
TCE	TEMPORARY CONSTRUCTION EASEMENT
TEL	TELEPHONE
THRU	THROUGH
TOC	TOP OF CONCRETE
TOF	TOP OF FOOTING
TOG	TOP OF GROUT, TOP OF GRATE
TOS	TOP OF SLAB
TOW	TOP OF WALL
TP	TURNING POINT
TRANS	TRANSITION
TYP	TYPICAL
UDFCD	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
VC	VERTICAL CURVE
VCC	VALLEY COUNTRY CLUB
VEL	VELOCITY
VERT	VERTICAL
VIF	VERIFY IN FIELD
VPC	POINT OF VERTICAL CURVATURE
VPI	POINT OF VERTICAL INTERSECTION
VPT	POINT OF VERTICAL TANGENT
W	WEST
W/	WITH
WS	WATER SURFACE

CIVIL LEGEND

EXISTING / THIS CONTRACT

- BM — BENCH MARK
- BRIDLE EASEMENT
- BRUSH/TREE LINE
- CENTER LINE, BUILDING, ROAD, ETC.
- CHANNEL STATIONING AND CENTERLINE (10+00)
- CONTOUR LINE (5280)
- CULVERT
- DEMOLITION (OR)
- DRAINAGE WAY OR DITCH
- FENCE LINE
- OVERHEAD POWERLINE (E-OVH)
- PROPERTY LINE
- CATCH BASIN OR INLET (CB OR CB)
- ELECTRIC OVERHEAD POWER POLE
- ELECTRIC TRANSFORMER
- FENCE POST OR GUARD POST
- FIRE HYDRANT
- GUY ANCHOR
- LIGHT POLE
- MANHOLE (D OR S)
- SLOPE, DIRECTION OF FLOW
- STRUCTURE, BUILDING OR FACILITY
- SPOT ELEVATION (5280.1)
- SURVEY CONTROL POINT OR POINT OF INTERSECTION
- UTILITY POLE
- WATER
- INLETS, TYPE R & C
- PROPOSED RCP
- ASPHALT REPLACEMENT
- CONCRETE GUTTER
- CONCRETE SIDEWALK CONCRETE GUTTER PAN
- CONCRETE RAMP
- ROADBASE CLASS 6

SECTION / DETAIL DESIGNATIONS

SECTION (LETTER) OR DETAIL (NUMERAL) DESIGNATION — DRAWING NUMBER (REPLACED WITH A LINE IF TAKEN AND SHOWN ON SAME SHEET) — ON DRAWING WHERE SECTION OR DETAIL IS TAKEN: 100-A-10010A1 — DRAWING NUMBER WHERE SHOWN

B SECTION — SCALE — 100-S-3001 — ON DRAWING WHERE SECTION IS SHOWN: DRAWING NUMBER(S) WHERE TAKEN

2 DETAIL — SCALE — 200-M-10B10A — ON DRAWING WHERE DETAIL IS SHOWN: DRAWING NUMBER(S) WHERE TAKEN

TITLE — SCALE — ON DRAWING WHERE ONLY A TITLE IS REQUIRED WITH NO REFERENCE (EG: ELEVATIONS)

B — SECTION CALLOUT WHERE SECTION IS ON THE SAME SHEET AND CUT EXTENDS TO A FIXED LIMIT

B / C-1 — SECTION CALLOUT WHERE SECTION IS ON ANOTHER SHEET AND CUT EXTENDS THROUGHOUT ENTIRE SHEET

1 — KEYNOTE NUMBER

1 — REVISION / ADDENDA NUMBER

N — NORTH ARROW

SHEET LIMITS KEY

DRAWING NUMBER PP-X — LOWER LEFT CORNER DWG

PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	DSGN	DR	CHK	BS	REVISION	BY	APVD
			JM				AT	

ch2m:
9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112

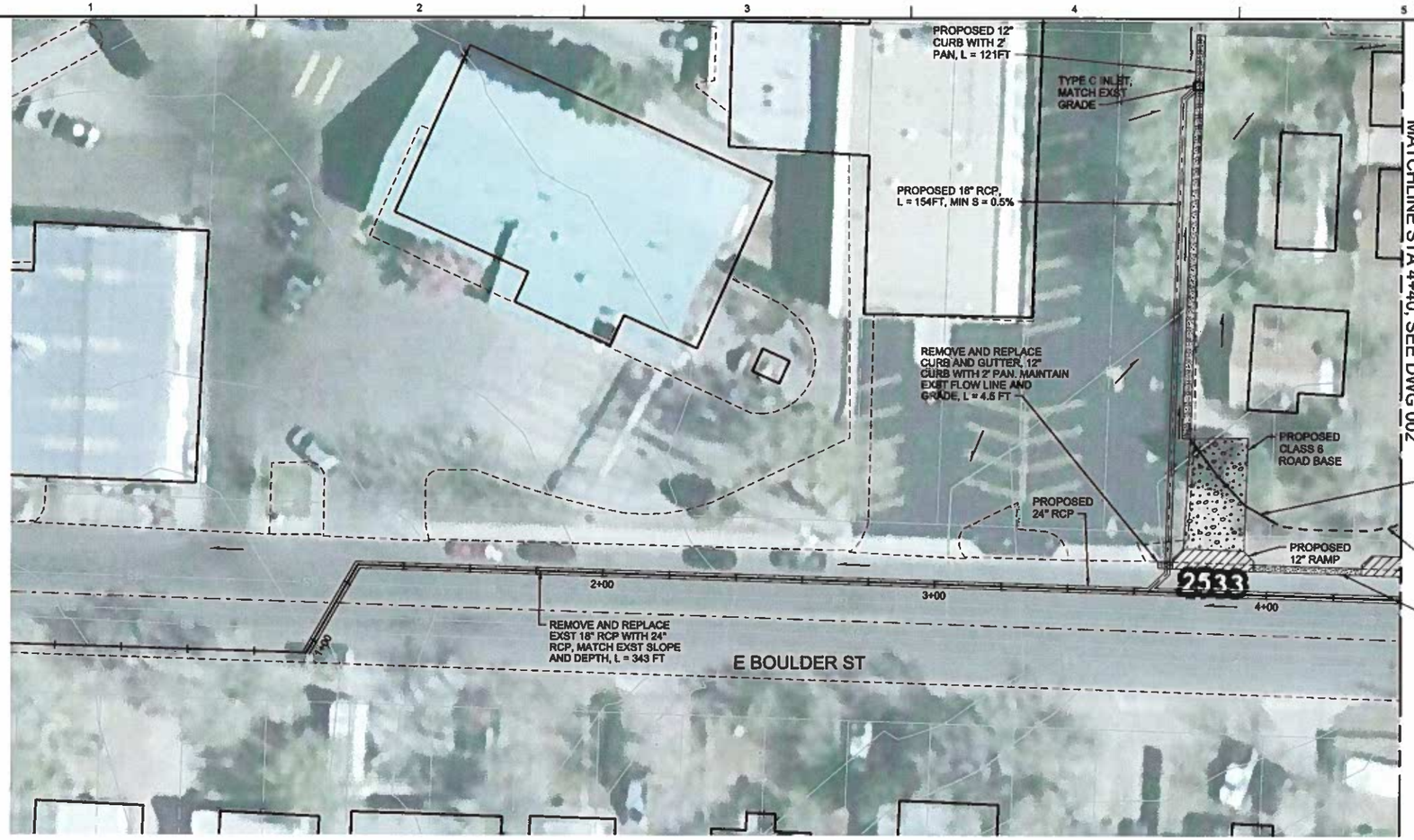
LITTLE SHOOKS RUN -BOULDER & PITKIN IMPROVEMENTS

NOTES, ABBREVIATIONS AND LEGEND

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	NOVEMBER 2017
PROJ	691414
DWG	G-2
SHEET	3 of 7

30% DOCUMENT



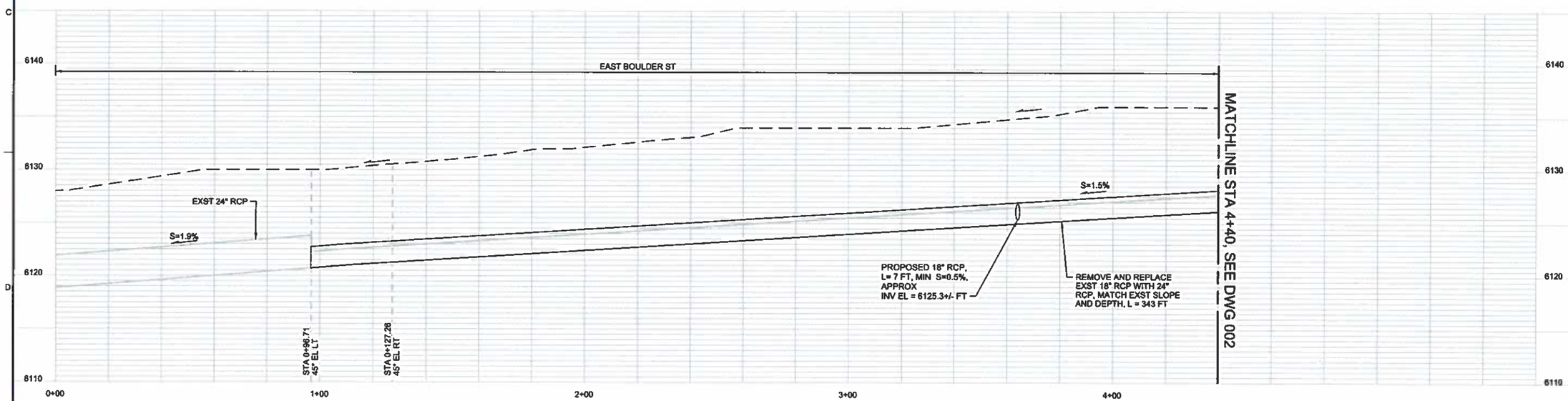
NOTE:

1. ELEVEATION'S NOTED ON THESE PLANS ARE BASED ON 2011 2' LIDAR DATA AND ARE APPROXIMATE. IN ALL CASES, PROPOSED FLOW LINE ELEVATIONS ARE TO MATCH EXISTING CONDITIONS OR MODIFIED PER OWNERS REPRESENATIVE.

N

0 20 40 60

Scale In Feet



PRELIMINARY
NOT FOR
CONSTRUCTION

NO.	DSGN	DATE	DR	CHK	REVISION	BY	APVD
			JM	BS		AT	APVD

9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112
ch2m:

WATER RESOURCES ENGINEERING

COLORADO SPRINGS

LITTLE SHOOKS RUN -BOULDER & PITKIN IMPROVEMENTS

STA 0+00 TO STA 4+40

30% DOCUMENT

VERIFY SCALE

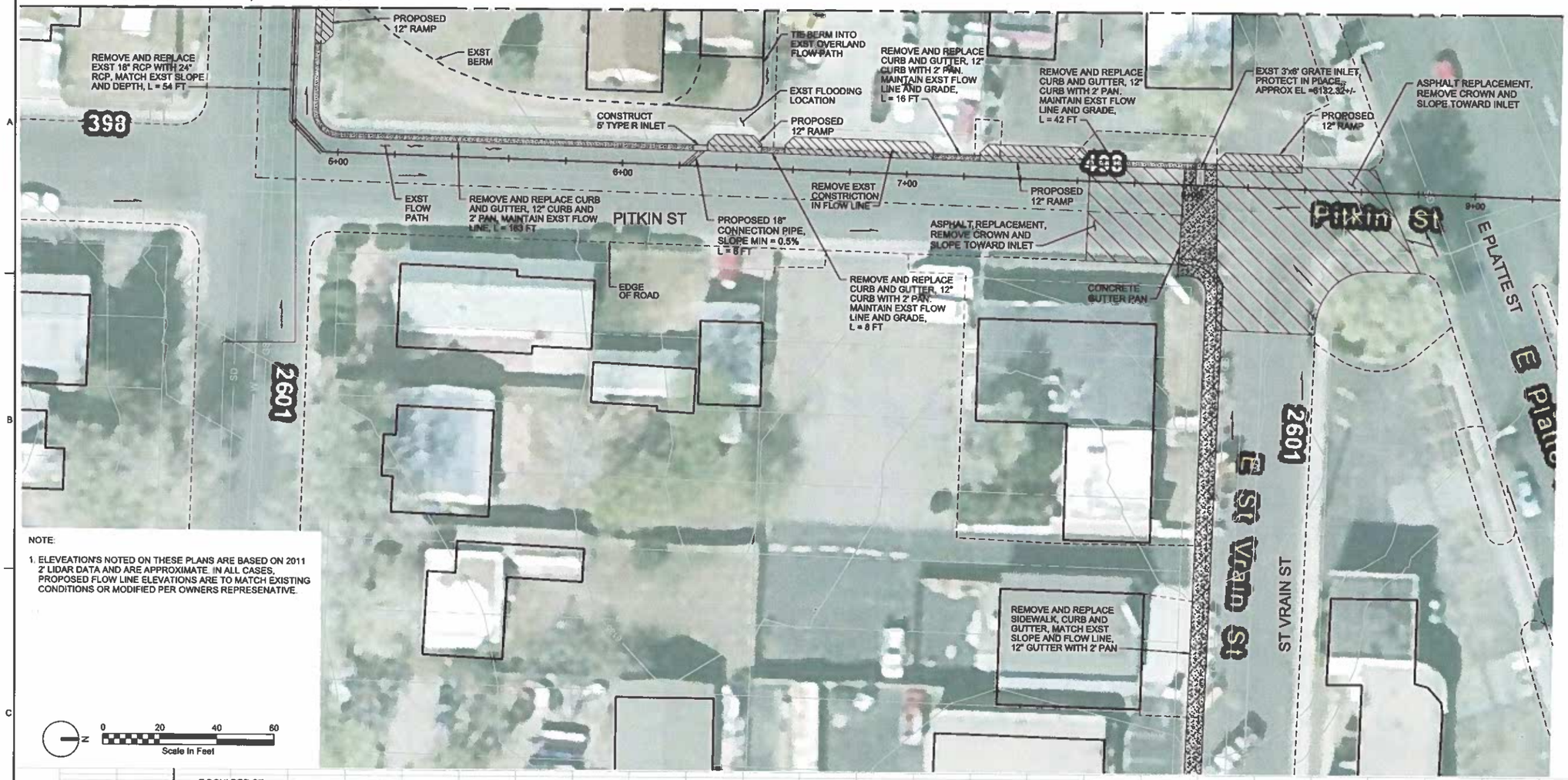
BAR IS ONE INCH ON ORIGINAL DRAWING

0 1"

DATE	NOVEMBER 2017
PROJ	691414
DWG	C-1
SHEET	4 of 7

$PWURL $PWPATH FILENAME: LSP-050-C-C001.dgn PLOT DATE: 2017\11\01 PLOT TIME: 1:33:47 PM

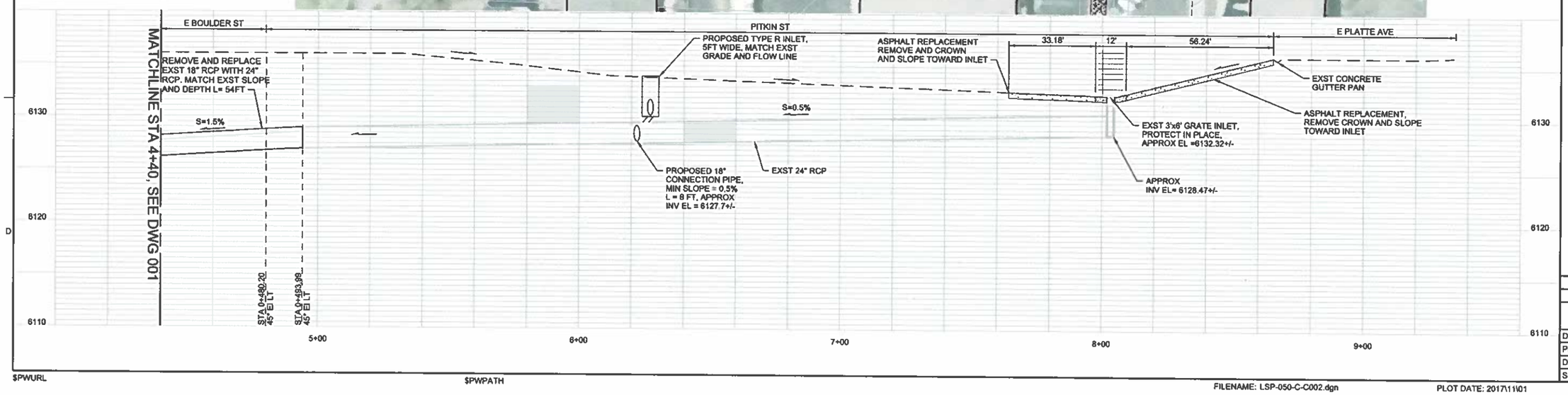
MATCHLINE STA 4+40, SEE DWG 001



NOTE:

1. ELEVEATION'S NOTED ON THESE PLANS ARE BASED ON 2011 2' LIDAR DATA AND ARE APPROXIMATE. IN ALL CASES, PROPOSED FLOW LINE ELEVATIONS ARE TO MATCH EXISTING CONDITIONS OR MODIFIED PER OWNERS REPRESENATIVE.

N 0 20 40 60
Scale In Feet



PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	DSGN	DR	JM	REVISION	CHK	BS	APVD	BY	APVD	AT

9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112
ch2m:

WATER RESOURCES ENGINEERING
COLORADO SPRINGS

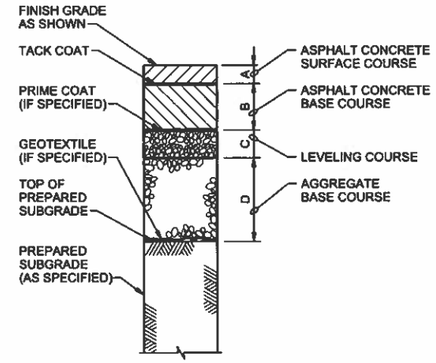
LITTLE SHOOKS RUN -BOULDER & PITKIN IMPROVEMENTS
STA 4+40 TO STA 8+00

REUSE OF DOCUMENTS

30% DOCUMENT

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2017
PROJ	691414
DWG	C-2
SHEET	5 of 7



PAVEMENT TYPE(S)	DIMENSION (INCHES)			
	A	B	C	D
A1	*	*	*	*
A2	*	*	*	*
A3	*	*	*	*

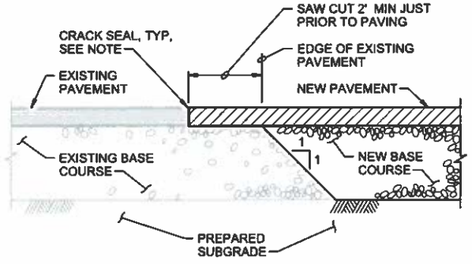
NOTE:

PROVIDE ASPHALT CONCRETE PAVEMENT TYPE AS SHOWN ON PLANS.

ASPHALT CONCRETE PAVEMENT

NTS

3212-210



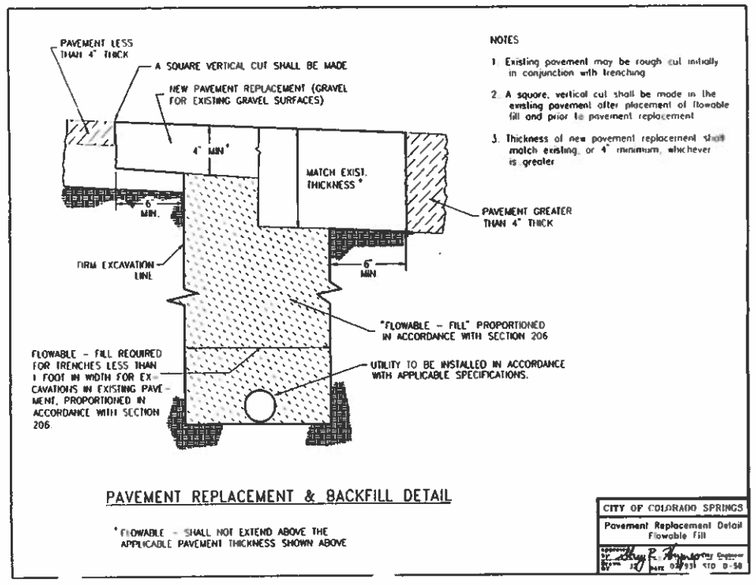
NOTE:

PAINT EDGE OF EXISTING ASPHALT WITH TACK COAT PRIOR TO PAVING.
CRACK SEAL JOINT AFTER PAVING OPERATION HAS BEEN COMPLETED.

PAVEMENT CONNECTION

NTS

3212-215



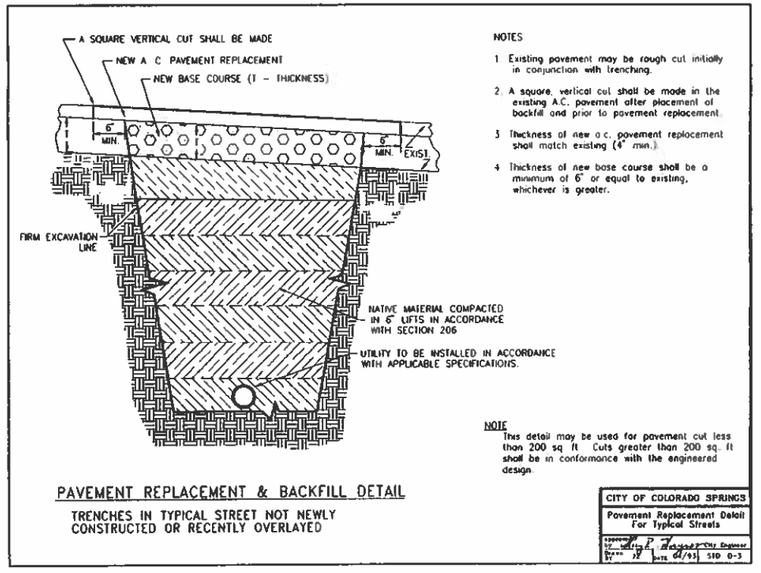
NOTES

1. Existing pavement may be rough cut initially in conjunction with trenching
2. A square, vertical cut shall be made in the existing pavement after placement of flowable fill and prior to pavement replacement
3. Thickness of new pavement replacement shall match existing, or 4" minimum, whichever is greater

PAVEMENT REPLACEMENT & BACKFILL DETAIL

* FLOWABLE - SHALL NOT EXTEND ABOVE THE APPLICABLE PAVEMENT THICKNESS SHOWN ABOVE

CITY OF COLORADO SPRINGS
Pavement Replacement Detail Flowable Fill
STD D-58



NOTES

1. Existing pavement may be rough cut initially in conjunction with trenching.
2. A square, vertical cut shall be made in the existing A.C. pavement after placement of backfill and prior to pavement replacement.
3. Thickness of new a.c. pavement replacement shall match existing (4" min.)
4. Thickness of new base course shall be a minimum of 6" or equal to existing, whichever is greater.

NOTE

This detail may be used for pavement cut less than 200 sq. ft. Cuts greater than 200 sq. ft shall be in conformance with the engineered design.

PAVEMENT REPLACEMENT & BACKFILL DETAIL

TRENCHES IN TYPICAL STREET NOT NEWLY CONSTRUCTED OR RECENTLY OVERLAYED

CITY OF COLORADO SPRINGS
Pavement Replacement Detail For Typical Streets
STD D-3

1 DETAILS

NTS

PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	APVD
DSGN	JM	DR	BS	AT
		CHK		APVD
				AT

9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112

ch2m:

LITTLE SHOOKS RUN -BOULDER & PITKIN IMPROVEMENTS

DETAILS

VERIFY SCALE

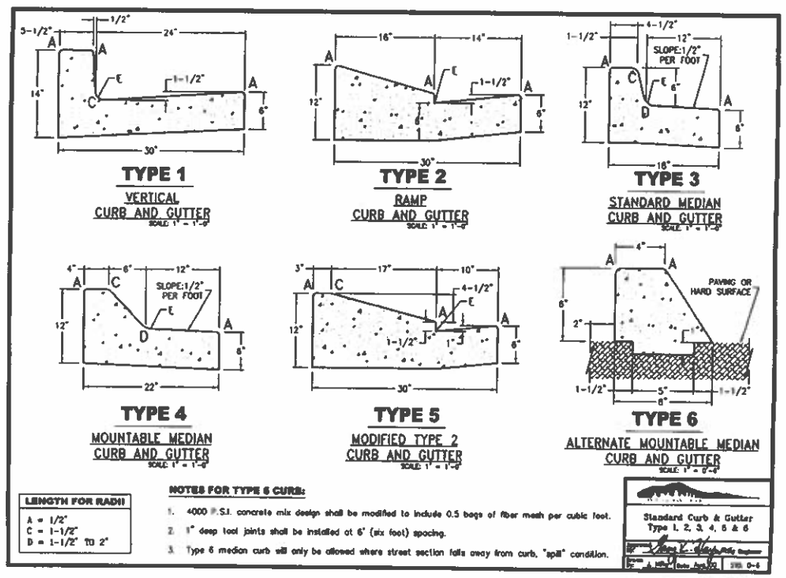
BAR IS ONE INCH ON ORIGINAL DRAWING

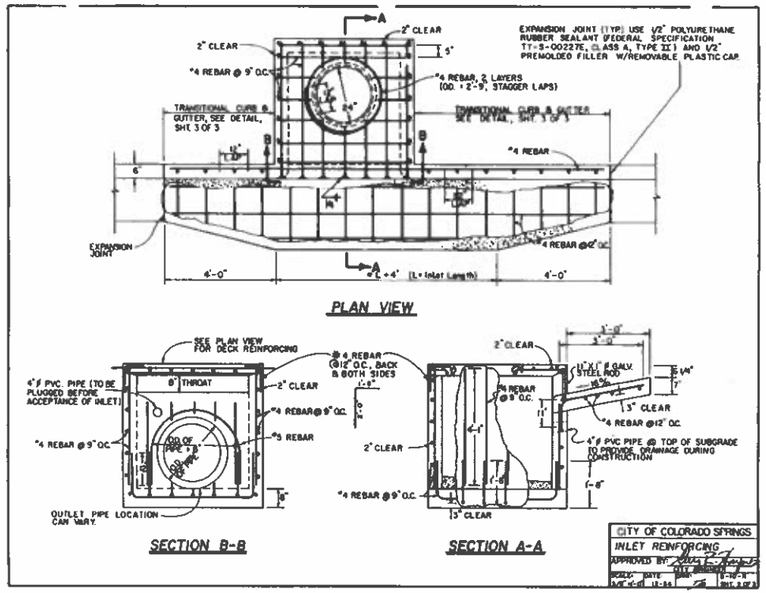
0 1"

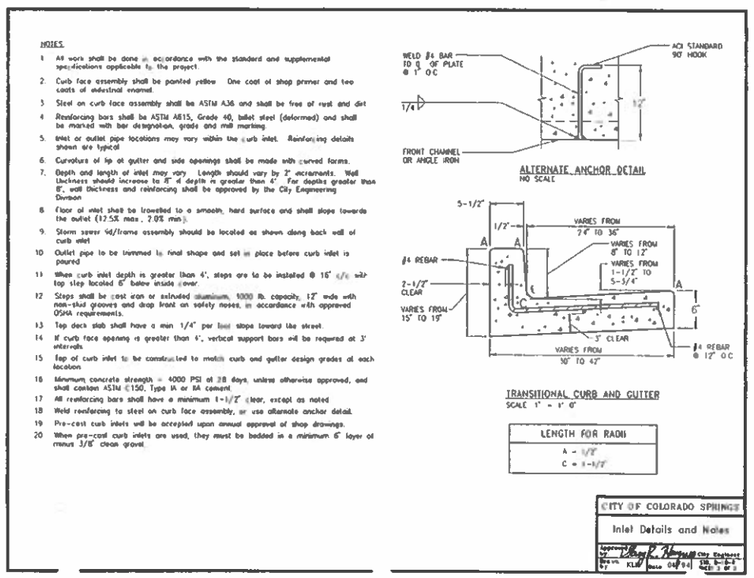
DATE	NOVEMBER 2017
PROJ	691414
DWG	DT-1
SHEET	6 of 7

30% DOCUMENT

$PWURL $PWPATH FILENAME: LSP-050-C-DT001.dgn PLOT DATE: 2017\11\01 PLOT TIME: 9:18:20 AM







1 DETAILS
NTS

PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	DR	REVISION	CHK	APV'D
DSGN		JM		BS	AT
				BY	APV'D

9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112
ch2m:

WATER RESOURCES ENGINEERING
COLORADO SPRINGS UTILITIES

LITTLE SHOOKS RUN - BOULDER & PITKIN IMPROVEMENTS
DETAILS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"

DATE	NOVEMBER 2017
PROJ	691414
DWG	DT-2
SHEET	7 of 7

30% DOCUMENT

$PWURL $PWPATH FILENAME: LSP-050-C-DT002.dgn PLOT DATE: 2017\11\01 PLOT TIME: 9:48:15 AM

LITTLE SHOOKS RUN - PITKIN AND BOULDER
BID SCHEDULE
ENGINEER: CH2M
2017.10.30

Phase 1

BID ITEM	DESCRIPTION	QUANTITY	PAY UNIT	UNIT PRICE	TOTAL COST OF BID ITEM
2	Mobilization	1.0	LS	$2,093.74	$2,093.74
4	Surveying	1.0	LS	$2,093.74	$2,093.74
5	Traffic Control	1.0	LS	$2,093.74	$2,093.74
7	12" Curb w/ 2' Pan	430.0	LF	$43.00	$18,490.00
8	12" Curb Ramp	120.0	SY	$180.00	$21,600.00
9	18" RCP	8.0	LF	$72.00	$576.00
10	Concrete Pan	49.0	SY	$180.00	$8,820.00
11	Type R Inlet	1.0	EA	$8,000.00	$8,000.00
12	HMA - remove and replace	465.0	SY	$88.00	$40,920.00
SUBTOTAL					$104,687.23
CONTINGENCY				20%	$20,937.45
BID TOTAL					$125,624.68

Phase 2

BID ITEM	DESCRIPTION	QUANTITY	PAY UNIT	UNIT PRICE	TOTAL COST OF BID ITEM
1	Mobilization	1.0	LS	$1,868.87	$1,868.87
2	Surveying	1.0	LS	$1,868.87	$1,868.87
3	Traffic Control	1.0	LS	$1,868.87	$1,868.87
4	12" Curb w/ 2' Pan	122.0	LF	$43.00	$5,246.00
5	18" RCP	156.0	LF	$71.00	$11,076.00
6	24" RCP	400.0	LF	$82.00	$32,800.00
7	Class 6 Road Base	12.0	CY	$61.00	$732.00
8	Type C Inlet	1.0	EA	$8,000.00	$8,000.00
9	Utility Relocates	3.0	EA	$2,000.00	$6,000.00
10	Sidewalk	116.0	SY	$110.00	$12,760.00
11	Additional Curb and Gutter to the east.	261.0	LF	$43.00	$11,223.00
SUBTOTAL					$93,443.62
CONTINGENCY				20%	$18,688.72
BID TOTAL					$112,132.34

Combined Project Cost

SUBTOTAL		$198,130.85
CONTINGENCY	20%	$39,626.17
BID TOTAL		$237,757.02

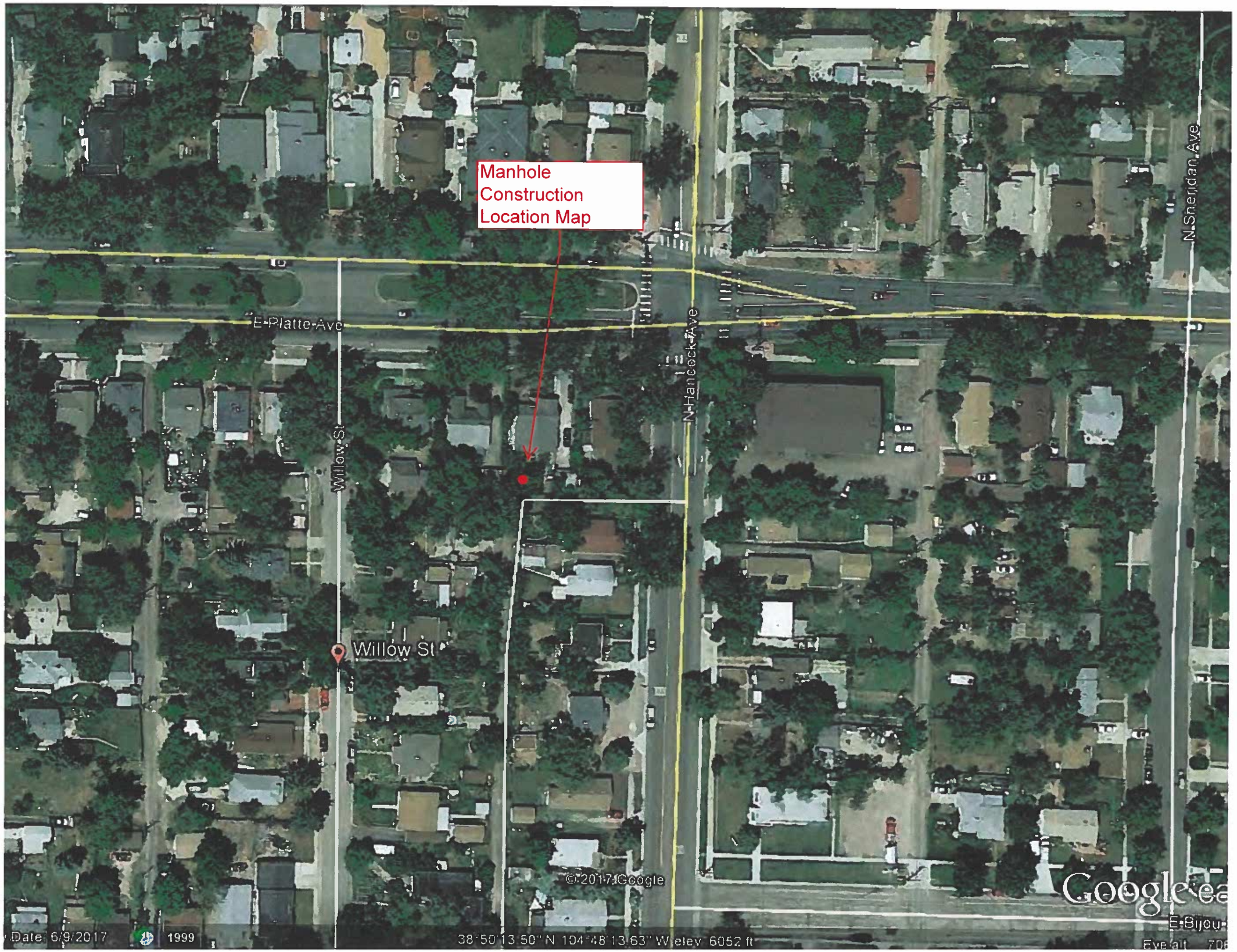

E Platte Ave
PROJECT LOCATION
Niagara Ave
Farragut Ave


EXISTING GAS SERVICE (TYP)
EXISTING INLET (TO REMAIN)
EXISTING WATER MAIN
10'
CONST (2) TYPE D-10-R INLETS AND
CONNECT TO EXISTING INLET

PAGE INTENTIONALLY LEFT BLANK

Appendix C
Conceptual Design

PAGE INTENTIONALLY LEFT BLANK


Manhole
Construction
Location Map
E Platte Ave
Willow St
N Hancock Ave
N Sheridan Ave
Willow St
©2017 Google
Google
Date: 6/9/2017
1999
38°50'13.50" N 104°48'13.63" W elev 6052 ft


Proposed Location of Manhole. Exact Location to be field verified by City CM. Potholing shall be completed by Contractor.
© 2017 Google
© 2017 Google
38°50'13.35" N 104°48'14.62" W elev 6052 ft

PLATTE AVENUE

INSTITUTE STREET

CUSTER AVENUE

CEDAR STREET

WILLOW STREET

12" Water Main

4" Gas Line

4" Water Line (To be lowered by Contractor) (See detail drawing in Spec's)

2" (±1½" Gas Main

Sanitary Sewer (To be relocated - See Sheet 6 of 6)

Install (1) Drop Inlet (Connect Storm Drains From North (South

Residence

Tree

Woven Wire Fence (Remove (Replace)

6" Spruce Trees

Hedge Row (Remove (Replace)

36" Elm Tree 30°54'00" Def. Angle

Rose Bushes (Remove (Replace)

30" Tree 54°56'00" Def. Angle

Residence

Sanitary Sewer Manhattan

Residence

Conc. Block Wall Wooden Picket Fence

16' Alley

50' Elm Tree

Carport (Drive to be removed and replaced by Contractor

Residence

4" Water Line (To be lowered by Contractor) (See detail drawing in Spec's)

Sanitary Sewer Manhole

Residence 5' Brick Wall (Remove (Replace)

15" Elm Trees

Wood Fence (Remove (Replace)

6"±10 30" Def Angle

Garage

Residence

8' Board Fence (Remove (Replace)

Tree 5'-4" Elm Trees

Install (1) Drop Inlet

Residence

Hedge Row (Remove (Replace)

Install (2) Drop Inlets (Connect Storm Drains From North (South

Sanitary Sewer (To be relocated - See Sheet 4 of 6)

5" Gas Main (To be lowered by Gas Dept.)

Hedge row of 6'±to 8' Elm Trees

Def Angle 16°11'00"

Sanitary Sewer Manhole

Conc. Inc.

Steel Inc.

24" Elm Tree

90' Willow Tree Cluster of Trees

Power Pole (To be relocated by Elec. Dept)

Concrete Wing Wall (Remove)

Install (2) Drop Inlets (Connect Storm Drains From North

Sanitary Sewer (To be relocated - See Sheet 4 of 6)

16' Alley

96" C.M.P. to be salvaged for City Street Dept.

24" Tree

2-6" Elm Trees

2-8" Elm Trees

Cluster of 4-6" Elm Trees

24" Tree

Install (1) Drop Inlet

4" Water Line (To be Lowered by Contractor) (See detail drawing in Spec's)

2" Gas Main (To be lowered by Gas Dept)

4" Gas Main

Existing 20" Water Main (Lowered under previous Contract)

Garage

Install (2) Drop Inlets (Connect Storm Drains From North.

Sanitary Sewer Manhole

Garage

Power Pole

Def Angle 3°46'00"

3-6" Picket Fence on ℄

Cluster of small Trees

Concrete Wing Wall

Install (1) Drop Inlet

Proposed Location of Manhole Exact Location to be field verified by City CM Patholing shall be completed by Contractor

4" Water Line (To be connected into Pipe Arch for Blow-off purposes.)

4" Gas Main

20' Alley

Garage

Def Angle 15°18'00"

Def Angle 14°06'00"

Existing 12" S.S. (To be relocated - See Sheet 5 of 6)

Install (2) Drop Inlets (Connect Storm Drains From North

Existing 6" Gas Main (Lowered under previous Contract)

Sanitary Sewer (To be relocated - See Sheet 4 of 6)

Existing 16" Water Main (Lowered under Previous Contract)

Note:
All bushes, shrubs, plants, lawns and etc. will be replaced as required by individual property owners.

Demolition Item: This area contains a rectangular Concrete and Masonry Box - Size varies from 4.5 to 5.0' high with a 5.0 to 8.0 Bottom

N

Scale
1"=40' Horiz.
1"=6' Vert

LITTLE SHOOKS RUN
DRAINAGE BASIN IMPROVEMENTS
PHASE II
PLAN & PROFILE

E. HUTCHINSON & ASSOCIATES, INC.
CONSULTING ENGINEERS
COLORADO SPRINGS, COLORADO

Job No. 89-28
File No. 1085

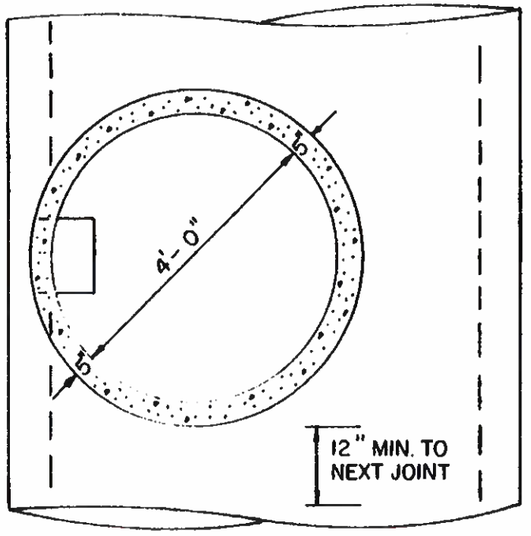
6035
6030
6025
6020
6015
6010
6005
6000

20+00 21+00 22+00 23+00 24+00 25+00 26+00 27+00 28+00 29+00 30+00 31+00 32+00 33+00

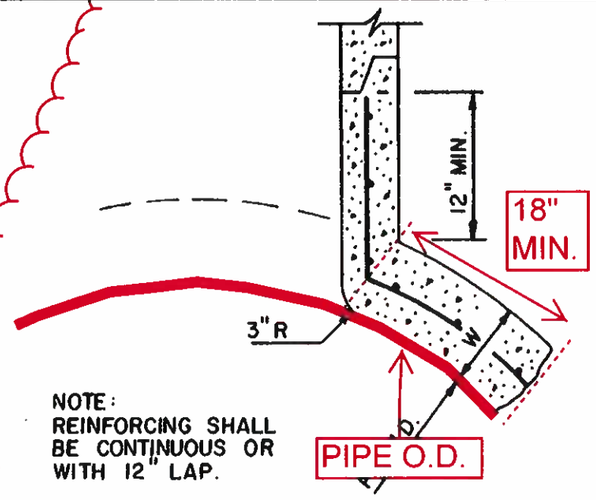
10.00' @ 1.5% S

Sheet 1 of 6
File No. 1085

MODIFIED



PLAN VIEW
SCALE 3/8"=1'-0"

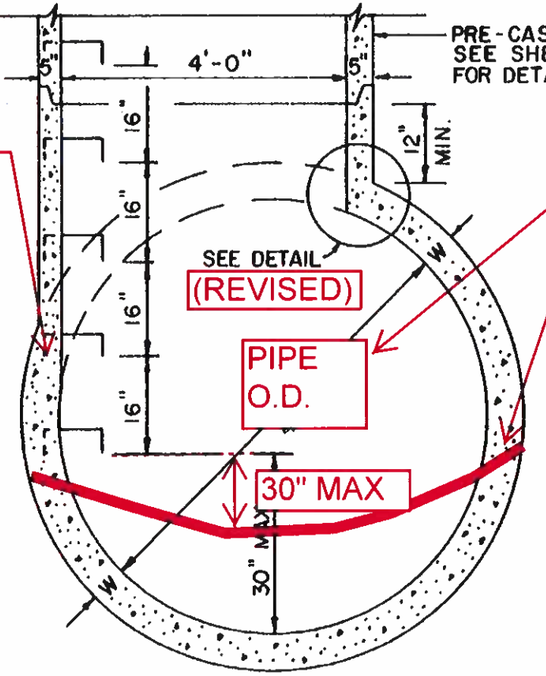


R.C.P. CONNECTION DETAIL
SCALE 3/4"=1'-0"

NOTES:

1. Type III manholes shall be used only with approval by the City Engineer and only when all of the following conditions are met:
   a. Pipe is 48" or larger inside diameter
   b. No change in pipe size
   c. No change in pipe material
   d. No change in horizontal alignment
   e. Slope is flat and continuous
2. Type III manholes shall be fabricated by the manufacturer/supplier and delivered to the site as a single unit. Field fabrication shall not be permitted.
3. Either ladder or steps shall be installed. Lowest step shall be a maximum of 30" above the invert of the pipe.

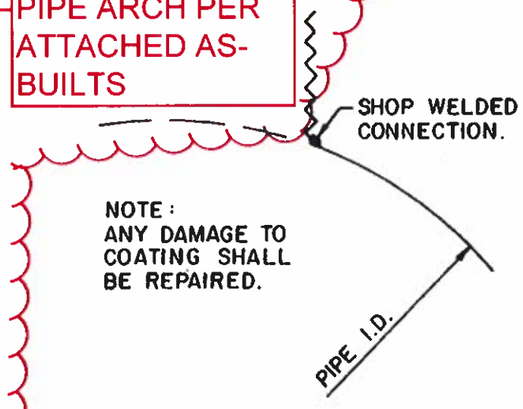
SHALL BE POURED BEHIND EXISTING PIPE OD. LADDER RUNGS SHALL BE DRILLED THROUGH EXISTING PIPE ARCH AND EMBEDDED WITHIN PROPOSED CONCRETE SECTION



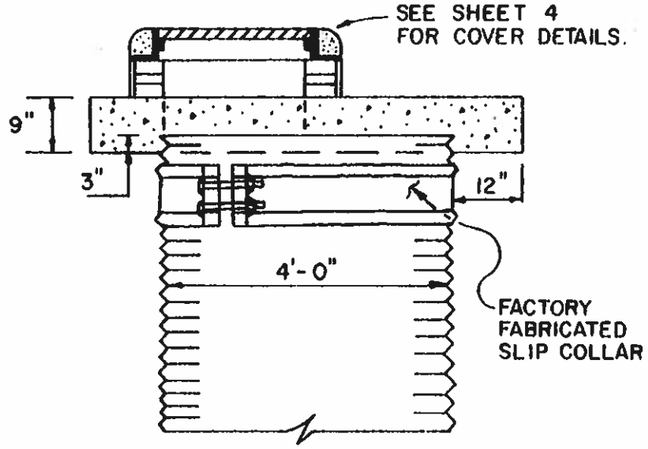
SECTION VIEW
SCALE 3/8"=1'-0"

MODIFIED

EX. PIPE IS MULTI-PLATE PIPE ARCH PER ATTACHED AS-BUILTS



C.S.P. CONNECTION DETAIL
SCALE 3/4"=1'-0"



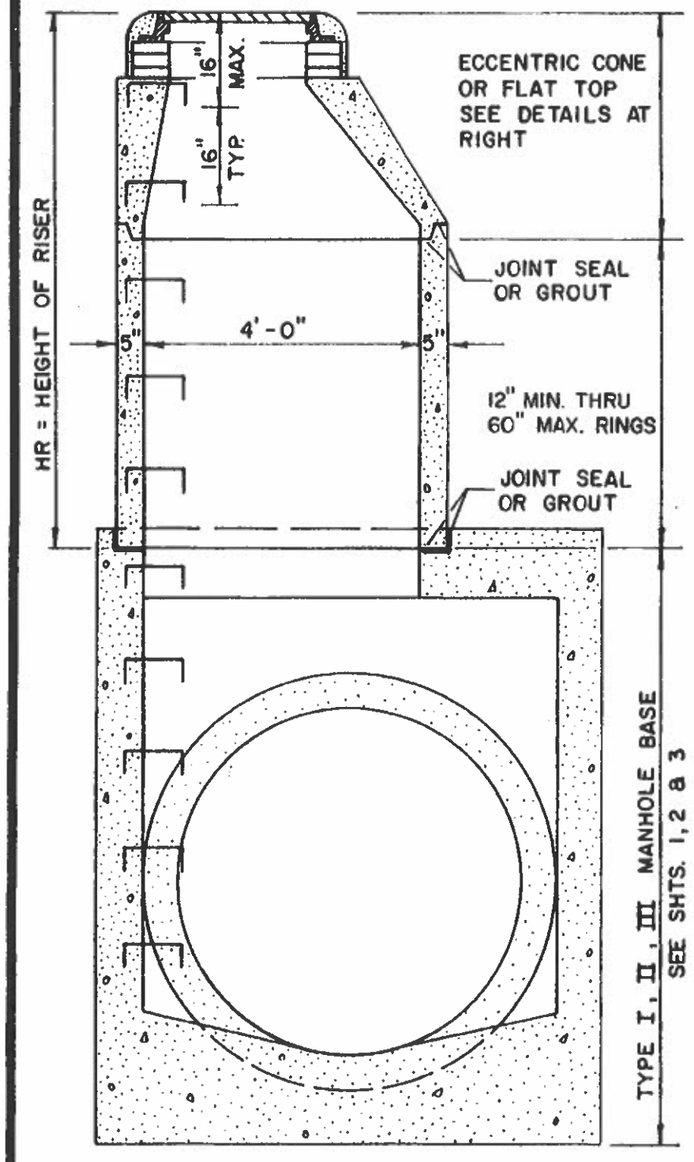
SPECIAL LID FOR USE WITH C.S.P. RISER.
SCALE 3/8"=1'-0"

CITY OF COLORADO SPRINGS

STORM SEWER MANHOLE-TYPE III

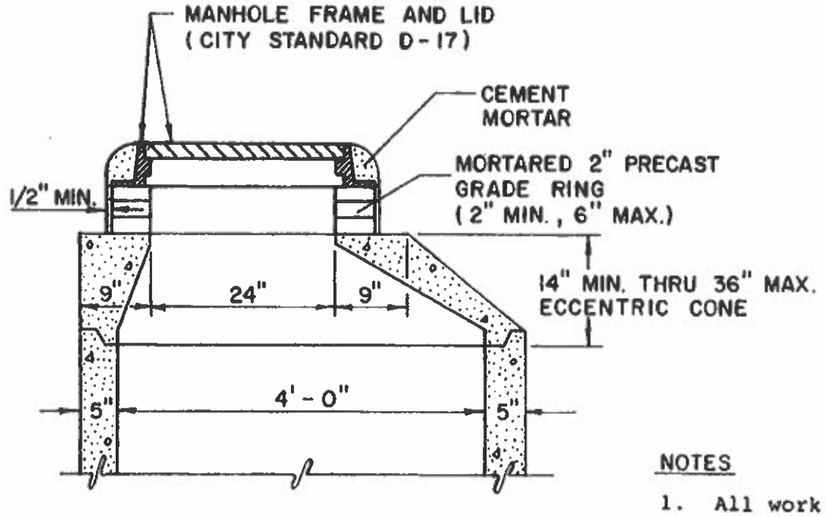
APPROVED BY Gary R. Haynes
CITY ENGINEER

SCALE:	DATE:	DRAWN:	SHEET: D-20C
AS SHOWN	JAN. 89	P.L.B.	3 OF 4



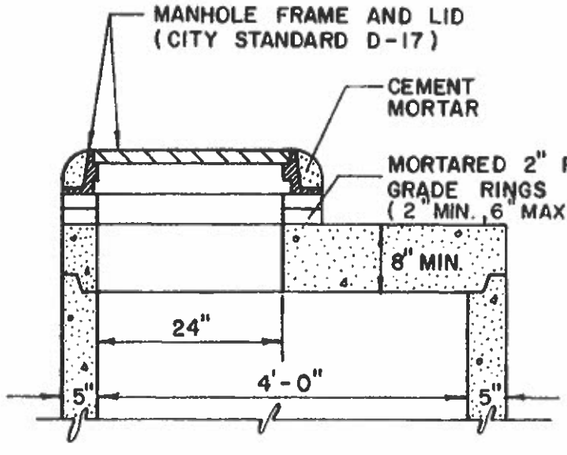
SECTION VIEW

SCALE: 3/8" = 1'-0"



ECCENTRIC CONE TOP

(FOR HR > 3' ±) SCALE: 1/2" = 1'-0"



ECCENTRIC FLAT TOP

(FOR HR < 3' ±) SCALE: 1/2" = 1'-0"

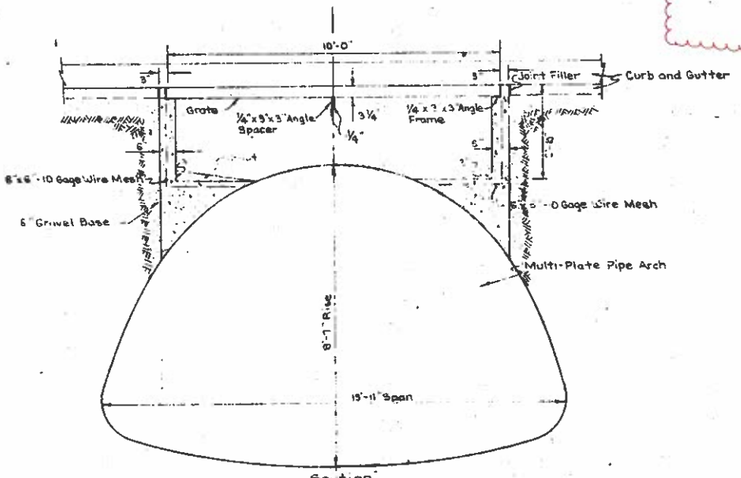
NOTES

1. All work shall be done in accordance with the standard and supplemental specifications applicable to the project.
2. Precast risers shall conform to ASTM C-478.
3. Steps shall be installed when manhole depth exceeds 30". Steps shall be cast iron or extruded aluminum, 1000 lb. capacity, 12" wide with non-skid grooves and drop front on safety noses, in accordance with approved OSHA requirements.

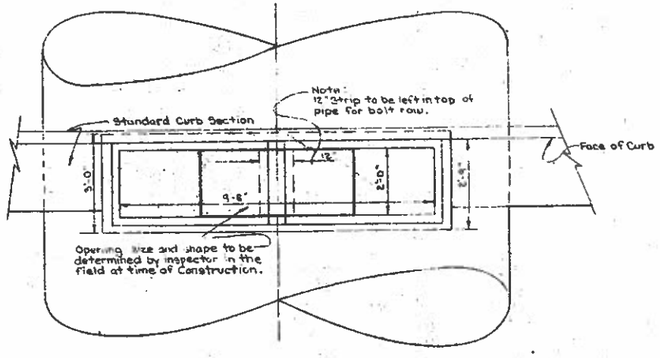
STORM SEWER MANHOLE PRECAST RISER

CITY OF COLORADO SPRINGS			
STORM SEWER-COVER & RISER			
APPROVED BY Gary R. Hayes CITY ENGINEER			
SCALE: AS SHOWN	DATE: JAN. 89	DRAWN: PLB	SHEET: D-20D 3 OF 4

EXISTING PIPE DETAILS

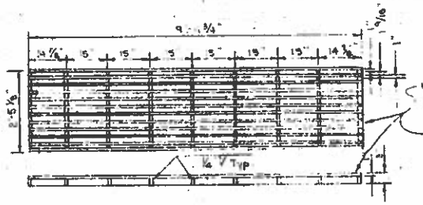


Section
Scale 1"=2"

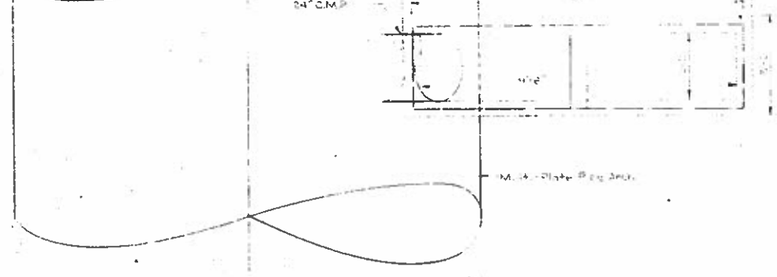


Plan
Scale 1=2'

Street Drop-Inlet Details

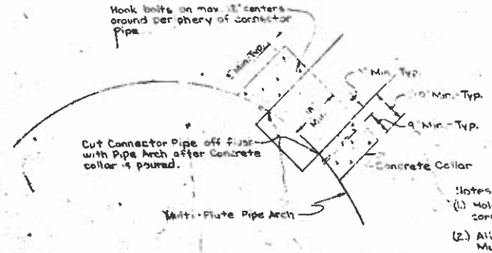


Grate Details
Scale 1"=2'-0"
(Same for Street & Alley Inlets)



Plan
Scale 1=2'

Alley Drop-Inlet Details



Notes:
(1.) Hole to be cut in Multi-Plate Pipe Arch to receive connector pipe after Pipe Arch in erected.
(2.) All hook bolts to be located inside valley of Multi-Plate corrugations.

Typical Section at Connector Pipes
Scale 1"=2'

Drop-inlet and Catch-Basin Details
Little Shooks Run-Drainage Basin Improvements
Phase II

SCALE: As Shown	APPROVED BY:	DRAWN BY: R.W.H.
DATE: June 1969	Job No. 69-29	REVISED

R. KEITH HOOK & ASSOCIATES, INC.
ENGINEERS · PLANNERS · SURVEYORS
COLORADO SPRINGS, COLORADO

DRAWING NUMBER 1085

Sheet 3 of 5

CITY OF COLORADO SPRINGS
EAST BOULDER ST & PITKIN ST DRAINAGE IMPROVEMENTS
COLORADO SPRINGS, COLORADO
30% PRELIMINARY DESIGN DRAWINGS

NOVEMBER 2017

LOCATION MAP
NTS

N
VICINITY MAP
NTS

SHEET INDEX

AGENCIES

SERVICE	ENTITY	POINT OF CONTACT
PREPARED FOR:	CITY CAPITAL IMPROVEMENTS 30 SOUTH NEVADA AVENUE, SUITE 401 COLORADO SRPINGS, CO 80903	ADAM COPPER, PE (719) 385-XXXX
CIVIL ENGINEER:	CH2M HILL 9189 S JAMAICA ST ENGLEWOOD, CO 80112	ALLEN TURNER, PE (720) 286-4510
ENGINEERING DIVISION:	CITY OF COLORADO SPRINGS 30 S. NEVADA AVE. SUITE 401 COLORADO SPRINGS, CO 80903	MIKE CHAVEZ (719) 385-5408
WATER/WASTEWATER:	SPRINGS UTILITIES 1521 HANCOCK EXPRESSWAY COLORADO SPRINGS, CO 80901	ADAM BAKER (719) 668-4737

REVIEWED BY

CITY ENGINEERING DIVISION

BY: _____
ROADWAY DATE

BY: _____
TRAFFIC DATE

BY: _____
WATER RESOURCE DIVISION DATE

CITY STREETS DIVISION

BY: _____
DATE

SPRINGS UTILITIES WATER/WASTEWATER

BY: _____
DATE

UTILITY NOTIFICATION CENTER
OF COLORADO
CALL BEFORE YOU DIG
811
Call 2 days prior to any digging, grading or excavating for the marking of underground member utilities

DETAILED DRAINAGE CONSTRUCTION PLANS AND SPECIFICATIONS ENGINEERS STATEMENT

THESE DETAILED PLANS AND SPECIFICATIONS WERE PREPARED UNDER MY DIRECTION AND SUPERVISION. SAID DETAILED PLANS AND SPECIFICATIONS HAVE BEEN PREPARED ACCORDING TO THE CRITERIA ESTABLISHED BY THE CITY FOR DETAILED DRAINAGE PLANS AND SPECIFICATIONS, AND SAID PLANS AND SPECIFICATIONS ARE IN CONFORMITY WITH THE MASTER PLAN OF THE DRAINAGE BASIN. SAID DETAILED DRAINAGE PLANS AND SPECIFICATIONS MEET THE PURPOSES FOR WHICH THE DRAINAGE FACILITY(S) IS DESIGNED. I ACCEPT RESPONSIBILITY FOR ANY LIABILITY CAUSED BY ANY NEGLIGENT ACT, ERRORS, OR OMISSIONS ON MY PART IN PREPARATION OF THE DETAILED DRAINAGE PLANS AND SPECIFIATIONS.

ALLEN TURNER, P.E. ######### DATE
FOR AND ON BEHALF OF CH2M ENGINEERS

PRELIMINARY
NOT FOR
CONSTRUCTION

NO.	DATE	REVISION	BY	APVD
DSGN	JM	DR	CHK	AT
	BS		APVD	AT

9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112

ch2m:

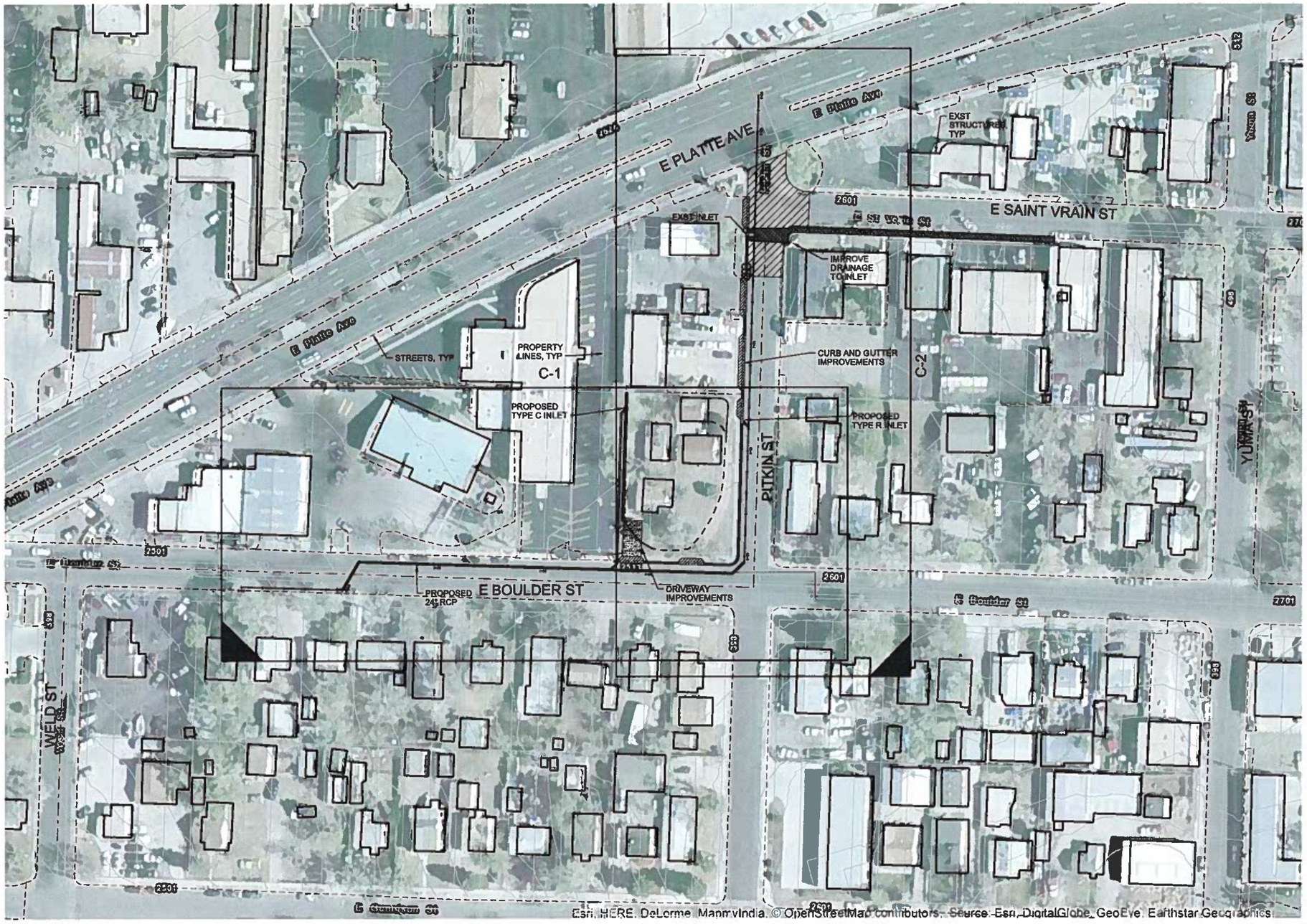
WATER RESOURCES ENGINEERING
COLORADO SPRINGS UTILITIES

LITTLE SHOOKS RUN - BOULDER & PITKIN IMPROVEMENTS
COVER SHEET

30% DOCUMENT

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"

DATE	NOVEMBER 2017
PROJ	691414
DWG	G-1
SHEET	1 of 7



N

0 50 100 150

Scale In Feet

PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	APVD
DSGN	JM	DR	BSI	APVD
		QHK		AT

9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112

WATER RESOURCES ENGINEERING

COLORADO SPRINGS UTILITIES

ch2m:

LITTLE SHOOKS RUN -BOULDER & PITKIN IMPROVEMENTS

OVERALL SITE PLAN AND KEYMAP

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING

0 1"

DATE	NOVEMBER 2017
PROJ	691414
DWG	G-3
SHEET	2 of 7

30% DOCUMENT

$PWURL $PWPATH FILENAME: LSP-050-C-G002.dgn PLOT DATE: 2017\11\01 PLOT TIME: 1:58:54 PM

GENERAL SITE NOTES:

1. SOURCE OF TOPOGRAPHY SHOWN ON THE CIVIL PLANS ARE BASE MAPS PROVIDED BY THE CITY OF COLORADO SPRINGS IN 2011 CITY FIMS DATA, NAVD88 STATE PLAN CENTRAL COORDINATE SYSTEM. EXISTING CONDITIONS MAY VARY FROM THOSE SHOWN ON THESE PLANS.
2. THE CONTRACTOR SHALL VERIFY EXISTING CONDITIONS AND ADJUST WORK PLAN ACCORDINGLY PRIOR TO BEGINNING CONSTRUCTION. EXISTING TOPOGRAPHY, STRUCTURES, AND SITE FEATURES ARE SHOWN SCREENED AND/OR LIGHT-LINED. NEW FINISH GRADE, STRUCTURES, AND SITE FEATURES ARE SHOWN HEAVY-LINED UNLESS INDICATED OTHERWISE ON PLANS.
3. MAINTAIN, RELOCATE, OR REPLACE EXISTING SURVEY MONUMENTS, CONTROL POINTS, AND STAKES WHICH ARE DISTURBED OR DESTROYED.
4. PERFORM THE WORK TO PRODUCE THE SAME LEVEL OF ACCURACY AS THE ORIGINAL MONUMENT(S) IN A TIMELY MANNER, AND AT THE CONTRACTOR'S EXPENSE.
5. STAGING AREA SHALL BE FOR CONTRACTOR'S EMPLOYEE PARKING, CONTRACTOR'S TRAILERS AND ON-SITE STORAGE OF MATERIALS. PROVIDE TEMPORARY FENCING AS NECESSARY TO MAINTAIN SECURITY AT ALL TIMES.
6. ELEVATIONS GIVEN ARE TO FINISH GRADE UNLESS OTHERWISE SHOWN.
7. SLOPE UNIFORMLY BETWEEN CONTOURS AND SPOT ELEVATIONS SHOWN.
8. CONTRACTOR SHALL BE RESPONSIBLE FOR IMPLEMENTING AND MAINTAINING EROSION CONTROL DEVICES DURING CONSTRUCTION.
9. CONTRACTOR SHALL TAKE ALL OTHER MEASURES TO POSITIVELY PRECLUDE EROSION MATERIALS FROM LEAVING THE SITE.

ABBREVIATIONS

ACI	AMERICAN CONCRETE INSTITUTE
ACWWA	ARAPAHOE COUNTY WATER AND WASTEWATER AUTHORITY
ADDL	ADDITIONAL
ADJ	ADJACENT
AGGR	AGGREGATE
APVD	APPROVED
AVG	AVERAGE
@	AT
BETW	BETWEEN
BL	BASELINE
BOC	BOTTOM OF CONCRETE
BPS	BEGIN POOL SECTION, LOOKING DOWNSTREAM
BRS	BEGIN RIFFLE SECTION, LOOKING DOWNSTREAM
BVC	BEGINNING OF VERTICAL CURVE
CFS	CUBIC FEET PER SECOND
CCBWQA	CHERRY CREEK BASIN WATER QUALITY AUTHORITY
CIP	CAST IN PLACE
CJ	CONSTRUCTION JOINT
CL	CENTERLINE
CLSM	CONTROLLED LOW STRENGTH MATERIAL
CMP	CORRUGATED METAL PIPE
CONC	CONCRETE
CONDO	CONDOMINIUM
CONT	CONTINUED, CONTINUOUS, CONTINUATION
COORD	COORDINATE
CS	CROSS SECTION
CTR	CENTER
CU FT	CUBIC FOOT
CY, CU YD	CUBIC YARD
DIA	DIAMETER
DT	DETAIL
EA	EACH
ECCV	EAST CHERRY CREEK VALLEY WATER AND SANITATION DISTRICT
EG	EXAMPLE
EL	ELEVATION, EASEMENT LINE
ENGR	ENGINEER
EQ	EQUATION
EQL	EQUAL
ESC	EROSION AND SEDIMENT CONTROL
EXST, EXIST	EXISTING
FIG	FIGURE
FES	FLARED END SECTION
FG	FINISH GRADE
FL	FLOW LINE
FT	FOOT OR FEET
FPS	FEET PER SECOND
G, GND	GROUND
GESC	GRADING, EROSION, AD SEDIMENT CONTROL
GPS	GLOBAL POSITION SYSTEM
HGL	HYDRAULIC GRADE LINE
HGT	HEIGHT
HORIZ	HORIZONTAL
INV EL	INVERT ELEVATION
IN	INCH
INV, INVT	INVERT
IP	INLET PROTECTION
JCT	JUNCTION
L	LENGTH
LAT	LATITUDE
LB	POUND
LB/FT^2	POUNDS PER SQUARE FOOT
LF	LINEAR FEET
LONG	LONGITUDINAL
LT	LEFT
MAX	MAXIMUM
MH	MANHOLE
MIN	MINIMUM
MISC	MISCELLANEOUS
NAVD	NORTH AMERICAN VERTICAL DATUM
N	NORTH
NGVD	NATIONAL GEODETIC VERTICAL DATUM
NIC	NOT IN CONTRACT
NO., #	NUMBER
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
O.F.	OUTSIDE FACE
OPP	OPPOSITE
OZ	OUNCE
PC	POINT OF CURVE
PI	POINT OF INTERSECTION
PL	PROPERTY LINE
POB	POINT OF BEGIN
POE	POINT OF END
PP	POWER POLE
PRC	POINT OF REVERSE CURVE
PRCST	PRECAST
PROP	PROPERTY
PT	POINT OF TANGENCY
PVC	POLYVINYL CHLORIDE
PVI	POINT OF VERTICAL INTERSECTION
PVMT	PAVEMENT
PVT	POINT OF VERTICAL TANGENCY
R OR RAD	RADIUS
RCP	REINFORCED CONCRETE PIPE
REC	RECORDED
REF	REFER OR REFERENCE
REINF	REINFORCED, REINFORCING, REINFORCE
REQD	REQUIRED
RT	RIGHT
S	SLOPE, SOUTH
SB	SEDIMENT BASIN
SCHED	SCHEDULE
SECT	SECTION
SED	SEDIMENTATION
SEMSWA	SOUTHEAST METRO STORMWATER AUTHORITY
SH	SHEET
SPEC, SPECS	SPECIFICATIONS
SQ	SQUARE
SQ FT	SQUARE FOOT, FEET
SQ IN	SQUARE INCH
SQ YD	SQUARE YARD
ST	STORM DRAIN
STA	STATION
STD	STANDARD
STRL	STRUCTURAL
T	SHEAR
T&B	TOP AND BOTTOM
TAN	TANGENT
TB	TOP OF BOULDER
TCE	TEMPORARY CONSTRUCTION EASEMENT
TEL	TELEPHONE
THRU	THROUGH
TOC	TOP OF CONCRETE
TOF	TOP OF FOOTING
TOG	TOP OF GROUT, TOP OF GRATE
TOS	TOP OF SLAB
TOW	TOP OF WALL
TP	TURNING POINT
TRANS	TRANSITION
TYP	TYPICAL
UDFCD	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
VC	VERTICAL CURVE
VCC	VALLEY COUNTRY CLUB
VEL	VELOCITY
VERT	VERTICAL
VIF	VERIFY IN FIELD
VPC	POINT OF VERTICAL CURVATURE
VPI	POINT OF VERTICAL INTERSECTION
VPT	POINT OF VERTICAL TANGENT
W	WEST
W/	WITH
WS	WATER SURFACE

CIVIL LEGEND

EXISTING / THIS CONTRACT

- BENCH MARK
- BRIDLE EASEMENT
- BRUSH/TREE LINE
- CENTER LINE, BUILDING, ROAD, ETC.
- CHANNEL STATIONING AND CENTERLINE (10+00)
- CONTOUR LINE (5280)
- CULVERT
- DEMOLITION
- DRAINAGE WAY OR DITCH
- FENCE LINE
- OVERHEAD POWERLINE (E-OVH)
- PROPERTY LINE
- CATCH BASIN OR INLET (CB)
- ELECTRIC OVERHEAD POWER POLE
- ELECTRIC TRANSFORMER
- FENCE POST OR GUARD POST
- FIRE HYDRANT
- GUY ANCHOR
- LIGHT POLE
- MANHOLE (D) OR (S)
- SLOPE, DIRECTION OF FLOW
- STRUCTURE, BUILDING OR FACILITY
- SPOT ELEVATION (5280.1)
- SURVEY CONTROL POINT OR POINT OF INTERSECTION
- UTILITY POLE
- WATER
- INLETS, TYPE R & C
- PROPOSED RCP
- ASPHALT REPLACEMENT
- CONCRETE GUTTER
- CONCRETE SIDEWALK CONCRETE GUTTER PAN
- CONCRETE RAMP
- ROADBASE CLASS 6

SECTION / DETAIL DESIGNATIONS

SECTION (LETTER) OR DETAIL (NUMERAL) DESIGNATION — ON DRAWING WHERE SECTION OR DETAIL IS TAKEN:

DRAWING NUMBER (REPLACED WITH A LINE IF TAKEN AND SHOWN ON SAME SHEET) — DRAWING NUMBER WHERE SHOWN

B SECTION — SCALE — 100-S-3001 — ON DRAWING WHERE SECTION IS SHOWN: DRAWING NUMBER(S) WHERE TAKEN

2 DETAIL — SCALE — 200-M-10B10A — ON DRAWING WHERE DETAIL IS SHOWN: DRAWING NUMBER(S) WHERE TAKEN

TITLE — SCALE — ON DRAWING WHERE ONLY A TITLE IS REQUIRED WITH NO REFERENCE (EG: ELEVATIONS)

SECTION CALLOUT WHERE SECTION IS ON THE SAME SHEET AND CUT EXTENDS TO A FIXED LIMIT

SECTION CALLOUT WHERE SECTION IS ON ANOTHER SHEET AND CUT EXTENDS THROUGHOUT ENTIRE SHEET

KEYNOTE NUMBER

REVISION / ADDENDA NUMBER

NORTH ARROW

SHEET LIMITS KEY

DRAWING NUMBER PP-X — LOWER LEFT CORNER DWG

PRELIMINARY NOT FOR CONSTRUCTION

NO.	DSGN	DATE	REVISION	DR	CHK	APVD
	JM				BS	AT
					BY	APVD
						AT

ch2m:
9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112

WATER RESOURCES ENGINEERING
COLORADO SPRINGS

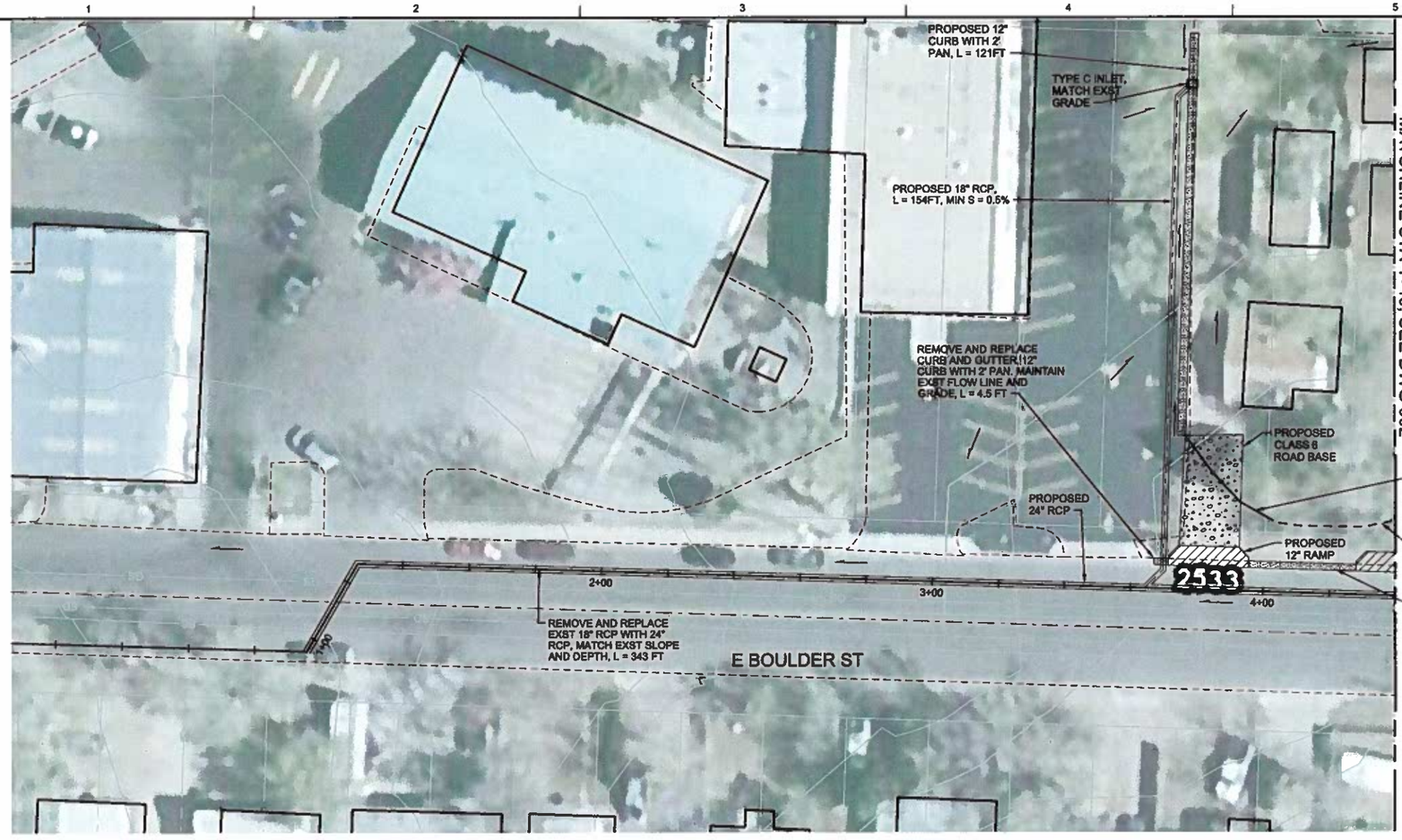
LITTLE SHOOKS RUN - BOULDER & PITKIN IMPROVEMENTS

NOTES, ABBREVIATIONS AND LEGEND

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING (0 — 1")

DATE	NOVEMBER 2017
PROJ	691414
DWG	G-2
SHEET	3 of 7

30% DOCUMENT

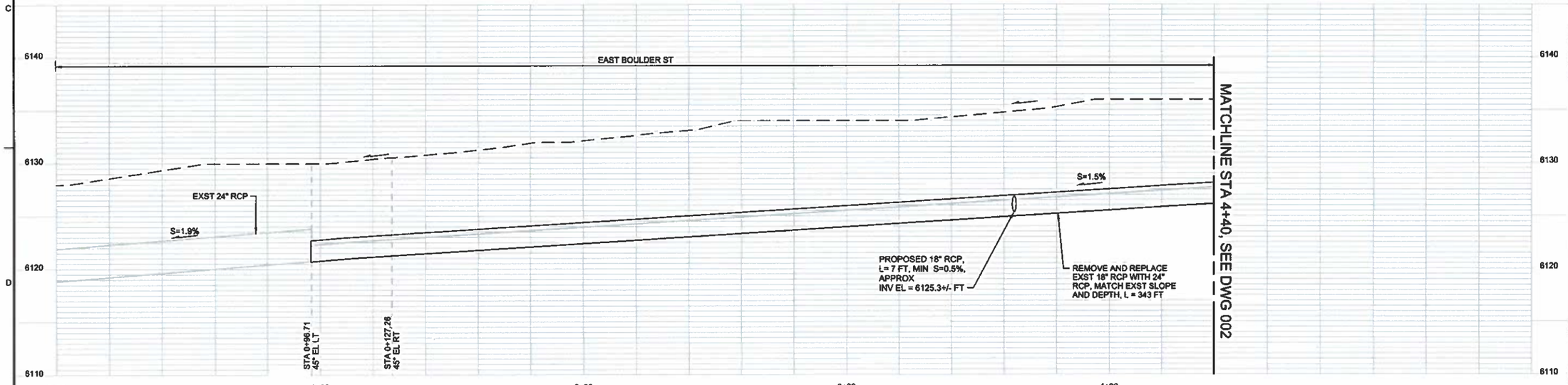


NOTE:

1. ELEVEATION'S NOTED ON THESE PLANS ARE BASED ON 2011 2' LIDAR DATA AND ARE APPROXIMATE. IN ALL CASES, PROPOSED FLOW LINE ELEVATIONS ARE TO MATCH EXISTING CONDITIONS OR MODIFIED PER OWNERS REPRESENATIVE.

N

0 20 40 60
Scale In Feet



PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	DSGN	DR	REVISION	CHK	BY	APVD
		JM	BS		AT	AT	AT

9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112

WATER RESOURCES ENGINEERING

COLORADO SPRINGS

ch2m:

LITTLE SHOOKS RUN -BOULDER & PITKIN IMPROVEMENTS

STA 0+00 TO STA 4+40

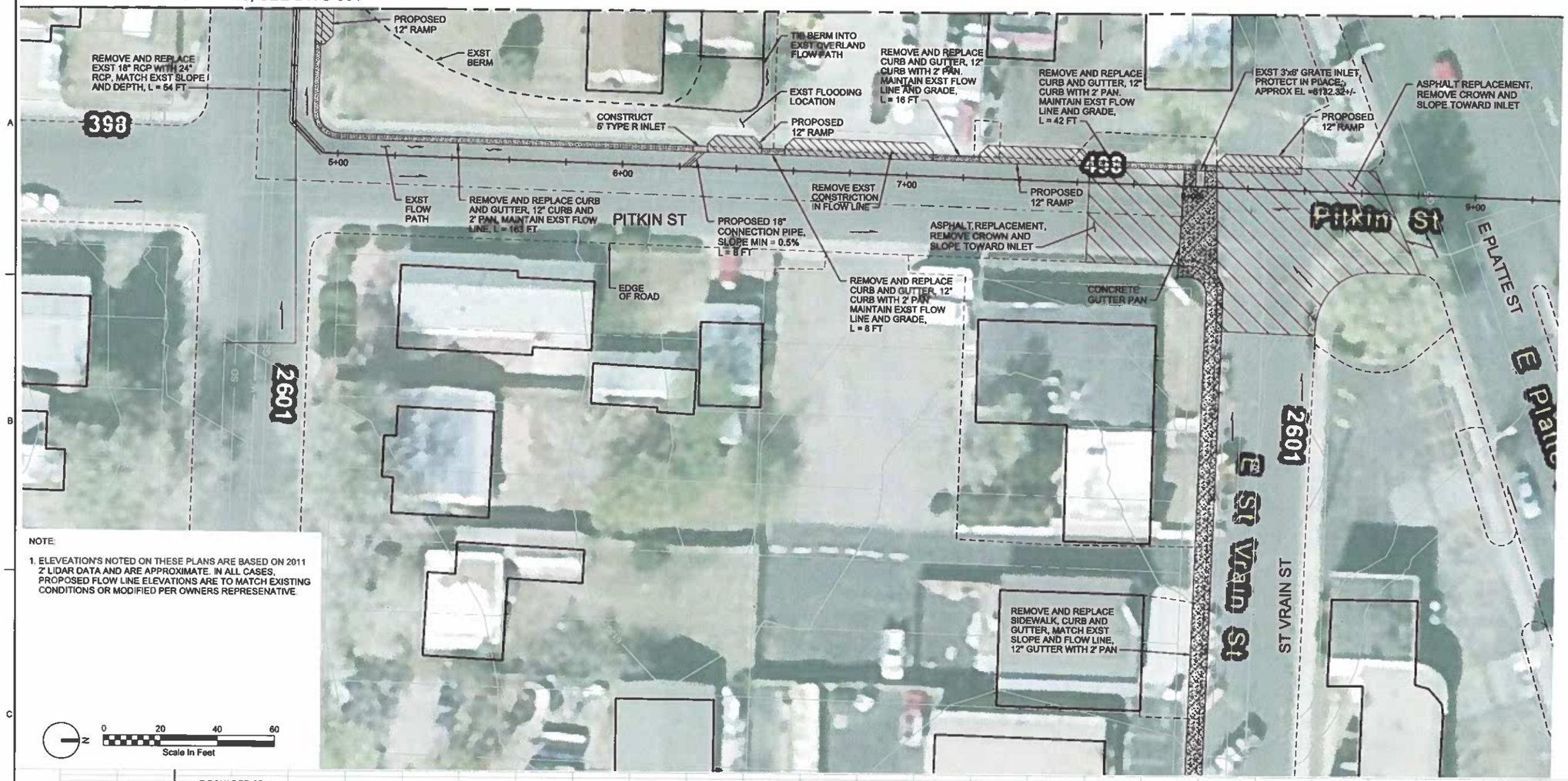
30% DOCUMENT

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2017
PROJ	691414
DWG	C-1
SHEET	4 of 7

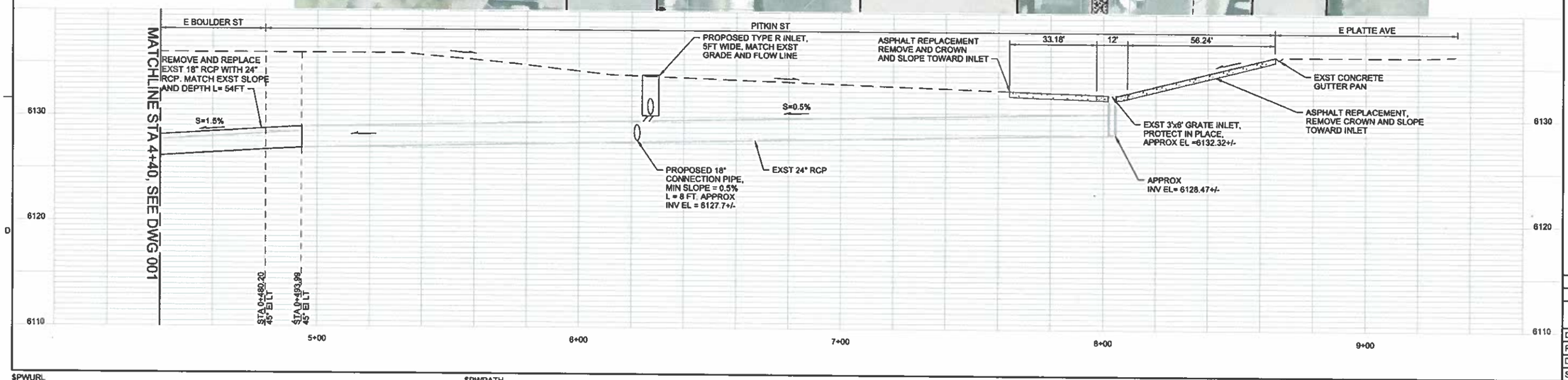
MATCHLINE STA 4+40, SEE DWG 001



NOTE:

1. ELEVEATION'S NOTED ON THESE PLANS ARE BASED ON 2011 2' LIDAR DATA AND ARE APPROXIMATE. IN ALL CASES, PROPOSED FLOW LINE ELEVATIONS ARE TO MATCH EXISTING CONDITIONS OR MODIFIED PER OWNERS REPRESENATIVE.

N 0 20 40 60
Scale In Feet



PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	APVD
DSGN		DR JM	CHK BS	APVD AT

9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112

WATER RESOURCES ENGINEERING
COLORADO SPRINGS

ch2m:

LITTLE SHOOKS RUN - BOULDER & PITKIN IMPROVEMENTS

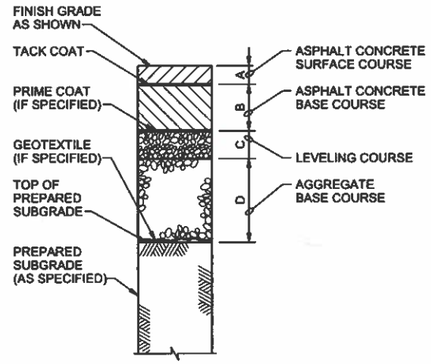
STA 4+40 TO STA 8+00

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2017
PROJ	691414
DWG	C-2
SHEET	5 of 7

30% DOCUMENT

$PWURL $PWPATH FILENAME: LSP-050-C-C002.dgn PLOT DATE: 2017\11\01 PLOT TIME: 1:54:34 PM

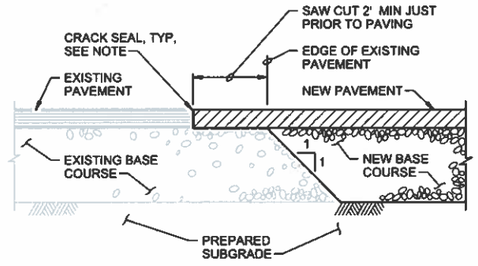


PAVEMENT TYPE(S)	DIMENSION (INCHES)			
	A	B	C	D
A1	*	*	*	*
A2	*	*	*	*
A3	*	*	*	*

NOTE:
PROVIDE ASPHALT CONCRETE PAVEMENT TYPE AS SHOWN ON PLANS.

ASPHALT CONCRETE PAVEMENT
NTS

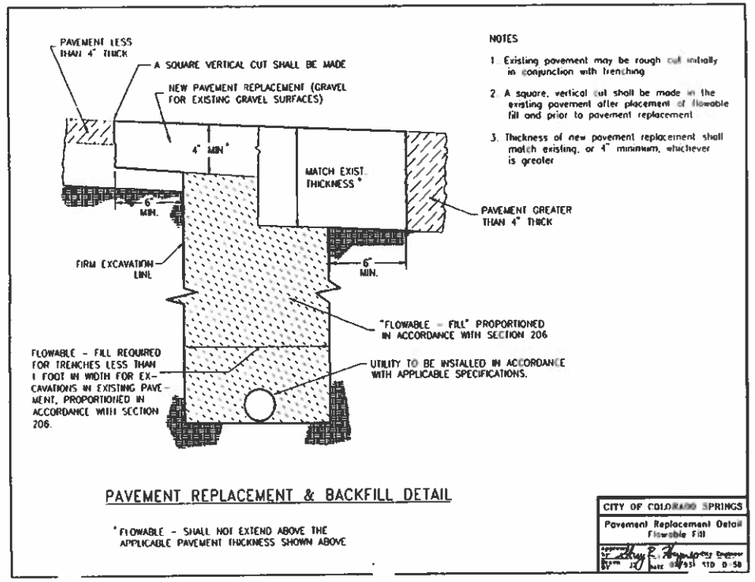
3212-210



NOTE:
PAINT EDGE OF EXISTING ASPHALT WITH TACK COAT PRIOR TO PAVING.
CRACK SEAL JOINT AFTER PAVING OPERATION HAS BEEN COMPLETED.

PAVEMENT CONNECTION
NTS

3212-215

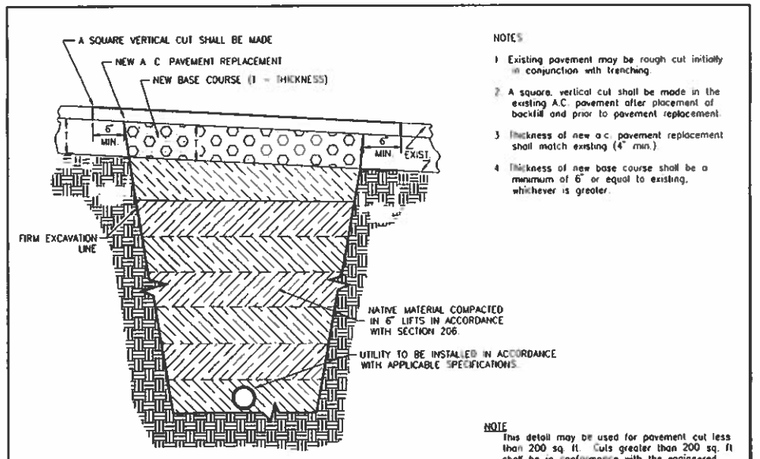


NOTES
1. Existing pavement may be rough cut initially in conjunction with trenching.
2. A square, vertical cut shall be made in the existing pavement after placement of flowable fill and prior to pavement replacement.
3. Thickness of new pavement replacement shall match existing, or 4" minimum, whichever is greater

PAVEMENT REPLACEMENT & BACKFILL DETAIL

* FLOWABLE - SHALL NOT EXTEND ABOVE THE APPLICABLE PAVEMENT THICKNESS SHOWN ABOVE

CITY OF COLORADO SPRINGS
Pavement Replacement Detail
Flowable Fill
City Engineer
By: [illegible] Date: 10/95 STD D-58



NOTES
1. Existing pavement may be rough cut initially in conjunction with trenching.
2. A square, vertical cut shall be made in the existing A.C. pavement after placement of backfill and prior to pavement replacement.
3. Thickness of new a.c. pavement replacement shall match existing (4" min.)
4. Thickness of new base course shall be a minimum of 6" or equal to existing, whichever is greater.

NOTE
This detail may be used for pavement cut less than 200 sq. ft. Cuts greater than 200 sq. ft shall be in conformance with the engineered design.

PAVEMENT REPLACEMENT & BACKFILL DETAIL
TRENCHES IN TYPICAL STREET NOT NEWLY CONSTRUCTED OR RECENTLY OVERLAYED

CITY OF COLORADO SPRINGS
Pavement Replacement Detail
For Typical Streets
City Engineer
By: [illegible] Date: 04/95 STD D-3

1 DETAILS
NTS

PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	DSGN	DR	CHK	APVD
BY	REVISION	BS	AT	APVD	AT

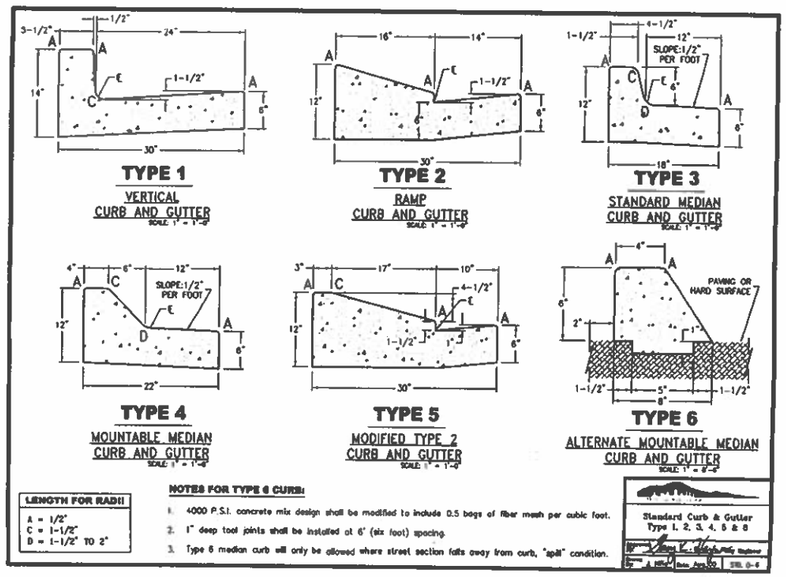
9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112
ch2m:

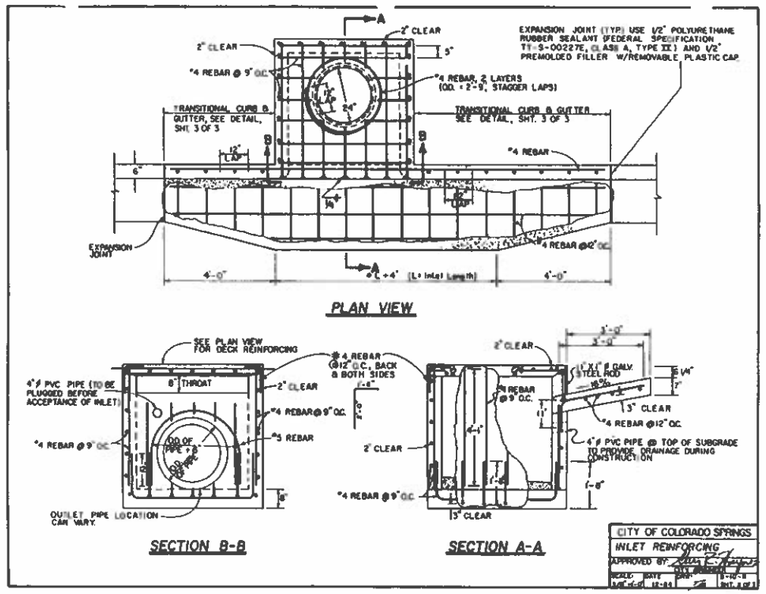
LITTLE SHOOKS RUN -BOULDER & PITKIN IMPROVEMENTS
DETAILS

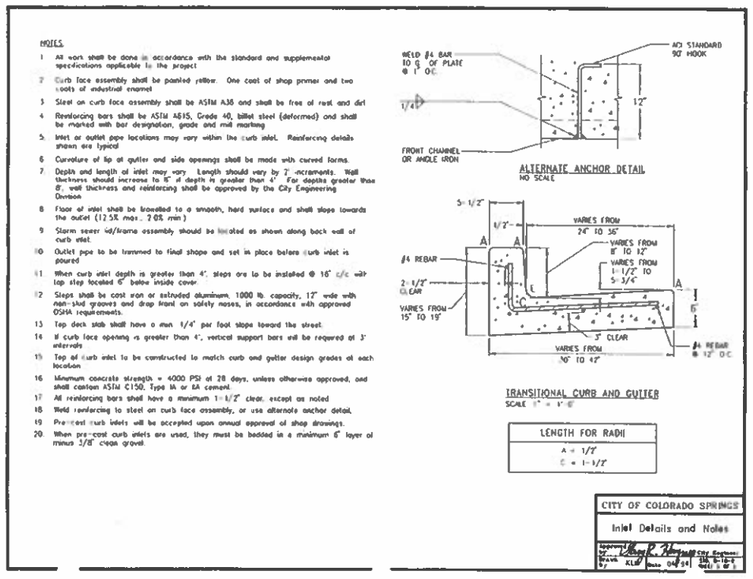
VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	NOVEMBER 2017
PROJ	691414
DWG	DT-1
SHEET	6 of 7

30% DOCUMENT







1 DETAILS
NTS

PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	DSGN	DR	JM	REVISION	CHK	BS	APVD	BY	APVD	AT

9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112
ch2m:
WATER RESOURCES ENGINEERING
COLORADO SPRINGS

LITTLE SHOOKS RUN - BOULDER & PITKIN IMPROVEMENTS
DETAILS

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"

DATE	NOVEMBER 2017
PROJ	691414
DWG	DT-2
SHEET	7 of 7

30% DOCUMENT

$PWURL $PWPATH FILENAME: LSP-050-C-DT002.dgn PLOT DATE: 2017\11\01 PLOT TIME: 9:48:15 AM

PAGE INTENTIONALLY LEFT BLANK

CITY OF COLORADO SPRINGS
LITTLE SHOOKS RUN CULVERT UPHEAVAL
COLORADO SPRINGS, COLORADO
30% PRELIMINARY DESIGN DRAWINGS

DECEMBER 2017

LOCATION MAP
NTS

N
VICINITY MAP
NTS

SHEET INDEX

AGENCIES

SERVICE	ENTITY	POINT OF CONTACT
PREPARED FOR:	CITY CAPITAL IMPROVEMENTS 30 SOUTH NEVADA AVENUE, SUITE 401 COLORADO SRPINGS, CO 80903	ADAM COPPER, PE (719) 385-XXXX
CIVIL ENGINEER:	CH2M HILL 9189 S JAMAICA ST ENGLEWOOD, CO 80112	ALLEN TURNER, PE (720) 286-4510
ENGINEERING DIVISION:	CITY OF COLORADO SPRINGS 30 S. NEVADA AVE, SUITE 401 COLORADO SPRINGS, CO 80903	MIKE CHAVEZ (719) 385-5408
WATER/WASTEWATER:	SPRINGS UTILITIES 1521 HANCOCK EXPRESSWAY COLORADO SPRINGS, CO 80901	ADAM BAKER (719) 668-4737

REVIEWED BY

CITY ENGINEERING DIVISION

BY: _____
ROADWAY DATE

BY: _____
TRAFFIC DATE

BY: _____
WATER RESOURCE DIVISION DATE

CITY STREETS DIVISION

BY: _____
DATE

SPRINGS UTILITIES WATER/WASTEWATER

BY: _____
DATE

UTILITY NOTIFICATION CENTER
OF COLORADO
CALL BEFORE YOU DIG
811
Call 2 days prior to any digging, grading or excavating for the marking of underground member utilities

DETAILED DRAINAGE CONSTRUCTION PLANS AND SPECIFICATIONS ENGINEERS STATEMENT

THESE DETAILED PLANS AND SPECIFICATIONS WERE PREPARED UNDER MY DIRECTION AND SUPERVISION. SAID DETAILED PLANS AND SPECIFICATIONS HAVE BEEN PREPARED ACCORDING TO THE CRITERIA ESTABLISHED BY THE CITY FOR DETAILED DRAINAGE PLANS AND SPECIFICATIONS, AND SAID PLANS AND SPECIFICATIONS ARE IN CONFORMITY WITH THE MASTER PLAN OF THE DRAINAGE BASIN. SAID DETAILED DRAINAGE PLANS AND SPECIFICATIONS MEET THE PURPOSES FOR WHICH THE DRAINAGE FACILITY(S) IS DESIGNED. I ACCEPT RESPONSIBILITY FOR AMY LIABILITY CAUSED BY ANY NEGLIGENT ACT, ERRORS, OR OMISSIONS ON MY PART IN PREPARATION OF THE DETAILED DRAINAGE PLANS AND SPECIFIATIONS.

ALLEN TURNER, P.E. ######## DATE
FOR AND ON BEHALF OF CH2M ENGINEERS

PRELIMINARY
NOT FOR
CONSTRUCTION

NO.	DATE	REVISION	DR	CHK	APVD	BY	APVD
DSGN			JM	BS	AT		AT

9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112

ch2m:

WATER RESOURCES ENGINEERING
COLORADO SPRINGS

LITTLE SHOOKS RUN CULVERT UPHEAVAL
GENERAL
COVER SHEET

30% DOCUMENT

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	DECEMBER 2017
PROJ	691414
DWG	G-1
SHEET	1 of X

GENERAL SITE NOTES:

1. SOURCE OF TOPOGRAPHY SHOWN ON THE CIVIL PLANS ARE BASE MAPS PROVIDED BY THE CITY OF COLORADO SPRINGS IN 2011 CITY FIMS DATA, NAVD88 STATE PLAN CENTRAL COORDINATE SYSTEM. EXISTING CONDITIONS MAY VARY FROM THOSE SHOWN ON THESE PLANS.
2. THE CONTRACTOR SHALL VERIFY EXISTING CONDITIONS AND ADJUST WORK PLAN ACCORDINGLY PRIOR TO BEGINNING CONSTRUCTION. EXISTING TOPOGRAPHY, STRUCTURES, AND SITE FEATURES ARE SHOWN SCREENED AND/OR LIGHT-LINED. NEW FINISH GRADE, STRUCTURES, AND SITE FEATURES ARE SHOWN HEAVY-LINED UNLESS INDICATED OTHERWISE ON PLANS.
3. MAINTAIN, RELOCATE, OR REPLACE EXISTING SURVEY MONUMENTS, CONTROL POINTS, AND STAKES WHICH ARE DISTURBED OR DESTROYED.
4. PERFORM THE WORK TO PRODUCE THE SAME LEVEL OF ACCURACY AS THE ORIGINAL MONUMENT(S) IN A TIMELY MANNER, AND AT THE CONTRACTOR'S EXPENSE.
5. STAGING AREA SHALL BE FOR CONTRACTOR'S EMPLOYEE PARKING, CONTRACTOR'S TRAILERS AND ON-SITE STORAGE OF MATERIALS. PROVIDE TEMPORARY FENCING AS NECESSARY TO MAINTAIN SECURITY AT ALL TIMES.
6. ELEVATIONS GIVEN ARE TO FINISH GRADE UNLESS OTHERWISE SHOWN.
7. SLOPE UNIFORMLY BETWEEN CONTOURS AND SPOT ELEVATIONS SHOWN.
8. CONTRACTOR SHALL BE RESPONSIBLE FOR IMPLEMENTING AND MAINTAINING EROSION CONTROL DEVICES DURING CONSTRUCTION.
9. CONTRACTOR SHALL TAKE ALL OTHER MEASURES TO POSITIVELY PRECLUDE EROSION MATERIALS FROM LEAVING THE SITE.

ABBREVIATIONS

ACI	AMERICAN CONCRETE INSTITUTE
ACWWA	ARAPAHOE COUNTY WATER AND WASTEWATER AUTHORITY
ADDL	ADDITIONAL
ADJ	ADJACENT
AGGR	AGGREGATE
APVD	APPROVED
AVG	AVERAGE
@	AT
BETW	BETWEEN
BL	BASELINE
BOC	BOTTOM OF CONCRETE
BPS	BEGIN POOL SECTION, LOOKING DOWNSTREAM
BRS	BEGIN RIFFLE SECTION, LOOKING DOWNSTREAM
BVC	BEGINNING OF VERTICAL CURVE
CFS	CUBIC FEET PER SECOND
CCBWQA	CHERRY CREEK BASIN WATER QUALITY AUTHORITY
CIP	CAST IN PLACE
CJ	CONSTRUCTION JOINT
CL	CENTERLINE
CLSM	CONTROLLED LOW STRENGTH MATERIAL
CMP	CORRUGATED METAL PIPE
CONC	CONCRETE
CONDO	CONDOMINIUM
CONT	CONTINUED, CONTINUOUS, CONTINUATION
COORD	COORDINATE
CS	CROSS SECTION
CTR	CENTER
CU FT	CUBIC FOOT
CY, CU YD	CUBIC YARD
DIA	DIAMETER
DT	DETAIL
EA	EACH
ECCV	EAST CHERRY CREEK VALLEY WATER AND SANITATION DISTRICT
EG	EXAMPLE
EL	ELEVATION, EASEMENT LINE
ENGR	ENGINEER
EQ	EQUATION
EQL	EQUAL
ESC	EROSION AND SEDIMENT CONTROL
EXST, EXIST	EXISTING
FIG	FIGURE
FES	FLARED END SECTION
FG	FINISH GRADE
FL	FLOW LINE
FT	FOOT OR FEET
FPS	FEET PER SECOND
G, GND	GROUND
GESC	GRADING, EROSION, AD SEDIMENT CONTROL
GPS	GLOBAL POSITION SYSTEM
HGL	HYDRAULIC GRADE LINE
HGT	HEIGHT
HORIZ	HORIZONTAL
INV EL	INVERT ELEVATION
IN	INCH
INV, INVT	INVERT
IP	INLET PROTECTION
JCT	JUNCTION
L	LENGTH
LAT	LATITUDE
LB	POUND
LB/FT^2	POUNDS PER SQUARE FOOT
LF	LINEAR FEET
LONG	LONGITUDINAL
LT	LEFT
MAX	MAXIMUM
MH	MANHOLE
MIN	MINIMUM
MISC	MISCELLANEOUS
NAVD	NORTH AMERICAN VERTICAL DATUM
N	NORTH
NGVD	NATIONAL GEODETIC VERTICAL DATUM
NIC	NOT IN CONTRACT
NO., #	NUMBER
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
O.F.	OUTSIDE FACE
OPP	OPPOSITE
OZ	OUNCE
PC	POINT OF CURVE
PI	POINT OF INTERSECTION
PL	PROPERTY LINE
POB	POINT OF BEGIN
POE	POINT OF END
PP	POWER POLE
PRC	POINT OF REVERSE CURVE
PRCST	PRECAST
PROP	PROPERTY
PT	POINT OF TANGENCY
PVC	POLYVINYL CHLORIDE
PVI	POINT OF VERTICAL INTERSECTION
PVMT	PAVEMENT
PVT	POINT OF VERTICAL TANGENCY
R OR RAD	RADIUS
RCP	REINFORCED CONCRETE PIPE
REC	RECORDED
REF	REFER OR REFERENCE
REINF	REINFORCED, REINFORCING, REINFORCE
REQD	REQUIRED
RT	RIGHT
S	SLOPE, SOUTH
SB	SEDIMENT BASIN
SCHED	SCHEDULE
SECT	SECTION
SED	SEDIMENTATION
SEMSWA	SOUTHEAST METRO STORMWATER AUTHORITY
SH	SHEET
SPEC, SPECS	SPECIFICATIONS
SQ	SQUARE
SQ FT	SQUARE FOOT, FEET
SQ IN	SQUARE INCH
SQ YD	SQUARE YARD
ST	STORM DRAIN
STA	STATION
STD	STANDARD
STRL	STRUCTURAL
T	SHEAR
T&B	TOP AND BOTTOM
TAN	TANGENT
TB	TOP OF BOULDER
TCE	TEMPORARY CONSTRUCTION EASEMENT
TEL	TELEPHONE
THRU	THROUGH
TOC	TOP OF CONCRETE
TOF	TOP OF FOOTING
TOG	TOP OF GROUT, TOP OF GRATE
TOS	TOP OF SLAB
TOW	TOP OF WALL
TP	TURNING POINT
TRANS	TRANSITION
TYP	TYPICAL
UDFCD	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT
VC	VERTICAL CURVE
VCC	VALLEY COUNTRY CLUB
VEL	VELOCITY
VERT	VERTICAL
VIF	VERIFY IN FIELD
VPC	POINT OF VERTICAL CURVATURE
VPI	POINT OF VERTICAL INTERSECTION
VPT	POINT OF VERTICAL TANGENT
W	WEST
W/	WITH
WS	WATER SURFACE

CIVIL LEGEND

EXISTING / THIS CONTRACT

- CENTER LINE, BUILDING, ROAD, ETC.
- CENTERLINE AND STATIONING (10+00)
- CONTOUR LINE (5280)
- CULVERT
- DEMOLITION
- DRAINAGE WAY OR DITCH
- FENCE LINE
- E-OVH — OVERHEAD POWERLINE
- EL — PERMANENT EASEMENT LINE
- PROPERTY LINE
- STAGING OR WORK AREA LIMITS
- TEMPORARY CONSTRUCTION EASEMENT
- CB OR CB — CATCH BASIN OR INLET
- D OR S — MANHOLE
- STRUCTURE, BUILDING OR FACILITY
- 5280.1 — SPOT ELEVATION
- WATER
- CONCRETE PAVEMENT

SECTION / DETAIL DESIGNATIONS

SECTION (LETTER) OR DETAIL (NUMERAL) DESIGNATION — ON DRAWING WHERE SECTION OR DETAIL IS TAKEN:

A — 1 — 100-A-10010A1

DRAWING NUMBER (REPLACED WITH A LINE IF TAKEN AND SHOWN ON SAME SHEET) — DRAWING NUMBER WHERE SHOWN

B SECTION — SCALE — 100-S-3001 — ON DRAWING WHERE SECTION IS SHOWN: DRAWING NUMBER(S) WHERE TAKEN

2 DETAIL — SCALE — 200-M-10B10A — ON DRAWING WHERE DETAIL IS SHOWN: DRAWING NUMBER(S) WHERE TAKEN

TITLE — SCALE — ON DRAWING WHERE ONLY A TITLE IS REQUIRED WITH NO REFERENCE (EG: ELEVATIONS)

B — SECTION CALLOUT WHERE SECTION IS ON THE SAME SHEET AND CUT EXTENDS TO A FIXED LIMIT

B C-1 — B C-1 — SECTION CALLOUT WHERE SECTION IS ON ANOTHER SHEET AND CUT EXTENDS THROUGHOUT ENTIRE SHEET

1 — KEYNOTE NUMBER

1 — REVISION / ADDENDA NUMBER

N — NORTH ARROW

SHEET LIMITS KEY — DRAWING NUMBER — PP-X — LOWER LEFT CORNER DWG

PRELIMINARY NOT FOR CONSTRUCTION

NO	DATE	DSGN	DR	CHK	REVISION	BY	APVD
		JM	BS	AT		AT	AT

ch2m:
9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112

WATER RESOURCES ENGINEERING

COLORADO SPRINGS

LITTLE SHOOKS RUN CULVERT UPHEAVAL

GENERAL NOTES, ABBREVIATIONS, AND LEGEND

30% DOCUMENT

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING. 0 1"

DATE	DECEMBER 2017
PROJ	691414
DWG	G-2
SHEET	2 of X

DESIGN MANUAL:

1. CORRUGATED STEEL PIPE DESIGN MANUAL

SOIL DESIGN PARAMETERS:

2. SOIL UNIT WEIGHT:
   a. 122 POUND PER CUBIC FOOT (PCF)
3. EQUIVALENT DRAINED FLUID PRESSURES:
   a. AT REST: 79 PCF
4. EQUIVALENT UNDRAINED FLUID PRESSURES:
   a. AT REST: 102 PCF
5. DRAINED SOIL CONDITIONS WERE ASSUMED FOR CALCULATION OF SHORING LOADS.
6. ADDITIONAL INFORMATION AVAILABLE FROM OWNER. SUBSURFACE EXPLORATION REPORT DATED SEPTEMBER 22, 2017 BY KUMAR AND ASSOCIATES

FORMWORK, SHORING AND BRACING

1. STRUCTURES SHOWN ON THE DRAWINGS HAVE BEEN DESIGNED FOR STABILITY UNDER FINAL CONDITIONS ONLY. DESIGN SHOWN DOES NOT INCLUDE NECESSARY COMPONENTS OR EQUIPMENT FOR STABILITY OF THE STRUCTURES DURING CONSTRUCTION. CONTRACTOR IS RESPONSIBLE FOR WORK RELATING TO CONSTRUCTION ERECTION METHODS, BRACING, SHORING, RIGGING, GUYS, SCAFFOLDING, FORMWORK, AND OTHER WORK AIDS REQUIRED TO SAFELY PERFORM THE WORK SHOWN.
2. TEMPORARY SHORING SHALL REMAIN IN PLACE CONCRETE HAS REACHED 80 PERCENT OF THE 28 DAY COMPRESSIVE STRENGTH AS DETERMINED BY FIELD CYLINDER BREAKS.

CONCRETE REINFORCING

7. GALVANIZED REINFORCING STEEL:
   a. TYPICAL ASTM A767 OR A123, GRADE 60
8. MINIMUM CLEARANCE FOR REINFORCEMENT BARS, UNLESS SHOWN OTHERWISE SHALL BE:
   a. WHEN PLACED ON GROUND: 3"
   b. OTHER CONCRETE SURFACES 2"
9. 90 DEGREE BENDS, UNLESS OTHERWISE SHOWN, SHALL BE ACI 318 STANDARD HOOKS
10. REINFORCEMENT BENDS AND LAPS, UNLESS OTHERWISE NOTED, SHALL SATISFY THE FOLLOWING MINIMUM REQUIREMENTS:
    a. #4 BARS = 1'-4"
    b. #5 BARS = 1'-7"
    c. #6 BARS = 1'-10"

HIGH EARLY STRENGTH CAST IN PLACE CONCRETE

1. 7-DAY COMPRESSIVE STRENGTHS: 5000 PSI
2. CONCRETE MIX DESIGN SHALL BE IN CONFORMANCE WITH ACI 301, SPECIFICATIONS FOR STRUCTURAL CONCRETE.
3. DOCUMENTATION OF AVERAGE STRENGTH FOR EACH PROPOSED MIX DESIGN IN ACCORDANCE WITH ACI 301
4. MIX DESIGN SHALL CONTAIN PROPORTIONS OF MATERIALS AND ADMIXTURES TO BE USED ON PROJECT, SIGNED BY MIX DESIGNER.
5. AGGREGATES SHALL BE IN CONFORMANCE WITH ASTM C33, STANDARD SPECIFICATION FOR CONCRETE AGGREGATES.
6. WATER CEMENT RATION SHALL BE LESS THAN OR EQUAL TO 0.45
7. REQUIRED SLUMP SHALL BE COORDINATED WITH CONTRACTOR FOR TYPE OF PLACEMENT.
8. CONCRETE CURING SHALL BE PROVIDED IN THE FORM OF A WET CURE MAINTAINED UNTIL THE CONCRETE ACHIEVES 80 PERCENT OF THE DESIGN STRENGTH OR A WATER BASED CURING COMPOUND MEETING ASTM C1315 TYPE 1, CLASS A
9. WATERSTOP SHALL BE INSTALLED AND AS NOTED ON DRAWINGS.

CONCRETE TESTING

1. CONTRACTOR SHALL ENGAGE QUALIFIED TESTING FIRM TO PREPARE AND TEST CONCRETE CYCLINDERS IN CONFORMANCE WITH ASTM C31 STANDARD PRACTICE FOR MAKING AND CURING CONCRETE TEST SPECIMENS IN THE FIELD AND C39 STANDARD TEST METHOD FOR COMPRESSIVE STRENGTH OF CYLINDRICAL CONCRETE SPECIMENS.
2. AT A MINIMUM, PROVIDE ONE CYLINDER FOR TESTING AT 3-DAYS, AND TWO CYLINDERS FOR TESTING AT 7-DAYS.
3. CONTRACTOR MAY REQUEST ADDITIONAL TESTING AND OR CYLINDERS TO CONFIRM STRENGTHS PRIOR TO REMOVAL OF SHORING SYSTEM.

CONTROLLED LOW STRENGTH MATERIAL

1. CONTRACTOR SHALL PROVIDE A UNIT PRICE FOR CONTROLLED LOW STRENGTH MATERIAL (CLSM).
2. CONTRACTOR SHALL PROVIDE A MOBILIZATION COST, IF ANY, FOR THE INITIATION OF CLSM PLACEMENT.
3. CLSM SHALL HAVE A 28 DAY STRENGTH BETWEEN 50 AND 150 PSI IN ACCORDANCE WITH ASTM D4832, STANDARD TEST METHOD FOR PREPARATION AND TESTING OF CONTROLLED LOW STRENGTH MATERIAL TEST CYLINDERS

STRUCTURAL STEEL AND METAL FABRICATIONS

1. STRUCTURAL STEEL SHALL CONFORM TO THE FOLLOWING ASTM STANDARDS.
   a. W-SHAPES A992
   b. MISCELLANEOUS SHAPES INCLUDING
   c. ANGLES, CHANNELS, PLATES, ETC. A572, GRADE 50
2. HOT DIP GALVANIZE IN ACCORDANCE WITH ASTM A123

PERMEATION GROUTING

4. THE DIRECT PRESSURE INJECTION OF A CHEMICAL FLUID GROUT INTO THE GROUND TO FILL THE SPACES BETWEEN SOIL PARTICLES, WITHOUT CAUSING EXCESSIVE MOVEMENT OR FRACTURING OF THE SOIL FORMATION. PERMEATION GROUTING IS PERFORMED TO PROVIDE A MORE CONSISTENT AND STABLE SOIL MATRIX
5. CONTRACTOR SHALL PROVIDE A UNIT PRICE FOR PERMEATION GROUTING.
6. CONTRACTOR SHALL PROVIDE A MOBILIZATION COST FOR THE INITIATION OF GROUTING IN ADDITION TO THE UNIT PRICE COST.
7. PERMEATION GROUTING SHALL BE PERFORMED IF UPON INSPECTION OF THE SUBGRADE AT THE REPAIR AREAS INDICATES VOID FORMATIONS THAT WILL NOT BE ADEQUATELY ADDRESSED BY THE PLACEMENT OF THE NEW CONCRETE SLAB OR CLSM. THIS DETERMINATION WILL BE MADE BY THE OWNER.
8. THE PERMEATION GROUTING SHALL BE PERFORMED WITH A CHEMICAL FLUID GROUT THAT IS COMPOSED OF (1) MATRIX FORMING BASE MATERIALS, (2) REACTANTS AND, (3) ACCELERATORS OR RETARDERS.
9. IF PERMEATION GROUTING IS REQUIRED FOR THE STABILIZATION OF SOILS TO BE EXCAVATED, THE 28-DAY COMPRESSIVE STRENGTH SHALL BE NO GREATER THAN 50 PSI.

PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	DSGN	DR	CHK	APVD
		JM	BS	AT	AT

REVISION

NO.	BY	APVD

9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112

ch2m:

WATER RESOURCES ENGINEERING

COLORADO SPRINGS

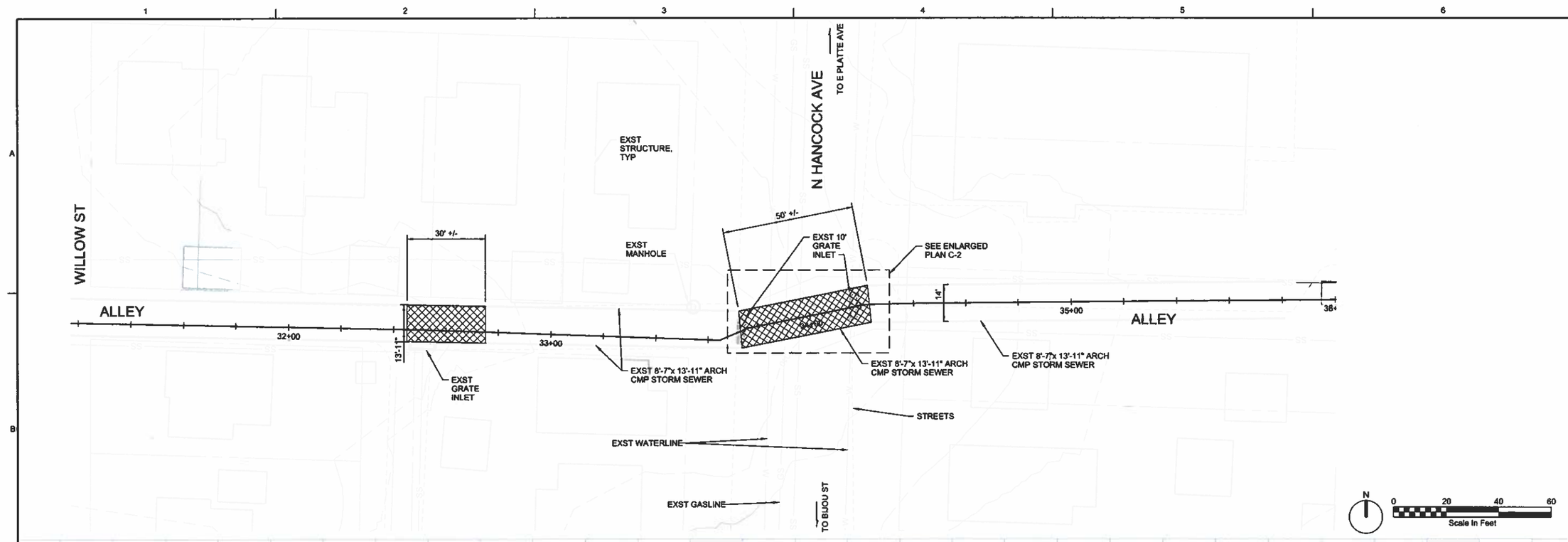
LITTLE SHOOKS RUN CULVERT UPHEAVAL

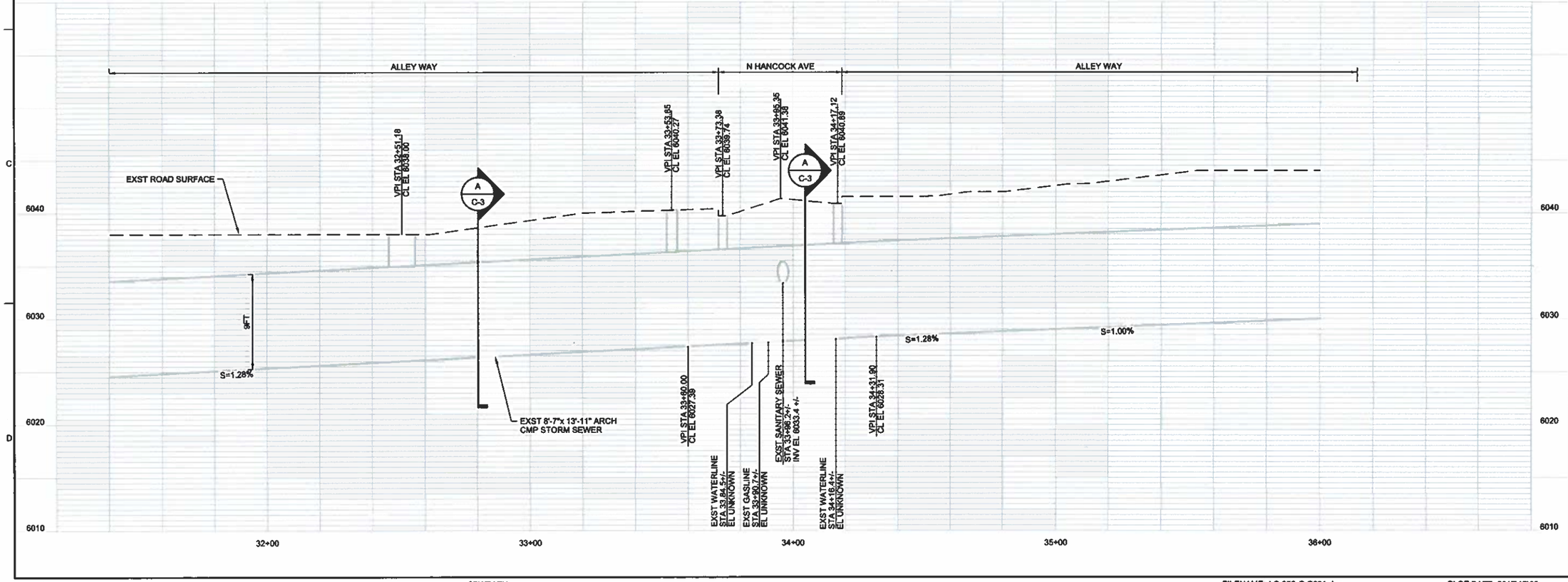
STRUCTURAL NOTES

30% DOCUMENT

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"

DATE	DECEMBER 2017
PROJ	691414
DWG	G-3
SHEET	3 of X





PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	DSGN	DR	CHK	APVD	BY	APVD
		WG	BS	AT	AT		

REVISION

9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112

WATER RESOURCES ENGINEERING

COLORADO SPRINGS

ch2m:

LITTLE SHOOKS RUN CULVERT UPHEAVAL

REMOVAL PLAN LOCATIONS 1 & 2

30% DOCUMENT

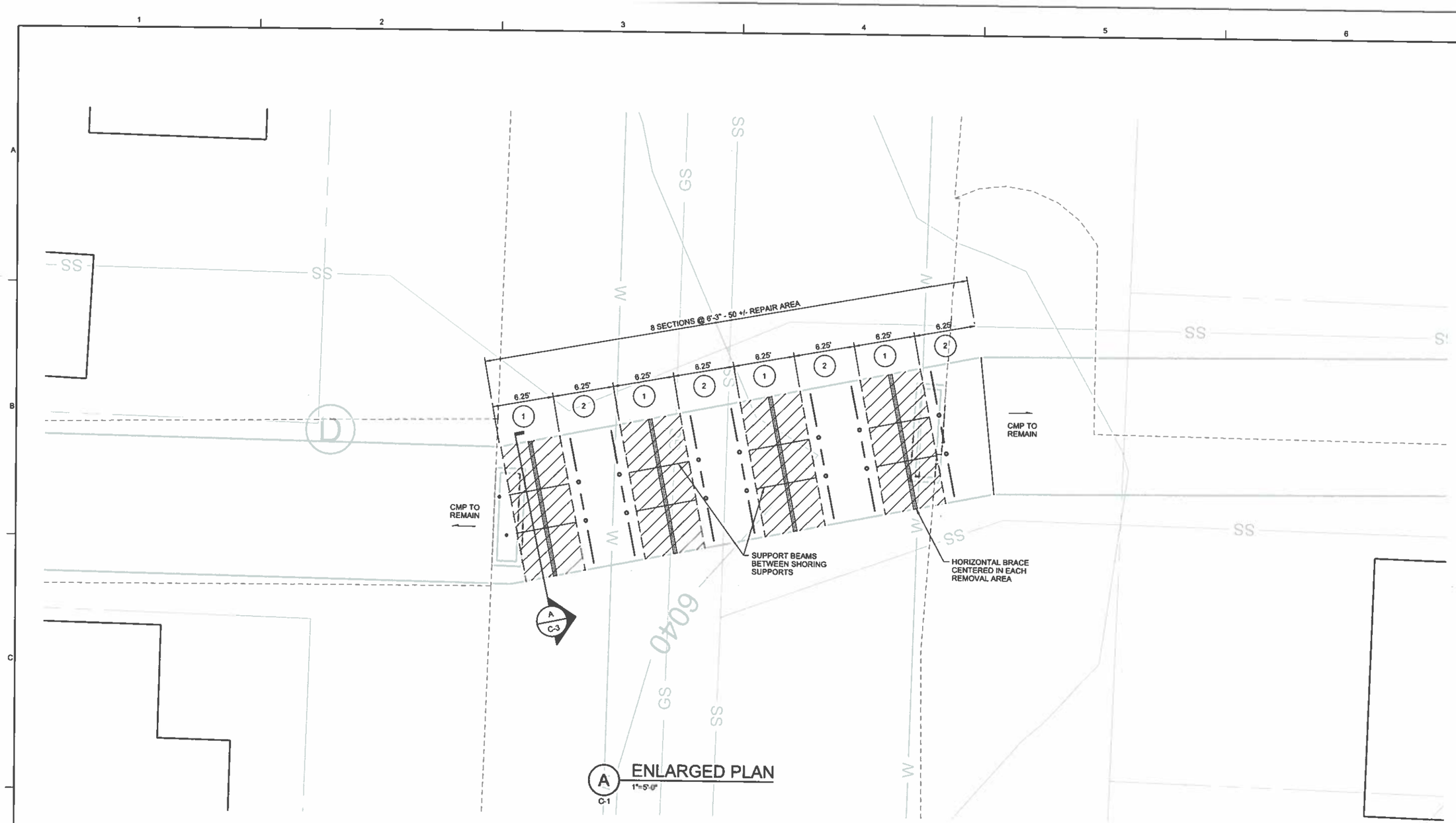
VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.

0 1"

DATE	DECEMBER 2017
PROJ	691414
DWG	C-1
SHEET	X of X

$PWURL $PWPATH FILENAME: LS-050-C-C001.dgn PLOT DATE: 2017\12\08 PLOT TIME: 12:37:44 PM



A ENLARGED PLAN
C-1 1"=5'-0"

SYMBOLS

- VERTICAL SHORING POST WITH 20,000LB WORKING CAPACITY
- SHORING POST SET AT ANGLE
- AREAS INDICATED AS FIRST FOR REMOVAL
- (1) STAGE 1 REMOVAL AND REPAIR
- (2) STAGE 2 REMOVAL AND REPAIR

DEMOLITION NOTES:

1. CONTRACTOR SHALL BEGIN REPAIR AT DAMAGED CULVERT SECTION LOCATED UNDER HANCOCK AVENUE. REPAIR AT ALLEY SHALL NOT COMMENCE UNTIL THE WORK AT HANCOCK IS COMPLETE AND AT DIRECTION OF OWNER.
2. REPAIRS SHALL BE COMPLETE ED IN 2 -STAGES AS INDICATED BY THIS PLAN.
3. REPAIR SHALL GENERALLY FOLLOW THE PROCESS NOTED BELOW:
   A. PERMEATION GROUTING AT THE LOWER CULVERT CORNERS WILL ONLY BE REQUIRED IF DURING REMOVAL OF THE LOWER CORNER RADIUS SECTION THE SUBGRADE MATERIAL BEGINS TO RAVEL OR COLLAPSE.
   B. INSTALL BRACING TO SUPPORT LOADS INDICATED ON THE DRAWING, SEE SHORING NOTES.
   C. REMOVE EXISTING CONCRETE SLAB.
   D. REMOVE EXISTING DAMAGED CULVERT SECTIONS FROM THE UPPER SEAM OF LOWER CORNER RADIUS ACROSS BOTTOM TO OPPOSITE UPPER SEAM OF LOWER CORNER RADIUS.
      i. MONITOR SOILS FOR SIGNS OF COLLAPSE OR SIGNIFICANT RAVELING.
      ii. REMOVE BOLTS AT UPPER SEAM OF CORNER PLATE. DO NOT CUT EXISTING PLATE.
      iii. EXISTING BOLT HOLES WILL BE UTILIZED FOR CONNECTION TO NEW CONCRETE SLAB, SEE DETAIL 1, DRAWING C-5.
      iv. ALL OTHER PLATES MAY BE CUT.
4. REMOVAL SHALL BE IN APPROXIMATED 8-FOOT SEGMENTS WITH 8-FEET BETWEEN EACH AREA OF REMOVAL.
5. COMPLETE REPAIR OF STAGE 1 REMOVAL AREAS.
6. AFTER CONCRETE OBTAINS DESIGN STRENGTH, MOVE SHORING TO NEW LOCATIONS AND PROCEED WITH STAGE 2 REMOVAL AND REPAIR.

N
0 5 10 15
Scale In Feet

PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	APVD
DSGN	WG	DR	CHK	BS
			APVD	AT

9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112
ch2m:

WATER RESOURCES ENGINEERING
COLORADO SPRINGS

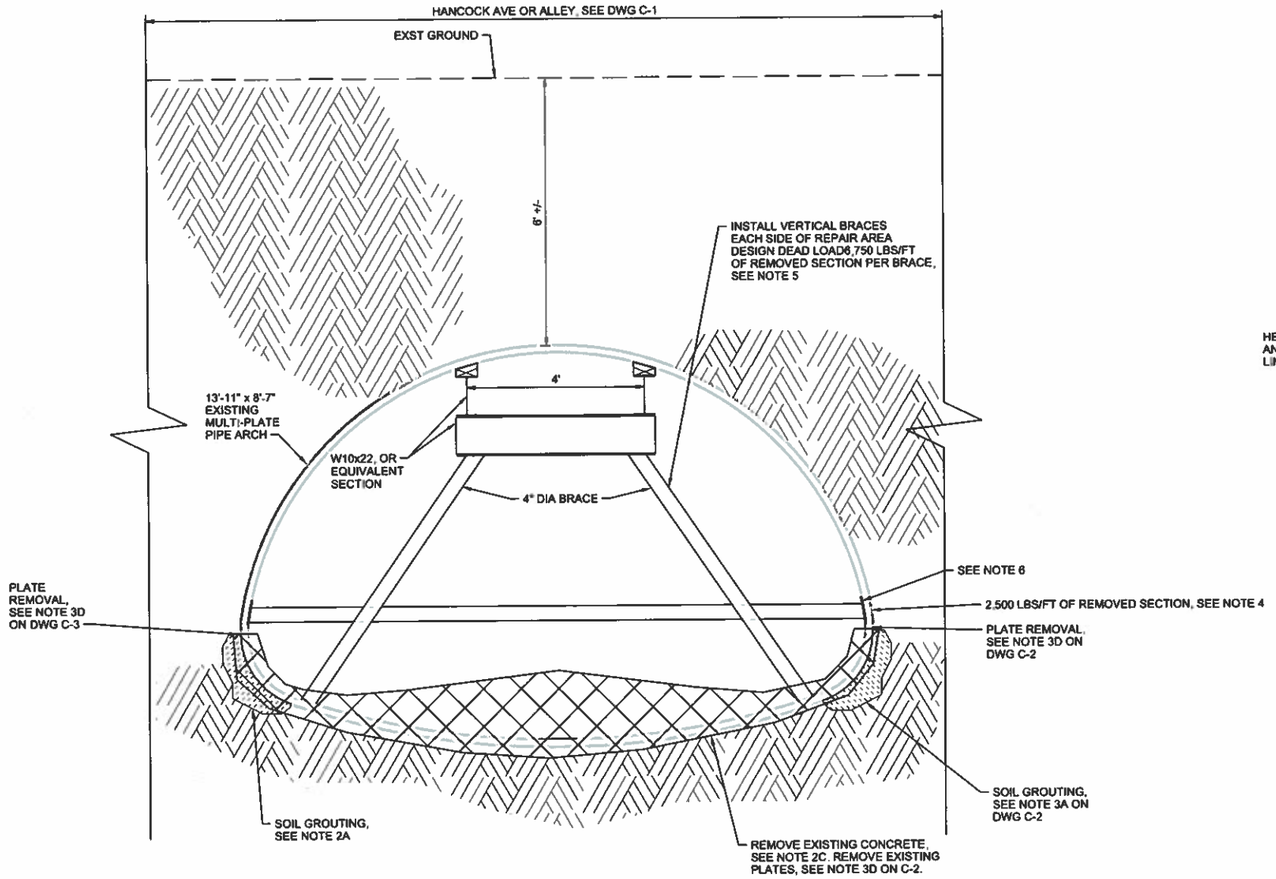
LITTLE SHOOKS RUN CULVERT UPHEAVAL
ENLARGED PLAN

30% DOCUMENT

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"

DATE	DECEMBER 2017
PROJ	691414
DWG	C-2
SHEET	X of X

$PWURL $PWPATH
FILENAME: LS-050-C-C002.dgn PLOT DATE: 2017\12\08 PLOT TIME: 12:38:55 PM



SHORING

1. CONTRACTOR SHOULD WORK WITH EXPERIENCED SHORING SYSTEM PROVIDER AND DESIGNER.
2. SUGGESTED LOCATIONS AND GEOMETRY OF SHORING SYSTEM ARE NOT FINAL AND PROVIDED AS A GENERAL GUIDE TO THE REQUIRED TEMPORARY SUPPORT SYSTEM.
3. SHORING LOADS ARE BASED ON SOIL WEIGHT AND LATERAL LOADING. LIVE LOADS SUCH AS TRAFFIC OR CONSTRUCTION LOADS ARE NOT INCLUDED IN THE VALUES PROVIDED.
4. HORIZONTAL BRACE SHALL BE LOCATED AT CENTERLINE OF EACH SECTION OF INVERT REMOVAL BEFORE INITIATING DEMOLITION.
5. LOCATE EACH SIDE OF SECTIONS TO BE REMOVED. PROVIDE ANGLED SHORES TO AVOID HEAVED INVERT.
6. WHERE BRACES CONTACT CORRUGATED PLATE PROVIDE NESTED PLATE 12 GA PLATE, MINIMUM 18-INCH SQUARE.

(A) DEMOLITION AND BRACING

1"=1'-0"

C-1
C-2

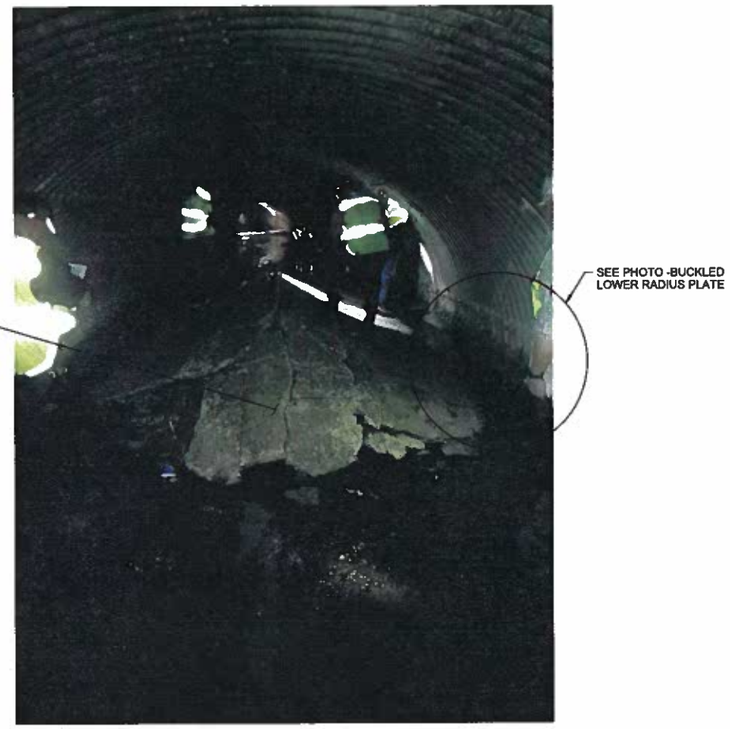


PHOTO - SECTION A

NTS

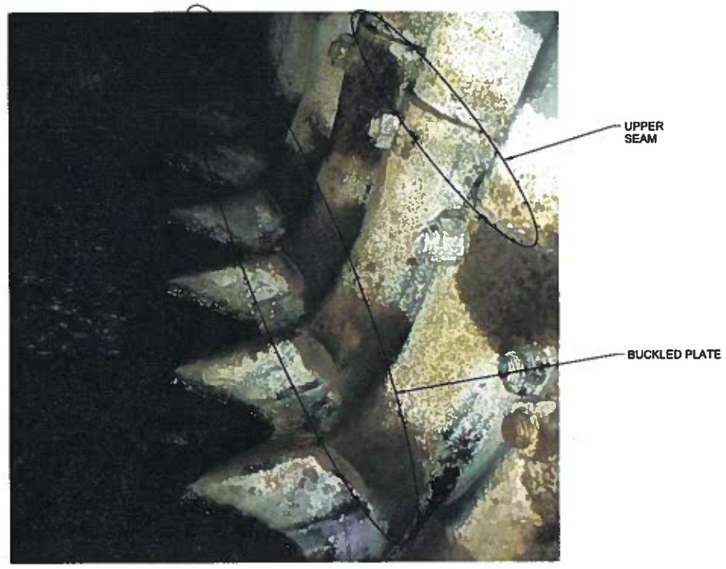


PHOTO - BUCKLED LOWER RADIUS PLATE

NTS

PRELIMINARY NOT FOR CONSTRUCTION

NO.	DSGN	DATE	DR	REVISION	CHK	APVD	BY	APVD
	JM		BS		AT	AT		

9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112

ch2m:

LITTLE SHOOKS RUN CULVERT UPHEAVAL

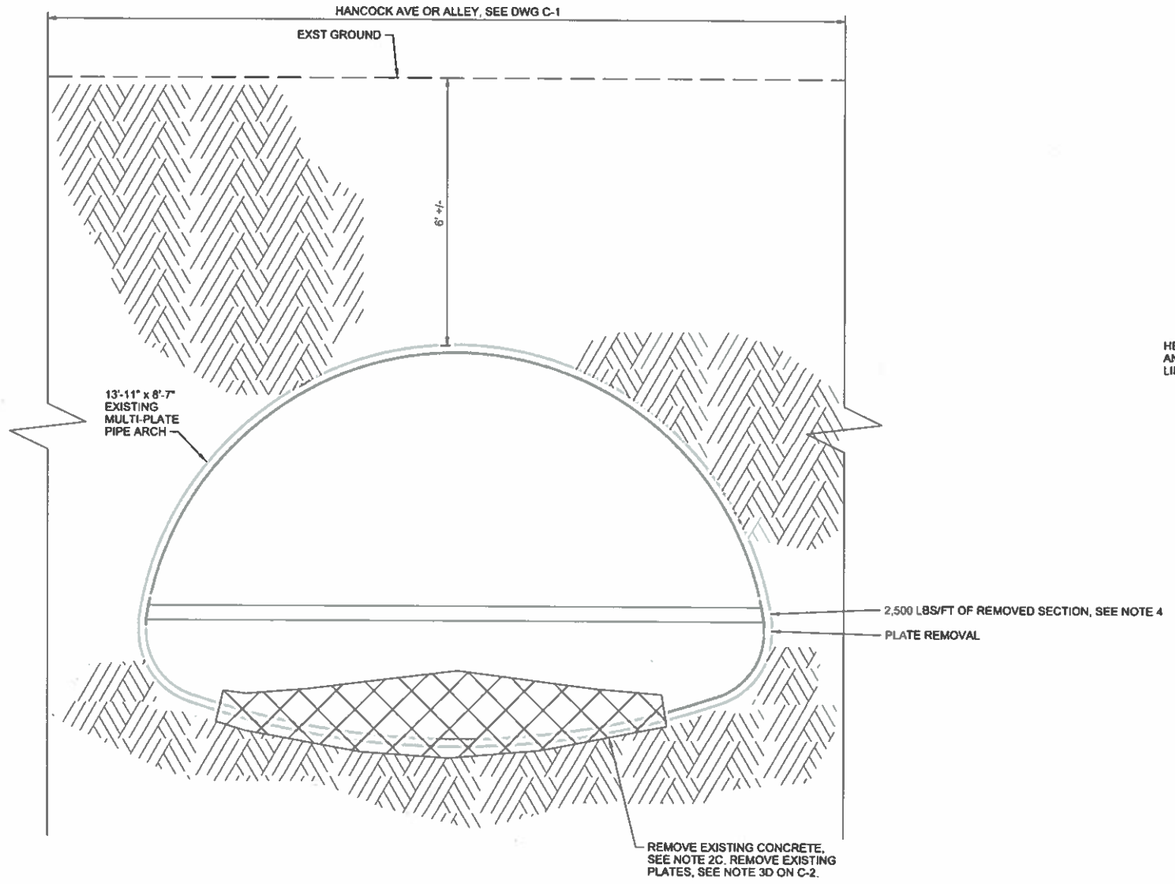
CIVIL
DEMO SECTION

VERIFY SCALE

BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	DECEMBER 2017
PROJ	691414
DWG	C-3
SHEET	X of X

30% DOCUMENT



SHORING

1. CONTRACTOR SHOULD WORK WITH EXPERIENCED SHORING SYSTEM PROVIDER AND DESIGNER.
2. SUGGESTED LOCATIONS AND GEOMETRY OF SHORING SYSTEM ARE NOT FINAL AND PROVIDED AS A GENERAL GUIDE TO THE REQUIRED TEMPORARY SUPPORT SYSTEM.
3. SHORING LOADS ARE BASED ON SOIL WEIGHT AND LATERAL LOADING. LIVE LOADS SUCH AS TRAFFIC OR CONSTRUCTION LOADS ARE NOT INCLUDED IN THE VALUES PROVIDED.
4. HORIZONTAL BRACE SHALL BE LOCATED AT CENTERLINE OF EACH SECTION OF INVERT REMOVAL BEFORE INITIATING DEMOLITION. CONTRACTOR OPTION TO INSTALL TWO HORIZONTAL BRACES WITH 2'-0" BETWEEN.
5. WHERE BRACES CONTACT CORRUGATED PLATE PROVIDE NESTED PLATE 12 GA PLATE, MINIMUM 18-INCH SQUARE.

A DEMOLITION AND BRACING - OPTION 2
NTS

C-1
C-2

OPTION 2:

FOLLOWS ALL NOTES INDICATED HERE AND THOSE ON DRAWING C-2 EXCEPT THAT THE LOWER CORNER RADIUS SECTION SHALL REMAIN IN PLACE. OPTION 2 REPAIR IS SHOWN IN SECTION A ON DRAWING C-5A.

ALTERNATE OPTION 2

PHOTO - SECTION A
NTS

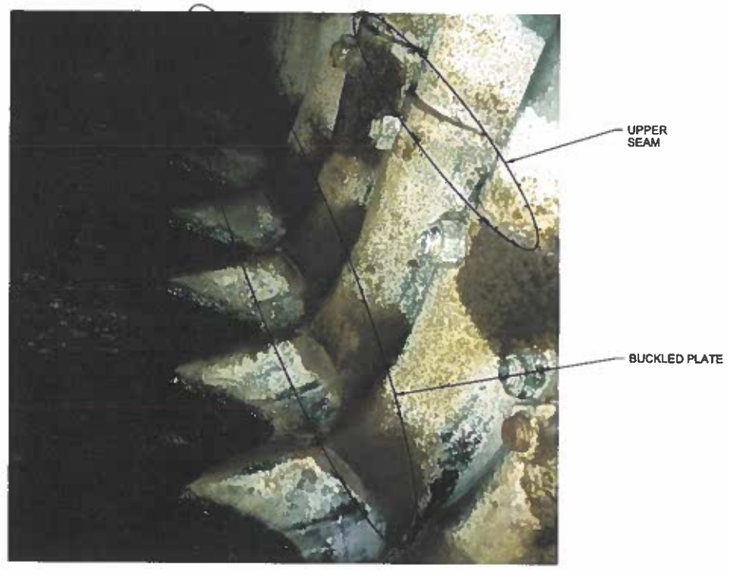


PHOTO - BUCKLED LOWER RADIUS PLATE
NTS

PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	REVISION	BY	APVD
DSGN	JM	DR	CHK	BS
			APVD	AT
			BY	AT

9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112
ch2m:

WATER RESOURCES ENGINEERING
COLORADO SPRINGS

LITTLE SHOOKS RUN CULVERT UPHEAVAL
CIVIL
ALTERNATE DEMO SECTION

30% DOCUMENT

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	DECEMBER 2017
PROJ	691414
DWG	C-3A
SHEET	X of X

ch2m

SUBMITTAL REVIEW RESPONSE

Project Name: Little Shooks Run 9' X 14' Culvert Repair
Owner: City of Colorado Springs
Project Number: 691414

SUBMITTAL NUMBER:	001	Contractor's No:	1
DESCRIPTION:	Engineer Stamped Shoring Plan		
SPEC SECTION:	NA		

TO BE COMPLETED BY PRIMARY REVIEWER:

SUBMITTAL DESIGNATION: ☒ ACTION ☐ DEFERRED ☐ INFORMATIONAL

☒ Approved	☐ Approved As Noted
☐ Partial Approval, Resubmit as Noted	☐ Revise and Resubmit
☐ Not Subject to Review	

INFORMATION SUBMITTAL:

☒ Meets Conditions	☐ Does Not Meet Conditions

Engineer's review and acceptance of this submittal are expressly limited as provided in the Contract Documents and are only to determine conformance with information given in the Contract documents and compatibility with the design concept for the completed project as a functioning whole as indicated in the Contract Documents. Contractor is, and Engineer is NOT, responsible for all matters relating to fabrication, shipping, handling, storage, assembly, installation, construction (including all safety aspects of performing the Work), and for coordinating the Work.

The stamped engineering drawings related to the shoring of the Little Shooks Run Steel Pipe and agree that the shoring as submitted will meet the intent of shoring the pipe for construction.

CH2M: Harry Elliot	Date: 04/10/18
Signature	Date: 04/10/18

Return this form to: jadair@springsgov.com with any required attachments.

Please refer to attached drawings for comments.

DRX Enterprises, LLC

MATERIAL SUBMITTAL FOR APPROVAL

OWNER: City of Colorado Springs

TO (Project Manager)	FROM (Contractor)	DATE
Mr. John Adair	DRX Enterprises,LLC	1-Mar-2018

CONTRACT NUMBER	SUBMISSION NUMBER	SUBMITTAL
R008415 - 2018-002	1	[X] NEW [ ] RESUBMITTAL

PREVIOUS SUBMISSION NUMBER	PROJECT NAME
NA	Shooks Run Steel Pipe

TO BE COMPLETED BY CONTRACTOR | **FOR OWNER USE ONLY**

Item No	Reference	Description of Material *(Include Type, Model No, Catalog No, Mfg, etc.)*	Approved	Dis-Approved	Initial
1		Engineered Stamped Shoring Plan			

TYPED OR PRINTED NAME AND TITLE	SIGNATURE	DATE
Robert A. Benefiel / Chief Estimator - PM		1-Mar-18

FOR OWNER USE ONLY

TO: PROJECT MANAGER

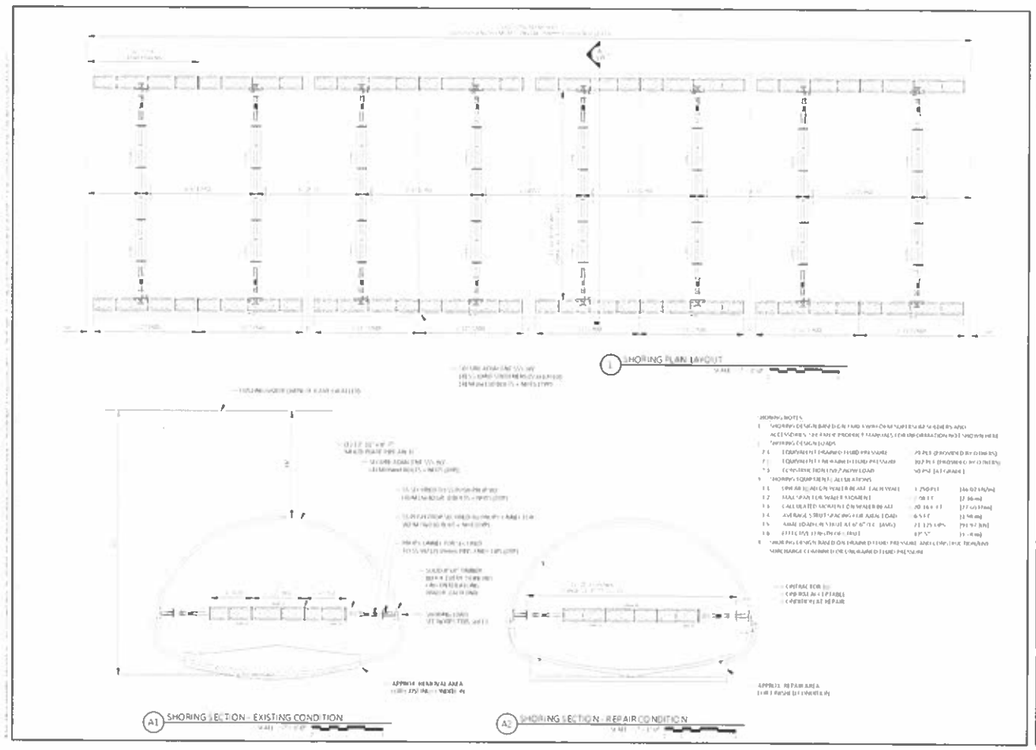
Recommend [ ] Approval [ ] Disapproval as Indicated Above and Subject to Any Applicable Comments

TYPED OR PRINTED NAME AND TITLE	SIGNATURE	DATE

TO (Contractor)

[ ] Approved [ ] Disapproved as Indicated Above and Subject to Any Applicable Comments on the Reverse Side. Request Resubmittal on Disapproved Items Within ____ Days of Date Shown Below.

TYPED OR PRINTED NAME AND TITLE	SIGNATURE	DATE



Crimson Engineering Associates, Inc

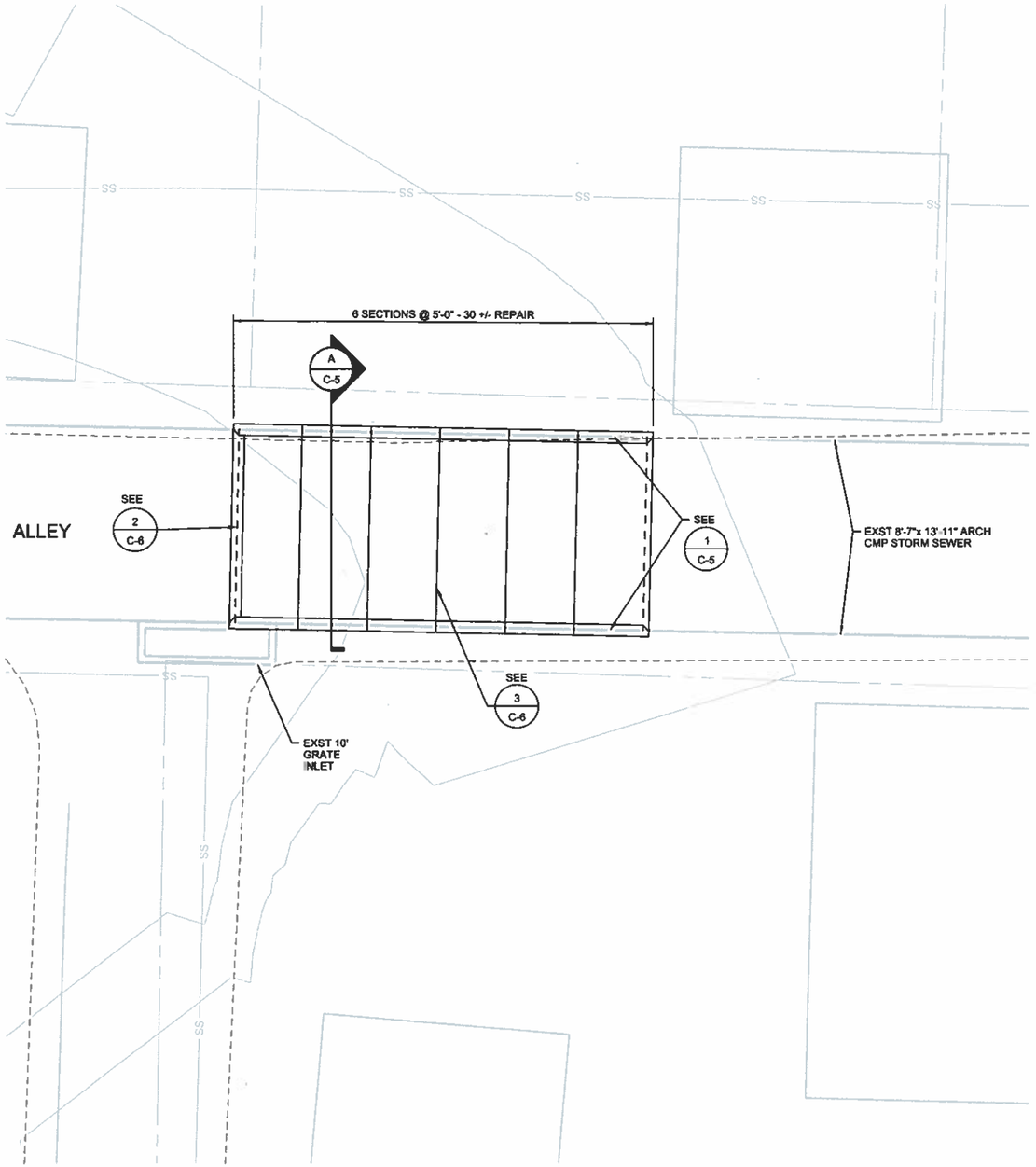
CEA

DATE	REVISIONS/ISSUES
07/12/2018	ISSUED FOR PERMIT
07/19/2018	ISSUED FOR CONSTRUCTION

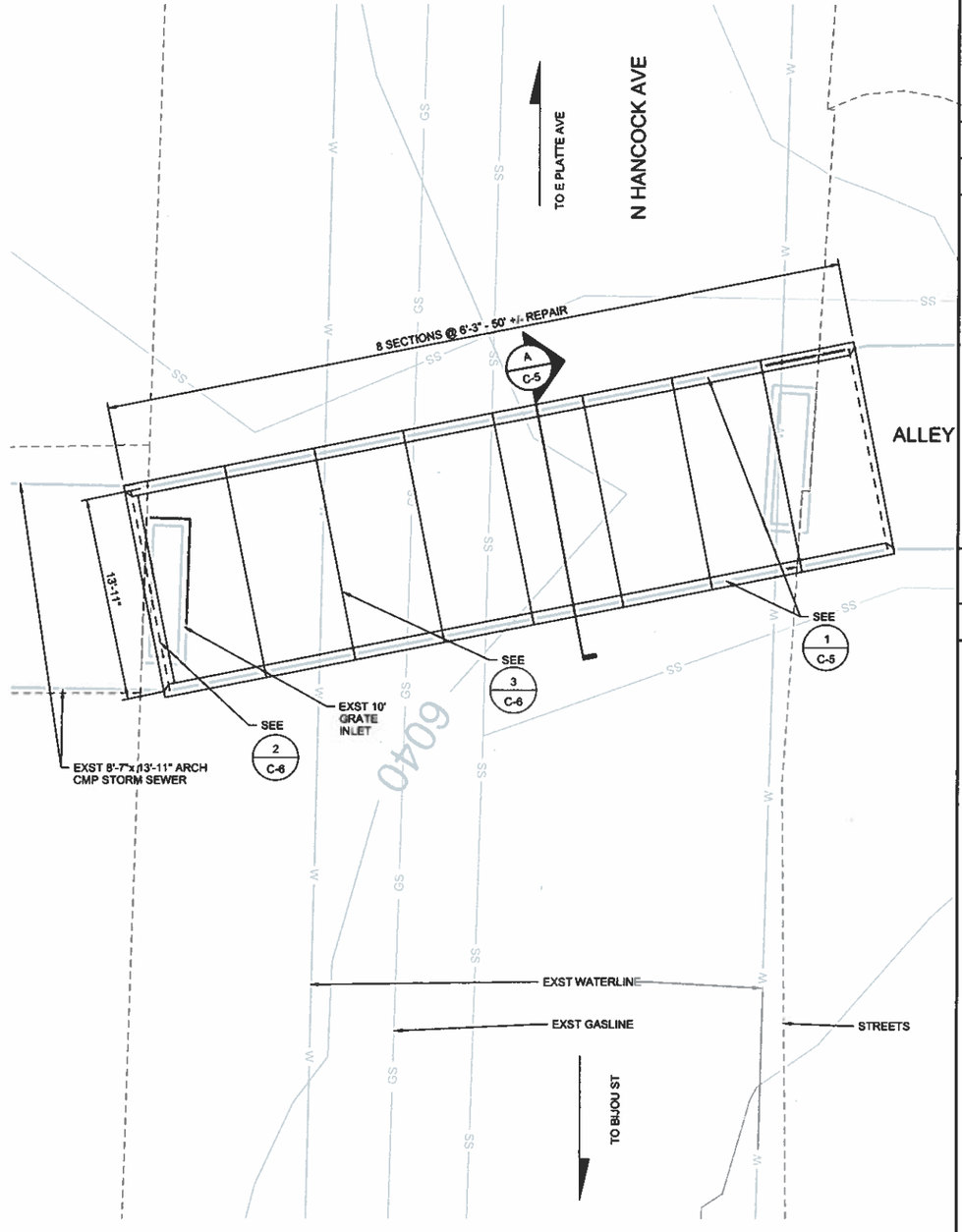
PROJECT: LITTLE SHOOFLY RUN CULVERT UPHEAVAL

SHEET TITLE: CULVERT TEMPORARY SHORING

PROJECT #	170999
DRAWN BY	AS
CHECKED BY	
DATE	07/19/18
SHEET	1.0
SCALE	



A ENLARGED PLAN (30FT SECTION) - 4 FT ABOVE INVERT
1"=5'-0"



B ENLARGED PLAN (50 FT SECTION) - 4 FT ABOVE INVERT
1"=5'-0"

N
0 5 10 15
Scale In Feet

PRELIMINARY
NOT FOR
CONSTRUCTION

NO.	DATE	DSGN	DR	CHK	APVD
		WG	BS	AT	AT

REVISION BY APVD

9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112
ch2m:

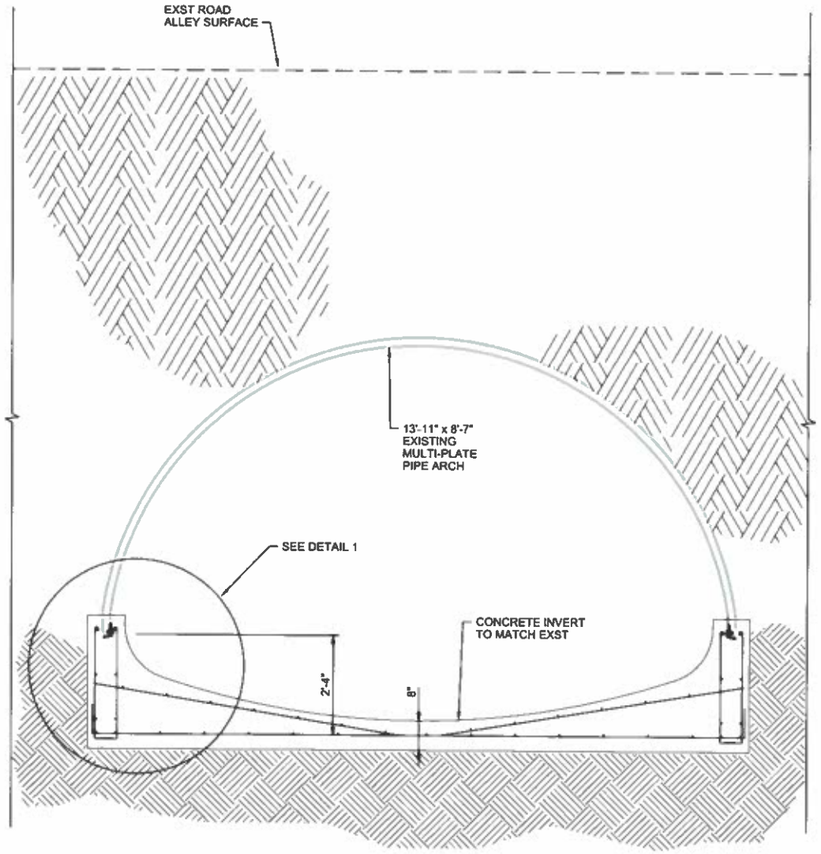
WATER RESOURCES ENGINEERING
COLORADO SPRINGS

LITTLE SHOOKS RUN CULVERT UPHEAVAL
ENLARGED PLAN
4 FEET ABOVE INVERT

30% DOCUMENT

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

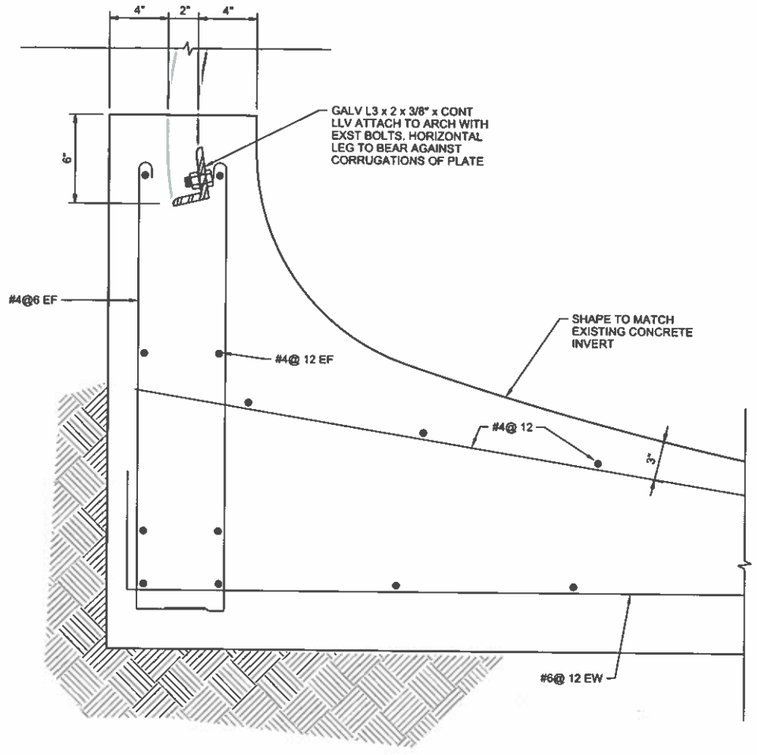
DATE	DECEMBER 2017
PROJ	691414
DWG	C-4
SHEET	X of X



NOTE:

1. BRACING NOT SHOWN

A C-4 REPAIR SECTION
1"=1'-0"



1 C-4 DETAIL
1/4"=1'-0"

PRELIMINARY
NOT FOR
CONSTRUCTION

NO.	DATE	REVISION	BY	APVD
DSGN	JM	DR	BS	AT
		CHK	APVD	AT

9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112
ch2m:
WATER RESOURCES ENGINEERING
COLORADO SPRINGS

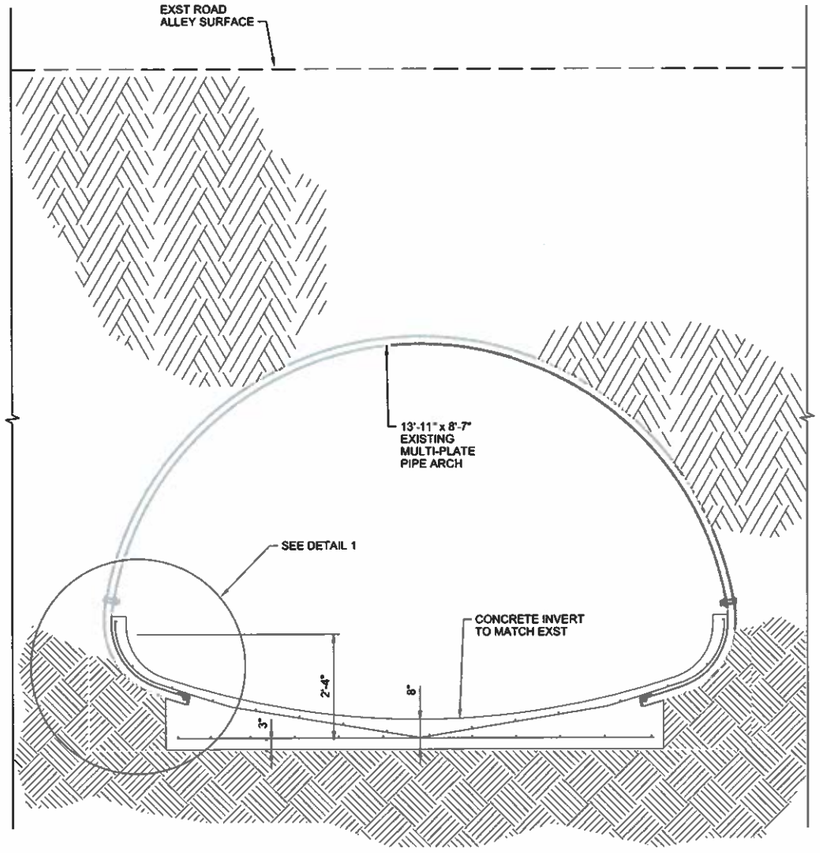
LITTLE SHOOKS RUN CULVERT UPHEAVAL
CIVIL
REPAIR SECTION

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	DECEMBER 2017
PROJ	691414
DWG	C-5
SHEET	X of X

30% DOCUMENT

$PWURL $PWPATH FILENAME: LS-050-C-C005.dgn PLOT DATE: 2017\12\08 PLOT TIME: 12:42:19 PM

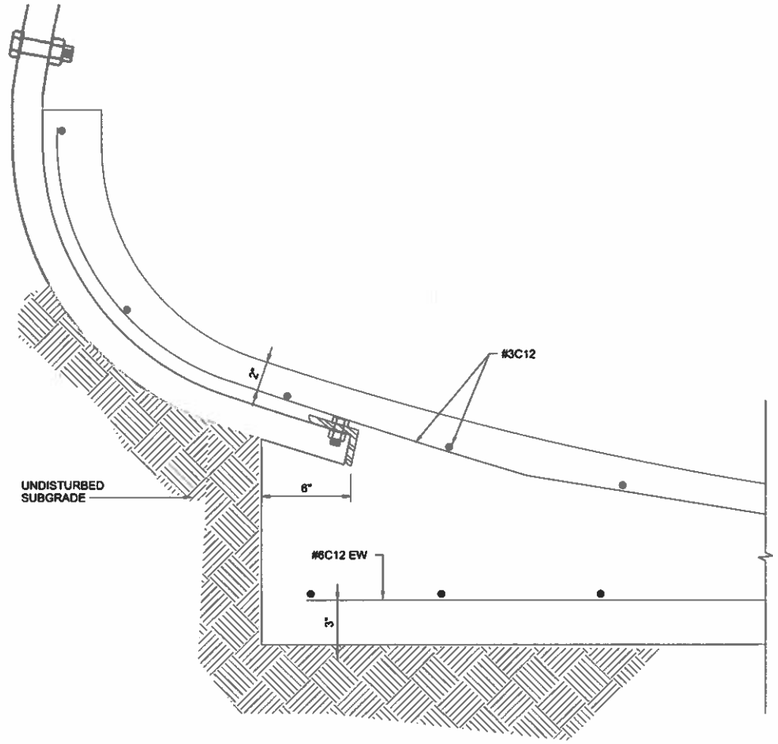


NOTE:

1. BRACING NOT SHOWN

A C-4 **REPAIR SECTION OPTION 2**
NTS

ALTERNATE OPTION 2



1 C-4 **DETAIL OPTION 2**
NTS

PRELIMINARY
NOT FOR
CONSTRUCTION

NO.	DATE	DSGN	DR	CHK	APVD
		JM	BS	AT	AT

REVISION BY APVD

ch2m:
9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112

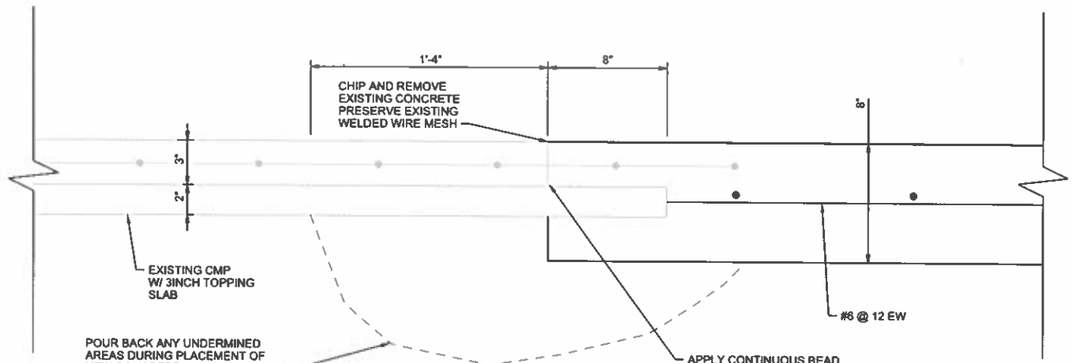
LITTLE SHOOKS RUN CULVERT UPHEAVAL

CIVIL
ALTERNATE REPAIR SECTION

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

DATE	DECEMBER 2017
PROJ	691414
DWG	C-5A
SHEET	X of X

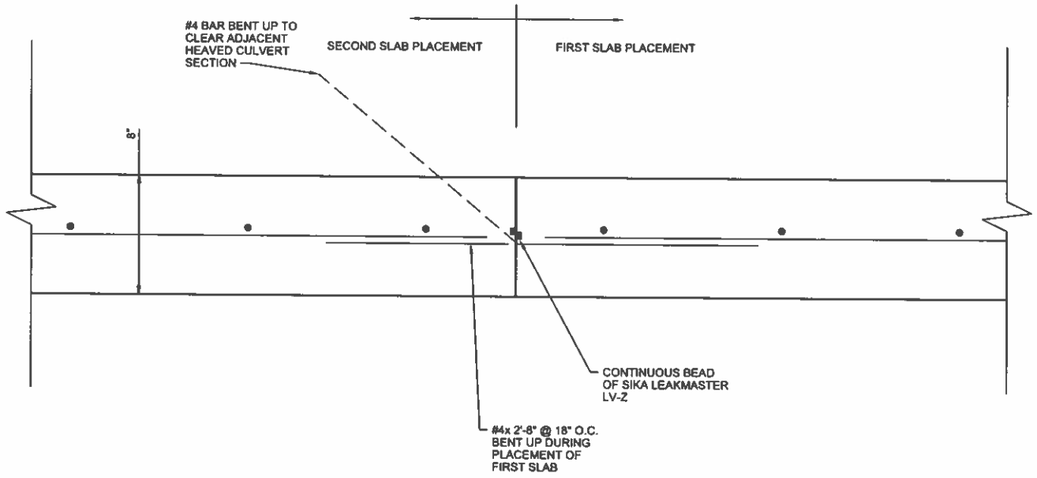
30% DOCUMENT



NOTES:

1. AT BOTH UPSTREAM AND DOWNSTREAM CONNECTION OF NEW TO EXISTING CONTACT OWNER FOR INVESTIGATION TO DETERMINE EXISTENCE AND EXTENT OF ANY AND ALL VOIDS.
2. ANY VOIDS EXTENDING BEYOND 2'-0" FROM THE REPAIR TRANSITION SHALL BE FILLED WITH CLSM PERMEATION GROUTING.
3. PAYMENT FOR CLSM SHALL BE PER UNIT COST ESTABLISHED IN CONTRACT.
4. IF AFTER INSPECTION AND PLACEMENT OF CLSM IT IS DETERMINED VOIDS HAVE NOT BEEN COMPLETELY FILLED, THE OWNER WILL DIRECT THE CONTRACTOR TO INITIATE PERMEATING GROUTING.
5. PAYMENT FOR PERMEATION GROUTING SHALL BE PER UNIT COST ESTABLISHED IN THE CONTRACT.

2 DETAIL
1"=1'-0"
C-4



3 DETAIL
1"=1'-0"
C-4

PRELIMINARY NOT FOR CONSTRUCTION

NO.	DATE	DSGN	DR	JM	BS	CHK	REVISION	BY	APVD
									AT
									APVD
									AT

9189 SOUTH JAMAICA ST
ENGLEWOOD, CO 80112
ch2m:

WATER RESOURCES ENGINEERING
COLORADO SPRINGS UTILITIES

LITTLE SHOOKS RUN CULVERT UPHEAVAL
CIVIL
REPAIR SECTION DETAIL

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"

DATE	DECEMBER 2017
PROJ	691414
DWG	C-6
SHEET	X of X

30% DOCUMENT

PAGE INTENTIONALLY LEFT BLANK