HNTB Corporation
The HNTB Companies
Infrastructure Solutions

7400 West 129th Street
Suite 100
Overland Park, KS 66213

Telephone (913) 491-9333
Facsimile (913) 491-9337
www.hntb.com

May 1, 2018

Re: Feasibility Study
170th Terrace & Switzer
City Project No. SD-1438

Introduction

HNTB was selected by the City of Overland Park to perform a feasibility study for two culvert crossings on 170th Terrace (170th), near Switzer Road. The homes along 170th are at least 30 years older than adjacent upstream and downstream residential developments. The two drainage systems in the project area each consist of a detention basin for a development upstream of a culvert under 170th, and a development with an enclosed storm sewer downstream. The two culverts are connected to the detention basins and downstream systems with swales that run through the yards of the adjoining properties. The City is interested in identifying flooding risks and determining the feasibility of installing a storm sewer system to connect the existing detention basins to the existing downstream system. This system would be designed to current city standards for roadway overtopping and alleviate flooding concerns and would also alleviate extended low flows in the existing dry swale system.

Exiting Conditions

170th was developed in the 1970's. The drainage system along the street consists of ditches and driveway culverts, generally directing stormwater to a pair of main culvert crossings. These culvert crossings (noted in this memo as "east" and "west") also convey stormwater from properties south of 170th. The west culvert is a 36" High-Density-Polyethylene (HDPE) pipe, and the east culvert is a 53" x 32" corrugated metal pipe (CMP).

The drainage area south of 170th was developed in the 2010's with residential construction (Terrybrook Farms). Detention basins were installed near the north property line of Terrybrook Farms. These detention basins drain through overland swales on the older residential properties fronting 170th to the culverts under 170th. The swales continue north to the property line of the Coffee Creek Crossing residential subdivision where the stormwater is collected by area inlets constructed in the subdivision and drained by a storm sewer system to Coffee Creek.

Drainage areas upstream and downstream of the two culvert crossings in the project limits were delineated based on Johnson County AIMS contours and based on development plans provided by the City of Overland Park. The drainage areas are shown in Figure 1.

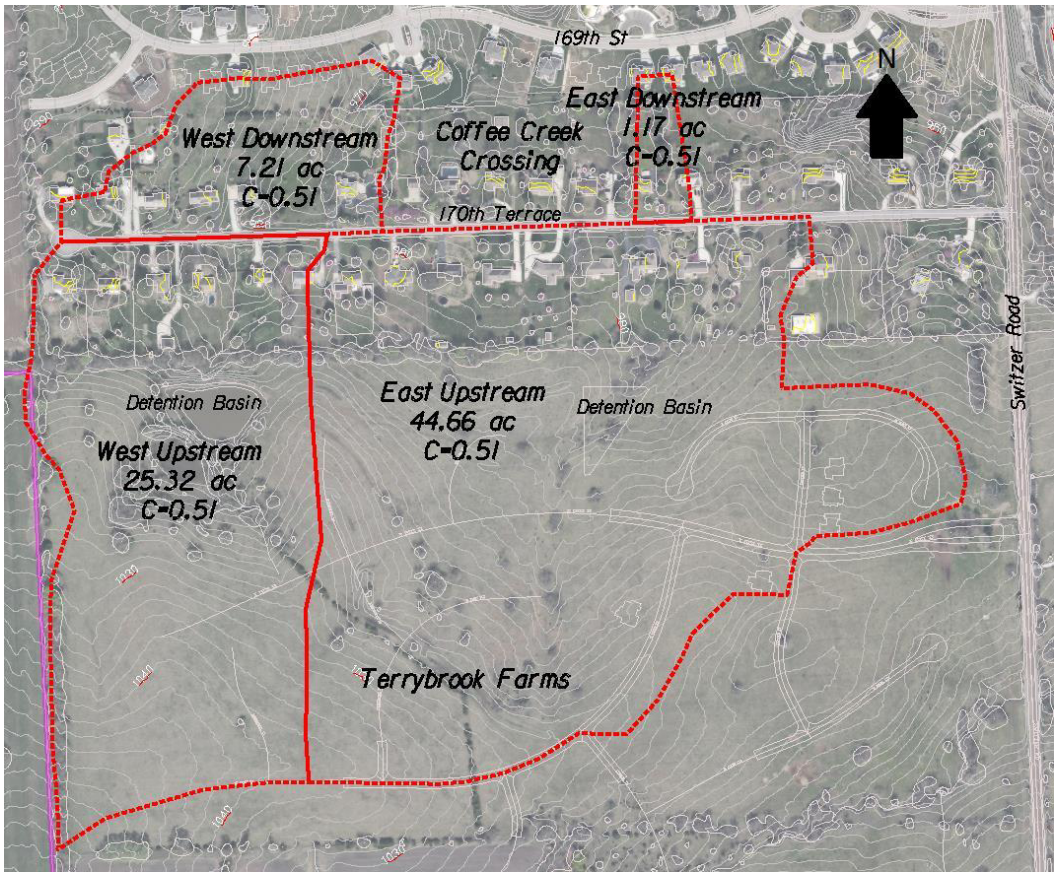


Figure 1 Drainage Area Map

The drainage area for the west culvert is 25.3 acres and the drainage area to the east culvert is 44.7 acres. Hydrologic calculations using the rational method are attached to this memo. The upstream Terrybrook Farms development was assumed to be fully developed residential (rational C=0.51). At the direction of City staff, the proposed public storm sewer system was analyzed using peak flows, neglecting the privately owned upstream detention basins. A 10" plastic pipe was installed upstream and downstream of 170th on the west system, and upstream of 170th on the east system, likely by the developer of the upstream neighborhood. These pipes were calculated to roughly convey 5 cfs, a small fraction of even the 50% storm for each system, and are therefore neglected by all calculations in this study.

The existing swale and culvert system was analyzed using HEC-RAS 5.0.4 based on AIMS contour data and surveyed flowlines of the east and west culvert. An existing conditions hydraulic model was created to model the east and west swales and culverts. Water surface profiles and flooding extents were computed for the 50%, 10%, and 1% storms.

Based on the existing conditions analysis, 170th was found to overtop in the 50% event at both crossings. In the 50% event, the west crossing was found to overtop by 6 inches and the east crossing was found to overtop by 3 inches. In the 10% event, the west crossing was found to overtop by 8 inches and the east crossing was found to overtop by 5 inches. In the 1% event, the west crossing was found to overtop by 12 inches and the east crossing was found to overtop by 7 inches. The 1% storm floodplain extents are shown in Figure 2.

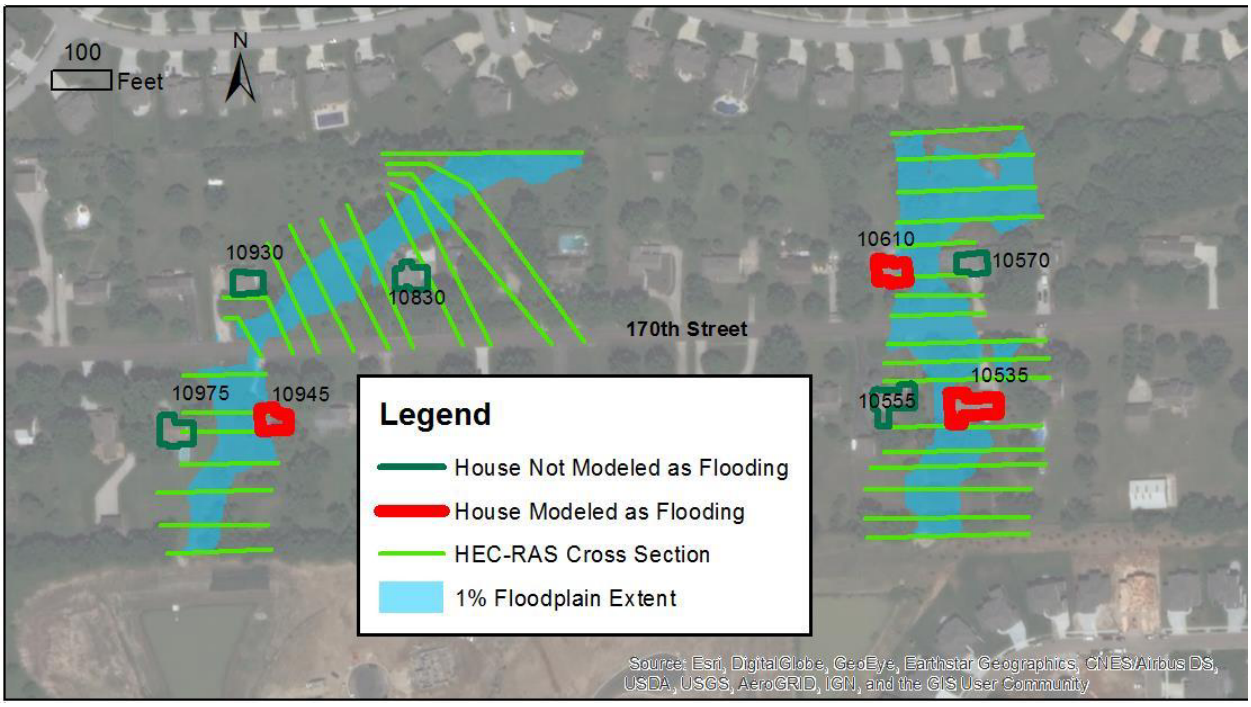


Figure 2 Existing Floodplain Extents

Lowest adjacent grades (LAG) and lowest openings (LO) were surveyed for 8 habitable structures adjacent to the swales. The surveyed values were compared to the computed HEC-RAS water surface values and tabulated below:

				Water Surface			LAG Flood Depth (+) / Freeboard (-)			LO Flood Depth (+) / Freeboard (-)		
		LAG	LO	50%	10%	1%	50%	10%	1%	50%	10%	1%
West	10930 W 170th Terr	982.05	983.69	976.70	976.91	977.13	-5.35	-5.14	-4.92	-6.99	-6.78	-6.56
	10830 W 170th Terr	971.79	972.20	970.77	970.83	971.09	-1.02	-0.96	-0.7	-1.43	-1.37	-1.11
	10975 W 170th Terr	986.25	986.64	984.27	984.39	984.61	-1.98	-1.86	-1.64	-2.37	-2.25	-2.03
	10945 W 170th Terr	983.30	983.34	983.44	983.56	983.79	0.14	0.26	0.49	0.10	0.22	0.45
East	10610 W 170th Terr	966.61	966.75	967.51	967.65	967.80	0.9	1.04	1.19	0.76	0.9	1.05
	10570 W 170th Terr	969.95	971.26	968.20	968.40	968.60	-1.75	-1.55	-1.35	-3.06	-2.86	-2.66
	10555 W 170th Terr	975.51	977.71	973.71	973.86	974.00	-1.8	-1.65	-1.51	-4	-3.85	-3.71
	10535 W 170th Terr	973.76	973.64	973.71	973.86	974.00	-0.05	0.1	0.24	0.07	0.22	0.36

Highlighted values indicate water surface exceeds home structure LAG / LO.

The flooding results indicated by the model were compared with the responses to flood surveys sent to residents by the City of Overland Park. The resident at 10945 W 170th Terrace reported that their finished walkout basement has previously flooded by at least 1" deep in the house, which appears consistent with the model results. The resident at 10535 W 170th Terrace did not indicate that their house had flooded, but in a discussion at the project site with HNTB indicated that overflows from the swale had inundated their backyard during storm events and come near the openings to the house, reasonably consistent with the model considering the graphical floodplain limits and that the upstream detention basin was neglected. No correspondence or discussion was noted with the residents of 10610 W. 170th Terrace (the third house modeled as flooding).

In summary, three homes (10945 W. 170th Terr. and 1610 W. 170th Terr. and 10535 W. 170 Terr.) were found to be below the modeled 50% flood elevation vs. City lowest opening criteria. While 10535 W. 170 Terr. was found to be protected from flooding in the 50% event when measured against lowest adjacent grade, the calculated freeboard is less than 0.1 ft. These same three homes were also found to have lowest openings and lowest adjacent grades below the 10% and 1% events. Street overtopping was modeled to occur in storms as frequent as the 50% event, but less than 7 inches for both the 50% and 10% events. Street overtopping in the 1% event was modeled to be in excess of the 7 inches maximum allowed by City criteria.

Recommendations

The recommended proposed drainage system for this area consists of two storm sewer systems to convey stormwater through the project area. An overflow swale should also be graded along the surface path of the pipe system. A conceptual storm sewer routing, sizing, and profile was developed to meet City of Overland Park criteria. The following were set as additional considerations for this system:

- Overall system (combination of pipes and overflow swale) should convey the 1% storm with the EGL 1' below the low openings of adjacent homes per City criteria
- Directly connect the detention basin outlets to the proposed pipe system to minimize future erosion issues and remove the potential for the basin outlet to bypass the pipe system
- Minimum pipe sizes for the east and west systems will match the outlet pipe size of the adjacent detention basin and maximum pipe sizes will be the size of the downstream system (pipes will not decrease in size going downstream)
- Minimize property owner impacts where possible

The following exhibit (Figure 3) illustrates the overall layout of the proposed system. The west system consists of 42" RCP from the detention basin to the north side of 170th , where size is increased to 48" to the tie in with the existing area inlet and 48" RCP at the south property line of the Coffee Creek development. The east system consists of 48" RCP from the detention basin outlet to the area inlet at the south property line of the Coffee Creek development.

Figure 3 Conceptual Enclosed System Layout

Both systems should be directly connected to the outlet pipes of the detention basins with junction boxes. Details of the junction boxes will need to be addressed during final design to minimize the height of exposed junction box at the face of the detention basin berm. Final design plans and construction will also need to minimize impacts to the existing berms during construction. As placed in the conceptual drawings, a 1:1 slope could be graded during construction to facilitate installation of the junction boxes without disturbing the berm crest.

Area inlets are provided on each system just downstream of the proposed junction boxes to capture un-detained flow from the back of the side of the adjacent Terrybrook Farms lots. These structures also allow the pipes to be aligned with the property lines within the project limits. Area inlets are also provided upstream of 170th in order to capture runoff from between 170th and the detention basin and convey it under the roadway. A driveway culvert at 10930 W. 170th Terrace will need to be reconstructed and connected to a junction box due to the proximity of the driveway.

A conceptual plan & profile of the recommended storm sewer system is shown on the attached drawings.

Utility impacts along the alignment were considered. The west system will likely require:

- Multiple power poles (also holding the communication lines in the area) will require bracing during construction.
- Potential relocation of existing water main within right-of-way crossing the proposed storm sewer.
- Potential relocation of existing gas main outside of right-of-way crossing the proposed storm sewer. It is unknown if the gas main is in an existing private easement. The proposed alignment

runs parallel to the gas main but is offset in order to allow construction of the storm sewer without impacting the majority of the gas line.

The east system will likely require:

- Potential relocation of existing water main within right-of-way crossing the proposed storm sewer.
- Potential relocation of existing gas main outside of right-of-way crossing the proposed storm sewer. It is unknown if the gas main is in an existing private easement.

Existing water mains appear to be in City of Overland Park right-of-way, and are assumed to not be reimbursable relocations. The existing gas main that is crossed and power poles are located outside of the right-of-way shown in the AIMS mapping, and it is unknown if they are in a private easement. Therefore, the cost estimate includes an allowance for utility relocation (in conjunction with septic system relocation).

Proposed permanent draining easements and temporary construction easements will be required. Based on City criteria, permanent easements will need to be 20 ft wide along the proposed storm pipe. Temporary construction easements were laid out to provide additional construction access along the alignment.

Additional considerations that should be addressed during final design:

- The storm sewer alignment should be surveyed to verify pipe cover, and private feature impacts.
- In most locations, placing the proposed pipe system generally along the property line minimized pipe length, property owner impacts and matched the upstream or downstream connecting system location and is consistent with City practice for storm sewer alignment. At 10610 and 10570 W. 170th Terrace, this alignment would require removing and replacing a significant number of mature trees. For this concept study, the cost of replacing the trees with nursery stock was included. This alignment should be further analyzed during final design.
- There is potential to decrease the depth of the east system upstream of 170th if desired during final design. As set, the EGL of the system is at the ground surface. Decreasing the depth would reduce the available hydraulic head on the upstream end of the system and at the inlet at 170th and would potentially require a larger pipe size in order to maintain the EGL.
- Existing Area Inlet Ex2 (shown in the conceptual plan & profile drawings) may need to be modified in order to accommodate the inlet pipe without conflicting with the existing throat opening.
- Utility conflicts with each proposed storm sewer system should be coordinated during design. Field survey of utility markings was obtained in the vicinity of the 170th roadway crossings, however during design additional survey should be obtained along the remainder of the alignment and service line locations should be identified any service line conflicts coordinated.
- The conceptual storm sewer alignments avoid major septic system impacts based upon field observations and HNTB discussions with residents. Specifically, at 10975 & 10945 W 170th Terr, and 10555 & 10535 W 170th Terr, the proposed alignment is centered between observed septic surface cleanouts. At 10830 W 170th Terr the septic systems are located away from the eastern

property line based on discussion with the property owner. No septic infrastructure was observed for 10610 and 10570 W 170th Terr.

No design drawings or records of the septic systems were available from Kansas Department of Health and Environment or City of Overland Park. Lateral fields and holding tanks should be located during the design process to verify impacts. If septic systems are impacted, the project will likely need to bring them in-line with the current applicable codes. The cost estimate assumes that most septic systems have been avoided based on the limited existing information, but provides an allowance in combination with potential utility relocations for relocation and improvement to code of approximately one system.

Project Cost

A conceptual cost estimate was completed for the recommended storm sewer system and is attached. The overall construction cost is estimated at $810,000, including a 20% contingency. The total project cost is estimated at $973,000.

The total 2018 Johnson County Appraised value of the three habitable structures modeled as being at risk of flooding is $983,125, including a 25% factor for moving, closing, demolition, and relocation costs. This does not include the cost of improvements so that roadway overtopping meets criteria.

HNTB

CITY OF OVERLAND PARK

170th Terrace & Switzer Feasibility Study

City Project No. SD-1438 Date: April 30, 2018

Concept Cost Estimate

Bid Items No.	Item Description	Unit	Unit Price	Quantity	Total Cost
1	Pre Construction Survey	Each	$ 400	8	$ 3,200
2	Clearing and Grubbing	Lump Sum	$ 10,000	1	$ 10,000
3	Removal of Existing Structures	Lump Sum	$ 5,000	1	$ 5,000
4	Ditch / Swale Grading	Each	$ 5,000	1	$ 5,000
5	Type I Street Repair	Sq. Yd.	$ 90	161	$ 14,510
6	Aggregate Driveway	Sq. Yd.	$ 30	57	$ 1,713
7	Concrete Driveway	Sq. Yd.	$ 60	88	$ 5,307
8	Inlet (6'x6') (Area)	Each	$ 6,500	4	$ 26,000
9	Junction Box (6'x6')	Each	$ 6,500	5	$ 32,500
10	18" Storm Sewer (RCP)	Ln. Ft.	$ 95	25	$ 2,375
11	42" Storm Sewer (RCP)	Ln. Ft.	$ 190	344	$ 65,360
12	48" Storm Sewer (RCP)	Ln. Ft.	$ 240	1,502	$ 360,480
13	18" End Section (RCP)	Each	$ 2,000	1	$ 2,000
14	Fence (Ornamental Metal)	Ln. Ft.	$ 40	50	$ 2,000
15	Fence (Wood)	Ln. Ft.	$ 30	426	$ 12,780
16	Traffic Control	Lump Sum	$ 10,000	1	$ 10,000
17	Tree Replacement	Each	$ 350.00	33	$ 11,550
18	Sodding	Sq. Yd.	$ 5	6,153	$ 30,767
19	Temporary Seeding	Acre	$ 1,000	2	$ 2,000
20	Landscaping	Lump Sum	$ 16,000	1	$ 16,000
21	Lawn Sprinkler System (Est.)	Each	$ 2,000	8	$ 16,000
22	Erosion Control	Each	$ 30,000	1	$ 30,000
23	Contractor Construction Staking	Lump Sum	$ 10,000	1	$ 10,000

Notes:

All Unit Prices based on 2018 values. The costs shown on this estimate represent an estimate of probable costs prepared in good faith and with reasonable care. HNTB has no control over the costs of construction labor, materials, or equipment, nor over competitive bidding or negotiating methods and does not make any commitment or assume any duty to assure that bids or negotiated prices will not vary from this estimate.

Due to the conceptual nature of this estimate, sums have been rounded to the nearest $1000.

Construction Cost	**$**	**675,000**
Contingency (20%)	**$**	**135,000**
2018 Total Construction Cost	**$**	**810,000**
Engineering & Survey (Design)	**$**	**81,000**
Utility / Septic Relocation (5% of Construction)	**$**	**41,000**
Easement Acquisition (Administrative) (5% of Construction)	**$**	**41,000**
2018 Total Project Cost	**$**	**973,000**

170th Terrace Existing Conditions Hydrology Calculations

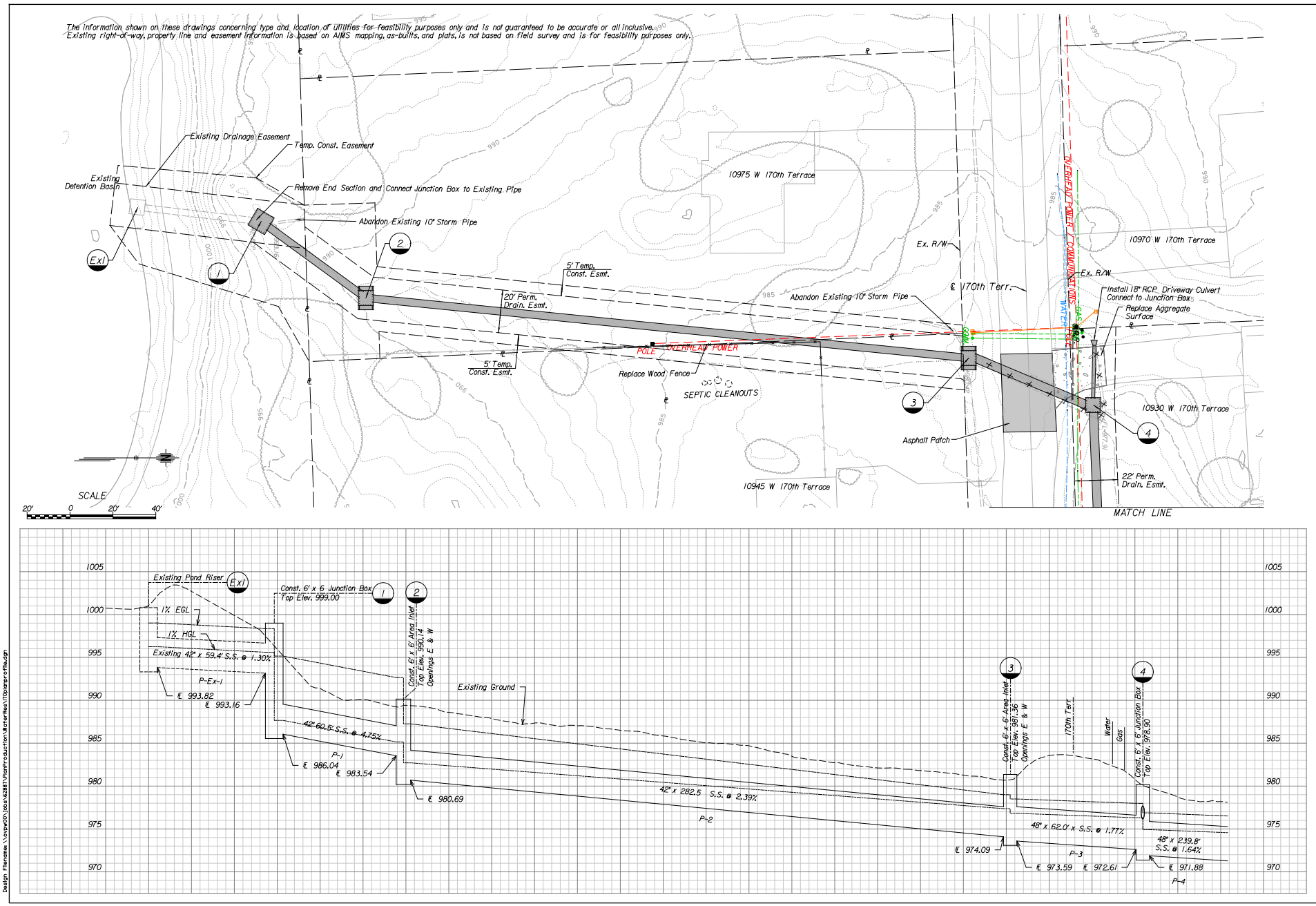
Region	Area$_1$	Wt. C	Area Total	Time of Concentration	Tme of Concentration											I50%	Q50%	I10%	Q10%	I1%	Q1%
					T_I	(Inlet Time)				T_T	(Travel Time)										
	0.51					Length	El 1	El. 2	Slope		Elev. 1	Elev. 2	Lining	Length	Slope						
			ac	min	min	ft	ft	ft		min	ft	ft		ft		in./hr	cfs	in./hr	cfs	in./hr	cfs
	25.32	0.51	25.32	13.0	7.4	100	1056.5	1053.6	2.9%	2.9	1053.6	1024	Street Gutter	1032	2.9%	4.0	51.1	5.5	71.0	7.8	125.8
WestUS										2.7	1024	980.42	Turf	956	4.6%						
	32.53	0.51	32.53	14.9						1.9	977.91	964.37	Turf	514	2.6%	3.7	61.8	5.2	86.1	7.4	152.9
WestDS																					
EastUS	44.66	0.51	44.66	16.4	10.6	100	1039	1038	1.0%	3.2	1038	993	Street Gutter	1267	3.6%	3.5	80.7	5.0	113.1	7.1	203.1
										2.5	993	969.78	Turf	750	3.1%						
EastDS	45.83	0.51	45.83	17.4						1.0	969.3	959.37	Turf	318	3.1%	3.4	80.6	4.8	113.3	7.0	203.8

I = Rainfall Intensity
Q = Discharge (Q=kCIA per rational method)
(k=1.25 for 1%, 1.0 otherwise)

Proposed Pipe Design Calculations

	STRUCTURE		DELTA A (ac)	SUM A (ac)	C	DELTA CA	SUM CA	DELTA T (min)	T (min)	STORM FREQ	I (in/hr)	Q (cfs)	CAP (cfs)	DIA (in)	TYPE	FL UP (ft)	FL DOWN (ft)	SLOPE (%)	VEL (ft/s)	Q/Qf	TOP ELEV. (ft)	HGL (ft)	EGL (ft)
	NO.	TYPE																					
West System																							
	Ex-1	Existing Pond Riser	18.28		0.51	9.32		11.57													1000.80	996.25	999.01
P-Ex-1				18.28			9.32		11.57	1%	10.23	95.32	114.71	42	RCP	993.82	993.16	1.30%	13.33	0.83			
	1	6' x 6' Junction Box	0.00		0.00	0.00		0.05													999.00	987.66	995.16
P-1				18.28			9.32		11.62	1%	10.20	95.10	219.36	42	RCP	986.04	983.54	4.75%	21.97	0.43			
	2	6' x 6' Area Inlet	0.66		0.51	0.34		0.28													990.14	982.71	987.25
P-2				18.94			9.66		11.89	1%	10.19	98.38	155.44	42	RCP	980.69	974.09	2.39%	17.09	0.63			
	3	6' x 6' Area Inlet	6.39		0.51	3.26		0.06													981.36	977.37	978.99
P-3				25.32			12.92		11.96	1%	10.09	130.38	191.07	48	RCP	973.59	972.61	1.77%	10.38	0.68			
	4	6' x 6' Junction Box	0.00		0.00	0.00		0.25													980.17	977.60	978.51
P-4				27.38			13.96		12.21	1%	10.07	140.66	183.95	48	RCP	971.88	968.04	1.64%	11.19	0.76			
	5	6' x 6' Junction Box	0.00		0.00	0.00		0.22													977.25	972.70	974.61
P-5				27.38			13.96		12.43	1%	10.00	139.61	143.74	48	RCP	967.84	966.18	1.00%	11.11	0.97			
	6	6' x 6' Junction Box	0.00		0.00	0.00		0.30													975.97	970.93	972.82
P-6				27.38			13.96		12.72	1%	9.93	138.68	202.74	48	RCP	965.68	959.65	1.99%	11.04	0.68			
	Ex-2	Existing 6' x 6' Area Inlet	5.16		0.51	2.63		0.18													964.37	965.94	968.56
P-Ex-2				32.54			16.60		12.91	1%	9.84	163.36	222.51	48	RCP	959.45	954.48	2.40%	13.00	0.73			
	Ex-3	Existing 6' x 6' Area Inlet	0.00		0.00	0.00		0.00													961.10	961.10	963.73
																					TW =	**961.10**	**983.29**
East System																							
	Ex-4	Existing Pond Riser	30.54		0.51	15.58		15.29													986.20	981.78	983.78
P-Ex-4				30.54			15.58		15.29	1%	9.15	142.48	94.77	48	RCP	977.42	977.19	0.44%	11.34	1.50			
	7	6' x 6' Junction Box	0.00		0.00	0.00		0.07													982.61	981.19	983.19
P-7				30.54			15.58		15.36	1%	9.13	142.13	227.12	48	RCP	968.32	966.72	2.07%	19.07	0.63			
	8	6' x 6' Area Inlet	1.59		0.51	0.81		0.29													974.97	969.05	972.88
P-8				32.13			16.39		15.65	1%	9.11	149.23	175.93	48	RCP	966.22	962.27	1.50%	15.71	0.85			
	9	6' x 6' Junction Box	12.52		0.51	6.39		0.30													971.66	965.00	971.51
P-9				44.65			22.77		15.94	1%	9.03	205.69	227.12	48	RCP	961.77	953.09	2.43%	20.47	0.91			
	Ex-5	Existing 8' x 8' Area Inlet	1.16		0.51	0.59		0.12													959.37	959.05	960.81
P-Ex-5				45.81			23.36		16.06	1%	8.95	209.23	338.64	60	RCP	952.09	950.06	1.69%	10.66	0.62			
	Ex-6	Existing 8' x 8' Junction Box	0.00		0.00	0.00		0.00													958.02	958.02	959.78
																					TW =	**958.02**	**983.29**

Note: Tailwater for both systems assumed at the rim elevation of downstream surveyed structure.



SHEET NO. 1 | TOTAL SHEETS 5

HNTB
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Overland Park, KS 66213
(913) 491-4333

OVERLAND PARK KANSAS
ABOVE AND BEYOND. BY DESIGN.

NO.	DATE	REVISIONS	BY	APP'D
1				
2				
3				
4				

170th Terrace Feasability Memo
PLAN & PROFILE
West System #1

Plotted on: 30-APR-2018 09:07 PM Model: ########Model########
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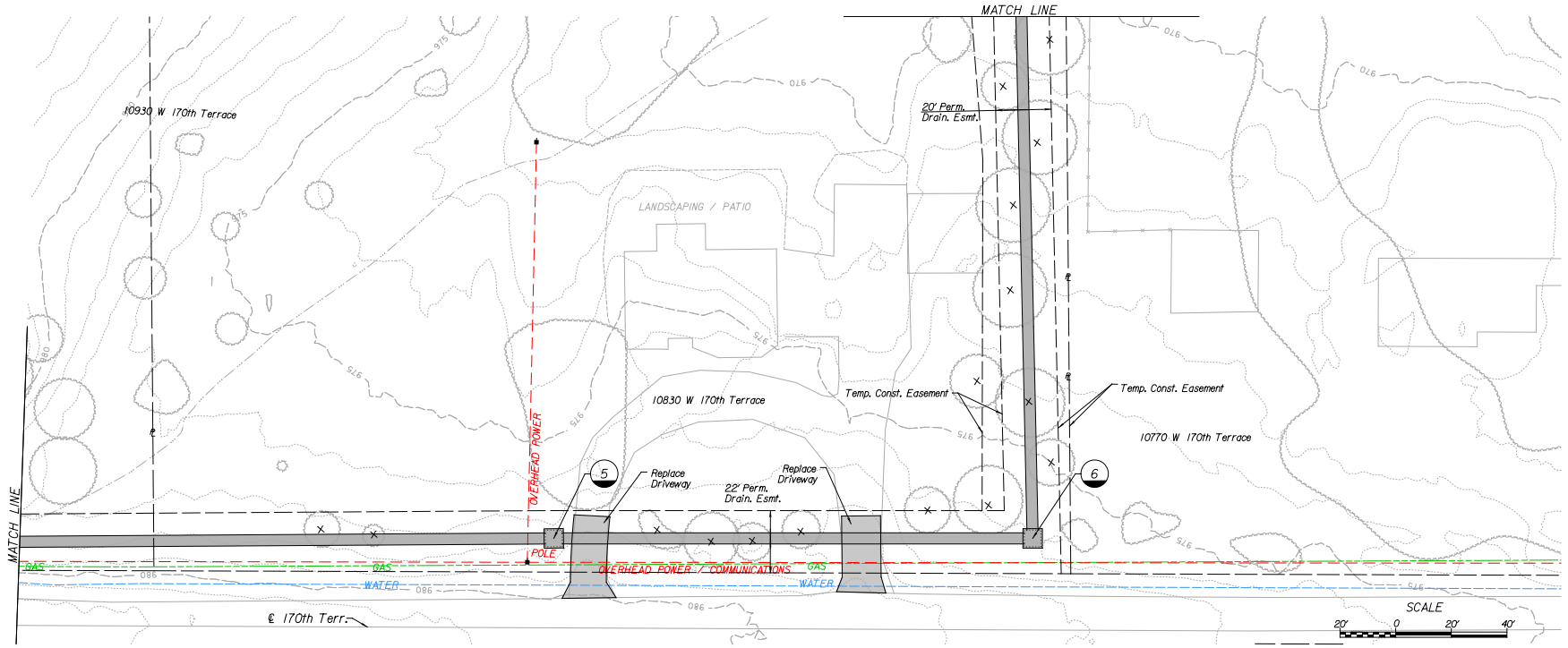

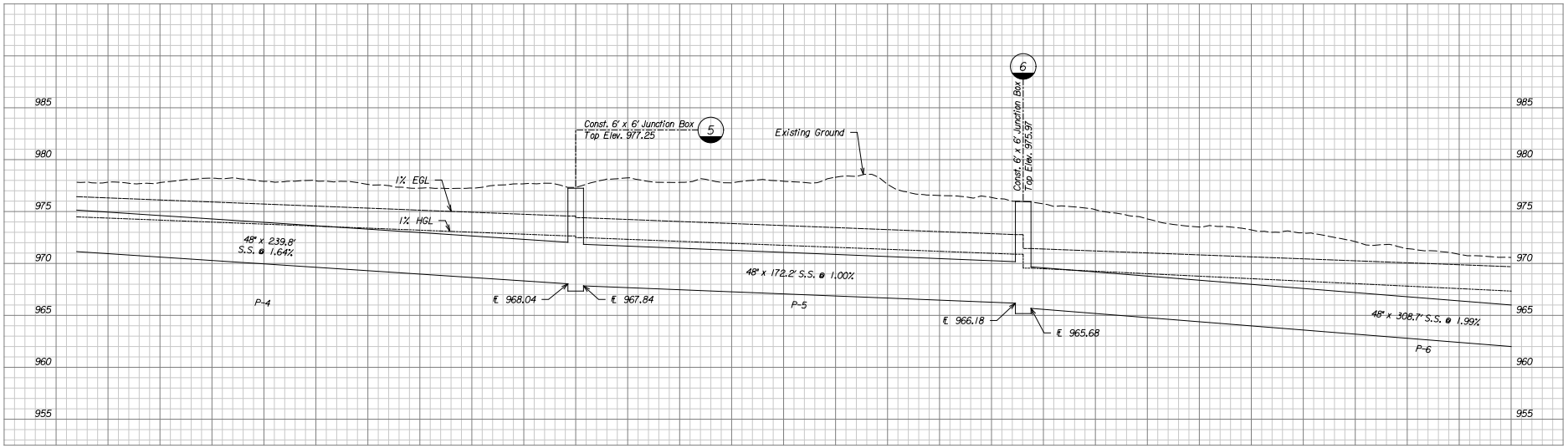

SHEET NO. 2 | TOTAL SHEETS 5

HNTB
7400 W 129th St., Suite 100
Overland Park, KS 66213
(913) 491-4333

OVERLAND PARK KANSAS
ABOVE AND BEYOND. BY DESIGN.

NO.	DATE	REVISIONS	BY	APP'D
1				
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170th Terrace Feasability Memo
PLAN & PROFILE
West System #2

Plotted on: 30-APR-2018 09:07 PM Model: ##########
By: zjarchow Plot Scale: 1:20 Pen Table: \\cvpw00\Jobs\62887\PlanProduction\Library\PrintPlot\22x34_UtilityLgen
Design Filename: \\cvpw00\Jobs\62887\PlanProduction\WaterRes\170blprofile.dgn

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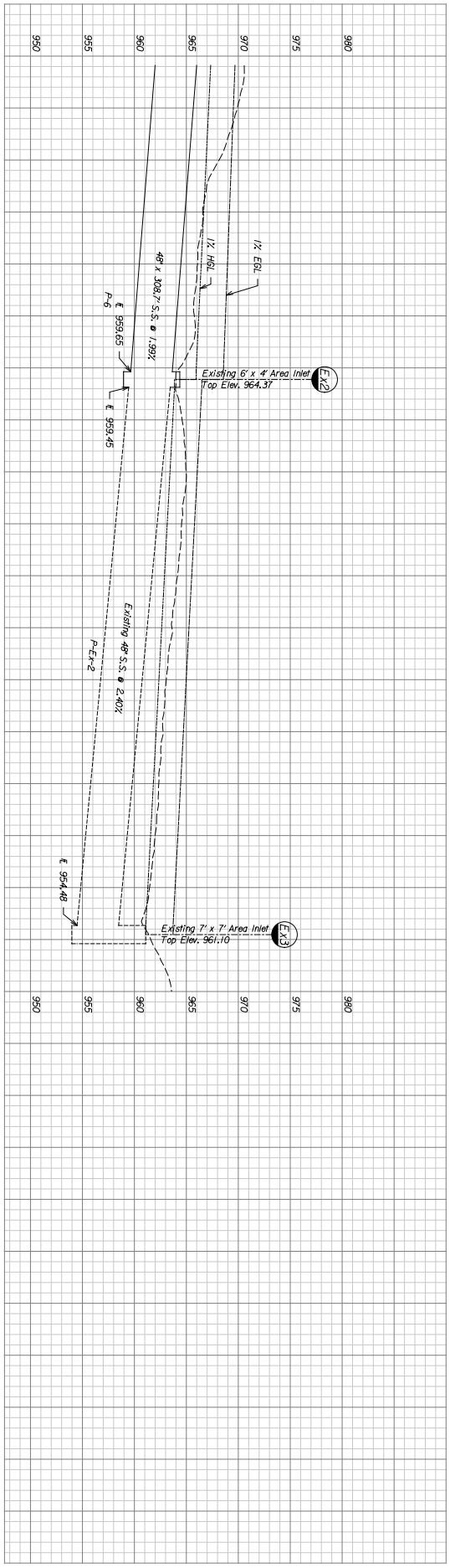
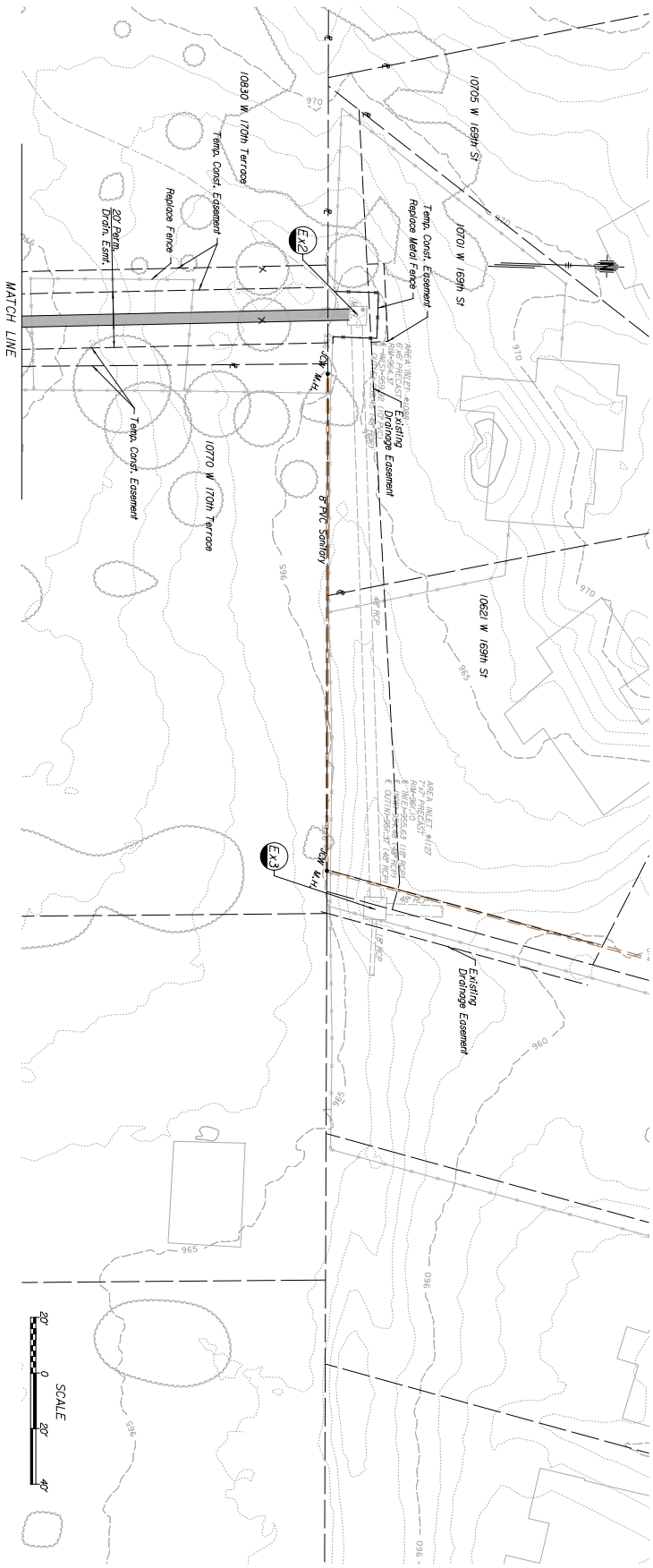
Byt zjarchow Plot Scales: 1:20 Pen Tables:\\ovpw00\Jobs\62887\PlanProduction\Library\PrintPlot\22x34_Utility.pen
Design Filename: \\ovpw00\Jobs\62887\PlanProduction\WaterRes\170planprofile.dgn





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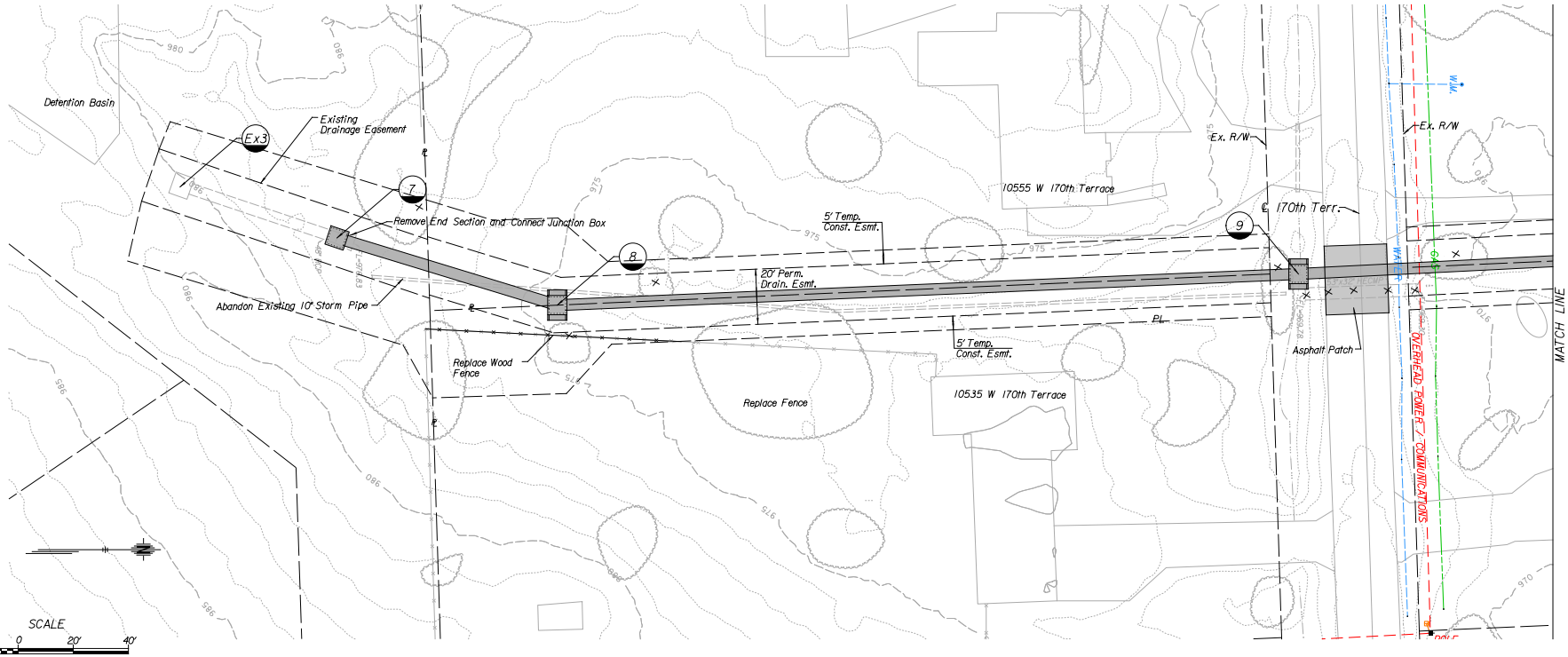
NO.	DATE	REVISIONS	BY	APP'D	

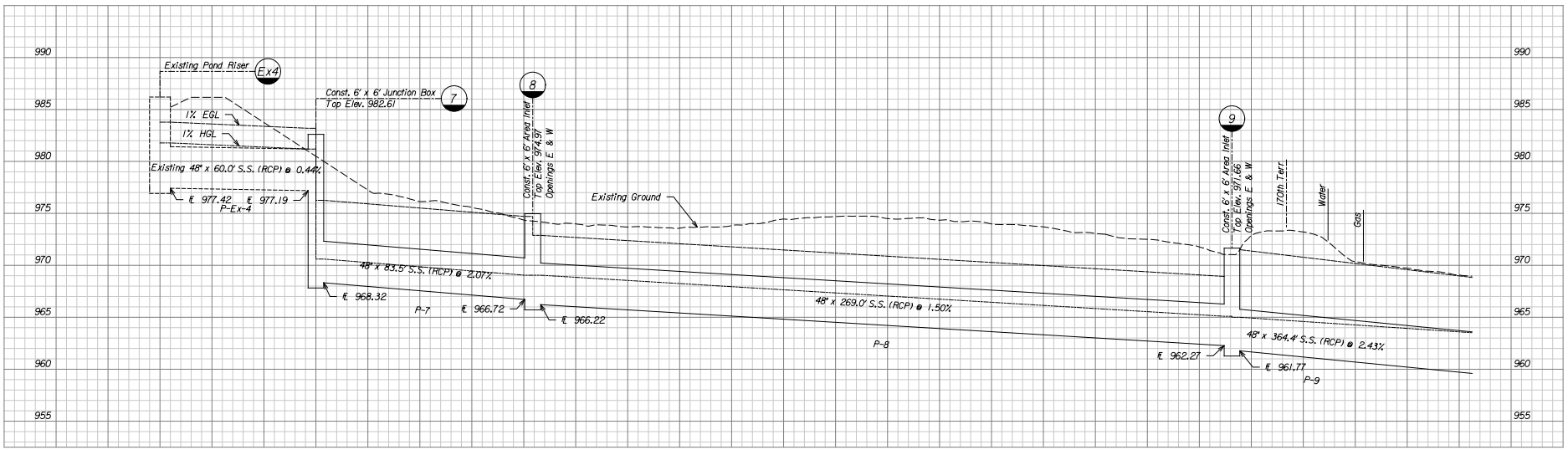
170th Terrace Feasability Memo
PLAN & PROFILE
West System #3

OVERLAND PARK KANSAS
ABOVE AND BEYOND. BY DESIGN.

HNTB
7400 W 129th St., Suite 100
Overland Park, KS 66213
(913) 491-9333

SHEET NO. 3
TOTAL SHEETS 5





170th Terrace Feasability Memo
PLAN & PROFILE
East System #1

NO.	DATE	REVISIONS	BY	APP'D
4				
3				
2				
1				

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SHEET NO.	TOTAL SHEETS
3	5

Plotted on: 30-APR-2018 09:07 PM Models:#####model#####
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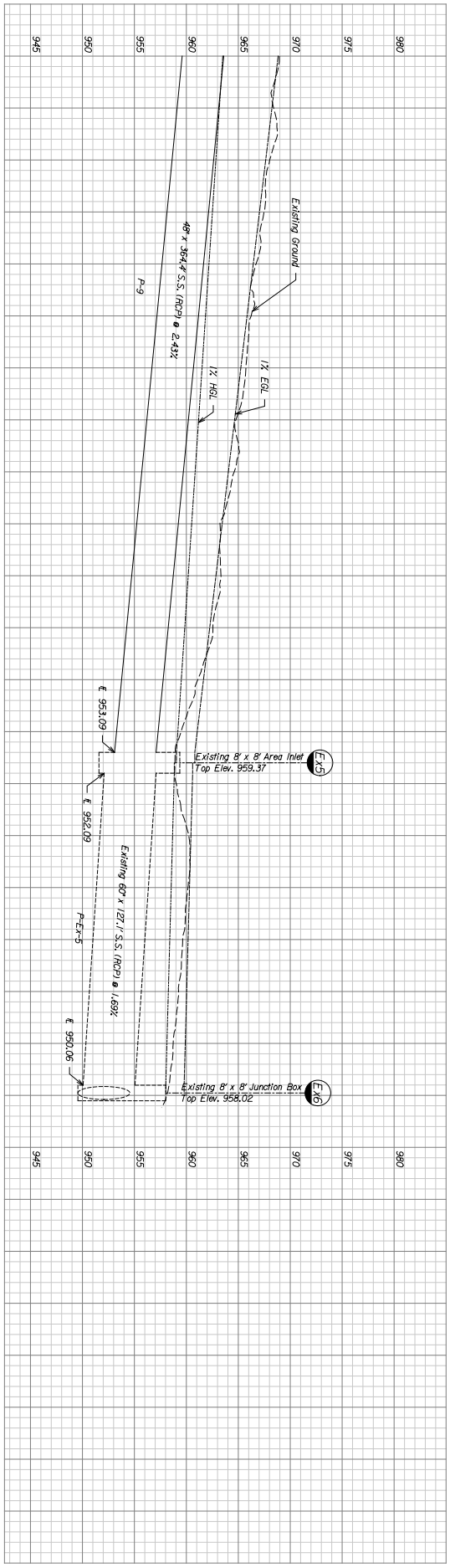

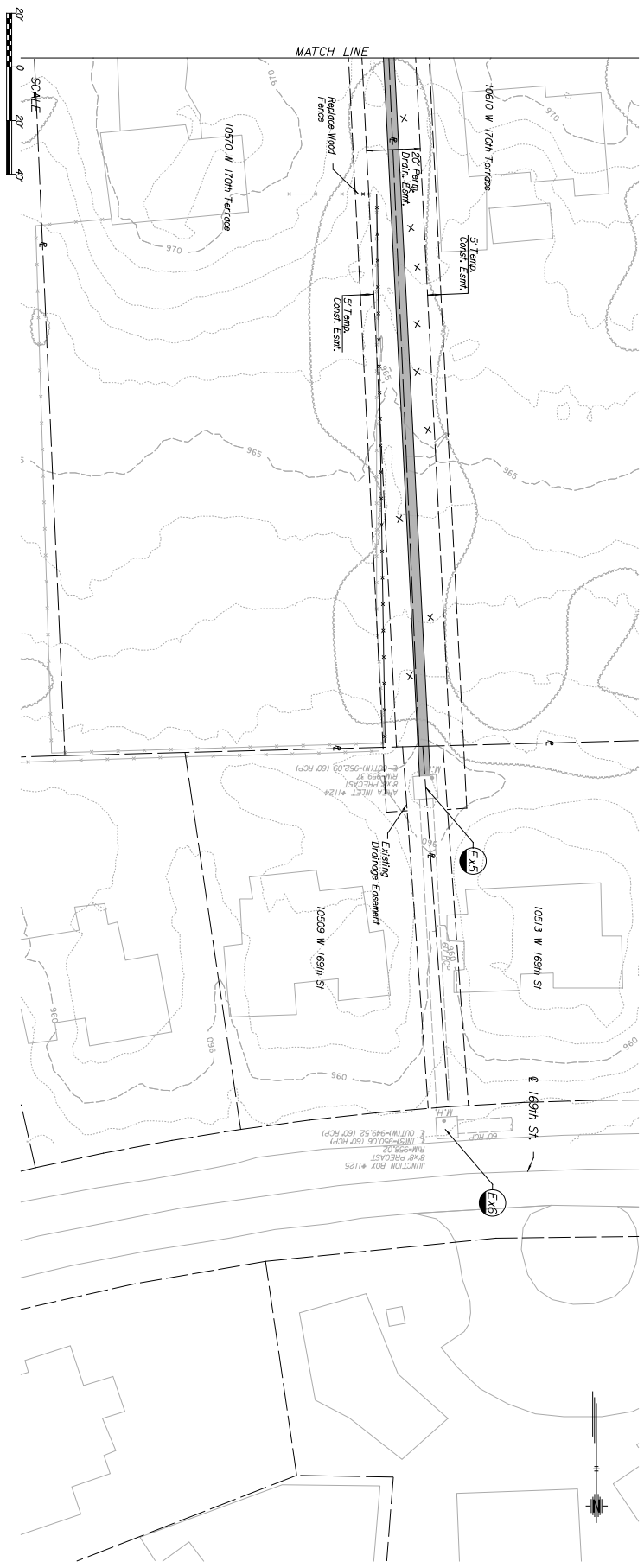

170th Terrace Feasability Memo
PLAN & PROFILE
East System #2

NO.	DATE	REVISIONS	BY	APP'D
4				
3				
2				
1				

OVERLAND PARK KANSAS
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SHEET NO. 4
TOTAL SHEETS 5