MEMORANDUM

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Successfully providing our clients and the community with quality planning, engineering and surveying services since 1980.

Date: January 16, 2020

To: Bob Finck

From: Marty L. Morlan, PE

Subject: 439874-1-22-01, St. Johns River to Sea Loop Trail Gap PD&E Study
Overview of Existing and Proposed Drainage Conditions
Additional Analysis/Review

Introduction

The Florida Department of Transportation (FDOT) is conducting a Project Development and Environment (PD&E) study to construct a multi-use trail from Lake Beresford Park to Grand Avenue in Volusia County. The purpose of this PD&E study is to evaluate engineering and environmental data and to document information that will aid Volusia County and FDOT District Five in determining the type, preliminary design and location of the proposed improvements. The project study area is shown in the figure below and totals approximately 3.6 square miles in size.

The project is located in WBID 2921D, Lake Woodruff Outlet and WBID 2893U1, Lake Beresford Drain and does not fall within any impaired water bodies or within the 100-year FEMA floodplain. The study area also falls within the jurisdiction of the St. Johns River Water Management District (SJRWMD). There are several existing permits within and adjacent to the alignments reviewed; however, none were found for the roadways being evaluated for the multi-use trail corridor.

Based on the evaluation of the alternatives, the Eastern Alignment Alternative is the Preferred Alternative and includes several typical sections, most of which include the addition of a 12' asphalt multi-use trail with 2' flat sod areas on both sides. Draft concept plans and typical sections (of which the drainage analysis is based on) are attached.

Existing Conditions
The study area consists of several road systems, mostly owned and operated by Volusia County. Typical sections of these roadways vary as does the existing right of way width. The intent of the project is to fit the trail within the existing right of way, where possible. For the Preferred Alternative alignment, the existing roadways do not have a substantial drainage conveyance ditch. Roadway drainage is mostly through overland flow along the side slopes of the roadway and percolates into the highly permeable soils adjacent to the roadway. In general, runoff drains from the east to the west to Lake Beresford and Lake Woodruff, and ultimately to the St. Johns River.

Field Review and Corridor Segmentation
An additional field review of the project corridor to further identify existing drainage patterns and features was performed on December 18, 2019. As a result of this field review, and a detailed review of the topographic GIS contours, the corridor has been divided into 10 segments. These segments represent the limits of high/low points along the Preferred trail corridor with each having their own outfalls. The segments are identified in the table below with their approximate limits which will need to be verified during final design based upon field survey.

Segment #	Adjacent Roadway	From	To
1	None	Lake Beresford Park	Alexander Drive
2	Alexander Drive	Railroad Access	Beresford Rd W
3	Beresford Rd W	Alexander Drive	S Beresford Rd
4	S Beresford Rd	Beresford Rd W	400 Feet S of Beresford Ave W
5	S Beresford Rd	400 Feet S of Beresford Ave W	Old New York Ave
6	Grand Ave	Old New York Ave	1300 Feet N of Old New York Ave
7	Grand Ave	1300 Feet N of Old New York Ave	New York Ave (SR 44)
8	Grand Ave	New York Ave (SR 44)	Wisconsin Ave
9	Grand Ave	Wisconsin Ave	Minnesota Ave
10	Minnesota Ave	Grand Ave	Grand Ave

Design Criteria
The intent of the multi-use trail project is to provide a safe passageway for pedestrians and bicyclists while minimizing impacts to utilities and adjacent properties. Based upon our preliminary analysis, the proposed improvements will not result in any significant adverse impacts to the drainage system. The design criteria for the trail is in accordance with the FDOT Florida Design Manual. Tie downs within the right of way are required so as to not block offsite runoff.

The project will adhere to SJRWMD criteria. The proposed project meets 62-330.051(10) for exemptions of construction for recreational trails for pedestrians and bicyclists. Therefore, formal treatment and attenuation calculations and compensation are not required. During final design, verification of the requirements will be required that the proposed improvements do not result in adverse drainage conditions along the roadway and adjacent properties.

Proposed Conditions
A 12-ft multi-use trail is proposed within the study area. A standalone stormwater management system and associated facilities are not anticipated to be required. The existing roadway does not have a formal drainage

system and there is no known history of flooding within the proposed construction limits. The project corridor is composed of gently sloping grades and highly permeable soils. It is expected that final design will allow for runoff to drain over the trail or through small cross drain pipes as needed to maintain the existing flow patterns. Small swales can be incorporated as feasible throughout the project limits. Swales placed between the proposed trail and parallel roadways will need some consideration of the combined runoff from the trail/roadway to be conveyed to historic discharge points. Since there are no defined existing swales along the roadways in current conditions, a determination of the final design criteria for the proposed conditions could impact the location, sizing and right-of-way requirements for the proposed conveyance features. The calculations and typical sections in this memorandum provide for a 10-year storm event for the combined runoff and do not impact any permitted facilities. The following are drainage recommendations and considerations for each segment of the corridor:

Segment 1 – Lake Beresford Park to Alexander Drive - The proposed trail will connect to the existing trail section within Lake Beresford Park and will run adjacent to the railroad within an existing easement. There is no defined existing drainage swale or feature along this segment which could be impacted. The overland flow is from east towards the west. There is an existing residence along the east side that is separated from the proposed trail corridor by a 60 ft existing right-of-way which provides driveway access. The recommended drainage design should consider the provision of incorporating small cross drains at low points along the trail to not obstruct the offsite flows should the trail design be elevated above existing grade. A small v-swale design (if required) could be considered in the design and placed along the east side of the trail within the easement.

Segment 2 – Railroad Access to Beresford Rd W -The proposed trail would be located along the east side of the existing gravel roadway. There is significant topographic relief to the east which has a residential property (see photo right) that has an existing dirt driveway which parallels Alexander Drive due to the 3-4 feet elevation difference between the east right-of-way and the roadway. It is recommended that consideration be given to reconstruct a portion of Alexander Drive both horizontally and vertically to allow a perpendicular driveway design to access Alexander Drive and to provide enough room/separation to allow the design of a drainage ditch/swale between the trail and the roadway. The ditch/swale design should also provide a drainage inlet and cross drain to convey the approximate 5 acres of drainage area from the east to the historic outfall low area on the west side of Alexander Drive. Another drainage consideration is the existing residence on the southwest corner of Alexander Drive/Beresford Rd W where the driveway slopes away from the roadway towards the residence garage (see photo left). The proposed ditch/swale located between the roadway and the trail at this driveway location should collect the roadway/trail runoff and convey it to the south and into a proposed cross drain

south of the residential property.

Segment 3 - **Alexander Drive to S Beresford Rd** - In this short segment of proposed trail, there is significant longitudinal grade (approximately 3-4%) along the existing roadway to convey the runoff from the roadway and proposed trail within the right-of-way along the roadway edge. To alleviate any potential erosion impacts along the northern shoulder, the recommended drainage design should consider the addition of a curb and gutter with a flume at the low point be placed adjacent to the roadway. There is an existing drainage outfall inlet located within the pavement (see photo left) on the corner at Beresford Rd W/S Beresford Rd. The inlet should be evaluated to determine if relocation or an additional inlet be added to improve drainage conditions. The use of a type F curb and gutter around the roadway return would provide a safer separation for trail users. This type of curb would also aid in keeping vehicles on the pavement through the return.

Segment 4 – **Beresford Rd W to 400 Feet S of Beresford Ave W**. This segment is the longest segment (approx. 3,200 ft.) from the low point to the high point along the corridor and has the largest offsite drainage (over 26 acres) flow from east towards the west and into S Beresford Rd right-of-way. A few large residential farms exist along the east side at a much higher elevation than the roadway. The offsite drainage flows during major storm events may overtop the existing roadway given there is no appreciable conveyance system along both sides of the roadway (see photo right looking North). There are two farms along the west side where the topography is lower than the roadway. Concept Plan S. Beresford Road Alternative 1 would place the trail along the west side. The recommended drainage design for this would include providing a trapezoidal swale (minimum 1 foot deep, 1:4 side slopes and a minimum 4 foot bottom width which would meet FDOT requirements for roadside recovery) located between the roadway and the trail to provide for the combined roadway and trail runoff. Some consideration for the provision/addition of a swale/ditch to handle the offsite drainage along the east side should be evaluated during final design. For the other Concept Plan S. Beresford Road alternatives (2 and portion of 3), which would place the trail along the east side, a similar trapezoidal swale would be placed on the east side between the roadway and the trail. The historic drainage outfall from this segment would require a drainage inlet (or mitered end section) and pipe to the railroad ditch.

Segment 5 - **400 Feet S of Beresford Ave W to Old New York Ave –** The existing roadway appears to run along a topographic ridge so the drainage runoff is limited to the roadway right-of-way. Similar to segment 4, there is no defined drainage conveyance feature along the roadsides. There are some larger residences/farms along the east side which are lower topographically than the roadway. In all three of the Concept Plan S. Beresford Road alternatives, the proposed trail would be placed along the west side and requires additional right-of-way. The recommended drainage design would provide a trapezoidal swale (same geometry as segment 4) between the proposed trail and the existing roadway. At the northern end, a side drain culvert will be necessary to convey the drainage under the trail to the railroad ditch adjacent to Old New York Ave.

Segment 6 - Old New York Ave to 1300 Feet N of Old New York Ave – The existing low point in the pavement at Old New York Ave/Grand Ave intersection appears to be the location where surface runoff, from the intersection and from Grand Ave to the north, collects and then flows south (overtopping Old New York Ave) into the railroad ditch outfall. Along Grand Ave, there is no existing drainage conveyance system. The recommended drainage design should include an inlet and cross drain at the intersection to improve the drainage conditions (see photo left which shows the low point on NW corner). The recommended drainage conveyance swale would place a trapezoidal section (same as segment 4) between the proposed trail and the roadway.

Segment 7 - 1300 Feet N of Old New York Ave to New York Ave (SR 44) – This segment appears to have an offsite drainage area (approximately 19 acres) along the west side of Grand Ave which flows towards the northeast and into the right-of-way. The historic outfall is into the New York Ave (SR 44) roadside swale drainage system. There are no driveways along this segment. Since the proposed trail would be located along the west side, the recommended drainage design would place a trapezoidal swale (same geometry as segments 4-6) in between the trail and the roadway. The offsite drainage should be accommodated for by allowing the flow to overtop the trail and into the trapezoidal ditch. A mitered end section and side drain culvert will be necessary to connect into the historic outfall at SR 44 (see photo above for the existing swale along the SW corner of SR 44/Grand Ave).

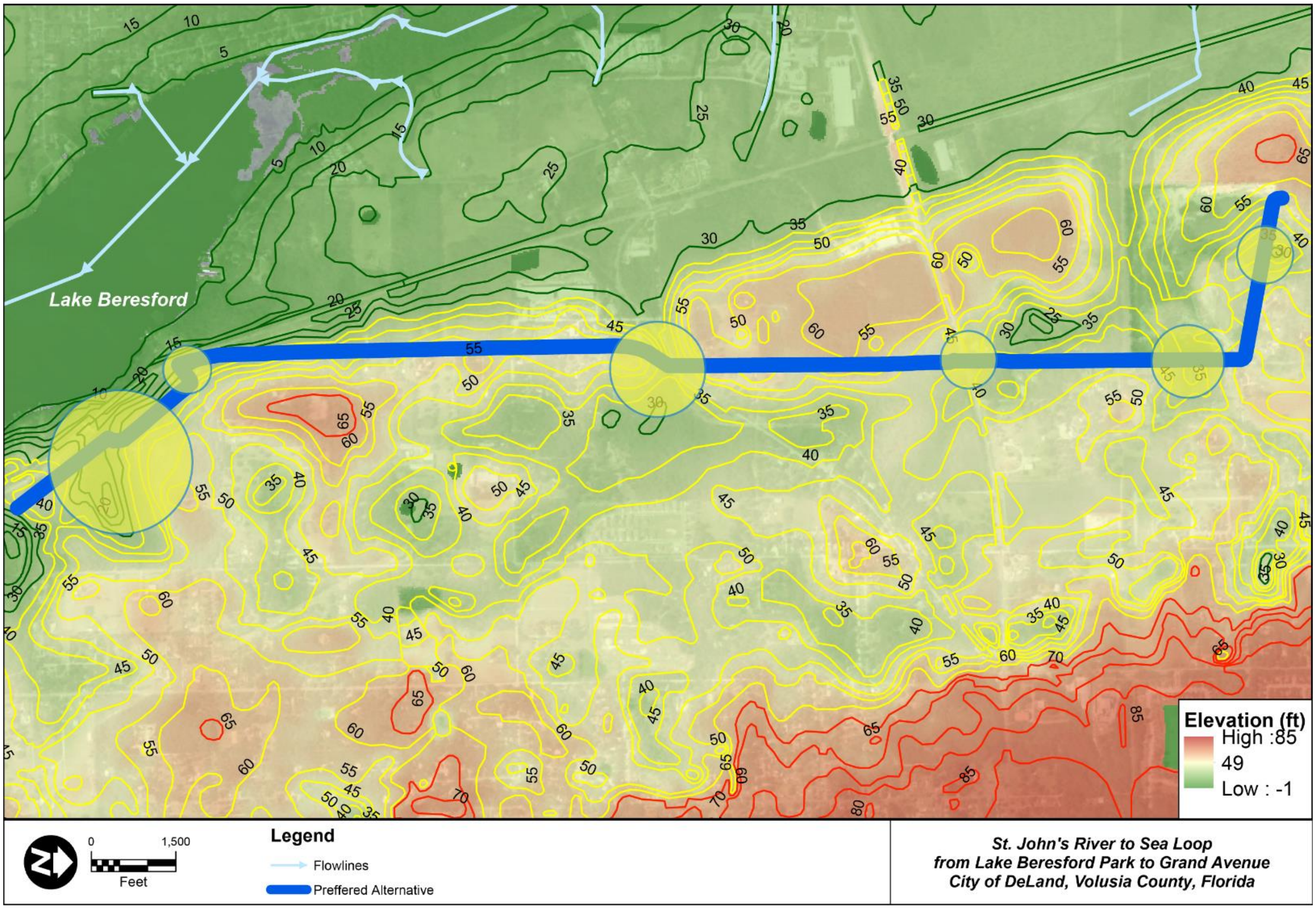
Segment 8 - New York Ave (SR 44) to Wisconsin Ave – This segment appears to drain to an existing isolated wetland located just west of Grand Ave and north of the BP gas station property. There is an offsite drainage area on the east side of Grand Ave which flows towards the west. It is assumed that there is a cross drain pipe near the roadway low point (approximately 400 feet north of SR 44) under Grand Ave (see photo to left) to connect this offsite drainage into the wetland system on the west. Since the proposed trail is to be located along the west side, the recommended drainage design would place a trapezoidal swale (same geometry as segments 4-7) between the trail and the roadway. It will be necessary to provide an inlet structure at the low point of the swale and provide either a new pipe to cross under the trail or connect to the existing cross drain. This would then outfall into the wetland system to the west.

Segment 9 and 10 - Wisconsin Ave to Minnesota Ave and from Grand Ave to Grand Ave – These two segments are located adjacent to the large debris disposal property owned by HTS Environmental Services, Inc. There is an existing embankment berm (approximately 3-4 feet high) located along the west side of Grand Ave and along the south side of Minnesota Ave just outside of the roadway shoulder area (see photo at right looking north along Grand Ave). The existing roadway runoff appears to be only the right-of-way area along the left side. The right side appears to drain to a low point depression outside of the roadway on private property located midway along each of the segments. The recommended drainage design is to utilize a concrete shoulder gutter placed at the outside of the shoulder area directly adjacent to the trail. This will provide for the conveyance of the trail/roadway drainage along the west side and will keep the impacts reduced to the existing embankment berm. It will be necessary to provide an inlet with cross-drain pipe at the low point to connect the drainage from the left side with the historic discharge locations on the right side.

Calculations

A review of the anticipated additional runoff based on the proposed 12' asphalt trail and adjacent roadway was estimated. Based on a ten-year storm event, per FDOT Drainage Manual Section 2.2, the potential flow from the impervious surfaces and roadway shoulder/swale was estimated. Using a trapezoidal swale (1:4 side slopes with 4 ft. wide bottom for roadside recovery) results in a swale depth of less than one foot (except for Segment 4 Concept Plan S. Beresford Road Alt. 2 and 3 with provision for offsite area – this requires a 1.13 foot depth) and a top width that varies from 9 feet to 12 feet. The swale would provide conveyance and could provide some retention if ditch blocks were introduced (not anticipated to be required since the project would likely be exempt from permitting). Similar calculations were done for an option for a v-shaped swale located between the trail and roadway (using 1:6 side slopes which meet roadside recovery requirements) and outside of the trail (using 1:4 side slopes). These swale shapes by calculations could result in slightly narrower ditch top widths (from 7 to 14 foot widths); however, these v-swales would likely require the use of additional back-side berms if located in fill sections or would require wider swale sections for driveway culverts/mitered end sections resulting in similar or greater widths than the trapezoidal design. The design of such a swale would be done at the final design stage of the project after the necessary additional data collection, including topographic survey, geotechnical investigation and determination of the appropriate and available locations for consideration, has been completed.

The flow patterns were analyzed based on the GIS contours. The low areas were reviewed more in-depth to verify potential for positive drainage outfall and to make sure the selected alternative would not incur a fatal flaw. These areas are identified with yellow circles in the following graphic.

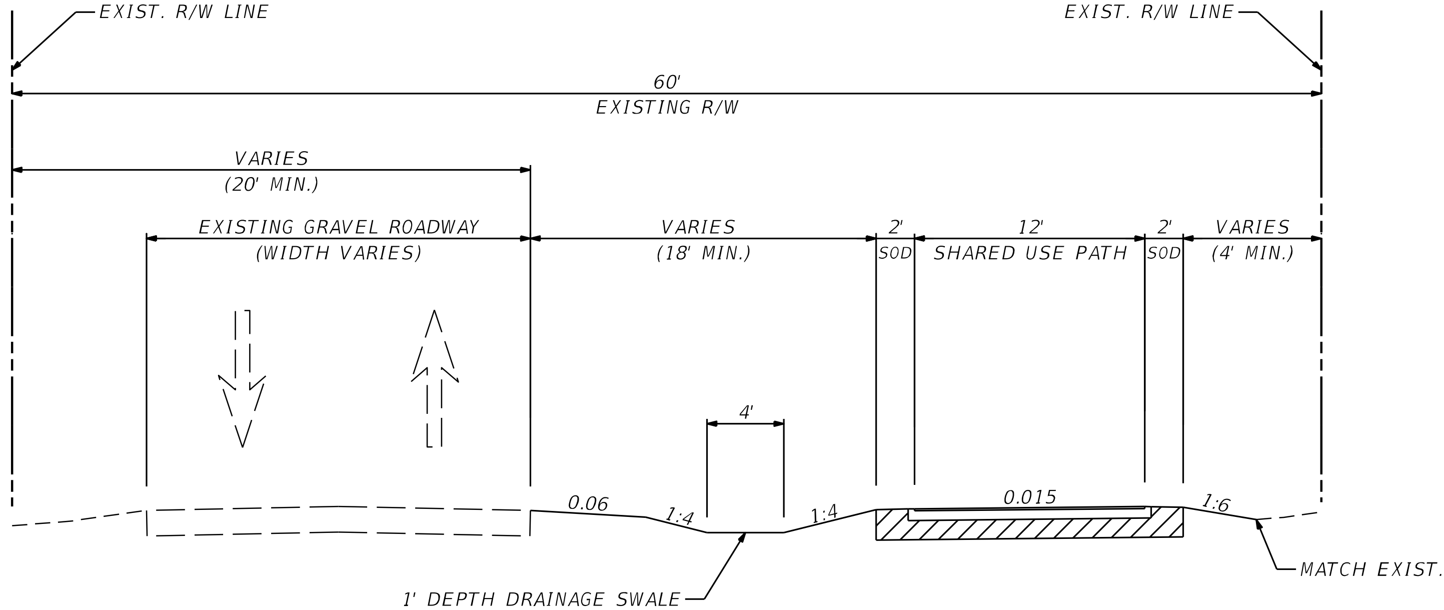


Final drainage analysis and drainage calculations will need to be assessed during final design following the topographic data collection to make sure there are no adverse impacts to on-site or off-site flow patterns. The final ditch/swale sizing will also be accomplished during development of the cross sections and trail profiles during final design.

APPENDIX

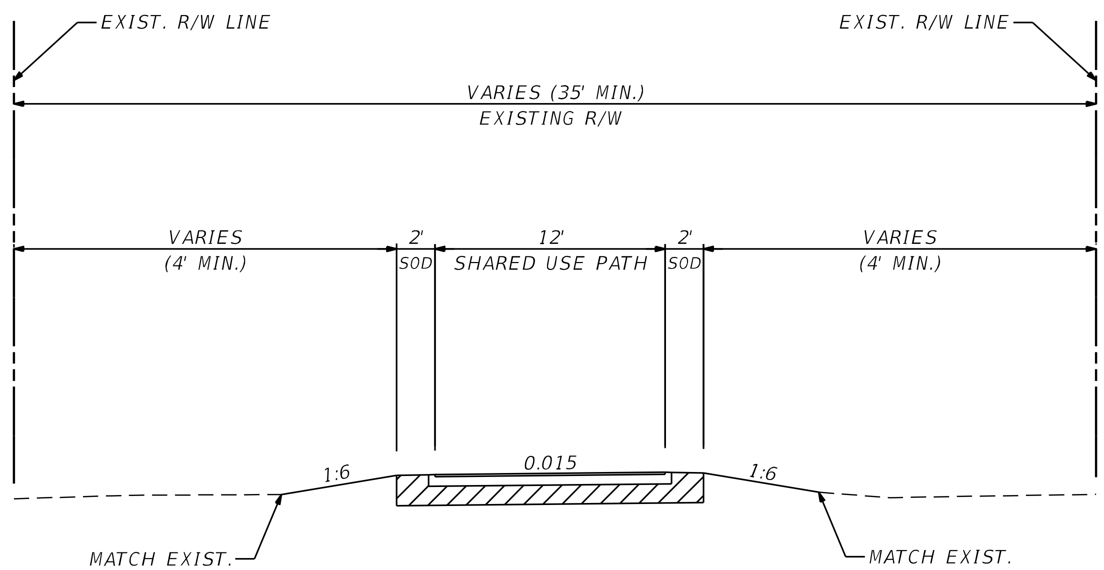
PRELIMINARY DRAINAGE ANALYSIS

CALCULATIONS AND MAP



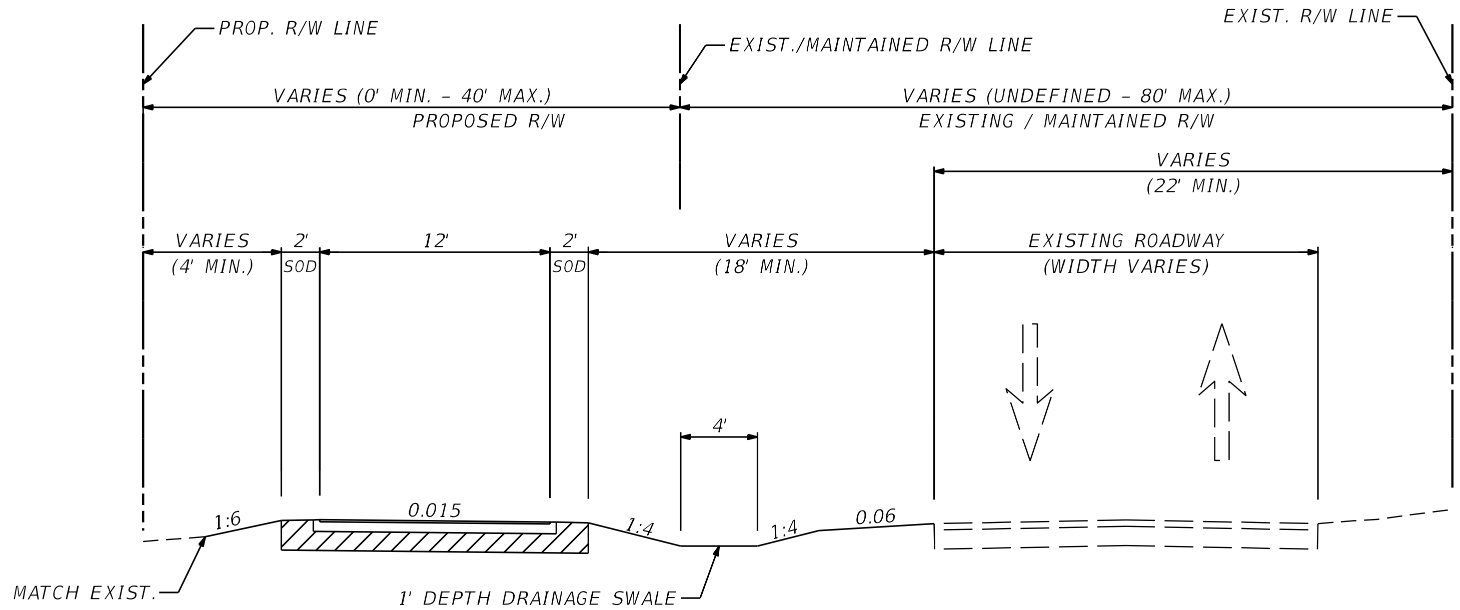
TYPICAL SECTION 2
FROM ALEXANDER DRIVE TO S BERESFORD ROAD
POSTED SPEED LIMIT: 25 MPH

Preliminary
01/16/2020 3:30:00 PM



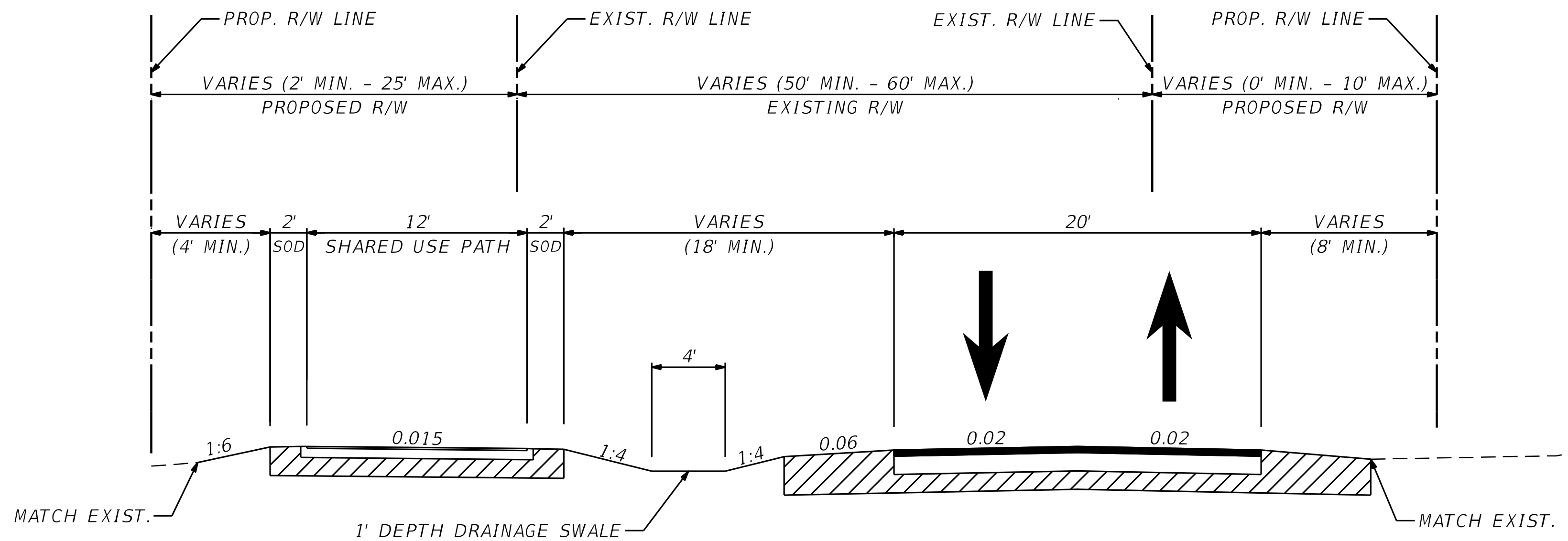
TYPICAL SECTION 1
FROM LAKE BERESFORD PARK TO ALEXANDER DRIVE
POSTED SPEED LIMIT: N/A

AIM ENGINEERING & SURVEYING 3802 CORPOREX PARK DRIVE SUITE 225 TAMPA, FL 33619	STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION		ST. JOHNS RIVER TO SEA LOOP TRAIL GAP PD&E STUDY TYPICAL SECTIONS	SHEET NO.
	ROAD NO.	COUNTY	FINANCIAL PROJECT ID	
	N/A	VOLUSIA	439874-1-22-01	2



TYPICAL SECTION 4
FROM BERESFORD AVENUE W TO OLD NEW YORK AVENUE
AND
FROM NEW YORK AVENUE (SR 44) TO W WISCONSIN AVENUE
POSTED SPEED LIMIT: 35 MPH

Preliminary
01/16/2020 3:30:21 PM



TYPICAL SECTION 3
FROM BERESFORD ROAD W TO BERESFORD AVENUE W
AND
FROM OLD NEW YORK AVENUE TO NEW YORK AVENUE (SR 44)
POSTED SPEED LIMIT: 30-35 MPH

AIM ENGINEERING & SURVEYING
3802 CORPOREX PARK DRIVE
SUITE 225
TAMPA, FL 33619

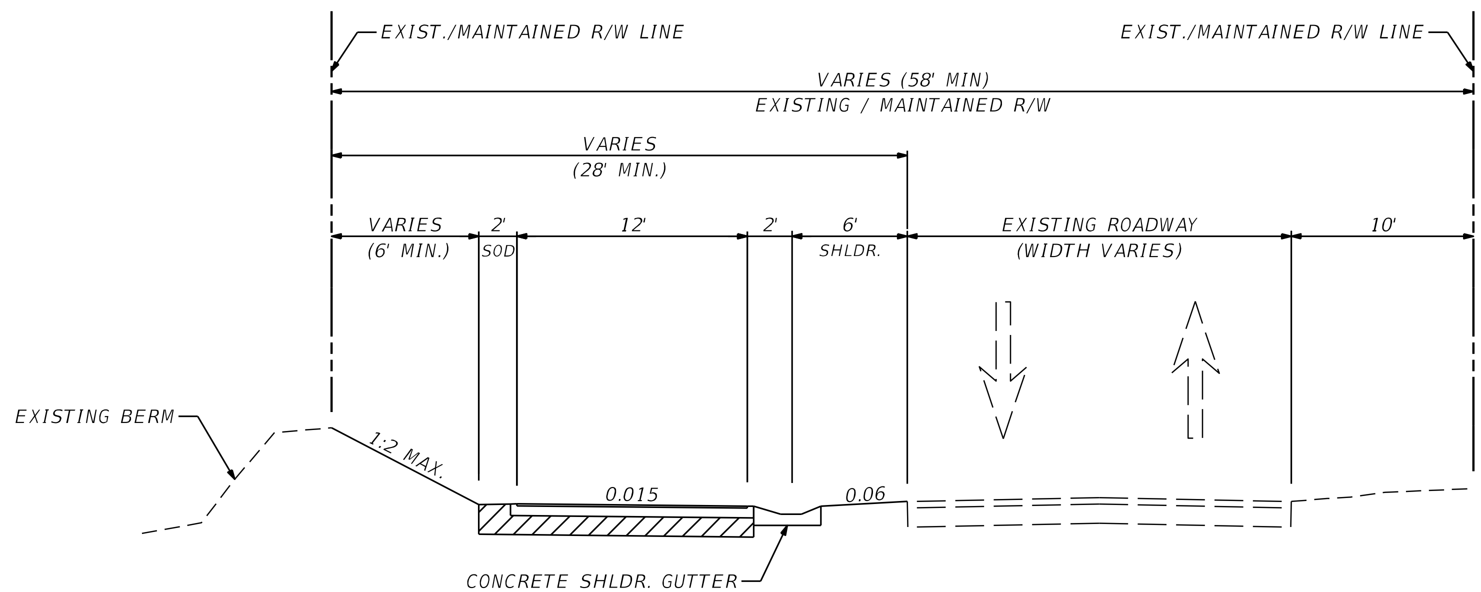
STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
N/A	VOLUSIA	439874-1-22-01

ST. JOHNS RIVER TO SEA LOOP
TRAIL GAP PD&E STUDY

TYPICAL SECTIONS

jmendoza 1/16/2020 3:16:56 PM T:\PROJECTS\D5 PD&E Continuing Services\SJR to Sea Loop Trail 439874-1\01 Engineering\CADD\TYPSEM03.DGN

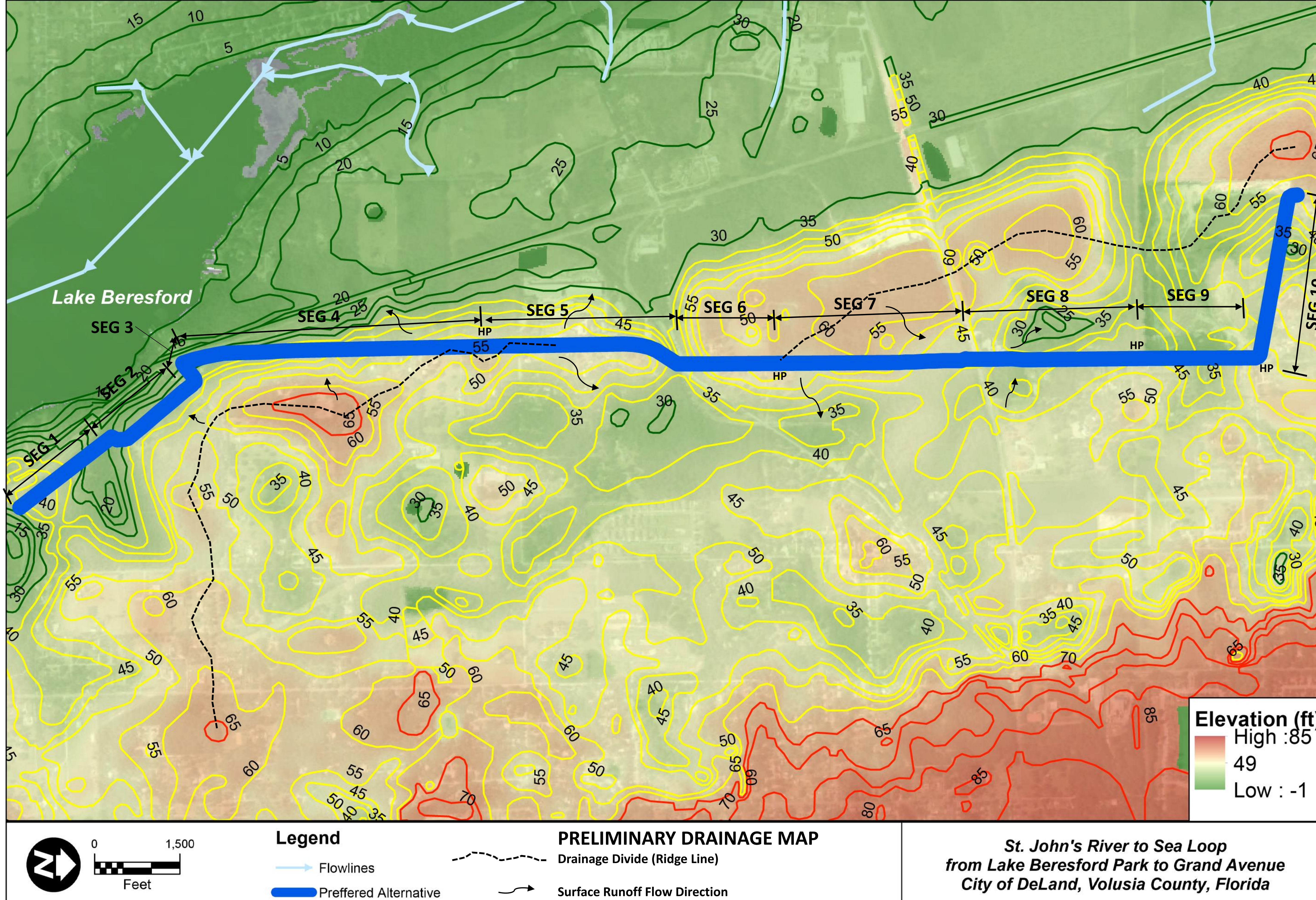


TYPICAL SECTION 5
FROM W WISCONSIN AVENUE TO GRAND AVENUE
POSTED SPEED LIMIT: 35 MPH

Preliminary
01/16/2020 3:30:41 PM

T:\PROJECTS\D5 PD&E Continuing Services\SJR to Sea Loop Trail 439874-1\01 Engineering\CADD\TYPSEM03.DGN 3:16:56 PM 1/16/2020 bmendoza

AIM ENGINEERING & SURVEYING 3802 CORPOREX PARK DRIVE SUITE 225 TAMPA, FL 33619	STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION			ST. JOHNS RIVER TO SEA LOOP TRAIL GAP PD&E STUDY	SHEET NO.
	ROAD NO.	COUNTY	FINANCIAL PROJECT ID		
	N/A	VOLUSIA	439874-1-22-01	TYPICAL SECTIONS	4


Lake Beresford
SEG 1
SEG 2
SEG 3
SEG 4
SEG 5
SEG 6
SEG 7
SEG 8
SEG 9
SEG 10
HP
Elevation (ft)
High :85
49
Low : -1
0
1,500
Feet
Legend
Flowlines
Preffered Alternative
PRELIMINARY DRAINAGE MAP
Drainage Divide (Ridge Line)
Surface Runoff Flow Direction
St. John's River to Sea Loop
from Lake Beresford Park to Grand Avenue
City of DeLand, Volusia County, Florida

FLORIDA DEPARTMENT OF TRANSPORTATION

HYDRAULIC WORKSHEET FOR ROADSIDE DITCHES

Road: **SJR2C Sea Loop Trail PD&E**

Project No.: **43987412201**

Path & Name: T:\PROJECTS\D5 PD&E Continuing Services\SJR to Sea Loop Trail 439874-1\01 Engineering\Drainage\[Ditch Worksheet.xls]Channel Sections

	Segment	Limits	Length (ft)	SIDE	% Slope	Drainage Area (Ac.)	"C"	Tc (min.)	I (in/hr)	Q (cfs)	F.S.		B.W. (ft)	B.S.		"n"	Input normal depth "d" (ft)	Ditch Flow Area A (ft^2)	Ditch Wetted Perimeter P (ft)	Hydraulic Radius R (ft)	Calculated Ditch Flow Q (cfs)	Ditch Velocity (ft/s)	Ditch Lining	Design Storm	Ditch/Swale Top Width (ft)	Remarks
TRAPEZOIDAL SWALE BETWEEN TRAIL & ROAD	2	Alexander Dr	1200	Rt	0.1%	4.86	0.20	36	4.25	**4.1**	4	:1	4	4	:1	0.06	**0.94**	7.2944	11.75144	0.620724	**4.2**	**0.6**	Sod	10	12	Roadside Ditch (between gravel rd and prop 12 ft trail)
	4 - Alt 1	Beresford Rd W to HP approx 3000 ft N	3000	Lt	1.0%	3.10	0.65	39	4.07	**8.2**	4	:1	4	4	:1	0.06	**0.75**	5.25	10.18466	0.515481	**8.4**	**1.6**	Sod	10	10	Roadside Ditch (between roadway and prop. 12ft trail)
	4 - Alt 2 & 3	Beresford Rd W to HP approx 3000 ft N	3000	Rt	1.0%	26.50	0.2	48	3.63	**19.2**	4	:1	4	4	:1	0.06	**1.13**	9.6276	13.31822	0.722889	**19.2**	**2.0**	Sod	10	14	Roadside Ditch (between roadway and prop. 12ft trail)
	5	3000 ft N of Beresford Rd W to Old New York Ave	2300	Lt or Rt	0.8%	2.32	0.6	26	4.99	**7.0**	4	:1	4	4	:1	0.06	**0.73**	5.0516	10.01973	0.504165	**7.1**	**1.4**	Sod	10	10	Roadside Ditch (between roadway and prop. 12ft trail)
	6	Old NY Ave to 1400 ft N	1400	Lt	1.0%	1.51	0.6	12	6.73	**6.1**	4	:1	4	4	:1	0.06	**0.64**	4.1984	9.277575	0.452532	**6.1**	**1.5**	Sod	10	10	Roadside Ditch (between roadway and prop. 12ft trail)
	7	1400 ft N of Old NY Ave to NY Ave (SR44)	1900	Lt	0.9%	19.00	0.2	83	2.59	**9.8**	4	:1	4	4	:1	0.06	**0.84**	6.1824	10.92682	0.565801	**9.9**	**1.6**	Sod	10	11	Roadside Ditch (between roadway and prop. 12ft trail)
	8	NY Ave (SR 44) to W Wisconsin Ave	1700	Lt	0.8%	1.83	0.6	19	5.72	**6.3**	4	:1	4	4	:1	0.06	**0.70**	4.76	9.772348	0.487089	**6.5**	**1.4**	Sod	10	10	Roadside Ditch (between roadway and prop. 12ft trail)
	9	W Wisconsin Ave to Minnesota Ave	1300	Lt	1.3%	1.40	0.6	10	7.09	**6.0**	4	:1	4	4	:1	0.06	**0.60**	3.84	8.947727	0.429159	**6.2**	**1.6**	Sod	10	9	Roadside Ditch (between roadway and prop. 12ft trail)
	10	Minnesota Ave to Grand Ave	1900	Lt	1.2%	2.05	0.6	16	6.11	**7.5**	4	:1	4	4	:1	0.06	**0.68**	4.5696	9.607424	0.475632	**7.6**	**1.7**	Sod	10	10	Roadside Ditch (between roadway and prop. 12ft trail)
V-SHAPE SWALE OUTSIDE OF TRAIL	2	Alexander Dr	1200	Rt	0.1%	1.05	0.63	13	6.56	**4.4**	4	:1	0	4	:1	0.06	**1.36**	7.3984	11.21485	0.659697	**4.4**	**0.6**	Sod	10	11	Alternative - Roadside Swale (sized for Trail runoff+1/2roadway)
	4	Beresford Rd W to HP approx 3000 ft N	3000	Lt	1.0%	2.62	0.63	33	4.45	**7.4**	4	:1	0	4	:1	0.06	**1.08**	4.6656	8.905908	0.523877	**7.5**	**1.6**	Sod	10	9	Alternative - Roadside Swale (sized for Trail runoff+1/2roadway)
	5	3000 ft N of Beresford Rd W to Old New York Ave	2300	Lt or Rt	0.8%	2.01	0.63	26	4.99	**6.4**	4	:1	0	4	:1	0.06	**1.06**	4.4944	8.740984	0.514176	**6.4**	**1.4**	Sod	10	9	Alternative - Roadside Swale (sized for Trail runoff+1/2roadway)
	6	Old NY Ave to 1400 ft N	1400	Lt	1.0%	1.22	0.63	15	6.25	**4.8**	4	:1	0	4	:1	0.06	**0.92**	3.3856	7.586514	0.446266	**4.9**	**1.4**	Sod	10	8	Alternative - Roadside Swale (sized for Trail runoff+1/2roadway)
	7	1400 ft N of Old NY Ave to NY Ave (SR44)	1900	Lt	0.9%	1.66	0.63	21	5.49	**5.8**	4	:1	0	4	:1	0.06	**1.00**	4	8.246211	0.485071	**5.8**	**1.5**	Sod	10	8	Alternative - Roadside Swale (sized for Trail runoff+1/2roadway)
	8	NY Ave (SR 44) to W Wisconsin Ave	1700	Lt	0.8%	1.48	0.63	18	5.84	**5.5**	4	:1	0	4	:1	0.06	**1.00**	4	8.246211	0.485071	**5.5**	**1.4**	Sod	10	8	Alternative - Roadside Swale (sized for Trail runoff+1/2roadway)
	9	W Wisconsin Ave to Minnesota Ave	1300	Lt	1.3%	1.13	0.63	14	6.40	**4.6**	4	:1	0	4	:1	0.06	**0.86**	2.9584	7.091742	0.417161	**4.7**	**1.6**	Sod	10	7	Alternative - Roadside Swale (sized for Trail runoff+1/2roadway)
	10	Minnesota Ave to Grand Ave	1900	Lt	1.2%	1.66	0.63	21	5.49	**5.8**	4	:1	0	4	:1	0.06	**0.95**	3.61	7.833901	0.460818	**5.8**	**1.6**	Sod	10	8	Alternative - Roadside Swale (sized for Trail runoff+1/2roadway)
VALE BETWEEN TRAIL & ROAD	2	Alexander Dr	1200	Rt	0.1%	1.05	0.63	13	6.56	**4.4**	6	:1	0	6	:1	0.06	**1.16**	8.0736	14.11201	0.572108	**4.4**	**0.5**	Sod	10	14	Alternative - Roadside Swale (sized for Trail runoff+1/2roadway) 1:6 Max sideslopes
	4	Beresford Rd W to HP approx 3000 ft N	3000	Lt	1.0%	2.62	0.63	33	4.45	**7.4**	6	:1	0	6	:1	0.06	**0.92**	5.0784	11.19228	0.453741	**7.4**	**1.5**	Sod	10	12	Alternative - Roadside Swale (sized for Trail runoff+1/2roadway) 1:6 Max sideslopes
	5	3000 ft N of Beresford Rd W to Old New York Ave	2300	Lt or Rt	0.8%	2.01	0.63	26	4.99	**6.4**	6	:1	0	6	:1	0.06	**0.91**	4.9686	11.07063	0.448809	**6.5**	**1.3**	Sod	10	11	Alternative - Roadside Swale (sized for Trail runoff+1/2roadway) 1:6 Max sideslopes
	6	Old NY Ave to 1400 ft N	1400	Lt	1.0%	1.22	0.63	15	6.25	**4.8**	6	:1	0	6	:1	0.06	**0.79**	3.7446	9.610765	0.389626	**4.9**	**1.3**	Sod	10	10	Alternative - Roadside Swale (sized for Trail runoff+1/2roadway) 1:6 Max sideslopes
	7	1400 ft N of Old NY Ave to NY Ave (SR44)	1900	Lt	0.9%	1.66	0.63	21	5.49	**5.8**	6	:1	0	6	:1	0.06	**0.86**	4.4376	10.46235	0.424149	**5.9**	**1.3**	Sod	10	11	Alternative - Roadside Swale (sized for Trail runoff+1/2roadway) 1:6 Max sideslopes

FLORIDA DEPARTMENT OF TRANSPORTATION

HYDRAULIC WORKSHEET FOR ROADSIDE DITCHES

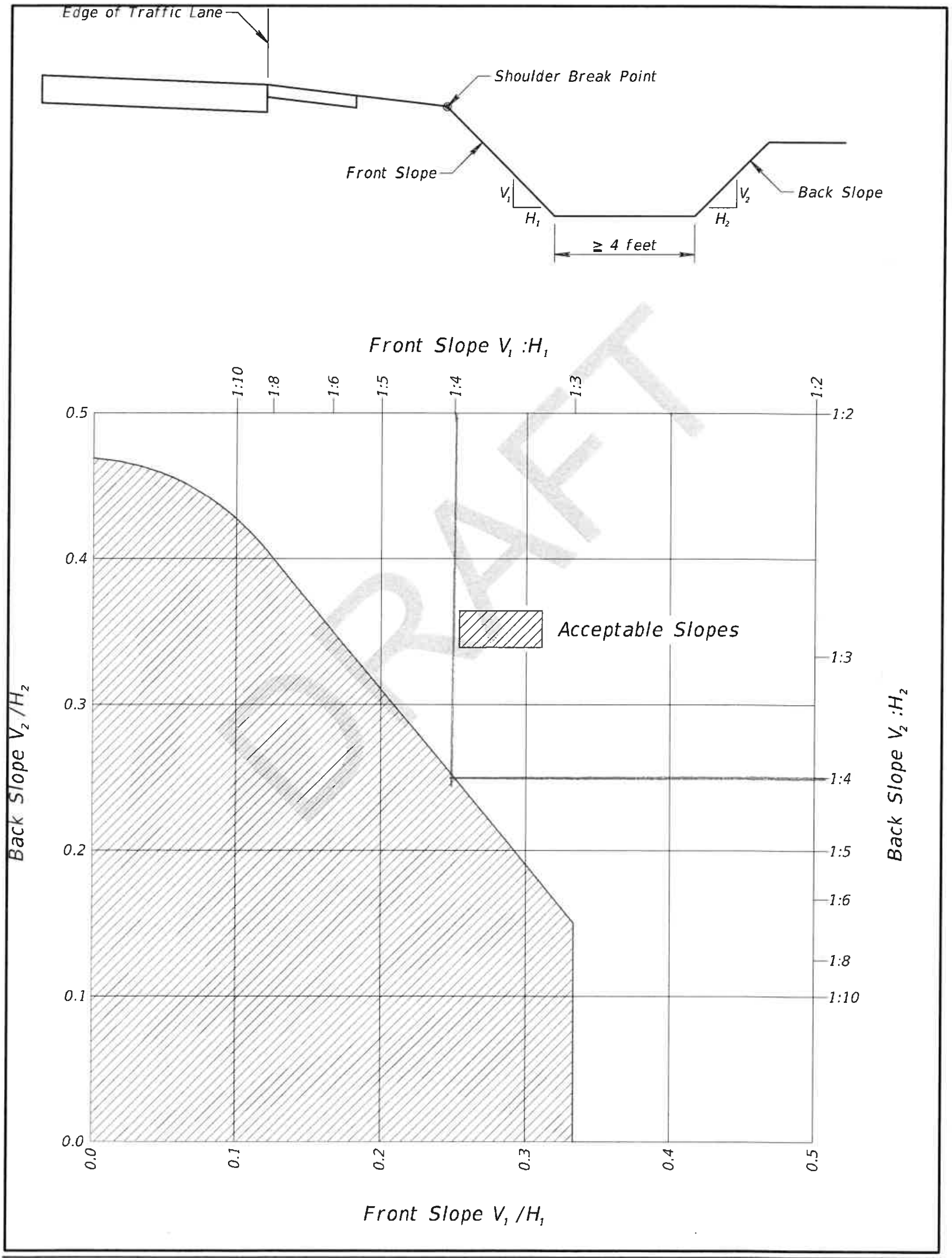
Road: **SJR2C Sea Loop Trail PD&E**

Project No.: **43987412201**

Path & Name: T:\PROJECTS\D5 PD&E Continuing Services\SJR to Sea Loop Trail 439874-1\01 Engineering\Drainage\[Ditch Worksheet.xls]Channel Sections

	Segment	Limits	Length (ft)	SIDE	% Slope	Drainage Area (Ac.)	"C"	Tc (min.)	I (in/hr)	Q (cfs)	F.S.		B.W. (ft)	B.S.		"n"	Input normal depth "d" (ft)	Ditch Flow Area A (ft^2)	Ditch Wetted Perimeter P (ft)	Hydraulic Radius R (ft)	Calculated Ditch Flow Q (cfs)	Ditch Velocity (ft/s)	Ditch Lining	Design Storm	Ditch/Swale Top Width (ft)	Remarks
V-SHAPE SW	8	NY Ave (SR 44) to W Wisconsin Ave	1700	Lt	0.8%	1.48	0.63	18	5.84	**5.5**	6	:1	0	6	:1	0.06	**0.86**	4.4376	10.46235	0.424149	**5.5**	**1.3**	Sod	10	11	Alternative - Roadside Swale (sized for Trail runoff+1/2roadway) 1:6 Max sideslopes
	9	W Wisconsin Ave to Minnesota Ave	1300	Lt	1.3%	1.13	0.63	14	6.40	**4.6**	6	:1	0	6	:1	0.06	**0.73**	3.1974	8.880833	0.360034	**4.6**	**1.4**	Sod	10	9	Alternative - Roadside Swale (sized for Trail runoff+1/2roadway) 1:6 Max sideslopes
	10	Minnesota Ave to Grand Ave	1900	Lt	1.2%	1.66	0.63	21	5.49	**5.8**	6	:1	0	6	:1	0.06	**0.81**	3.9366	9.854075	0.39949	**5.8**	**1.5**	Sod	10	10	Alternative - Roadside Swale (sized for Trail runoff+1/2roadway) 1:6 Max sideslopes

Figure 4 – 5 Roadside Ditches – Bottom Width ≥ 4 Feet



Source: Figure 3 – 6, 2011 AASHTO Roadside Design Guide.

Project:	SJR2C Sea Loop Trail	By: MLM	Date:	12/30/2019
Location:	Volusia	Checked:	Date:	

Time of Concentration (Tc) or Travel Time (Tt)

BASIN NAME: **Seg 2** **EX. & PROP.**

Present Developed **Tc** Tt through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segment.

Sheet flow (Applicable to Tc only)

	Segment ID	AB	BC	
1. Surface description		Grass, D	Cultivated1	
2. Manning's roughness coefficient, n (table 3-1)		0.24	0.06	
3. Flow length, L (total L<= 300 ft)	ft	300	1	
4. Two-Year 24-hour rainfall, P	in	4.5	4.5	
5. Land slope, S	ft/ft	0.0167	1.0000	
6. Tt = [(0.007)(nL)^0.8] / [(P^0.5)(s^0.4)]	Compute Tt.......hr	0.520	0.000	0.520

Shallow Concentrated Flow

	Segment ID	CD	DE	
7. Surface description (paved or unpaved)		UNPAVED	Paved	
8. Flow length, L	ft	669	1	
9. Watercourse slope, s	ft/ft	0.0224	18.8000	
10. Average velocity, V	ft/s	2.416	88.141	
11. Tt = L / 3600 V	Compute Tt.......hr	0.077	0.000	0.077

Channel Flow

	Segment ID	EF	FG	
12. Cross sectional flow area, a	ft2	6	28	
13. Wetted perimeter, p_w	ft	12.17	23.49	
14. Hydraulic radius, r = a / p_w	ft	0.49	1.19	
15. Channel slope , s	ft/ft	28.000	3.500	
16. Manning's roughness coefficient, n		0.03	0.1	
17. V = [1.49 $r^{2/3}$ $s^{1/2}$] / n	Compute V.......hr	164.06	31.34	
18. Flow length, L	ft	1	1	
19. Tt = L / 3600 V	Compute Tt.......hr	0.000	0.000	0.000

Pipe Flow

	Segment ID	GH	HI	
20. Pipe diameter, D	in	1	1	
21. Pipe slop[e, s	ft/ft	17.000	1.000	
22. Manning's roughness coefficient, n		0.012	0.012	
23. V = [1.49 $r^{2/3}$ $s^{1/2}$] / n	Compute V.......hr	38.76	9.40	
24. Flow length, L	ft	1	1	
25. Tt = L / 3600 V	Compute Tt.......hr	0.000	0.000	0.000

Total Time of Concentration

26. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, 19 and 25)	Hr	0.597
	Min	35.81
T:\PROJECTS\D5 PD&E Continuing Services\SJR to Sea Loop Trail 439874-1\01 Engineering\Drainage\[	**USE TC =**	**36**

Project:	SJR2C Sea Loop Trail	By: MLM	Date: 12/30/2019
Location:	Volusia	Checked:	Date:

Time of Concentration (Tc) or Travel Time (Tt)

BASIN NAME: **Seg 4 (Lt)**

Present Developed **Tc** Tt through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segment.

Sheet flow (Applicable to Tc only)

	Segment ID	AB	BC	
1. Surface description		Grass, D	Cultivated1	
2. Manning's roughness coefficient, n (table 3-1)		0.24	0.06	
3. Flow length, L (total L<= 300 ft)	ft	10	1	
4. Two-Year 24-hour rainfall, P	in	4.5	4.5	
5. Land slope, S	ft/ft	0.5000	1.0000	
6. Tt = [(0.007)(nL)^0.8] / [(P^0.5)(s^0.4)]	Compute Tt.......hr	0.009	0.000	0.009

Shallow Concentrated Flow

	Segment ID	CD	DE	
7. Surface description (paved or unpaved)		Unpaved	Paved	
8. Flow length, L	ft	3000	1	
9. Watercourse slope, s	ft/ft	0.0067	18.8000	
10. Average velocity, V	ft/s	1.317	88.141	
11. Tt = L / 3600 V	Compute Tt.......hr	0.633	0.000	0.633

Channel Flow

	Segment ID	EF	FG	
12. Cross sectional flow area, a	ft2	6	28	
13. Wetted perimeter, p_w	ft	12.17	23.49	
14. Hydraulic radius, r = a / p_w	ft	0.49	1.19	
15. Channel slope , s	ft/ft	28.000	3.500	
16. Manning's roughness coefficient, n		0.03	0.1	
17. V = [1.49 $r^{2/3}$ $s^{1/2}$] / n	Compute V.......hr	164.06	31.34	
18. Flow length, L	ft	1	1	
19. Tt = L / 3600 V	Compute Tt.......hr	0.000	0.000	0.000

Pipe Flow

	Segment ID	GH	HI	
20. Pipe diameter, D	in	1	1	
21. Pipe slop[e, s	ft	17.000	1.000	
22. Manning's roughness coefficient, n		0.012	0.012	
23. V = [1.49 $r^{2/3}$ $s^{1/2}$] / n	Compute V.......hr	38.76	9.40	
24. Flow length, L	ft	1	1	
25. Tt = L / 3600 V	Compute Tt.......hr	0.000	0.000	0.000

Total Time of Concentration

26. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, 19 and 25)	Hr	0.642
	Min	38.50
	USE TC =	**39**

Project:	SJR2C Sea Loop Trail	By: MLM	Date:	12/30/2019
Location:	Volusia	Checked:	Date:	

Time of Concentration (Tc) or Travel Time (Tt)

BASIN NAME: **Seg 4 (Rt)**

Present Developed **Tc** Tt through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segment.

Sheet flow (Applicable to Tc only)

	Seqment ID	AB	BC	
1. Surface description		Grass, D	Cultivated1	
2. Manning's roughness coefficient, n (table 3-1)		0.24	0.06	
3. Flow length, L (total L<= 300 ft)	ft	300	1	
4. Two-Year 24-hour rainfall, P	in	4.5	4.5	
5. Land slope, S	ft/ft	0.0167	1.0000	
6. Tt = [(0.007)(nL)^0.8] / [(P^0.5)(s^0.4)]	Compute Tt.......hr	0.520	0.000	0.520

Shallow Concentrated Flow

	Seqment ID	CD	DE	
7. Surface description (paved or unpaved)		Unpaved	Paved	
8. Flow length, L	ft	1400	1	
9. Watercourse slope, s	ft/ft	0.0071	18.8000	
10. Average velocity, V	ft/s	1.364	88.141	
11. Tt = L / 3600 V	Compute Tt.......hr	0.285	0.000	0.285

Channel Flow

	Seqment ID	EF	FG	
12. Cross sectional flow area, a	ft2	6	28	
13. Wetted perimeter, p_w	ft	12.17	23.49	
14. Hydraulic radius, $r = a / p_w$	ft	0.49	1.19	
15. Channel slope , s	ft/ft	28.000	3.500	
16. Manning's roughness coefficient, n		0.03	0.1	
17. $V = [1.49 r^{2/3} s^{1/2}] / n$	Compute V.......hr	164.06	31.34	
18. Flow length, L	ft	1	1	
19. Tt = L / 3600 V	Compute Tt.......hr	0.000	0.000	0.000

Pipe Flow

	Seqment ID	GH	HI	
20. Pipe diameter, D	in	1	1	
21. Pipe slop[e, s	ft	17.000	1.000	
22. Manning's roughness coefficient, n		0.012	0.012	
23. $V = [1.49 r^{2/3} s^{1/2}] / n$	Compute V.......hr	38.76	9.40	
24. Flow length, L	ft	1	1	
25. Tt = L / 3600 V	Compute Tt.......hr	0.000	0.000	0.000

Total Time of Concentration

26. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, 19 and 25)	Hr	0.805
	Min	48.31
	USE TC =	**48**

Project:	SJR2C Sea Loop Trail	By: MLM	Date:	12/30/2019
Location:	Volusia	Checked:	Date:	

Time of Concentration (Tc) or Travel Time (Tt)

BASIN NAME: **Segment 5**

Present Developed **Tc** Tt through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segment.

Sheet flow (Applicable to Tc only)

	Segment ID	AB	BC	
1. Surface description		Grass, D	Cultivated1	
2. Manning's roughness coefficient, n (table 3-1)		0.24	0.06	
3. Flow length, L (total L<= 300 ft)	ft	1	1	
4. Two-Year 24-hour rainfall, P	in	4.5	4.5	
5. Land slope, S	ft/ft	5.0000	1.0000	
6. Tt = [(0.007)(nL)^0.8] / [(P^0.5)(s^0.4)]	Compute Tt…….hr	0.001	0.000	0.001

Shallow Concentrated Flow

	Segment ID	CD	DE	
7. Surface description (paved or unpaved)		Unpaved	Paved	
8. Flow length, L	ft	2300	1	
9. Watercourse slope, s	ft/ft	0.0087	18.8000	
10. Average velocity, V	ft/s	1.505	88.141	
11. Tt = L / 3600 V	Compute Tt…….hr	0.425	0.000	0.425

Channel Flow

	Segment ID	EF	FG	
12. Cross sectional flow area, a	ft2	6	28	
13. Wetted perimeter, p_w	ft	12.17	23.49	
14. Hydraulic radius, $r = a / p_w$	ft	0.49	1.19	
15. Channel slope , s	ft/ft	28.000	3.500	
16. Manning's roughness coefficient, n		0.03	0.1	
17. $V = [1.49\ r^{2/3}\ s^{1/2}] / n$	Compute V…….hr	164.06	31.34	
18. Flow length, L	ft	1	1	
19. Tt = L / 3600 V	Compute Tt…….hr	0.000	0.000	0.000

Pipe Flow

	Segment ID	GH	HI	
20. Pipe diameter, D	in	1	1	
21. Pipe slop[e, s	ft	17.000	1.000	
22. Manning's roughness coefficient, n		0.012	0.012	
23. $V = [1.49\ r^{2/3}\ s^{1/2}] / n$	Compute V…….hr	38.76	9.40	
24. Flow length, L	ft	1	1	
25. Tt = L / 3600 V	Compute Tt…….hr	0.000	0.000	0.000

Total Time of Concentration

26. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, 19 and 25)	Hr	0.426
	Min	25.54
	USE TC =	**26**

Project: SJR2C Sea Loop Trail By: MLM Date: 12/30/2019
Location: Volusia Checked: Date:

Time of Concentration (Tc) or Travel Time (Tt)

BASIN NAME: **Segment 6**

Present Developed **Tc** Tt through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segment.

Sheet flow (Applicable to Tc only)

	Seqment ID	AB	BC	
1. Surface description		Grass, D	Cultivated1	
2. Manning's roughness coefficient, n (table 3-1)		0.24	0.06	
3. Flow length, L (total L<= 300 ft)	ft	1	1	
4. Two-Year 24-hour rainfall, P	in	4.5	4.5	
5. Land slope, S	ft/ft	5.0000	1.0000	
6. Tt = [(0.007)(nL)^0.8] / [(P^0.5)(s^0.4)]	Compute Tt.......hr	0.001	0.000	0.001

Shallow Concentrated Flow

	Seqment ID	CD	DE	
7. Surface description (paved or unpaved)		Unpaved	Paved	
8. Flow length, L	ft	1	1	
9. Watercourse slope, s	ft/ft	15.0000	18.8000	
10. Average velocity, V	ft/s	62.489	88.141	
11. Tt = L / 3600 V	Compute Tt.......hr	0.000	0.000	0.000

Channel Flow

	Seqment ID	EF	FG	
12. Cross sectional flow area, a	ft2	9	28	
13. Wetted perimeter, p_w	ft	13.25	23.49	
14. Hydraulic radius, r = a / p_w	ft	0.68	1.19	
15. Channel slope , s	ft/ft	0.011	3.500	
16. Manning's roughness coefficient, n		0.06	0.1	
17. V = [1.49 $r^{2/3}$ $s^{1/2}$] / n	Compute V.......hr	1.99	31.34	
18. Flow length, L	ft	1400	1	
19. Tt = L / 3600 V	Compute Tt.......hr	0.196	0.000	0.196

Pipe Flow

	Seqment ID	GH	HI	
20. Pipe diameter, D	in	1	1	
21. Pipe slop[e, s	ft	17.000	1.000	
22. Manning's roughness coefficient, n		0.012	0.012	
23. V = [1.49 $r^{2/3}$ $s^{1/2}$] / n	Compute V.......hr	38.76	9.40	
24. Flow length, L	ft	1	1	
25. Tt = L / 3600 V	Compute Tt.......hr	0.000	0.000	0.000

Total Time of Concentration

26. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, 19 and 25)	Hr	0.197
	Min	11.80
	USE TC =	**12**

T:\PROJECTS\D5 PD&E Continuing Services\SJR to Sea Loop Trail 439874-1\01 Engineering\Drainage\[

Project:	SJR2C Sea Loop Trail	By: MLM		Date:	12/30/2019
Location:	Volusia	Checked:		Date:	

Time of Concentration (Tc) or Travel Time (Tt)

BASIN NAME: **Segment 7**

Present Developed **Tc** Tt through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segment.

Sheet flow (Applicable to Tc only)

	Segment ID	AB	BC	
1. Surface description		Woods, L	Cultivated1	
2. Manning's roughness coefficient, n (table 3-1)		0.4	0.06	
3. Flow length, L (total L<= 300 ft)	ft	300	1	
4. Two-Year 24-hour rainfall, P	in	4.5	4.5	
5. Land slope, S	ft/ft	0.0067	1.0000	
6. Tt = [(0.007)(nL)^0.8] / [(P^0.5)(s^0.4)]	Compute Tt.......hr	1.128	0.000	1.128

Shallow Concentrated Flow

	Segment ID	CD	DE	
7. Surface description (paved or unpaved)		Unpaved	Paved	
8. Flow length, L	ft	150	1	
9. Watercourse slope, s	ft/ft	0.0067	18.8000	
10. Average velocity, V	ft/s	1.317	88.141	
11. Tt = L / 3600 V	Compute Tt.......hr	0.032	0.000	0.032

Channel Flow

	Segment ID	EF	FG	
12. Cross sectional flow area, a	ft2	9	28	
13. Wetted perimeter, p_w	ft	13.25	23.49	
14. Hydraulic radius, r = a / p_w	ft	0.68	1.19	
15. Channel slope , s	ft/ft	0.009	3.500	
16. Manning's roughness coefficient, n		0.06	0.1	
17. V = [1.49 $r^{2/3}$ $s^{1/2}$] / n	Compute V.......ft/s	1.78	31.34	
18. Flow length, L	ft	1400	1	
19. Tt = L / 3600 V	Compute Tt.......hr	0.219	0.000	0.219

Pipe Flow

	Segment ID	GH	HI	
20. Pipe diameter, D	in	1	1	
21. Pipe slop[e, s	ft	17.000	1.000	
22. Manning's roughness coefficient, n		0.012	0.012	
23. V = [1.49 $r^{2/3}$ $s^{1/2}$] / n	Compute V.......hr	38.76	9.40	
24. Flow length, L	ft	1	1	
25. Tt = L / 3600 V	Compute Tt.......hr	0.000	0.000	0.000

Total Time of Concentration

26. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, 19 and 25)	Hr	1.379
	Min	82.73
	USE TC =	**83**

Project: SJR2C Sea Loop Trail By: MLM Date: 12/30/2019
Location: Volusia Checked: Date:

Time of Concentration (Tc) or Travel Time (Tt)

BASIN NAME: **Segment 8**

Present Developed **Tc** Tt through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segment.

Sheet flow (Applicable to Tc only)

	Segment ID	AB	BC	
1. Surface description		Woods, L	Cultivated1	
2. Manning's roughness coefficient, n (table 3-1)		0.4	0.06	
3. Flow length, L (total L<= 300 ft)	ft	1	1	
4. Two-Year 24-hour rainfall, P	in	4.5	4.5	
5. Land slope, S	ft/ft	2.0000	1.0000	
6. Tt = [(0.007)(nL)^0.8] / [(P^0.5)(s^0.4)]	Compute Tt.......hr	0.001	0.000	0.002

Shallow Concentrated Flow

	Segment ID	CD	DE	
7. Surface description (paved or unpaved)		Unpaved	Paved	
8. Flow length, L	ft	1	1	
9. Watercourse slope, s	ft/ft	1.0000	18.8000	
10. Average velocity, V	ft/s	16.135	88.141	
11. Tt = L / 3600 V	Compute Tt.......hr	0.000	0.000	0.000

Channel Flow

	Segment ID	EF	FG	
12. Cross sectional flow area, a	ft2	3.5	28	
13. Wetted perimeter, p_w	ft	9.12	23.49	
14. Hydraulic radius, r = a / p_w	ft	0.38	1.19	
15. Channel slope , s	ft/ft	0.008	3.500	
16. Manning's roughness coefficient, n		0.06	0.1	
17. V = [1.49 $r^{2/3}$ $s^{1/2}$] / n	Compute V.......ft/s	1.15	31.34	
18. Flow length, L	ft	1300	1	
19. Tt = L / 3600 V	Compute Tt.......hr	0.314	0.000	0.314

Pipe Flow

	Segment ID	GH	HI	
20. Pipe diameter, D	in	1	1	
21. Pipe slop[e, s	ft	17.000	1.000	
22. Manning's roughness coefficient, n		0.012	0.012	
23. V = [1.49 $r^{2/3}$ $s^{1/2}$] / n	Compute V.......hr	38.76	9.40	
24. Flow length, L	ft	1	1	
25. Tt = L / 3600 V	Compute Tt.......hr	0.000	0.000	0.000

Total Time of Concentration

26. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, 19 and 25)	Hr	0.316
	Min	18.94
	USE TC =	**19**

Project: SJR2C Sea Loop Trail By: MLM Date: 12/30/2019
Location: Volusia Checked: Date:

Time of Concentration (Tc) or Travel Time (Tt)

BASIN NAME: **Segment 8**

Present Developed **Tc** Tt through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segment.

Sheet flow (Applicable to Tc only)

	Segment ID	AB	BC	
1. Surface description		Woods, L	Cultivated1	
2. Manning's roughness coefficient, n (table 3-1)		0.4	0.06	
3. Flow length, L (total L<= 300 ft)	ft	1	1	
4. Two-Year 24-hour rainfall, P	in	4.5	4.5	
5. Land slope, S	ft/ft	2.0000	1.0000	
6. Tt = [(0.007)(nL)^0.8] / [(P^0.5)(s^0.4)]	Compute Tt.......hr	0.001	0.000	0.002

Shallow Concentrated Flow

	Segment ID	CD	DE	
7. Surface description (paved or unpaved)		Unpaved	Paved	
8. Flow length, L	ft	1	1	
9. Watercourse slope, s	ft/ft	1.0000	18.8000	
10. Average velocity, V	ft/s	16.135	88.141	
11. Tt = L / 3600 V	Compute Tt.......hr	0.000	0.000	0.000

Channel Flow

	Segment ID	EF	FG	
12. Cross sectional flow area, a	ft2	3.5	28	
13. Wetted perimeter, p_w	ft	9.12	23.49	
14. Hydraulic radius, r = a / p_w	ft	0.38	1.19	
15. Channel slope , s	ft/ft	0.013	3.500	
16. Manning's roughness coefficient, n		0.06	0.1	
17. V = [1.49 $r^{2/3}$ $s^{1/2}$] / n	Compute V.......ft/s	1.51	31.34	
18. Flow length, L	ft	750	1	
19. Tt = L / 3600 V	Compute Tt.......hr	0.138	0.000	0.138

Pipe Flow

	Segment ID	GH	HI	
20. Pipe diameter, D	in	1	1	
21. Pipe slop[e, s	ft	17.000	1.000	
22. Manning's roughness coefficient, n		0.012	0.012	
23. V = [1.49 $r^{2/3}$ $s^{1/2}$] / n	Compute V.......hr	38.76	9.40	
24. Flow length, L	ft	1	1	
25. Tt = L / 3600 V	Compute Tt.......hr	0.000	0.000	0.000

Total Time of Concentration

26. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, 19 and 25)	Hr	0.139
	Min	8.35
	TC =	8

Project:	SJR2C Sea Loop Trail	By: MLM		Date:	12/30/2019
Location:	Volusia		Checked:	Date:	

Time of Concentration (Tc) or Travel Time (Tt)

BASIN NAME: **Segment 8**

Present Developed **Tc** Tt through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segment.

Sheet flow (Applicable to Tc only)

	Segment ID	AB	BC	
1. Surface description		Woods, L	Grass, S	
2. Manning's roughness coefficient, n (table 3-1)		0.4	0.15	
3. Flow length, L (total L<= 300 ft)	ft	1	1	
4. Two-Year 24-hour rainfall, P	in	4.5	4.5	
5. Land slope, S	ft/ft	2.0000	1.0000	
6. Tt = [(0.007)(nL)^0.8] / [(P^0.5)(s^0.4)]	Compute Tt.......hr	0.001	0.001	0.002

Shallow Concentrated Flow

	Segment ID	CD	DE	
7. Surface description (paved or unpaved)		Unpaved	Paved	
8. Flow length, L	ft	1	1	
9. Watercourse slope, s	ft/ft	1.0000	1.0000	
10. Average velocity, V	ft/s	16.135	20.328	
11. Tt = L / 3600 V	Compute Tt.......hr	0.000	0.000	0.000

Channel Flow

	Segment ID	EF	FG	
12. Cross sectional flow area, a	ft2	3.5	28	
13. Wetted perimeter, p_w	ft	9.12	23.49	
14. Hydraulic radius, $r = a / p_w$	ft	0.38	1.19	
15. Channel slope , s	ft/ft	0.012	3.500	
16. Manning's roughness coefficient, n		0.06	0.1	
17. $V = [1.49\ r^{2/3}\ s^{1/2}] / n$	Compute V.......ft/s	1.41	31.34	
18. Flow length, L	ft	1300	1	
19. Tt = L / 3600 V	Compute Tt.......hr	0.256	0.000	0.256

Pipe Flow

	Segment ID	GH	HI	
20. Pipe diameter, D	in	1	1	
21. Pipe slop[e, s	ft	17.000	1.000	
22. Manning's roughness coefficient, n		0.012	0.012	
23. $V = [1.49\ r^{2/3}\ s^{1/2}] / n$	Compute V.......hr	38.76	9.40	
24. Flow length, L	ft	1	1	
25. Tt = L / 3600 V	Compute Tt.......hr	0.000	0.000	0.000

Total Time of Concentration

26. Watershed or subarea Tc or Tt (add Tt in steps 6, 11, 19 and 25)	Hr	0.258
	Min	15.50
	TC =	**16**