FEASIBILITY REPORT:




Prepared for:

CITY OF FLAGSTAFF
STORMWATER SECTION – WATER SERVICES

FEASIBILITY REPORT:
WILDWOOD HILLS DRAINAGE MITIGATION
2401 W. ROUTE 66, FLAGSTAFF, AZ 86001
JANUARY 2019

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EXPIRES 6/30/2020

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1. INTRODUCTION

This feasibility study is performed to explore the drainage mitigation options for the Wildwood Hills (WWH) property, a senior citizen (over age 55) Mobile Home Park (MHP) located at 2401 W Route 66 in Flagstaff. The property is located in Section 19, Township 21N, and Range 07E, and fronts the southern side of Route 66 approximately 1600 ft east of the Woody Mountain Road intersection. Please see the following two figures for location mapping.

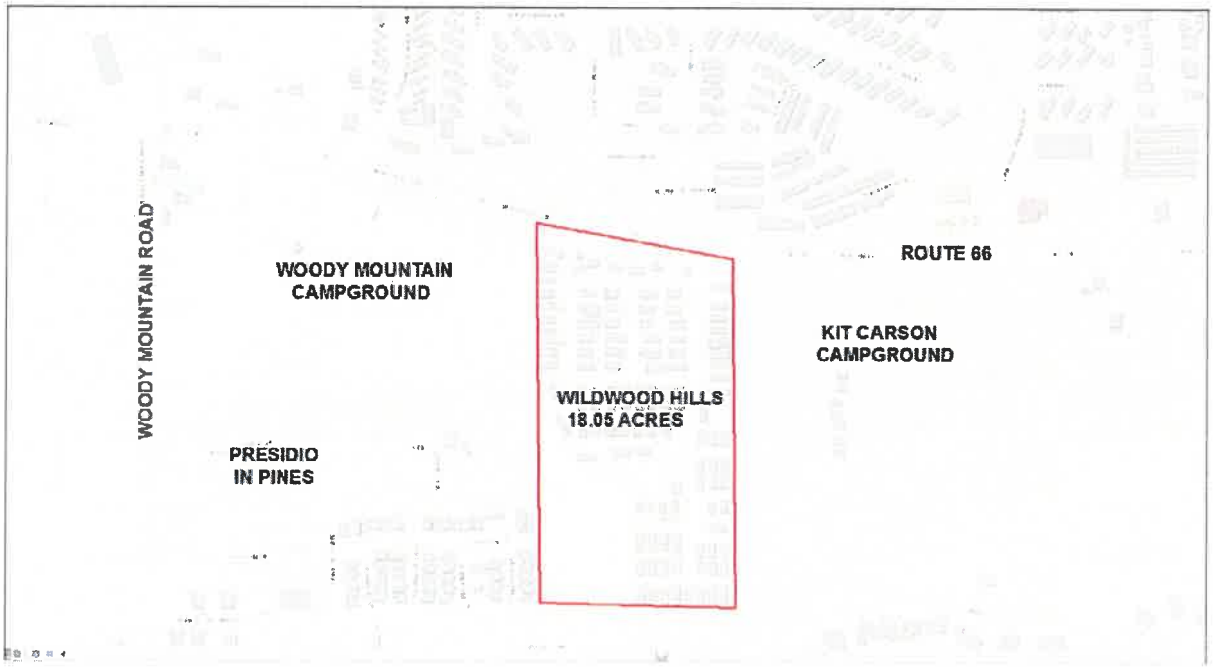

Figure 1: Location Map 1

Figure 2: Location Map 2

The original design and construction of the MHP made little or no allowance for the conveyance of off-site stormwater entering the property from the west. The historic flow pattern of the stormwater enters the MHP around the location of Unit 9 and travels in a east-southeast direction toward Unit 47 and discharging into the Kit Carson RV Park. The flow continues through the Kit Carson property to a culvert that conveys the flow northerly under Route 66. Again, the subject stormwater flow through the WWH development was given no positive drainage consideration except for some make-shift rock channels built later as an effort to mitigate flooding. The projected peak flow from a 100-year storm event (an event with a one percent probability occurring in any given year) is nearly 200 cubic feet per second (cfs), and this is accommodated by surface flow through the properties and streets. This is the offsite flow rate that enters the north half of the site from Woody Mountain Campground on west via the existing channels between Units 8, 9 and 10. Flood walls and flood proofing measures have been attempted by the residents with little success. There are no underground piping facilities to take even a portion of the flow.

Once the flow traverses through the existing rock channels between Units 8, 9 and 10, it enters street and heads south to low point in front of Units 17 and 18. The flow then enters the existing rock channel between Units 17, 18, 23 and 24, this rock channel terminates between Units 23 and 24 after passing under the deck of Unit 23. As the channel terminates, the flow enters streets and traverses through the MHP between the Units, streets and reaches low point in front of Units 46 and 47 and then heads east towards Kit Carson RV park.

To give an idea of the magnitude of this surface flow, 200 cfs equates to over six (6) tons of water flowing past any particular cross-section of the flow path every second. The following section of this report gives further description of the unsafe and untenable nature of this flooding problem.

The following images show the units that are frequently impacted by the flooding. The images also show the offsite flow points of entry into the north half of WWH and the existing rock channels.

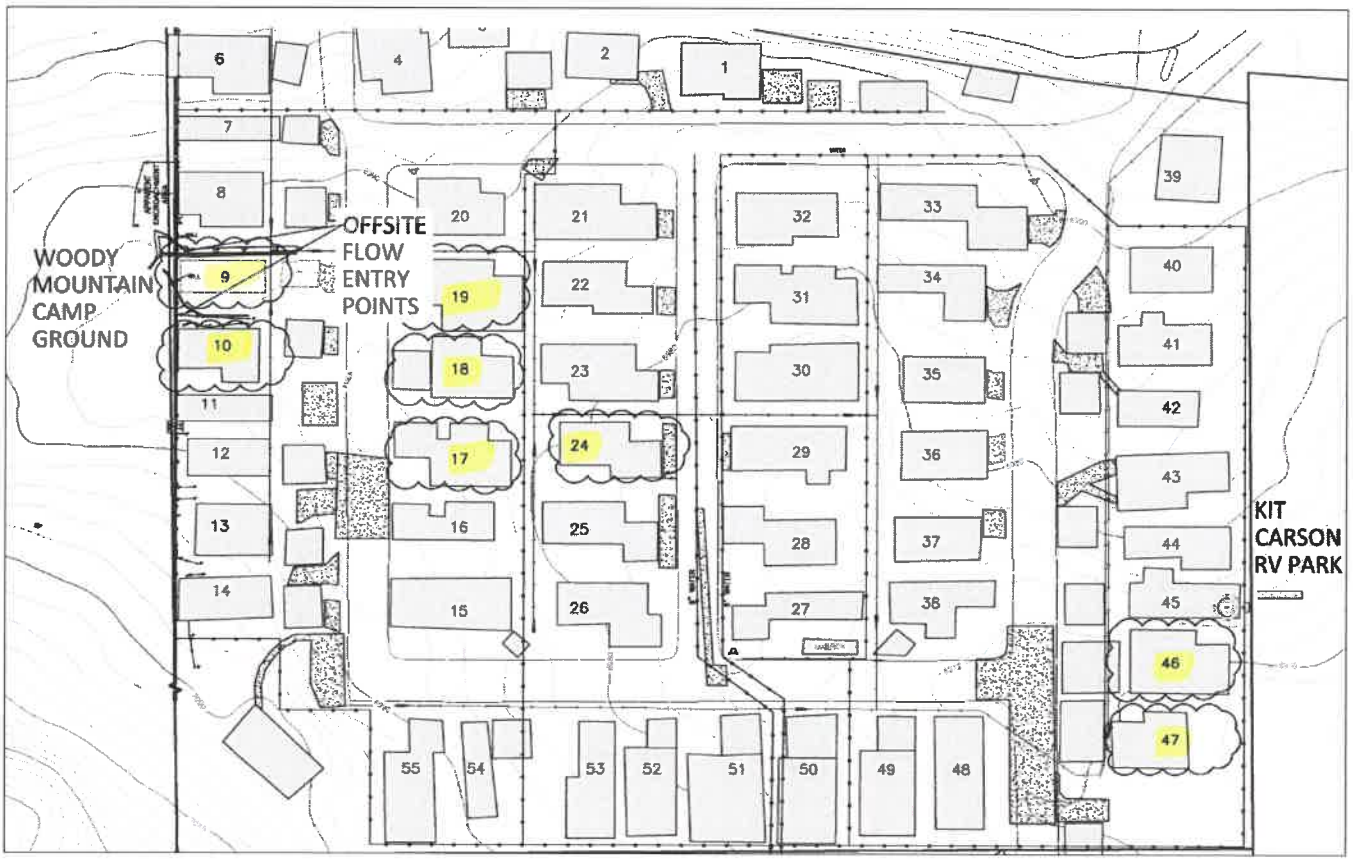

Figure 3: Units Impacted By Flooding And Offsite Flow Entry Points

**Units that are most frequently and most drastically impacted by the flooding are clouded in the image.*

Figure 4: Offsite Flow Entry Point (Looking West)

Figure 5: Rock Wall Channel Between Units 8 And 9 (Looking West)

2. FLOODING HISTORY

The following photo taken during one of the monsoon rains shows the drastic magnitude of one area of the MHP as the flow crosses the street to continue easterly through the narrow yards surrounding the garages and mobile home units.

A view from inside a car shows a flooded street in the Wildwood Hills Mobile Home Park during an early August storm.

Figure 6: Image of Street Flooding In Wildwood Hills (Looking South At Unit 24)

**Above picture shows flow in street as it exits the rock channel under deck of Unit 23. The flow can be seen in the streets and between units.*

Rainfall events are clearly subjecting the WWH residents with unsafe conditions. Flows ripping through and between homes and streets in this nature create massive, forceful momentum that can pick up objects, knock down people and cause significant property damages. It also poses hazardous conditions for not only vehicles but also for pedestrian accessibility.

Figure 7: Rock Channel Between Units 17, 18, 23 And 24 (Looking East)

**Above picture shows Unit 23 deck over the rock channel at the far end.*

Figure 8: Rock Channel Termination Under Unit 23 Deck (Looking West)

For further description of the example storms and news reports of the WWH drainage issues, the following links to videos are listed.

https://www.youtube.com/watch?v=rgcPMqq2P-k

https://azdailysun.com/news/local/video-august-flooding-in-wildwood-hills-mobile-home-park/youtube_b11faaa2-5ec2-5f2d-9eec-e0e03a33455e.html

https://azdailysun.com/news/local/video-flooding-in-wildwood-hills-mobile-home-park/youtube_82a94ada-e9cb-5b2e-bdd8-064363f80f24.html

https://www.youtube.com/watch?v=kz3nQxyb-tw

https://www.youtube.com/watch?v=yupWhcb_zYY

3. STUDY OBJECTIVES

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The purpose of this report is to provide conceptual design options for the mitigation of the flooding conditions in the Wildwood Hills (WWH) property. Although this is private property, the City of Flagstaff is offering to provide mitigation of at least 140 cfs of the existing overall estimated Q_{100} peak discharge of 197 cfs. This mitigation will entail the accommodation/conveyance of the flow on/through the WWH property. The remaining 57 cfs will be the responsibility of the WWH owners. For this study, the remaining flow of 57 cfs is assumed to continue as overland flow. Any additional off-site flow resulting from the planned Woody Mountain Campground development (increase in impervious areas) west of WWH will be negated by detention and LID/retention facilities on that property. The hydrology required for the estimation of the flow rates was completed in previous studies by Woodson Engineering (Preliminary Drainage Report for Wildwood Hills Detention Basin, May 2018). This current study of mitigation options for WWH includes only hydraulic analyses using conceptual methodology to size conduits. Subsequent to this study, final design proceedings will be necessary to assess all head losses and detailed hydraulic grade-line (HGL) determinations.

Further to the discussion on the off-site runoff from the west of WWH, there is an option for the reduction of the previously mentioned 197 cfs amount of runoff leading to the WWH property by eliminating one culvert (24" diameter) under Route 66 that is located west of the WWH property. Representatives from the ADOT advise that this culvert could be eliminated, and the flow can be re-channeled to flow along the northern part of the Route 66 right-of-way, thereby avoiding the WWH property. In fact, this work is proposed by ADOT as one of 250 "District-Wide" projects of which none were selected last year. It is understood that this work will not be prioritized anytime soon, unless the City of Flagstaff wanted to fund it. Although this work would somewhat reduce the extent of the flooding conditions at WWH from the estimated 197 cfs to approximately 188 cfs. This small improvement to the condition is considered not worth the significant cost when compared to the cost of augmenting the capacity of the conveyance of floodwaters through the WWH property. It is clearly more economically prudent to size the chosen on-site mitigation option to convey all the nominated flow (140 cfs).

Consideration should also be given to the on-site options to accommodate the entire 197 cfs flow to fully solve the flooding issue. The following options analysis will identify what the costs would be for these two levels of solution. It should be noted that the accommodation of the offsite runoff contribution of 140 cfs or the full 197 cfs does nothing to address the additional runoff that is currently being generated by the WWH itself, i.e. rainwater from existing onsite roofs, streets and yard areas and also the other offsite flows that impact the site from south (from Presidio in Pines) and from north from a 24-inch culvert under Route 66. However, both Option 1A and Option 1B can include grated manhole covers to allow onsite flows into the storm drain system. Though the storm drain is sized for only offsite flows for 100-year storm event, the system can accommodate some onsite flows for storm events lower than 100- year storm event. Also, with the time lag between onsite and offsite flows, the onsite flow may enter and leave the storm drain system sooner or before the arrival of the offsite flows. The option of adding grated manholes is also contingent upon the detailed storm drain analysis to ensure the HGL is below grade to avoid surging of flows from the manhole grates.

In this feasibility report, consideration has been given to both surface flow improvements and subsurface flow improvements. The options are discussed in the next section below.

These conceptual design efforts are based on available aerial imagery, City's GIS with 2-foot contours and as-built plan sheets from the Wildwood Hills Water and Sewer Extension project, please see Appendix D for the as builts. The depths of the existing water and sewer crossings are estimated from the rough contours and inverts provided on these as-builts. The actual location will require verification by potholing in the future for detailed design phase of the project.

4. MITIGATION OPTIONS

A. OPTION 1A – SUBSURFACE ACCOMMODATION OF 140 CFS

This option involves the installation/construction of underground storm drain piping through the streets of the WWH property. Appendix B Exhibits illustrate the conceptual plan and profile design of this system. At the western boundary of the WWH property the off-site runoff currently enters into the existing "makeshift" above-ground channel walls on both sides of Unit No. 9. It is proposed to channel all of the flow to one location and improve the open channel to be mostly underground while traversing over the existing sewer line and leading to a proposed inlet structure designed to receive 140 cfs. This grated inlet will have capture walls on both sides and allows for an overflow of the 57 cfs (197-140 = 57) that the City is suggesting to be handled by the WWH property facilities. The inlet structure will lead to a 48-inch diameter pipe, with smooth interior and with an exterior corrugated steel shell through the Unit No. 9 property and continue through the streets as shown. **This will involve the relocation/removal of the home Unit No. 9.** Consideration was given to constructing this piping while maintaining the home in place, however, the disruption of both Unit No 9 and the neighboring Unit No 10 would be so drastic that the complete removal of Unit No. 9 is more feasible. In this way, the construction can avoid the removal of trees that would otherwise greatly affect the homes. Upon removal of Unit No. 9, this space can be utilized to implement a sediment pond to capture sediment and debris from the offsite flow. Final design proceedings can further review and assess the possibility of

constructing without removal of the home, but for the costing of this concept study it is assumed that this one Unit will be displaced.

From Unit No. 9 the piping is proposed to follow the street alignment, as opposed to following the natural lowpoint areas running through the other home units and causing further disruption of personal property. Following this less intrusive street alignment necessarily involves a pipeline construction that "bucks" grade resulting in a 12-foot depth of trenching to lay the 48-inch diameter pipe through the high point at the street corner near Unit No. 15. The piping would be constructed at a minimum one (1) percent slope (required for pipeline capacity) and continue easterly in the middle of the street, requiring adjustments to the two water pipe crossings (near Unit No. 51) and possibly avoiding the sanitary sewer crossing (near Unit No. 49). For the cost analysis of this study, an allowance has been included for relocation of the utilities at potential conflict locations which should be confirmed by potholing at detailed design phase. To minimize the conflict with these utilities the stormwater line is proposed to transition from the 48-inch diameter pipe to a 6'x 3' (Width x Height) Reinforced Concrete Box Culvert (RCBC), enabling better cover from the top of the structure to the underside of the pavement.

Near the end of this proposed storm drain system, near Unit No. 47, there is an unavoidable conflict with the existing sanitary sewer crossing the street and leading to a lift station located in a shed next to the garage by Unit No. 47. This sewer crossing will need to be lowered. Additionally, this may lead to modifications to the lift station, due to the lowering of the influent pipe. Again, the exact elevation of the sewer system needs to be confirmed prior to final design. An allowance is made in this conceptual design phase for the lowering of the sewer crossing and the reconstruction of the lift station. It is noted that this lift station pumps the sewage up along the eastern property line of WWH to a gravity line in the Route 66 right-of-way.

As the traverse of the 6'x 3' RCBC leads to the eastern property line it is still too deep to "daylight" in the WWH property. The owners of the Kit Carson RV park will need to be agreeable to allowing the City to excavate an open channel through their property to a point as shown in the Exhibits. It would behoove the Kit Carson owners to have the open channel in their property to provide a clear channelization of the floodwaters and have the benefit of eliminating the flooding problems currently being experienced in this property as well. In fact, the extension of the open channel all the way to the existing culvert under Route 66 may be very beneficial to the Kit Carson property.

The overall cost of Option 1A has been estimated to be $1,133,578 (please see Appendix C for the detailed cost estimate). The overall cost includes an estimated $250,000 for the elimination of the home Unit No. 9. This cost includes demolition of Unit No. 9, either salvage the Unit or purchase of new Unit, owner compensation and installation costs. This figure may need to be revised based on more expert market value analytics and/or relocation procedures.

B. OPTION 1B – SUBSURFACE ACCOMMODATION OF 197 CFS PLUS ALLOWANCE FOR ON-SITE RUNOFF.

Subsurface Option 1B is identical to Option 1A except that the conveyance is sized to accommodate the entirety of the 197 cfs peak flow during the 100-year storm event, intercepting all the offsite flow. Additionally, allowance has been made for the cost of grated inlets directly

above the proposed pipeline in particular locations within the existing (pavement to be removed and replaced due to pipeline trenching) inverted crown of the roadways. It will be important to add a grated inlet at the low point in the road (next to Units 16 and 17) to deal more completely with the on-site runoff. The pipeline will need to be "upsized" from the previously discussed 48-inch diameter to a 54-inch diameter, and the box culvert section will require a 8'x3' (Width X Height) section instead of the 6'x3' section from the Option 1A design. This Option 1B will solve the flooding problems by receiving all the offsite runoff, and additionally dealing with the on-site runoff. The added cost for the grated inlets to deal with the on-site runoff is insignificant when compared to the overall cost of the pipeline required for the off-site flows. The project should consider adding these grated inlets to the Option 1A as well.

Consideration has also been given to the notion of constructing a detention basin somewhere in the WWH property such as the lot for Unit No. 9 or at the downstream outlet at the eastern property line. However, these areas are too small to amount to significant reduction in the flows and it would require unsightly safety fencing around the ponding or present an unsafe condition due to their close proximity to the neighboring units.

Additionally, in the scoping of this study it was mentioned to consider the upsizing of the detention basins located to the southwest in the Presidio in Pines residential development. There is a small detention basin in Presidio that discharges to the north half of WWH. It is a located between the street and lots. This basin being in midst of already improved areas has negligible scope of upsizing to cause any reduction in offsite flows.

There is another larger detention basin that discharges to the south half of WWH. While this basin may have some upsizing possibilities, it will require negotiations with the Presidio HOA. Since this basin discharges to the south half of WWH, the reduction to this basin outflow would affect the end of the subject system at the open channel being proposed in the Kit Carson property but does not have any impact on the flooding in the north half of WWH.

The overall cost of Option 1B has been estimated to be $1,213,684. Please see Appendix C for the detailed cost estimate. As mentioned for Option 1A, the overall cost includes an estimated $250,000 for the elimination of the home Unit No. 9. Again, this figure may need to be revised based on more expert market value analytics and/or relocation procedures.

C. OPTION 2 – SURFACE CHANNEL AND STORM DRAIN SYSTEM

The consideration of this option involves the improvements of surface channel (through properties) flow path which naturally exists in areas of least resistance. There are flood walls and other makeshift channelization efforts in place between Unit Nos. 8 and 9, Unit Nos. 9 and 10, Unit Nos. 17 and 18, Unit Nos. 23 and 24. These areas could be improved upon and extending the channel between Unit Nos. 29 and 30, and Unit Nos. 35 and 36, with a concrete channel between the units and culverts at the street crossings. However, this option would involve significant disruption through the yards, removal of trees, relocation of utilities, deep trenches near buildings, and destruction of all the personal property such as landscaping, decking, walkways and other established conditions built up over the past decades. Also, the channel option may require railing on both the sides for safety. Thus, this option would not be easily adopted as it would involve multiple unit owners and utility relocations which will significantly

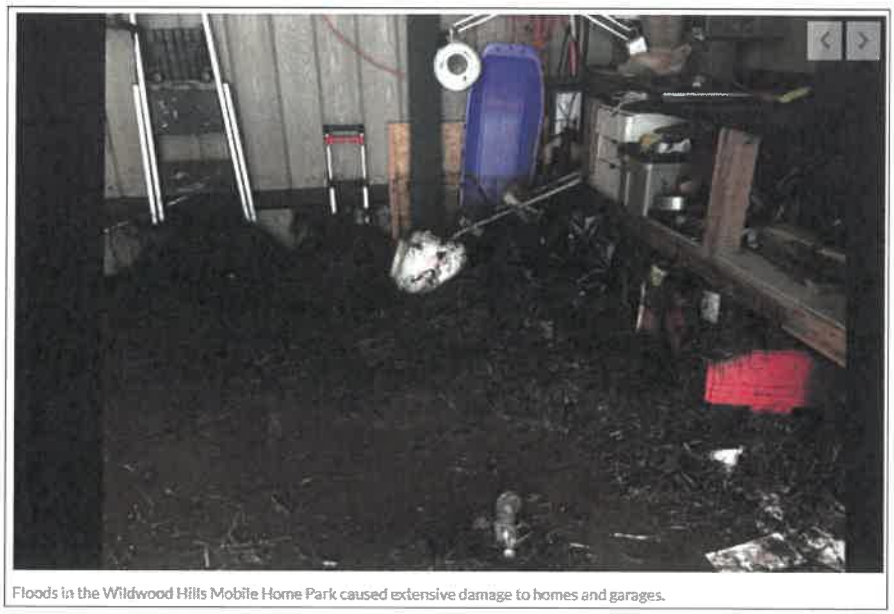
impact the project timeline and compensation costs and possible legal costs. Per cost analysis, this option is estimated to cost about $1,284,667 which is higher than Option1A and 1B. Thus, it is concluded that this option does not warrant further consideration.

D. OPTION 3 – NON-STRUCTURAL MITIGATION MEASURES

The non-structural option of protecting the properties in the drainage path by floodproofing, flood gates and possible relocation of homes in the drainage path, also is not worth serious consideration, due again to the unacceptable conditions presented by the resultant flow spilling out into the streets. This option may somewhat improve the protection of the units in the drainage path, but it would also lead to diversion of flows to the otherwise safe units. In addition, the residents are already implementing some measures to temporarily protect them from flooding, however, they require manual intervention of the residents to install gates prior to the storm event. Given, the fact that these are senior citizen dwellings, these measures may not be effective if not implemented in a timely fashion. Also, the offsite flows carry significant amount of sediment and debris which may cause clean up and property damage after major storm events. Following are some of the pictures with non-structural mitigation measures that the residents have implemented and the damage after the storm event.

Todd Vanosdell shows one of two flood gates he installed in the fence of his Wildwood Hills home to help floodwaters escape his property. The neighborhood tucked in a low-lying area between Wood Mountain Road and West Route 66 in Flagstaff has seen a massive increase in flooding from monsoon rains recently.

Figure 9: Image of Flood Gates Installed By The Residents



Floods in the Wildwood Hills Mobile Home Park caused extensive damage to homes and garages.

Figure 10: Image of Flood Damages To The Private Property

Figure 11: Image of Gates At Garage Installed By Residents (Unit 17)

5. RECOMMENDATIONS AND CONCLUSIONS

The study includes the subsurface and surface mitigation options, and the associated costs. Following are the conclusions and recommendations.

A. CONCLUSIONS

The two feasible options are Option 1A and 1B with storm drain system that convey either a portion of the flow or the entire offsite flow rate from the west.

- Options 1A and 1B cause the least disruption to the units as most the work will be in the street.
- These options also involve minimum utility conflicts as compared to the channel option (Option 2).
- With the storm drain system in the street, the future maintenance can be done without accessing yards or private properties.
- Option 1A costs are estimated at $1,133,578 while Option 1B is estimated at $1,213,684. Project may consider option 1B to provide additional benefits based on the available budget.

B. RECOMMENDATIONS

Following are some of the recommendations regarding the implementation of the chosen option:

- Coordination with the owner of the Kit Carson parcel to inform about the channel and obtain permission for construction and for drainage easement. City may consider extension of the channel through the Kit Carson parcel to the culvert crossing under Route 66, which could further benefit the property owner.
- Coordination with WWH MHP owner to discuss the remove/relocation of the home designated as Unit 9.
- Coordination with the Woody Mountain campground parcel owner to tie in the drainage improvements to bring offsite flow to the chosen WWH flood mitigation option.
- Ensure that a geotechnical investigation is carried out for the location of the proposed pipeline. Limestone bedrock was found in the Woody Mountain Campground development just west of the WWH property, and if encountered, could add significantly to the trenching costs. Rock excavation is currently not included in the cost estimates.
- Negotiation with affected homeowners. The cost estimates presented in Appendix C have allowances for compensating the affected homeowners. The $250,000 allowance for the removal of the Unit 9 home is based on an estimated market value of $100,000, plus relocation expenses. Similarly, in Option 2 allowances are identified for the compensation of all the properties affected. No legal fees have been included.

6. REFERENCES

i. Preliminary Drainage Report for Wildwood Hills Detention Basin, May 2018

ii. City of Flagstaff, GIS (2-foot contours)

iii. Wildwood Hills Water and Sewer Extension As-Builts, Rockwell Consultants, 1982

iv. FlowMaster, Bentley's Heastad Methods Solution Center

v. Autodesk Civil 3D, 2019

APPENDIX A: CONCEPTUAL STORMWATER CONVEYANCE SIZING

OPTION 1A

48-INCH ULTRA FLO CMP PIPE FLOW CAPACITY @ 1.0% SLOPE
6' X 3' (WIDTH X HEIGHT) REINFORCED CONCRETE BOX CULVERT FLOW CAPACITY @ 0.5% SLOPE

OPTION 1B

54-INCH ULTRA FLO CMP PIPE FLOW CAPACITY @ 1.0% SLOPE
8' X 3' (WIDTH X HEIGHT) REINFORCED CONCRETE BOX CULVERT FLOW CAPACITY @ 0.5% SLOPE

OPTION 2

5' x 3' (WIDTH X HEIGHT) RECTANGULAR CONCRETE CHANNEL CAPACITY @ 1.0% SLOPE

Worksheet for 48-Inch @ Slope=1% (Ultra Flo CMP)

Project Description	
Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data	
Roughness Coefficient	0.012
Channel Slope	0.010
Normal Depth	48.0
Diameter	48.0
Discharge	155.61

Results	
Discharge	155.61
Normal Depth	48.0
Flow Area	12.6
Wetted Perimeter	12.6
Hydraulic Radius	12.0
Top Width	0.00
Critical Depth	43.7
Percent Full	100.0
Critical Slope	0.009
Velocity	12.38
Velocity Head	2.38
Specific Energy	6.38
Froude Number	(N/A)
Maximum Discharge	167.39
Discharge Full	155.61
Slope Full	0.010
Flow Type	Undefined

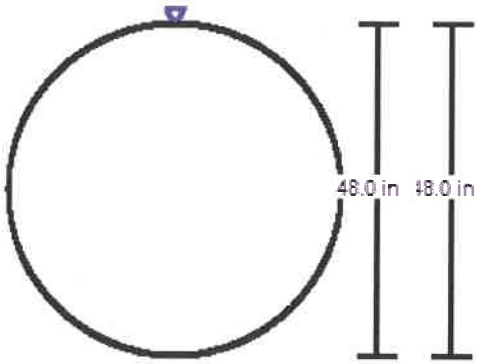
GVF Input Data	
Downstream Depth	0.0
Length	0.0
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Average End Depth Over Rise	0.0
Normal Depth Over Rise	100.0
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	48.0
Critical Depth	43.7
Channel Slope	0.010
Critical Slope	0.009

Cross Section for 48-Inch @ Slope=1% (Ultra Flo CMP)

Project Description	
Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data	
Roughness Coefficient	0.012
Channel Slope	0.010
Normal Depth	48.0
Diameter	48.0
Discharge	155.61



Worksheet for 6'X3' (WxH) RCBC @ Slope=0.5%

Project Description	
Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.005
Normal Depth	36.0
Height	3.0
Bottom Width	6.00
Discharge	145.48

Results	
Flow Area	18.0
Wetted Perimeter	18.0
Hydraulic Radius	12.0
Top Width	6.00
Critical Depth	31.6
Percent Full	100.0
Critical Slope	0.004
Velocity	8.08
Velocity Head	1.02
Specific Energy	4.02
Froude Number	0.823
Discharge Full	145.48
Slope Full	0.005
Flow Type	Subcritical

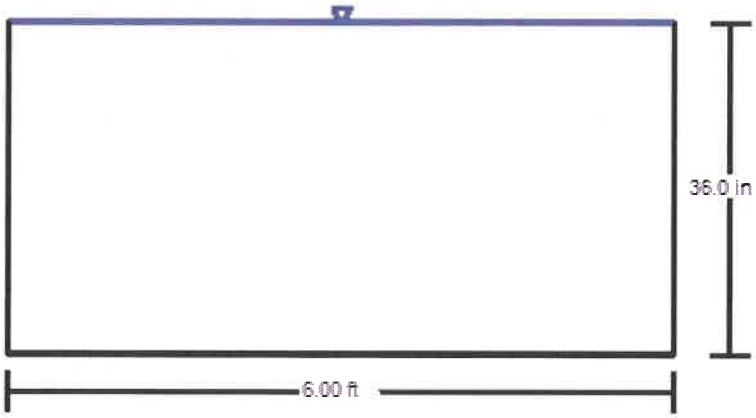
GVF Input Data	
Downstream Depth	0.0
Length	0.0
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Average End Depth Over Rise	0.0
Normal Depth Over Rise	100.0
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	36.0
Critical Depth	31.6
Channel Slope	0.005
Critical Slope	0.004

Cross Section for 6'X3' (WxH) RCBC @ Slope=0.5%

Project Description	
Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.005
Normal Depth	36.0
Height	3.0
Bottom Width	6.00
Discharge	145.48



Worksheet for 54-Inch @ Slope=1% (Ultra Flo CMP)

Project Description	
Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data	
Roughness Coefficient	0.012
Channel Slope	0.010
Normal Depth	54.0
Diameter	54.0
Discharge	213.02

Results	
Discharge	213.02
Normal Depth	54.0
Flow Area	15.9
Wetted Perimeter	14.1
Hydraulic Radius	13.5
Top Width	0.00
Critical Depth	49.4
Percent Full	100.0
Critical Slope	0.009
Velocity	13.39
Velocity Head	2.79
Specific Energy	7.29
Froude Number	(N/A)
Maximum Discharge	229.15
Discharge Full	213.02
Slope Full	0.010
Flow Type	Undefined

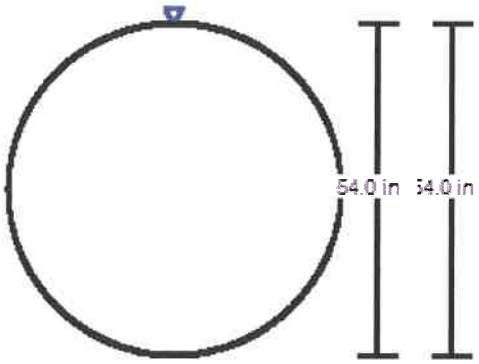
GVF Input Data	
Downstream Depth	0.0
Length	0.0
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Average End Depth Over Rise	0.0
Normal Depth Over Rise	100.0
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	54.0
Critical Depth	49.4
Channel Slope	0.010
Critical Slope	0.009

Cross Section for 54-Inch @ Slope=1% (Ultra Flo CMP)

Project Description	
Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data	
Roughness Coefficient	0.012
Channel Slope	0.010
Normal Depth	54.0
Diameter	54.0
Discharge	213.02



Worksheet for 8'x3' (WXH) RCBC @ Slope=0.5%

Project Description	
Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.005
Normal Depth	36.0
Height	3.0
Bottom Width	8.00
Discharge	205.56

Results	
Flow Area	24.0
Wetted Perimeter	22.0
Hydraulic Radius	13.1
Top Width	8.00
Critical Depth	32.9
Percent Full	100.0
Critical Slope	0.004
Velocity	8.57
Velocity Head	1.14
Specific Energy	4.14
Froude Number	0.872
Discharge Full	205.56
Slope Full	0.005
Flow Type	Subcritical

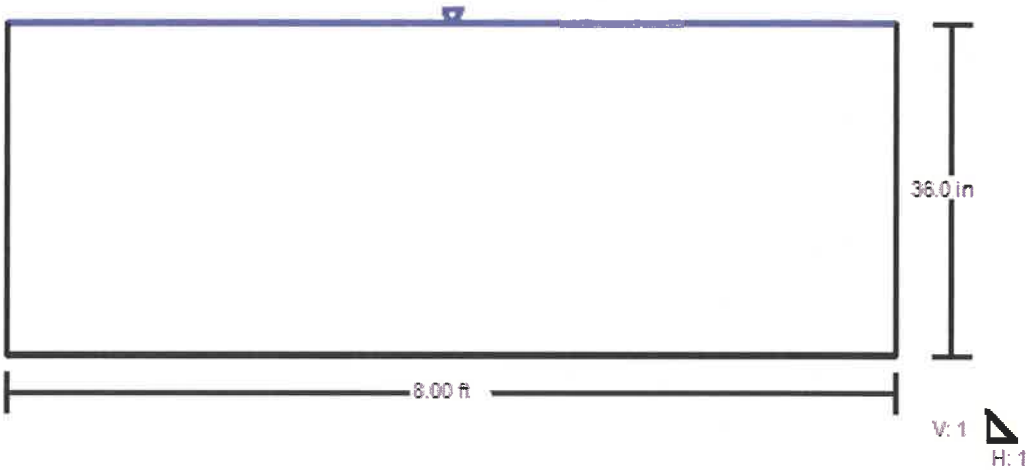
GVF Input Data	
Downstream Depth	0.0
Length	0.0
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Average End Depth Over Rise	0.0
Normal Depth Over Rise	100.0
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	36.0
Critical Depth	32.9
Channel Slope	0.005
Critical Slope	0.004

Cross Section for 8'x3' (WXH) RCBC @ Slope=0.5%

Project Description	
Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.005
Normal Depth	36.0
Height	3.0
Bottom Width	8.00
Discharge	205.56



Worksheet for 5'x3' Rectangular Channel @ Slope=1%

Project Description	
Friction Method	Manning Formula
Solve For	Discharge

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.010
Normal Depth	36.0
Bottom Width	5.00

Results	
Discharge	210.83
Flow Area	15.0
Wetted Perimeter	11.0
Hydraulic Radius	16.4
Top Width	5.00
Critical Depth	45.7
Critical Slope	0.005
Velocity	14.06
Velocity Head	3.07
Specific Energy	6.07
Froude Number	1.431
Flow Type	Supercritical

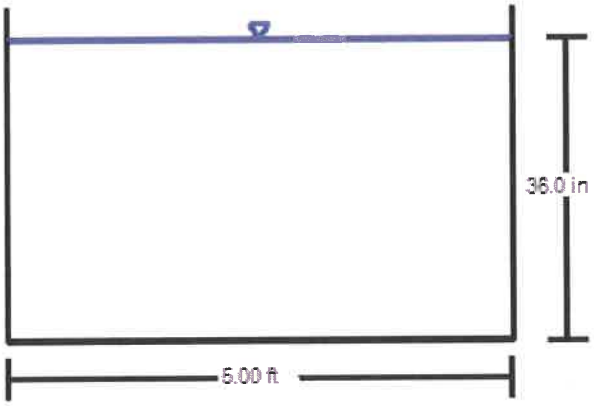
GVF Input Data	
Downstream Depth	0.0
Length	0.0
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0
Profile Description	N/A
Profile Headloss	0.00
Downstream Velocity	Infinity
Upstream Velocity	Infinity
Normal Depth	36.0
Critical Depth	45.7
Channel Slope	0.010
Critical Slope	0.005

Cross Section for 5'x3' Rectangular Channel @ Slope=1%

Project Description	
Friction Method	Manning Formula
Solve For	Discharge

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.010
Normal Depth	36.0
Bottom Width	5.00
Discharge	210.83



V: 1
H: 1

Bentley Systems, Inc. Haestad Methods Solution Center
27 Siemon Company Drive Suite 200 W
Watertown, CT 06795 USA +1-203-755-1666

APPENDIX B: CONCEPTUAL DESIGN PLANS

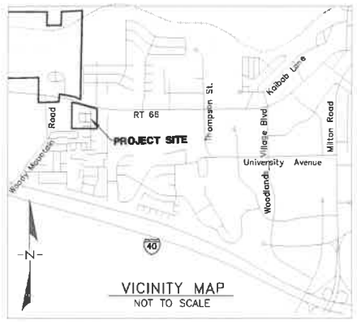
OPTION 1A PLAN AND PROFILE
OPTION 1B PLAN AND PROFILE
OPTION 2 PLAN

WILDWOOD HILLS
DRAINAGE FEASIBILITY STUDY

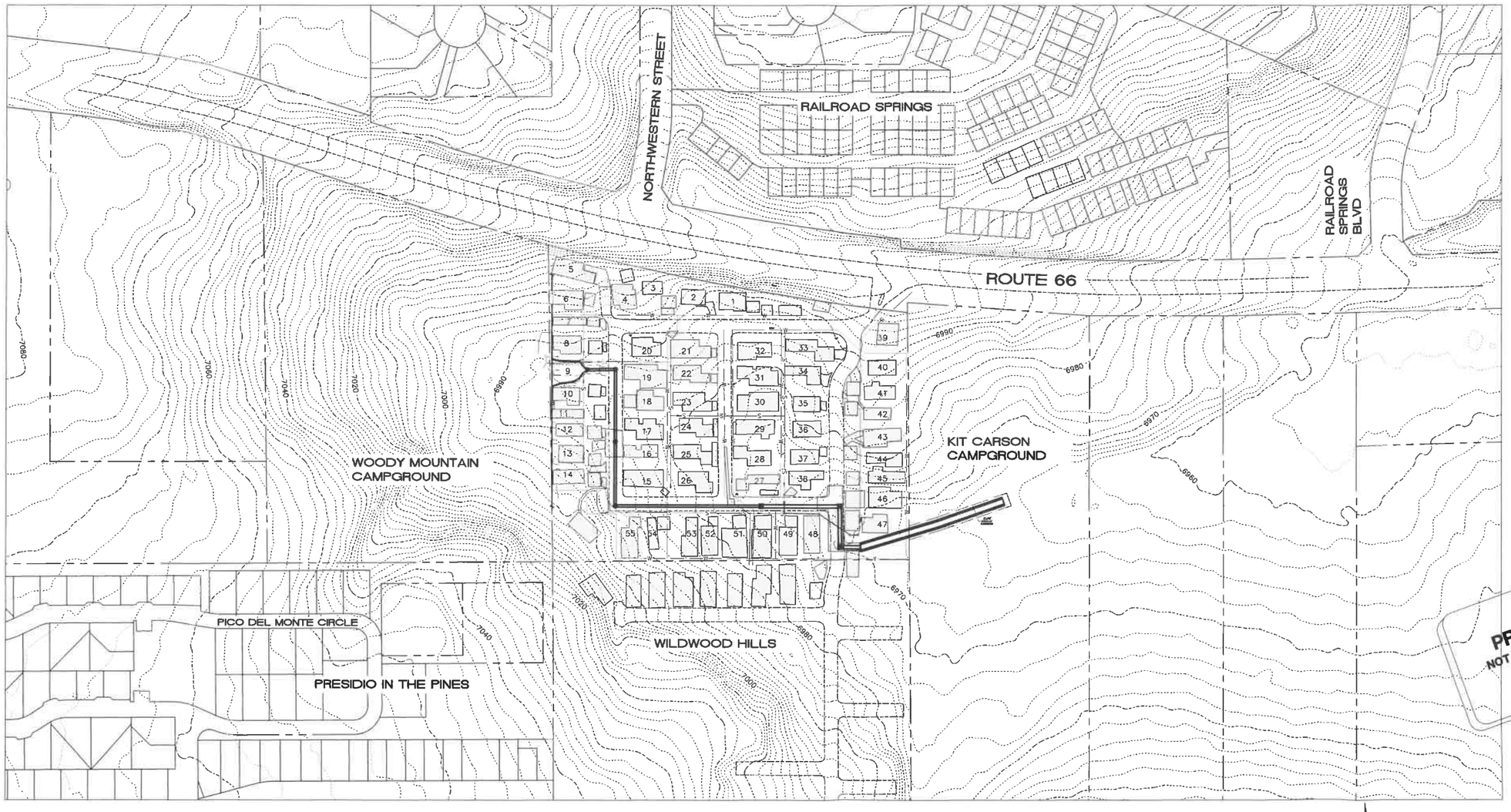
A PROPOSED IMPROVEMENT IN THE SE CORNER OF SECTION 19, TOWNSHIP 21 NORTH, RANGE 7 EAST, GILA AND SALT RIVER BASE AND MERIDIAN, COCONINO COUNTY, ARIZONA

LEGEND

- EXISTING PROPERTY LINE
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- EXISTING FLOWLINE
- EXISTING WATER LINE
- EXISTING SANITARY SEWER LINE
- EXISTING BARBED WIRE FENCE
- EXISTING WALL
- EXISTING CONCRETE
- EXISTING STRUCTURE
- EXISTING PAVEMENT
- PROPOSED SANITARY SEWER LINE
- PROPOSED STORM DRAIN
- EXISTING WATER VALVE
- EXISTING WATER METER
- EXISTING FIRE HYDRANT
- PROPOSED SANITARY SEWER MANHOLE
- PROPOSED STORM DRAIN MANHOLE
- PROPOSED CATCH BASIN



VICINITY MAP
NOT TO SCALE



PRELIMINARY
NOT FOR CONSTRUCTION OR RECORDING

SHEET INDEX

FIELD TOPOGRAPHY AND BOUNDARY SURVEY INFORMATION USED TO PREPARE THIS DRAWING WERE BASED ON CITY OF FLAGSTAFF GIS.

N

0 50 100 200
SCALE: 1" = 100
CONTOUR INTERVAL: 2'

SHEET 1 OF 6

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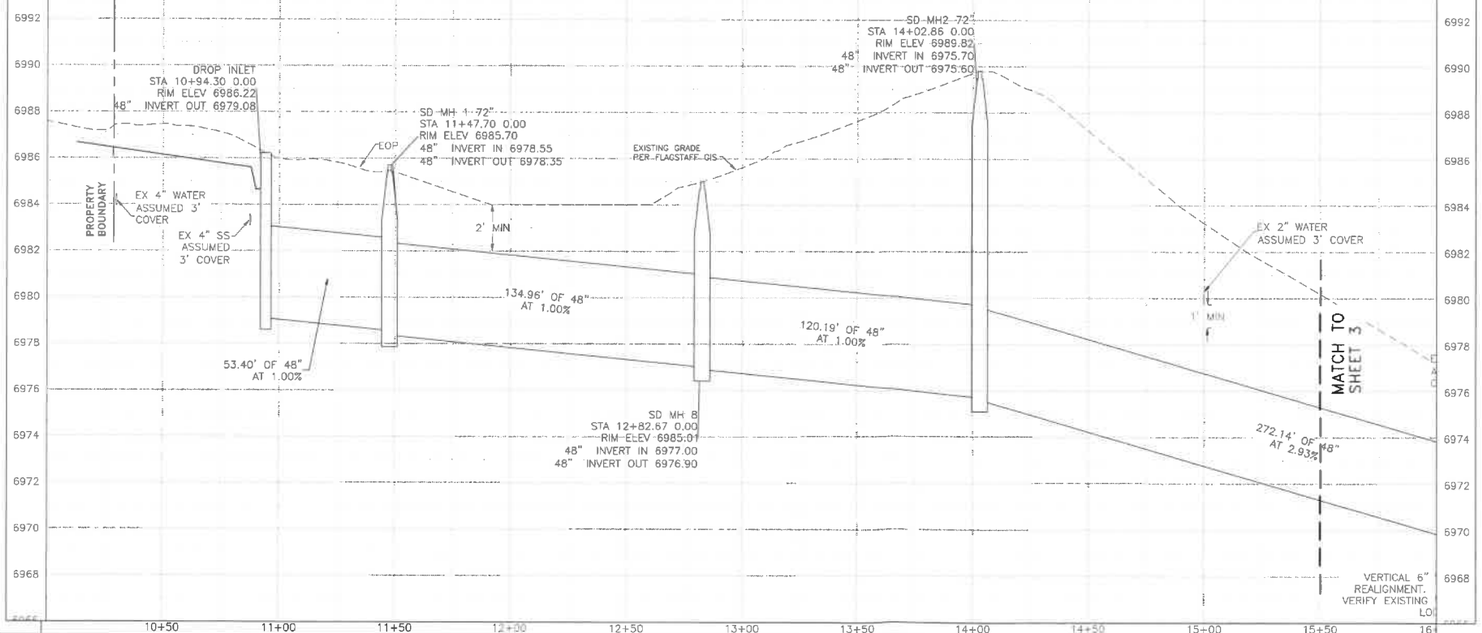
WILDWOOD HILLS DRAINAGE FEASIBILITY STUDY

DRAFTED BY: AAS
DATE: 1/2/19
PROJ. NO.: 117806
FN: PP OPT 1



CONSTRUCTION NOTES
PUBLIC IMPROVEMENTS

(01) REMOVE EXISTING ROCK WALL CHANNEL.

(10) INSTALL 48" CONTECH ULTRA FLO CMP OR APPROVED EQUAL IN ACCORDANCE WITH MAG SS 601 & 618.

(13) CONSTRUCT STORM DRAIN MANHOLE IN ACCORDANCE WITH MAG SD NO. 521, & NO. 522. GRATE IN LID.

(14) CONSTRUCT DITCH TO CONVEY OFFSITE FLOW TO DROP INLET STRUCTURE.

(16) CONSTRUCT DROP INLET STRUCTURE WITH CAPTURE WALLS TO RECEIVE A MAXIMUM OF 140 CFS.

(60) REMOVE AND REPLACE CONCRETE PAVEMENT

(61) REMOVE AND REPLACE ASPHALT ROADWAY PER TRENCHING AND BACKFILL DETAIL COF SD 9-01-03.

(90) INSTALL SAFETY RAILING.

0 15 30 60

SCALE: 1" = 30'
CONTOUR INTERVAL: 2'

PRELIMINARY
NOT FOR CONSTRUCTION OR RECORDING

GENERAL NOTES

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1/9/19

WILDWOOD HILLS DRAINAGE
FEASIBILITY STUDY
OPTION 1A

FN: OPTION 1A

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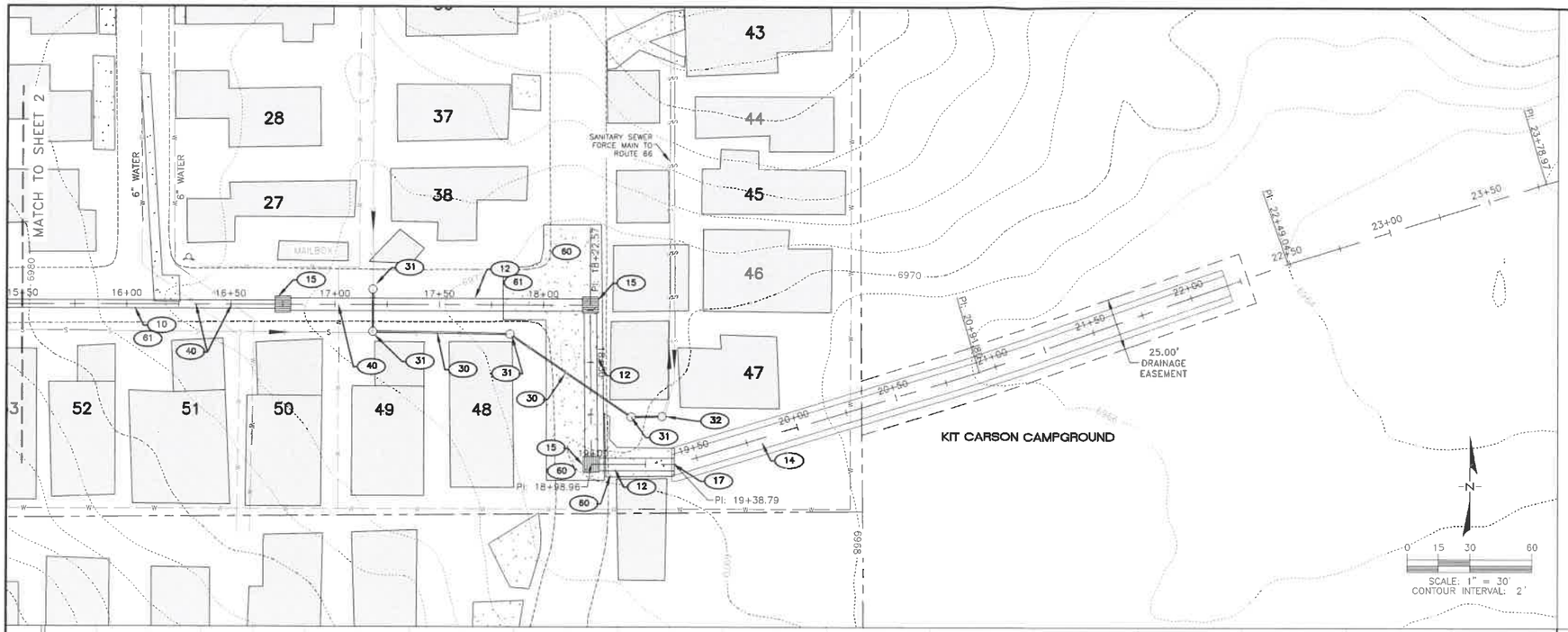
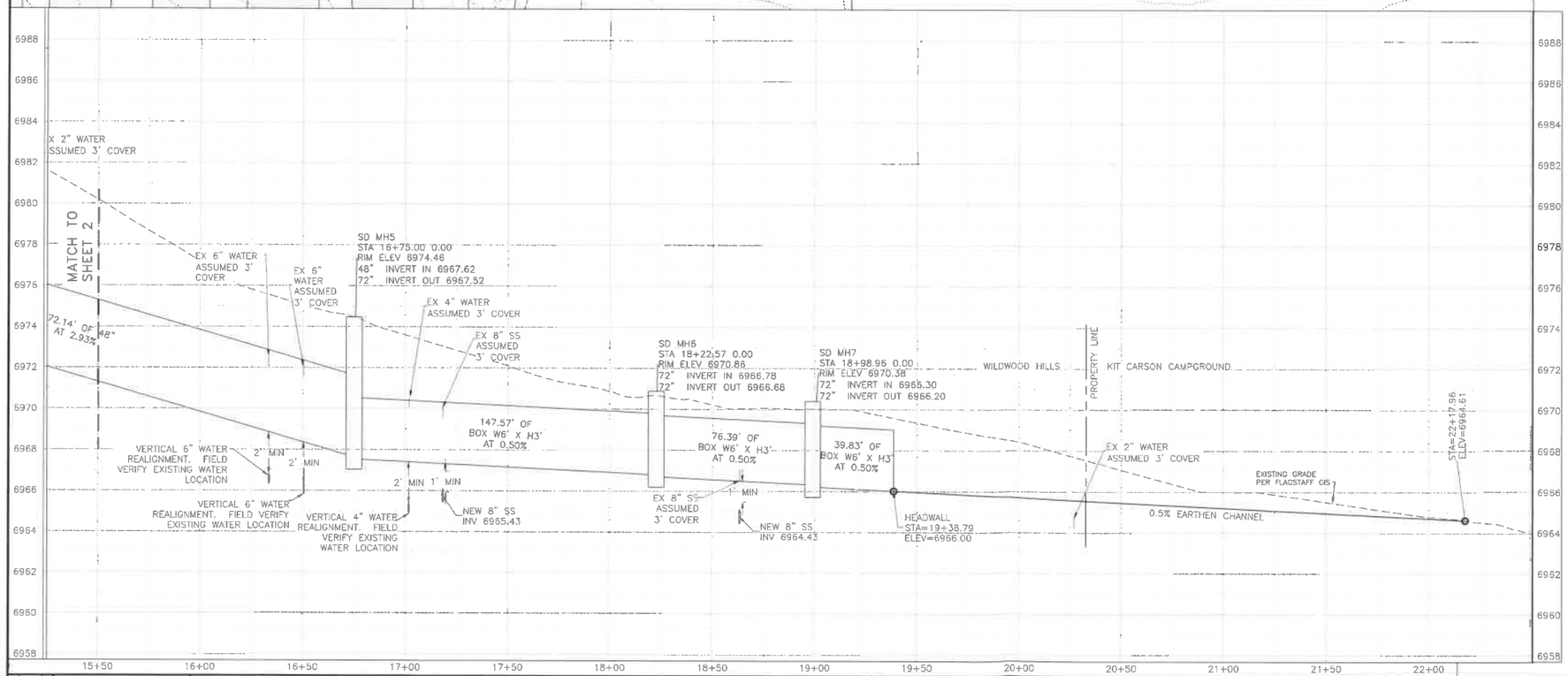
WILDWOOD HILLS DRAINAGE
FEASIBILITY STUDY

OPTION 1A

HOR SCALE: 1"=30'
VERT SCALE: 1"=3'
DATE: 1/9/19
PROJECT NO.: 117806
AGENCY NO.:
SHEET NO.: 2 OF 6

DESIGNED BY: SK
DRAFTED BY: AS
CHECKED BY: JH





CONSTRUCTION NOTES
PUBLIC IMPROVEMENTS

(10) INSTALL 48" CONTECH ULTRA FLO CMP OR APPROVED EQUAL IN ACCORDANCE WITH MAG SS 601 & 618.

(12) INSTALL 6'W X 3'H REINFORCED CONCRETE BOX CULVERT IN ACCORDANCE WITH MAG SS 206 & 505.

(13) CONSTRUCT STORM DRAIN MANHOLE IN ACCORDANCE WITH MAG SD NO. 521, & NO. 522.

(14) CONSTRUCT DITCH PER DETAIL ON THIS SHEET.

(15) CONSTRUCT CONCRETE JUNCTION BOX.

(17) CONSTRUCT HEADWALL

(30) INSTALL 8" PVC SEWER PER MAG SS 601 & 615. TYPICAL TRENCHING AND BACKFILL PER COF SD 9-01-030. REMOVE EXISTING SEWER.

(31) INSTALL SEWER CLEANOUT PER MAG SS 441.

(32) ADJUST EXISTING SEWER PUMP STATION OR REPLACE AS NEEDED.

(40) CONSTRUCT A VERTICAL REALIGNMENT OF EXISTING WATERLINE IN ACCORDANCE WITH MAG SD NO. 370. PROVIDE ADDITIONAL WATER PROTECTION IN ACCORDANCE WITH MAG SD NO. 404.

(60) REMOVE AND REPLACE CONCRETE PAVEMENT

(61) REMOVE AND REPLACE ASPHALT ROADWAY PER TRENCHING AND BACKFILL DETAIL COF SD 9-01-03.

LOCATED AT STORM DRAIN OUTLET IN WILDWOOD HILLS AND CONTINUES INTO KIT CARSON CAMPGROUND

EARTHEN CHANNEL DETAIL
N.T.S.

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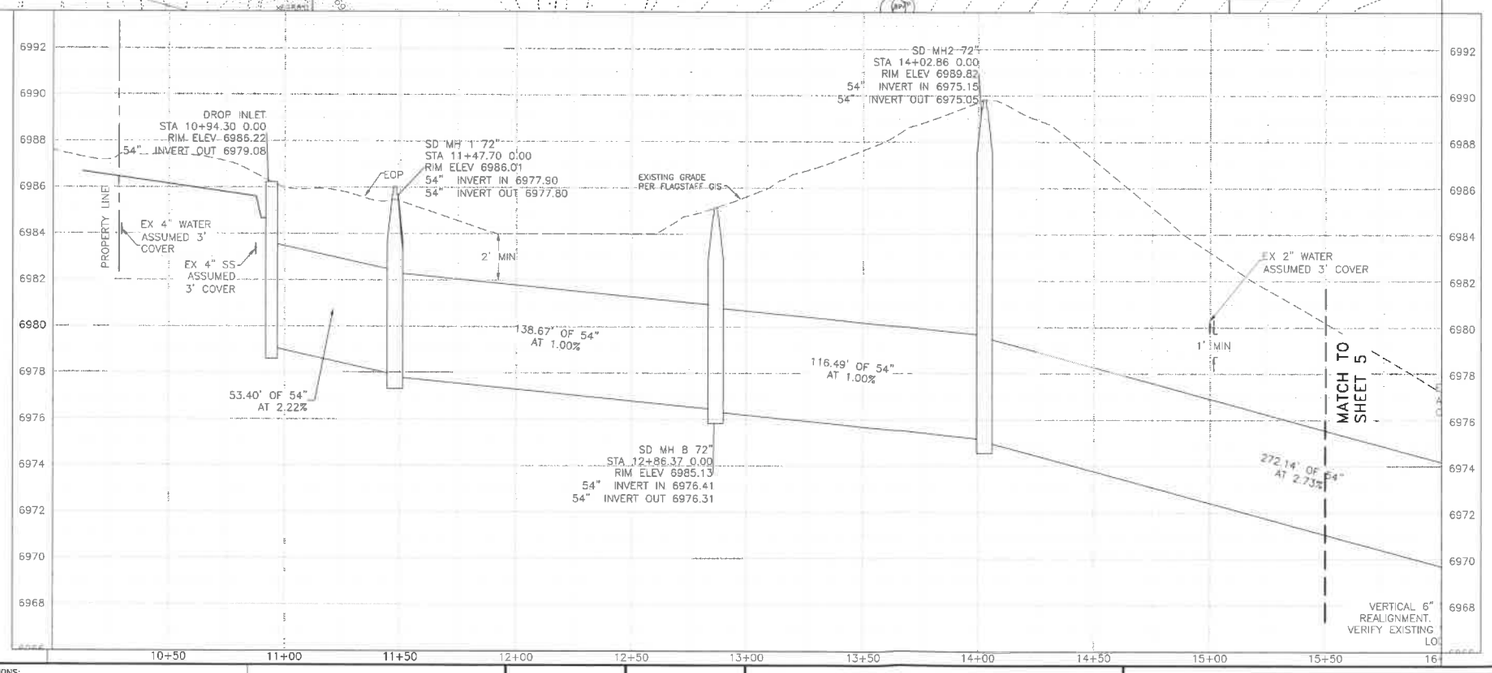
WILDWOOD HILLS DRAINAGE
FEASIBILITY STUDY

OPTION 1A

HOR SCALE: 1"=30'
VERT SCALE: 1"=3'
DATE: 1/2/19
PROJECT NO.: 117806
AGENCY NO.: .
SHEET NO.: 3 OF 6

DESIGNED BY: SK
DRAFTED BY: AS
CHECKED BY: JH



CONSTRUCTION NOTES
PUBLIC IMPROVEMENTS

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(14) CONSTRUCT DITCH TO CONVEY OFFSITE FLOW TO DROP INLET STRUCTURE.

(16) CONSTRUCT DROP INLET STRUCTURE WITH CAPTURE WALLS TO RECEIVE A MAXIMUM 197 CFS.

(60) REMOVE AND REPLACE CONCRETE PAVEMENT

(61) REMOVE AND REPLACE ASPHALT ROADWAY PER TRENCHING AND BACKFILL DETAIL COF SD 9-01-03.

(90) INSTALL SAFETY RAILING.

0 15 30 60

SCALE: 1" = 30'
CONTOUR INTERVAL: 2'

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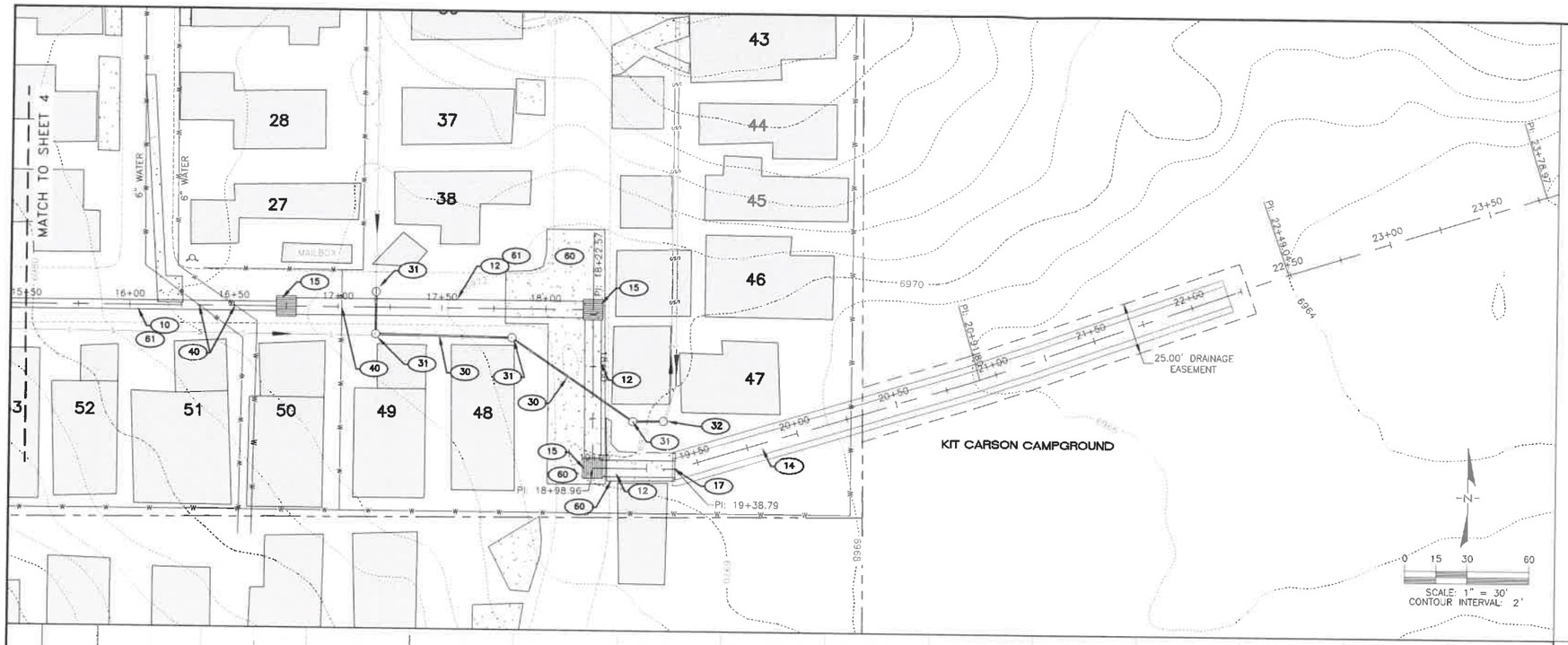
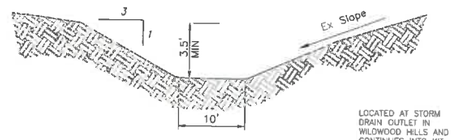
WILDWOOD HILLS DRAINAGE
FEASIBILITY STUDY

OPTION 1B

HOR SCALE: 1"=30'
VERT SCALE: 1"=3'
DATE: 1/9/19
PROJECT NO.: 117806
AGENCY NO.:
SHEET NO.: 4 OF 6

DESIGNED BY: SK
DRAFTED BY: AS
CHECKED BY: JH





LOCATED AT STORM DRAIN OUTLET IN WILDWOOD HILLS AND CONTINUES INTO KIT CARSON CAMPGROUND

EARTHEN CHANNEL DETAIL
N.T.S.

CONSTRUCTION NOTES
PUBLIC IMPROVEMENTS

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(13) CONSTRUCT STORM DRAIN MANHOLE IN ACCORDANCE WITH MAG SD NO. 521, & NO. 522.

(14) CONSTRUCT DITCH PER DETAIL ON THIS SHEET.

(15) CONSTRUCT CONCRETE JUNCTION BOX.

(17) CONSTRUCT HEADWALL

(30) INSTALL 8" PVC SEWER PER MAG SS 601 & 615. TYPICAL TRENCHING AND BACKFILL PER COF SD 9-01-030. REMOVE EXISTING SEWER.

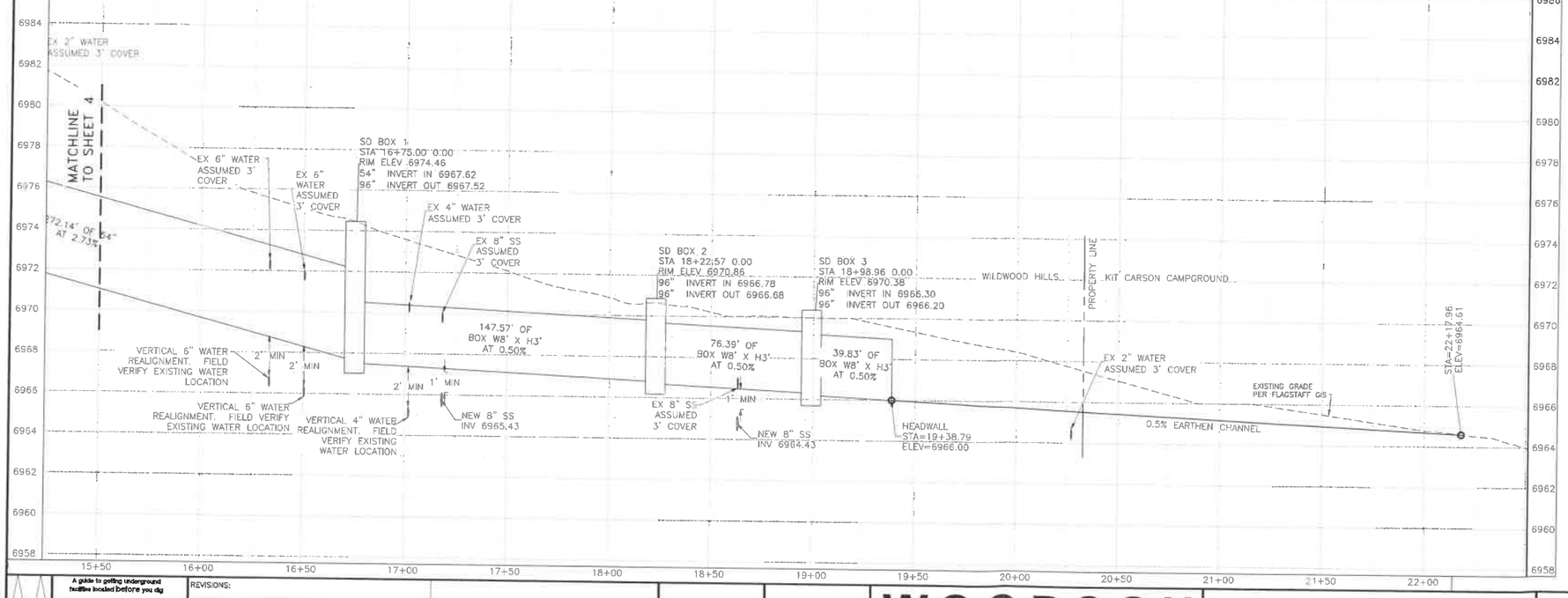
(31) INSTALL SEWER CLEANOUT PER MAG SS 441.

(32) ADJUST EXISTING SEWER PUMP STATION OR REPLACE AS NEEDED.

(40) CONSTRUCT A VERTICAL REALIGNMENT OF EXISTING WATERLINE IN ACCORDANCE WITH MAG SD NO. 370. PROVIDE ADDITIONAL WATER PROTECTION IN ACCORDANCE WITH MAG SD NO. 404.

(60) REMOVE AND REPLACE CONCRETE PAVEMENT

(61) REMOVE AND REPLACE ASPHALT ROADWAY PER TRENCHING AND BACKFILL DETAIL COF SD 9-01-03.



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FEASIBILITY STUDY
OPTION 1B

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WILDWOOD HILLS DRAINAGE
FEASIBILITY STUDY

OPTION 1B

HOR SCALE: 1"=30'
VERT SCALE: 1"=3'
DATE: 1/9/19
PROJECT NO.: 117806
AGENCY NO.:
SHEET NO.: 5 OF 6

DESIGNED BY: SK
DRAFTED BY: AS
CHECKED BY: JH

CONSTRUCTION NOTES
PUBLIC IMPROVEMENTS

(01) REMOVE EXISTING ROCK WALL CHANNEL.

(10) INSTALL 48" CONTECH ULTRA FLO CMP OR APPROVED EQUAL IN ACCORDANCE WITH MAG SS 601 & 618.

(11) INSTALL 36" CONTECH ULTRA FLO CMP OR APPROVED EQUAL IN ACCORDANCE WITH MAG SS 601 & 618.

(12) INSTALL 6'W X 3'H REINFORCED CONCRETE BOX CULVERT IN ACCORDANCE WITH MAG SS 206 & 505.

(13) CONSTRUCT STORM DRAIN MANHOLE IN ACCORDANCE WITH MAG SD NO. 521, & NO. 522.

(14) CONSTRUCT DITCH PER DETAIL ON SHEET 2.

(15) CONSTRUCT CONCRETE JUNCTION BOX.

(16) CONSTRUCT DROP INLET STRUCTURE WITH CAPTURE WALLS TO RECEIVE A MAXIMUM OF 140 CFS.

(17) CONSTRUCT HEADWALL.

(18) CONSTRUCT CONCRETE RECTANGULAR CHANNEL PER DETAIL ON THIS SHEET.

(30) INSTALL 8" DIA. PVC SEWER LINE IN ACCORDANCE WITH MAG SS 601 & 615. TYPICAL TRENCHING AND BACKFILL PER COF SD NO. 9-01-030.

(31) INSTALL SEWER CLEANOUT PER MAG SS 441.

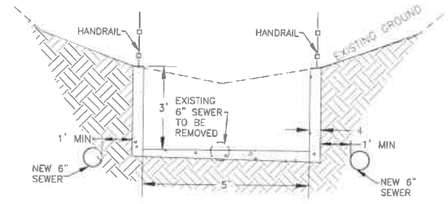
(32) ADJUST EXISTING SEWER PUMP STATION OR REPLACE AS NEEDED.

(40) CONSTRUCT A VERTICAL REALIGNMENT OF EXISTING WATERLINE IN ACCORDANCE WITH MAG SD NO. 370. PROVIDE ADDITIONAL WATER PROTECTION IN ACCORDANCE WITH MAG SD NO. 404.

(60) REMOVE AND REPLACE CONCRETE PAVEMENT

(61) REMOVE AND REPLACE ASPHALT ROADWAY PER TRENCHING AND BACKFILL DETAIL COF SD 9-01-03.

(90) INSTALL SAFETY RAILING.



(18) CONCRETE CHANNEL SECTION
NOT TO SCALE

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0 15 30 60
SCALE: 1" = 30'
CONTOUR INTERVAL: 2'

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1/9/19

WILDWOODHILLS DRAINAGE FEASIBILITY STUDY
OPTION 2

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WILD WOOD HILLS DRAINAGE FEASIBILITY STUDY

OPTION 2

HOR SCALE: 1"=30'
VERT SCALE: NA
DATE: 1/9/19
PROJECT NO.: 117806
AGENCY NO.:
SHEET NO.: 6 OF 6

DESIGNED BY: SK
DRAFTED BY: AS
CHECKED BY: JH

APPENDIX C: OPTIONS COST ESTIMATES

OPTION 1A COST ESTIMATE
OPTION 1B COST ESTIMATE
OPTION 2 COST ESTIMATE

Wildwood Hills Feasibility Study
Opinion of Probable Cost
Option 1A

Date: January 9, 2019

Item #	Item Description	Est Quant.	Unit	Unit Price	Total Price
1	Remove Existing Channels (bet. Units 8, 9 & 10)	1	LS	$5,000	$5,000
2	Remove Existing Sidewalk	250	SF	$4	$1,000
3	Remove Asphalt Pavement	1290	SY	$5	$6,449
4	Remove Private Driveways (Units 9, 48 & 49)	1750	SF	$4	$7,000
5	Remove Concrete pavement/pads	5888	SF	$5	$29,440
6	Replace Asphalt Pavement	1290	SY	$50	$64,489
7	Replace Private Driveways (Units 9, 48 & 49)	1150	EA	$10	$11,500
8	Replace Sidewalk	250	SF	$10	$2,500
9	Replace Concrete Pavement/Pads	5888	SF	$10	$58,880
10	ALLOWANCE Remove Unit (#9)	1	EA	$250,000	$250,000
11	Grade to Drain (between Units 8 and 10)	1	LS	$5,000	$5,000
12	Inlet Structure (between units 8 and 10)	1	EA	$15,000	$15,000
13	Earthern Channel (Kit Carson)	1	LS	$10,000	$10,000
14	48-Inch Ultra Flo CMP (Contech)	729	LF	$100	$72,900
15	6'x3' (Width X Height) RCBC (Forterra)	265	LF	$600	$159,000
16	Headwall (6'x3' RCBC) at Outlet	1	EA	$10,000	$10,000
17	Manholes (MAG 521-51" or larger)	3	EA	$9,000	$27,000
18	Transition Structures (cast-in-place)	3	EA	$15,000	$45,000
19	Vertical Water realignment at crossing (6-inch)	3	EA	$5,000	$15,000
20	8" Sanitary Sewer Remove/Replace	185	LF	$65	$12,025
21	Adjust sewer services (Units 48 & 49)	2	EA	$1,000	$2,000
22	New Sewer Cleanouts	4	EA	$700	$2,800
23	Sewer Lift Station	1	EA	$10,000	$10,000
24	Traffic Control	1	LS	$50,000	$50,000
Subtotal					***$871,983***
25	Engineering and Survey (10%)	1	LS	$87,198	$87,198
26	Contingency (20%)	1	LS	$174,397	$174,397
Total					**$1,133,578**

This estimate is based on the preliminary plans for the project dated 1/2/19
This estimate is made on the basis of oour experience and qualifications and represents our best judgement.
ALLOWANCE for removal of Unit 9 is based on an estimated market value of $100,000 plus relocation expenses. No allowance has been made for legal costs
Rock excavation cost (if any) is not included in the estimate. Geotechnical evaluation is recommended for detailed design phase.

Wildwood Hills Feasibility Study
Opinion of Probable Cost
Option 1B

Date: January 9, 2019

Item #	Item Description	Est Quant.	Unit	Unit Price	Total Price
1	Remove Existing Channels (bet. Units 8, 9 & 10)	1	LS	$5,000	$5,000
2	Remove Existing Sidewalk	250	SF	$4	$1,000
3	Remove Asphalt Pavement	1290	SY	$5	$6,449
4	Remove Private Driveways (Units 9, 48 & 49)	1750	SF	$4	$7,000
5	Remove Concrete pavement/pads	5888	SF	$5	$29,440
6	Replace Asphalt Pavement	1290	SY	$50	$64,489
7	Replace Private Driveways (Units 9, 48 & 49)	1150	EA	$10	$11,500
8	Replace Sidewalk	250	SF	$10	$2,500
9	Replace Concrete Pavement/Pads	5888	SF	$10	$58,880
10	ALLOWANCE Remove Unit (#9)	1	EA	$250,000	$250,000
11	Grade to Drain (between Units 8 and 10)	1	LS	$5,000	$5,000
12	Inlet Structure (between units 8 and 10)	1	EA	$15,000	$15,000
13	Earthern Channel (Kit Carson)	1	LS	$10,000	$10,000
14	54-Inch Ultra Flo CMP (Contech)	729	LF	$130	$94,770
15	8'x3' (Width X Height) RCBC (Forterra)	265	LF	$750	$198,750
16	Headwall (8'x3' RCBC) at Outlet	1	EA	$10,000	$10,000
17	Manholes (MAG 521-51" or larger)	3	EA	$9,000	$27,000
18	Transition Structures (cast-in-place)	3	EA	$15,000	$45,000
19	Vertical Water realignment at crossing (6-inch)	3	EA	$5,000	$15,000
20	8" Sanitary Sewer Remove/Replace	185	LF	$65	$12,025
21	Adjust sewer services (Units 48 & 49)	2	EA	$1,000	$2,000
22	New Sewer Cleanouts	4	EA	$700	$2,800
23	Sewer Lift Station	1	EA	$10,000	$10,000
24	Traffic Control	1	LS	$50,000	$50,000
Subtotal					***$933,603***
25	Engineering and Survey (10%)	1	LS	$93,360	$93,360
26	Contingency (20%)	1	LS	$186,721	$186,721
Total					**$1,213,684**

This estimate is based on the preliminary plans for the project dated 1/2/19
This estimate is made on the basis of oour experience and qualifications and represents our best judgement.
ALLOWANCE for removal of Unit 9 is based on an estimated market value of $100,000 plus relocation expenses. No allowance has been made for legal costs
Rock excavation cost (if any) is not included in the estimate. Geotechnical evaluation is recommended for detailed design phase.

Wildwood Hills Feasibility Study
Opinion of Probable Cost

Date: January 9, 2019

Option 2

Item#	Item Description	Est Quant.	Unit	Unit Price	Total Price
1	Remove Existing Channels (bet. Units 8, 9 & 10)	1	LS	$5,000	$5,000
2	Remove Existing Sidewalk	250	SF	$4	$1,000
3	Remove Asphalt Pavement	336	SY	$5	$1,680
4	Remove Concrete pavement/pads	1992	SF	$5	$9,960
5	Replace Asphalt Pavement	336	SY	$50	$16,800
6	Replace Sidewalk	250	SF	$10	$2,500
7	Replace Concrete Pavement/Pads	1992	SF	$10	$19,920
8	ALLOWANCE Remove Unit (#9)	1	EA	$250,000	$250,000
9	Grade to Drain (between Units 8 and 10)	1	LS	$5,000	$5,000
10	Inlet Structure (between units 8 and 10)	1	EA	$15,000	$15,000
11	Earthern Channel (Kit Carson)	1	LS	$10,000	$10,000
12	48-Inch Ultra Flo CMP (Contech)	359	LF	$100	$35,900
13	2 X 36-inch Ultra Flo CMP (Contech)	35	LF	$150	$5,250
14	Concrete Rectangular Channel (5-ft bottom width)	238	LF	$600	$142,800
15	ALLOWANCE disruption to Units 17, 18, 23, 24, 29, 30, 35, and 36	1	LS	$160,000	$160,000
16	6'x3' (Width X Height) RCBC (Forterra)	181	LF	$600	$108,600
17	Headwall (6'x3' RCBC) at Outlet	1	EA	$10,000	$10,000
18	Manholes (MAG 521-51" or larger)	2	EA	$9,000	$18,000
19	Transition Structures (cast-in-place)	3	EA	$15,000	$45,000
20	Vertical Water realignment at crossing (6-inch)	2	EA	$5,000	$10,000
21	8" Sanitary Sewer Remove/Replace	783	LF	$65	$50,895
22	New Sewer Cleanouts	7	EA	$700	$4,900
23	Sewer Lift Station	1	EA	$10,000	$10,000
24	Traffic Control	1	LS	$50,000	$50,000
Subtotal					***$988,205***
25	Engineering and Survey (10%)	1	LS	$98,821	$98,821
26	Contingency (20%)	1	LS	$197,641	$197,641
Total					**$1,284,667**

This estimate is based on the preliminary plans for the project dated 1/2/19
This estimate is made on the basis of oour experience and qualifications and represents our best judgement.
ALLOWANCE for removal of Unit 9 is based on an estimated market value of $100,000 plus relocation. No allowance has been made for legal costs
ALLOWANCE for disruption to other units is based on $20,000 per unit for areas that would be drastically affected. No allowance has been made for legal costs.
Rock excavation cost (if any) is not included in the estimate. Geotechnical evaluation is recommended for detailed design phase.

APPENDIX D: REFRENCE INFORMATION

AS BUILTS FOR WILDWOOD HILLS WATER AND SEWER EXTENSION

WILDWOOD HILLS

WATER & SEWER LINE EXTENSION

GENERAL NOTES

1. Approval of these plans by the City Engineer is for a one year period, subsequent to date of review. If construction work is not started within the one year period, or has been discontinued for any reason for longer than one year, the plans shall be resubmitted for review.

2. Plan review by the City Engineer does not extend to material quantities shown on these plans.

3. A public works permit, issued by the City, is required for all work in City rights-of-way or easements and for construction of any improvements intended to become public property.

4. The City shall be notified 24 hours prior to beginning different phases of construction so that inspectors may be scheduled.

5. All materials and workmanship shall comply with the City of Flagstaff "Design and Construction Standards and Specifications" and the M.A.G. "Uniform Standard Specifications for Public Works Construction" latest revision, with the latest City of Flagstaff Additions and Revisions, and with generally accepted good construction practice. All work and materials which do not conform to the Standards and Specifications are subject to removal and replacement at the Contractor's expense.

6. Any work performed without the knowledge and approval of the City Engineer or his representative, is subject to removal and replacement at the Contractor's expense.

7. The City Engineer or his representative may suspend the work by written notice when, in his judgement, progress is unsatisfactory, work being done is unauthorized or defective, weather conditions are unsuitable, or there is danger to the public health or safety.

8. The City Engineer may order any or all materials used in the work to be tested according to AASHO and ASTM Standards. The Contractor shall, at his expense, supply all samples required for testing.

9. The Contractor shall be responsible for maintenance of the streets and of partically completed portions of the work until final acceptance of the work. Any streets required to be closed for the construction activity shall be reopened within a reasonable time or upon order of the City Engineer. The regulation and control of all traffic shall be as directed by the City Engineer.

10. Approval of a portion of the work in progress does not guarantee its final acceptance. Testing and evaluation may continue until written final acceptance of a complete workable unit. Any defects which appear in the work within one year from the date of acceptance and which are due to improper workmanship or inferior materials supplied shall be corrected by or at the expense of the owner/developer or the Contractor.

11. Acceptance of completed public improvements will not be given until defective or unauthorized work is removed, final clean-up completed.

12. Location of underground utilities before work is begun is to be accomplished in accordance with ARS 40-366.22. Contact BLUE STAKE at 799-5139.

WATER AND SEWER NOTES

1. Rough grading must be completed prior to installation of underground utilities.

2. If backfilling is compacted by water settling, the trench shall be jetted when the pipe has one foot of cover.

3. No trench shall be filled with bedding material or backfilled until the excavation and pipe laying, respectively, have been approved by the City Engineer.

4. A pressure test is required of all water lines, and a hydrostatic or air test is required of all sewer lines. Test are to be conducted after backfilling is complete and compacted.

5. Water and sewer service lines are to be marked as shown on the standard service details.

6. Water line disinfection is to be accomplished as outline in Arizona State Department of Health Engineering Bulletin No. 8.

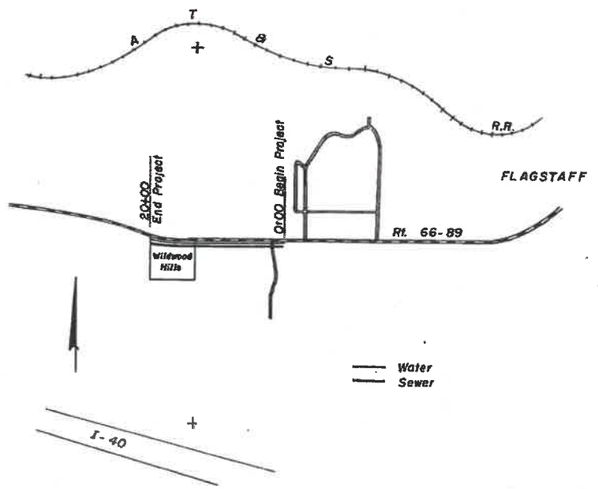
7. Water pipe classifications shall be Class 200 for A.C.P. and Class 150 for ductile iron pipe unless otherwise specified by the City Engineer.

8. All sewer lines will also be television inspected prior to acceptance by the City.

9. When a sewer crosses a water pipe at a point at which the sewer is 2 feet or more below the water pipe, no extra protection is required. At all other crossings the sewer shall be constructed of cast iron with leaded or mechanical joints for a distance of at least 6 feet in each direction from the crossing or, as an alternate, the sewer can be encased in concrete of 6 inches minimum thickness for the same distance.

NOTICE TO CONTRACTORS

1. THE DEPTH AND LOCATION OF UNDERGROUND UTILITIES SHOWN ON THESE PLANS ARE APPROXIMATE. THE CONTRACTOR SHALL NOTIFY THE UTILITY COMPANIES PRIOR TO ANY EXCAVATION TO VERIFY THE EXACT HORIZONTAL AND VERTICAL LOCATION OF THEIR UTILITY.
2. QUANTITIES ARE FOR PRELIMINARY COST ESTIMATING AND SHOULD NOT BE USED AS A BASIS FOR CONTRACTS OR BIDS.
3. A 48 HOUR NOTIFICATION IS REQUIRED PRIOR TO ANY NEED FOR STAKES TO SCHEDULE SURVEY CREWS.
4. A BLASTING PERMIT FOR WORK IN CITY OF FLAGSTAFF AND STATE OF ARIZONA RIGHT-OF-WAY SHALL BE OBTAINED FROM THE CITY OF FLAGSTAFF FIRE DEPARTMENT PRIOR TO COMMENCEMENT OF CONSTRUCTION.
5. TRAFFIC CONTROL IS REQUIRED AND SHALL BE DONE IN CONFORMANCE WITH THE "TRAFFIC CONTROL MANUAL FOR HIGHWAY CONSTRUCTION AND MAINTENANCE", ARIZONA DEPARTMENT OF TRANSPORTATION, LATEST EDITION. TWO-WAY TRAFFIC SHALL BE MAINTAINED AT ALL TIMES ON U.S. HIGHWAYS 66 AND 89.
6. A PUBLIC WORKS PERMIT, ISSUED BY THE ARIZONA DEPARTMENT OF TRANSPORTATION, IS REQUIRED FOR ALL WORK IN THE STATE OF ARIZONA RIGHT-OF-WAY.



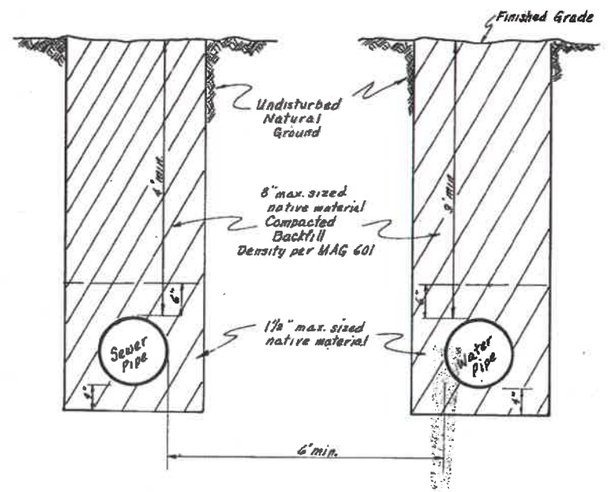
KEY MAP

1" = 1000'

CALL FOR THE BLUE STAKE
779-5139
Blue Stake Center
FAX COLLECT

APPROXIMATE QUANTITIES

Item	Unit	Quantity	Std Dwg. No.
10" V.C.P. Sewer Pipe	L.F.	2000	
Standard Manhole	Ea.	5	I- 20.10
6" ACP Water Pipe	L.F.	1318	
6" Gate Valve, Box & Cover	Ea.	7	I- 30.10
12" ACP Water Pipe	L.F.	2010	
12" Gate Valve, Box & Cover	Ea.	3	I- 30.10
12"x6" Tee	Ea.	2	I- 30.00
12" 45° Bend	Ea.	3	I- 30.00
Temp. Blow off	Ea.	1	I- 30.11
12"x2" Tap Sleeve & Valve	Ea.	1	MAG-340
Pavement Replacement	S.Y.	65	MAG-200
6" D.I. Pipe	L.F.	30	
6" Fire Hydrant	Ea.	3	I-30.20
Conc. Encasement or DIP		as req	I-10.10
6" 45° Bend	Ea	4	I-30.10
6" 90° Bend	Ea	2	"



APPROVALS

CONCEPT APPROVAL: *The City approves these plans for concept only. This certifies that the Developers Engineer has satisfied the minimum requirements of the City of Flagstaff design standards. All liability for errors or ommissions is the responsibility of the Developers Engineer.*

APPROVED BY Ronald A Sevian for FLAGSTAFF CITY ENGINEER — DATE 11/12/82

FLAGSTAFF CITY UTILITY DIRECTOR — DATE 10-14-82

NOTE: *Contractor must obtain Permit from ADOT prior to any construction in State of Arizona right-of-way.*

APPROVED BY ADOT — DATE 9-15-82

APPROVED BY FILE NO. 820425 ARIZONA DEPT. of HEALTH SERVICE — DATE 10-18-82

PLANS REVIEWED BY	DATE
A.P.S. Thomas W Brink	9/8/82
SO. UNION	
M.T. BELL Bruce Bartlett	9-8-82
WARNER CABLE	9-8-82

AS BUILT

Revised per City 6/15/82
Revised per City 8/11/82
Revised per City 9/8/82
per City 9/7/82
Comm 9/20/82

OFFSITE WATER & SEWER

ROCKWELL CONSULTANTS
3006 N. 38th Street Phoenix, Arizona 85018
(602) 957-1839

Job No: 1185/173 Sheet 1 of 3

CP-2468

SUB-95 POCKET-28

Sta 0+00 Exist M.H.

Install 400 L.F. New 10" VCP Sewer. Conn. to exist. stubout

Encase in Conc until 2' min. cover is reached I-10.10

Sta 4+00 M.H. #1 Install Standard M.H. per Std. Dwg. I-20.10

Install 400 L.F. 10" VCP Sewer

Sta. 8+00 M.H. #2 Install Standard M.H. per Std. Dwg. I-20.10

Install 200 L.F. New 10" VCP Sewer

Sta 0+00 Exist 12" Valve

US 66 & 89

Remove 65 S.Y. Pavement Replace in kind - Tee-Top MAG. 200

Install 800 L.F. New 12" ACP Water Line Conn. to Exist. Valve

Sta. 14+18 Install 12 Gate Valve B&C. per I-30.10

MATCH LINE STA. 10+00 Below

B.M. Elev. 6955.16'
Top 3" A.H.D. Brass Cap center of north concrete headwall ±140' west of Kit Carson Park office.

PLAN
SURVEYED
PLOTTED
DRAWN
CHECKED
QUANTITY CHECKED
R/W CHECKED
STRUCTURE, NOTATIONS CHKD
NOTE BOOK
NO.
BY
DATE

Exist. M.H. Sta 0+00

Exist. Profile of Proposed Sewer

400 L.F. 10" VCP S=0.0034

Exist. 10" S=0.0040

Rim 53.19

47.29

M.H. #1 Sta 4+00

Rim 52.50

40.89

400 L.F. 10" VCP S=0.0329

M.H. #2 Sta 8+00

Rim 69.32

42.05

200 L.F. 10" VCP S=0.0510

6962 6958 6954 6950

6976 6972 6968 6964

0 2 4 6 8 10

Install 200 L.F. New 10" VCP Sewer

Sta 12+00 M.H. #3 Install Std. M.H. per Std. Dwg. I-20.10

Sta. 13+00 Install 4" Sewer Tap (6' Deep)

Install 780 L.F. 12" ACP Water

MATCH LINE STA. 10+00 Above Right

Install 190 L.F. New 10" VCP Sewer

Sta 15+55 Install 12"x6" Tee & Thrust Blk per SD I-30.00

Sta 15+90 Install 2" Tap & 2" Water Meter

Sta 15+90 Install 12" Gate Valve, B&C. per I-30.10

Sta 16+00 M.H. #4 Install Std. M.H. per Std. Dwg. I-20.10

Install 380 L.F. 12" ACP Water

Install 320 L.F. New 10" VCP Sewer

Sta 16+40 Install 12"x6" Tee & Thrust Blk. per I-30.00

US 66 & 89

Sta 19+90 M.H. #5 Install Std. M.H. per S.D. I-20.10

Sta 20+00 Install Temp. Blow-off per SD I-30.11

Sta 19+50 Install 12" Gate Valve B&C S.D. I-30.10

Install 50 LF 12" ACP Water

SCALE Horiz 1"=40'
Vert. 1"=4'

Rim 31.50

90 LF 10" VCP S=0.0034

200 LF 10" VCP S=0.0590

M.H. #3 Sta 12+00

Rim 30.60

120 LF 10" VCP S=0.0750

328 LF 10" VCP S=0.0034

Use DIP until cover exceeds 4'

Rim 19.00

120 LF 10" VCP S=0.0750

160 LF 10" VCP S=0.0750

10" Stub Plugged

7013.80

M.H. #5 Sta 19+90

6990 6986 6982 6978

6998 6992 6988 6984

7016 7012 7008 7004

6996 7008 7004 7000 6996 7008 7016

10 12 14 16 18 20

PROFILE
SURVEYED
PLOTTED
DRAWN
CHECKED
QUANTITY CHECKED
R/W CHECKED
STRUCTURE, NOTATIONS CHKD
NOTE BOOK
NO.
BY
DATE

Dig Safely. Know what's below. Call before you dig. CALL FOR THE BLUE STAKES 779-5139 Blue Stake Center CALL COLLECT

AS BUILT

OFF-SITE WATER & SEWER

ROCKWELL CONSULTANTS
3006 N. 38th Street Phoenix, Arizona 85018
(602) 957-1839

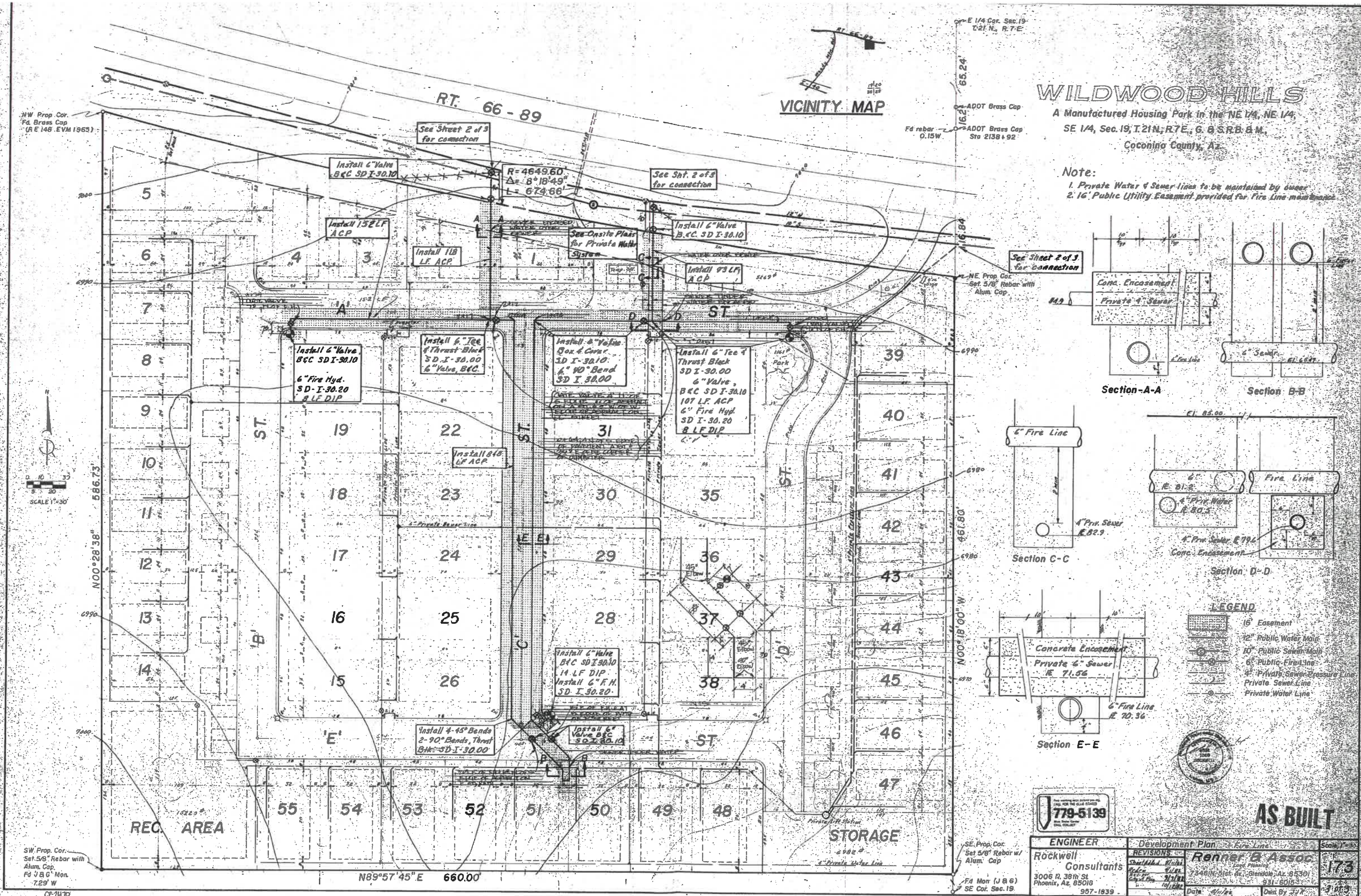
Job No. 1185/173 Sheet 2 of 3

6/15/82

PLATE 2-DOUBLE PLAN AND PROFILE-FULL DOT

CF-74A

SUB OF SHEET - 78



WILDWOOD HILLS
A Manufactured Housing Park in the NE 1/4, NE 1/4, SE 1/4, Sec. 19, T.21 N., R.7 E., G. & S.R.B. & M.
Coconino County, Az.
Note:
1. Private Water & Sewer lines to be maintained by owner.
2. 16' Public Utility Easement provided for Fire Line maintenance.
VICINITY MAP
RT. 66 - 89
NW Prop. Cor. Fd. Brass Cap (R.E 148 EVM 1963)
E 1/4 Cor. Sec. 19 T.21 N., R.7 E.
ADOT Brass Cap
Fd rebar 0.15W.
ADOT Brass Cap Sta 2138+92
NE. Prop. Cor. Set 5/8" Rebar with Alum. Cap
R=4649.60
Δ= 8°18'49"
L= 674.66'
See Sheet 2 of 3 for connection
Install 6" Valve B&C SD I-30.10
Install 152 LF ACP
Install 118 LF. ACP
See Onsite Plans for Private Water System
Install 6" Valve B&C SD I-30.10
Install 93 LF ACP
See Sht. 2 of 3 for connection
See Sheet 2 of 3 for connection
Install 6" Valve B&C SD I-30.10
6" Fire Hyd. SD-I-30.20
8 LF DIP
Install 6" Tee & Thrust Block SD I-30.00
6" Valve, B&C
Install 6" Valve Box & Cover SD I-30.10
6" 90° Bend SD I 30.00
Install 6" Tee & Thrust Block SD I-30.00
6" Valve, B&C SD I-30.10
107 L.F. ACP
6" Fire Hyd. SD I-30.20
8 LF DIP
Install 840 LF ACP
Install 6" Valve B&C SD I-30.10
14 LF DIP
Install 6" F.H. SD I.30.20
Install 4-45° Bends 2-90° Bends, Thrust Blk. SD I-30.00
Install 6" Valve B&C SD I-30.10
A ST
B ST
C ST
D ST
E ST
REC. AREA
STORAGE
586.73'
N00°28'38"
N00°18'00" W
461.80
N89°57'45" E 660.00'
SCALE 1"=30'
SW Prop. Cor. Set 5/8" Rebar with Alum. Cap
Fd J & G Mon. 7.29' W
SE Prop. Cor. Set 5/8" Rebar w/ Alum. Cap
Fd Mon (J & G) SE Cor. Sec. 19
Section-A-A
Conc. Encasement
Private 4" Sewer
Section B-B
6" Sewer
6" Fire Line
4" Priv. Sewer
Section C-C
Fire Line
4" Priv. Water
4" Priv. Sewer
Conc. Encasement
Section D-D
Concrete Encasement
Private 6" Sewer
6" Fire Line
Section E-E
LEGEND
16' Easement
12" Public Water Main
10" Public Sewer Main
6" Public Fire Line
4" Private Sewer Pressure Line
Private Sewer Line
Private Water Line
779-5139
AS BUILT
ENGINEER
Rockwell Consultants
3006 N. 38th St.
Phoenix, Az. 85018
957-1839
REVISIONS
Development Plan - Fire Line
Renner & Assoc.
931-6015
173

WILDWOOD HILLS

RT. 66 - 89

See Offsite Plans for Connection

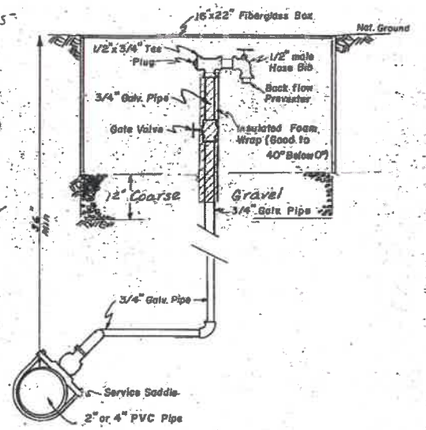
2" Water Meter
2" Anti-syphon Valve
2"x4" Increaser

See Offsite Plans for Connections

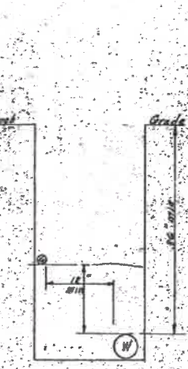
R=4642.60
Δ=8°18'49"
L=674.66'

NOTES:

1. Water lines to have a minimum of 36" of cover over top of barrel.
2. Water and Sewer line separation to conform to Std. Dwg. I-10.10
3. Fire Hydrant installation per Std. Dwg. I-30.20
4. Install 6" ACP Fire Main per City of Flagstaff Standards and Specifications Std. Dwg. I-30.00
5. 2" and 4" water lines are to be privately maintained by property owner.



RISER DETAIL



TRENCH D

LEGEND

- Fire Hydrant & Valve
- Valve
- Water Meter
- Anti-siphon Valve

APPROXIMATE QUANTITIES

4" Water Line PVC	2052 L.F.
4" Tee	2 Ea.
4"x2" Tee	3 Ea.
4" Valve	6 Ea.
2" Water Meter	1 Ea.
2" Anti syphon Valve	1 Ea.
2" Water Line PVC	1159 L.F.
2" Valve	3 Ea.
Service Taps PVC	56 Ea.

AS BUILT

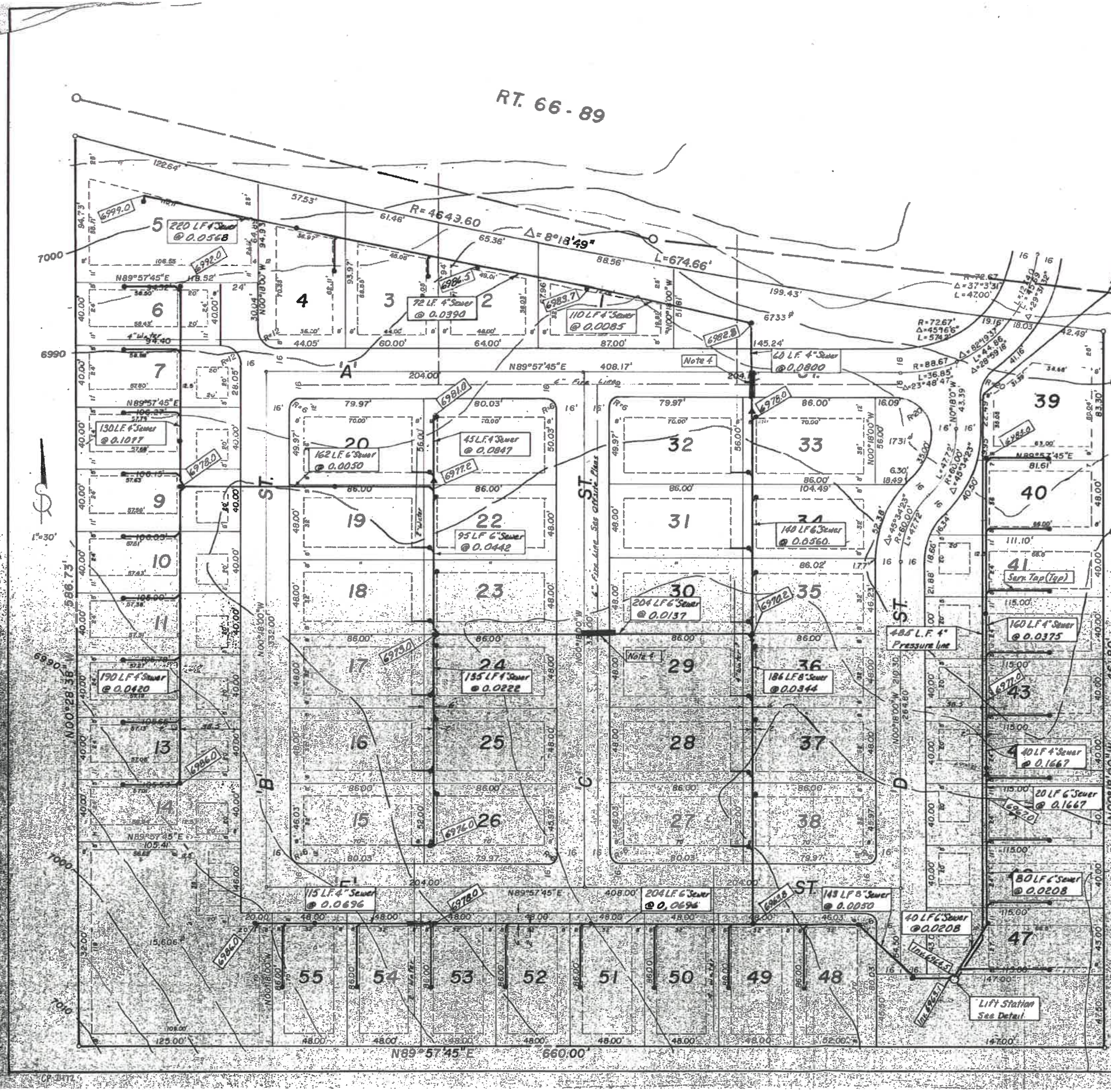
Revised Fire Line	10/16/82
Revised Fire Line	8/31/82
Revised Per City	6/28/82
Revised Per City	5/25/82

ONSITE WATER

ROCKWELL CONSULTANTS
3006 N. 36th Street Phoenix, Arizona 85018
(602) 957-1839

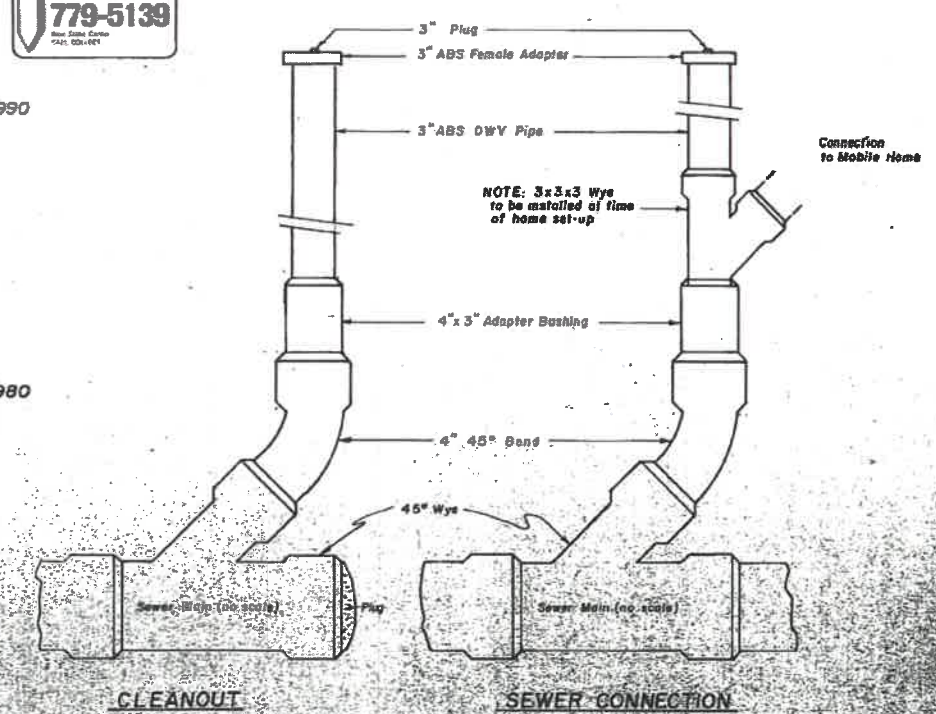
Job No. 1185 / 173 Sheet 1 of 1

WILDWOOD HILLS



NOTES

1. Water and Sewer line separation shall conform to Std. Dwg. I-10.10
2. Sewer line installation shall conform to the latest U.P.C.
3. Onsite private sewer lines to be maintained by property owner.
4. When a sewer crosses a water pipe at a point at which the sewer is 2' or more below the water pipe, no extra protection is required. At all other crossings the sewer shall be constructed of cast iron with leaded or mechanical joints for a distance of at least 6' in each direction from the crossing or, as an alternate, the sewer can be encased in concrete of 6" min. thickness for the same distance.



APPROXIMATE QUANTITIES

6" Sewer Line	945	L.F.
4" Sewer Line	1277	L.F.
4" Sewer Pressure	485	L.F.
Cleanout	75	Ea.
Lift Station	1	Ea.
8" Sewer Line	329	L.F.
4" Sewer Tap to City Main	1	Ea.

LEGEND

- Cleanout
- Reducer
- 6992.0 — Propose invert elevation
- Exist. Contours
- Proposed Onsite Sewer
- Proposed Offsite Sewer
- Conc. Encasement or D.I.P.

AS BUILT

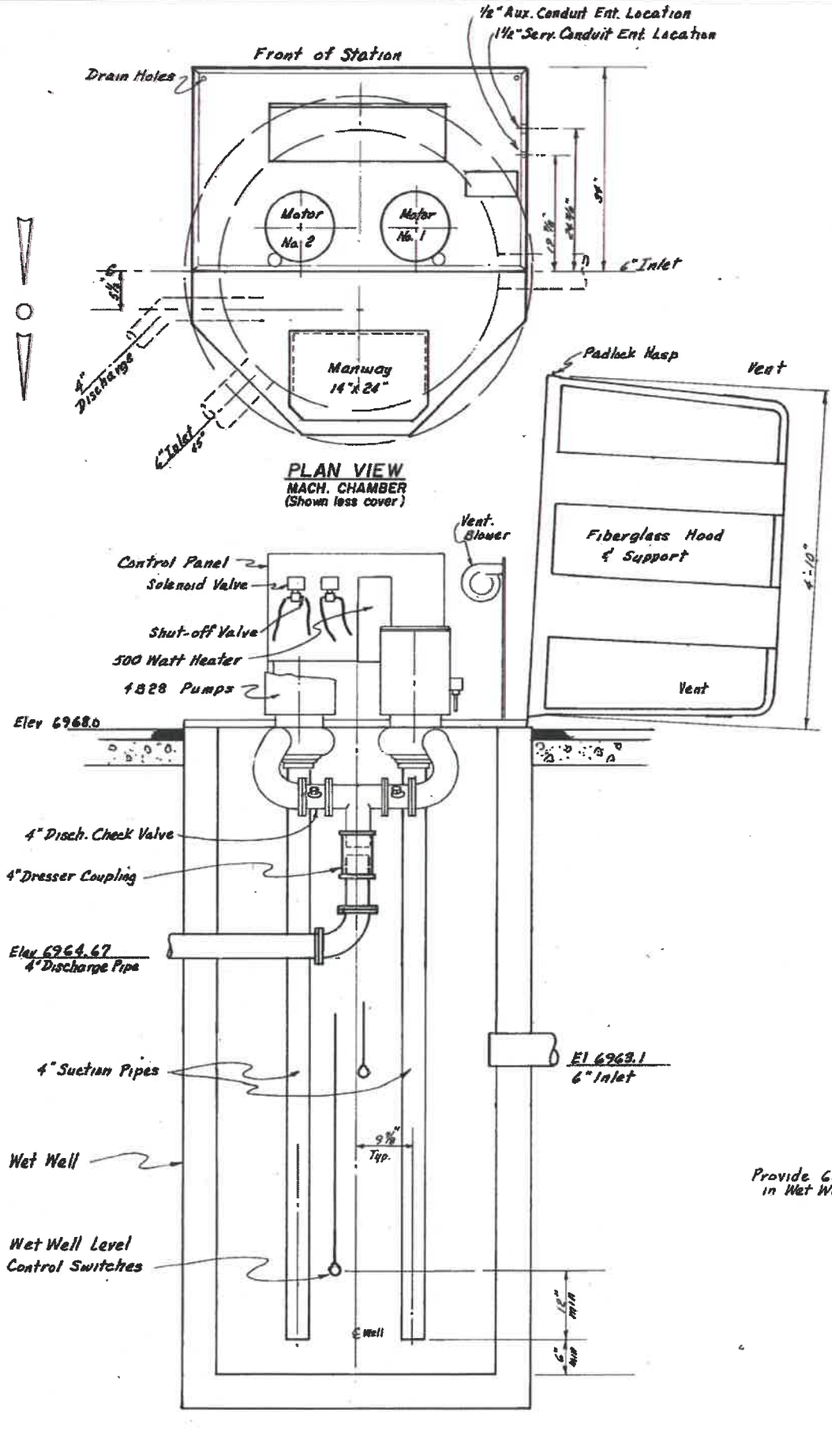
Add Fire Line
Revised per City
Revised Per City

ONSITE SEWER

ROCKWELL CONSULTANTS
3006 N. 38th Street Phoenix, Arizona 85018
(602) 957-1839

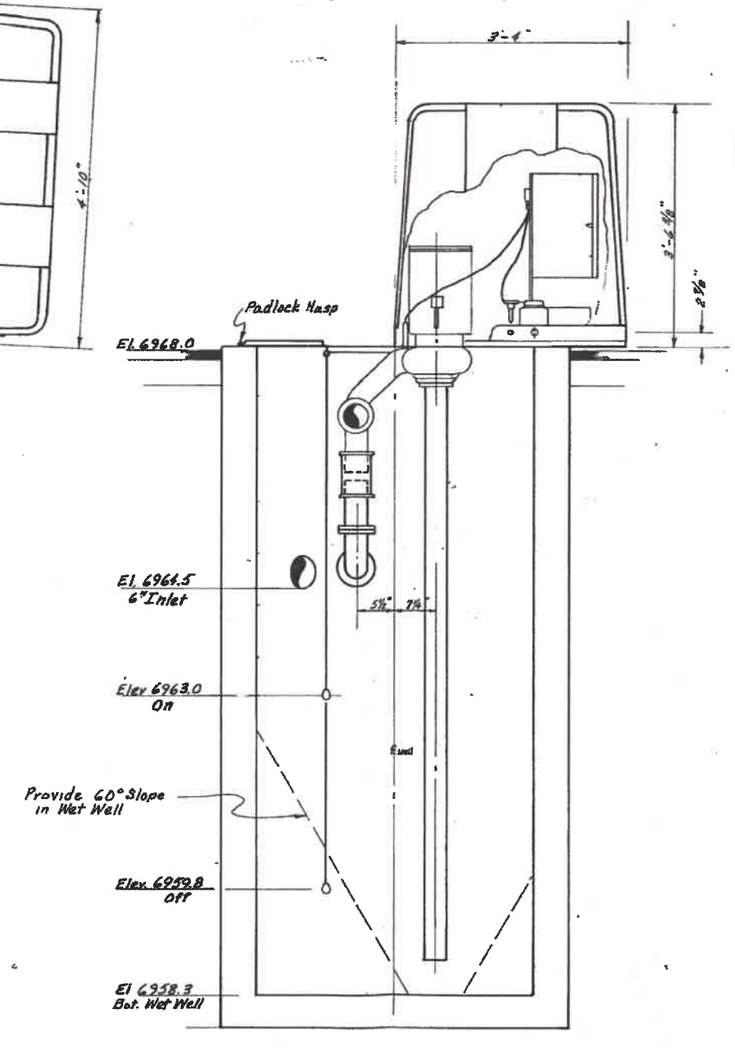
Job No. 1185 / 1737 | Sheet 1 of 2

SUB-8K POCKET

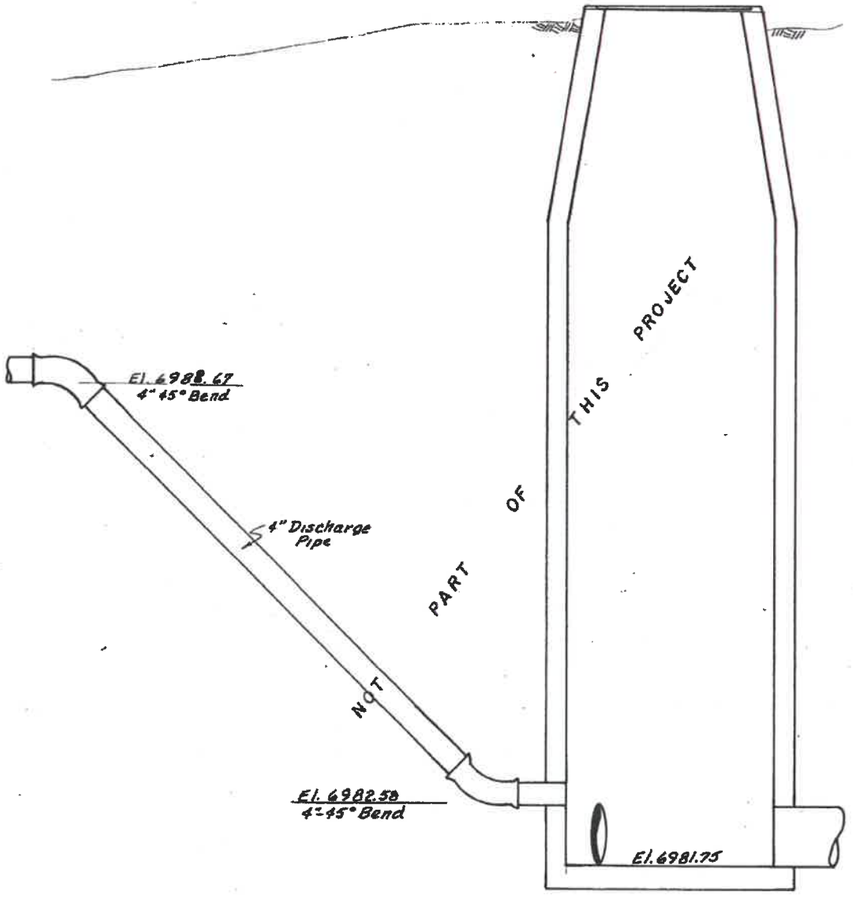


PLAN VIEW
MACH. CHAMBER
(Shown less cover)

SECTIONAL ELEVATION



CROSS SECTION



MANHOLE

779-5139

AS BUILT

Revised per City 8/11/82
6/10/82

DETAILS - Onsite Sewer

ROCKWELL CONSULTANTS
3006 N. 38th Street Phoenix, Arizona. 85018
(602) 957-1939

Job No. 1185/173 | Sheet 2 of 2