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TECHNICAL MEMORANDUM

To:	Agnes Martelet, Environmental Compliance Manager, City of Carmel
From:	Dudek and Waterways Consulting, Inc.
Prepared by:	Matt Weld, PE and Dudek (Permit Requirements)
Date:	February 14, 2019
Re:	Mission Trail Stream Stability Assessment

INTRODUCTION

The goal of this memorandum is to summarize methodology, results, and recommendations of our work performed in response to the City of Carmel's request for a stream stability survey within the Mission Trail Nature Preserve (Preserve). Specifically, the City requested the completion of the following tasks:

- Determine factors contributing to instability, as evidenced where steep channel banks are failing, the channel bed is incising, and high flows are utilizing downstream roads and trails instead of the stream course.
- Evaluate the stability of access and drainage improvements (e.g., gabion baskets, bridge crossings, wet ford crossing, culverts, and trails within the riparian corridor) to determine which are stable and which may need some sort of adjustment to address drainage-related concerns.
- Recommend actions to stabilize the stream and enhance overall habitat conditions in the riparian corridor.
- Identify anticipated permitting requirement associated with proposed maintenance, repairs or enhancements.

Work was performed by Waterways Consulting, Inc. (Waterways) and Dudek during the months of July through November of 2018.

The Preserve is located near the southeastern edge of the city of Carmel-by-the Sea. The 34-acre property was acquired by the City in the 1970s and was designated a nature park in 1979 by the Carmel City Council. A Master Plan for the Preserve was adopted by the City in the mid-1990s that sets forth goals and policies for long-term preservation and use of the Preserve. The southern edge of the Preserve fronts Rio Road and extends north into the wooded neighborhoods of Carmel near the Highway 1 corridor. The narrow, linear property is surrounded by improved residential properties within the City and unincorporated County areas. The Preserve is accessed from four signed trailheads and has a number of trails through the property.

Two main perennial drainages and several smaller drainages transect the Preserve. The main perennial drainage enters the Preserve at its northern end, runs along its western boundary and forks near the center of the Preserve. Another perennial drainage feeds into the Preserve from the east. The Preserve supports a mix of vegetation types.

METHODOLOGY

Background Data Review

Past Studies reviewed to inform our assessment included:

- Mission Trail Nature Preserve Master Plan
- Drainage Investigation for the Mission Fields Area of Carmel Valley – Summary Report (Nolte & Associates, 1986)
- Baseline Biological Assessment , Mission Trail Nature Preserve (Nedeff, 2016)
- Preliminary Soil Investigation for Storm Water Detention Pond (Neill Engineers, Inc., 1984)
- Carmel General Plan/Local Coastal Program (2004)

Topographic mapping and utility layers were also provided by the City in GIS format for review and incorporation into our study.

Visual Site Assessment and Meetings with Project Advisory Committee

The project was initiated with a kickoff meeting on July 9th, 2018, attended by Waterways, Dudek, Nicole Nedeff, and City Staff. The meeting focused on discussion of project goals and objectives, available resources, and scheduling.

An introductory site walk was attended on July 27th to review existing conditions. This walk was again attended by Dudek, Waterways, Nicole Nedeff, a representative of Friends of the Mission Trail Nature Preserve, and City staff. During this walk, the group walked the length of the Preserve and discussed known points of concern.

Waterways returned to visit the site on numerous occasions during and after mapping to hike the park perimeter and adjacent streets as design and analysis progressed.

A final site visit to the lower end of the Preserve was performed on October 25th and was attended by Waterways, Dudek, Nicole Nedeff, and City Environmental Compliance Manager Agnes Martelet. The purpose of this meeting was to review preliminary design drawings in the vicinity of the Preserve entrance at Rio Road.

Topographic Mapping

Topographic mapping was performed by Waterways staff on five separate dates in July and August 2018, using a combination of RTK GPS and total station equipment. Elevation Datum is NAVD 88. The horizontal datum is NAD83 California State Plane, Zone 3. Control was established using the Leica Geosystems Smartnet Global Navigation Satellite System (GNSS) Network. Our survey included a long profile of the primary channel, periodic cross sections, and topographic mapping at select areas where drainage concerns were most apparent. Our work was overlain onto watershed scale topography 2010 LiDAR survey provided by the City (AMBAG, 2010).

Long Profile Survey

The long profile survey extended from Rio Road to the upstream limit of the Preserve. Points were surveyed at cross sections, at significant grade breaks, and on prominent features such as grade

controls, weirs, or culverts. The profile is presented on Sheet C2 of the Attachment A, with stationing that corresponds to the site overview on Sheet C1.

Notable features on the profile include the following:

- Shallow channel in vicinity of stations 6+00 to 8+00, where flooding has been observed.
- Channel incision below the confluence at approximately Station 22+25
- Distinct break in channel profile at the station 22+25, where average channel gradient changes from approximately 1.4% to 7%.
- High number of constructed grade control elements (over 20) between Station 22+50 and upstream limit of Preserve, ad distance of approximately 1600 feet.

Cross Section Survey

Cross sections were surveyed periodically through the Preserve at representative locations or where features relevant to the study were observed. Twenty cross sections are presented on Sheets C9 through C11. Sheet C8 shows the cross section locations overlain onto the Preserve overview map.

Beginning at cross section A and extending through cross section I, there is clearly a broad flat floodplain available to the channel. However, it appears as if the channel has been relocated to the east side of the floodplain, hugging the toe of the slope. Cross sections C through F demonstrate that the channel is no longer occupying the lowest point in the floodplain, which appears to be well to the west of the current alignment. Channel realignment to the valley margins was a common management technique in the past, often used to optimize floodplains for ranching or farming, allowing uninterrupted access and improved opportunities to dry floodplains in early spring. The result appears to be a channel with an unnaturally straight planform and entrenched condition, offering reduced floodplain function.

Detailed Site Survey Maps

Detailed topographic maps were prepared to allow for development of higher resolution site plans at areas where erosion, sedimentation, or flooding problems were evident, or where potential projects were discussed during our site meetings. The following areas were mapped in greater detail, and area shown on Sheets C3 through C6 of Attachment A.

1. Tributary Crossing and Trail Junction
2. Concrete Ford and Trail Re-route Site
3. Bridges at Confluence

These sheets also provide preliminary repair recommendations, as described further below.

Hydrologic Assessment

A rainfall-runoff simulation model was prepared to allow us to analyze the project site hydrology during design storm events. The purpose of this modeling was to determine approximate runoff rates that would support hydraulic analysis of erosive forces, floodplain interaction, and hydraulic capacity at individual locations. The model was developed in sufficient detail for the purposes of this study, but should still be considered approximate since it did not include a calibration effort or a comprehensive mapping of the watershed outside the park boundaries, especially where located on private property.

These efforts would be considered outside the scope of the current study, but may be warranted in support of the final design of certain scenarios.

Mapping Sources

Our analysis was based on several different mapping resources. General watershed topography was provided by the City of Carmel in the form of a digital terrain model resulting from a LiDAR survey (AMBAG, 2010). Within the park boundaries, dense vegetation rendered the LiDAR mapping unreliable, so we used our own field observations and topographic data collection. Outside the park, drainage paths were determined by walking and/or driving the city and county streets and Caltrans right of way to visually inspect surface flow splits and pipe alignments where topography alone was not sufficiently detailed to accurately determine watershed or subwatershed boundaries. Outfall locations and approximate subwatershed boundaries were also provided by the City of Carmel and Monterey Resources Agency on large format maps included within Appendix 3. Figure 1A within Appendix 1 shows the resulting stormwater basin map with subwatersheds and junctions labeled.

Analysis

The contributing sub-basin drainage areas were evaluated using the Santa Barbara Urban Hydrology (SBUH) method in Autodesk® Storm and Sanitary Analysis 2016 (SSA) as follows:

- U.S. Department of Agriculture (USDA) Soil Conservation Service (SCS) Type 1A 24-hour storm events for Pebble Beach were used.
- Hydrologic soil types were determined from the USDA Natural Resources Conservation Service (NRCS) Web Soil Survey (see Appendix 1-B for NRCS Hydrologic Soil Report).
- Weighted average runoff curve number (CN) values were determined using the hydrologic soil type and percent type of cover as shown in Table 1, Appendix 1-C.
- Time of concentration was calculated in SSA using the SCS TR-55 method, see SSA reports in Appendix 1-D. Minimum time of concentration was set at 5 minutes.
- Area 1 (Basin CAR-10b) and Area 2 (Basin CAR-10a) were evaluated separately from each other to facilitate pipe sizing for future routing for each basin. Their combined flow was also evaluated for analysis of improvement downstream of these basins.

The pipes and channels were modeled as follows:

- Kinematic Wave link routing.
- Hazen-Williams force main equation.
- Pipes were modeled as concrete with a Manning's n value of 0.015.
- The open channel was modeled with a Manning's roughness of 0.04 for boulder steps in the upstream section and 0.025 for straight gravel beds in the downstream sections.
- The existing pipe system in Basin CAR-8 starts with a 24" pipe at the intersection of Ocean Avenue, Junipero Avenue, and Mountain View Avenue. After two blocks the pipe upsizes to a 36" pipe for another two blocks before upsizing to a 42" pipe prior to reaching the outfall. Initial modeling revealed that the existing 24" portion of the pipe system is undersized. This is resulted in a surcharge of the catch basin at the intersection and a net loss from the initial model due to overland flow. This reduced downstream flows in the primary channel located within the Preserve. According to the City, this pipe will eventually be upsized to prevent

overland flow. As a result, the existing 24" portion of the pipe was modeled as a future 36" pipe. The existing 36" and 42" portions of the system were below capacity during the 100-year storm so they were modeled as they exist today.

- Existing pipe inverts and slopes were assumed based on LIDAR surface topography to facilitate analysis of the stormwater flows in the creek. Any future upgrades to the existing pipe system in Basin CAR-8 should evaluate the system with measured inverts and slopes to ensure an accurate analysis of energy and hydraulic grade lines within the pipe system.

Results

Peak flows for the 2, 10, 50, and 100-year recurrence interval storms were calculated at points of interest or subwatershed boundaries and are provided within Table 1.

TABLE 1: Hydrology Study Results

	Storm Event Peak flow (cfs)			
Point of Interest	**2-year**	**10-year**	**50-year**	**100-year**
A (Upstream End of Project)	6.09	27.71	42.09	46.36
B (Station 22+00)	8.04	35.8	54.39	59.91
C (Tributary @Confluence, Sta 22+25)	27.02	97.31	142.13	155.30
D (Proposed Bridge, Sta 12+00)	30.65	117.23	174.08	190.87
E (culvert at Rio Rd)	31.28	124.10	186.31	204.81
Area 1 (Tributary from West, Sta 8+00)	0.22	2.05	4.24	4.95
Area 2 (existing culvert under Serra Trail, Sta 2+00)	0.18	1.22	1.95	2.16

Hydraulic Assessment

The results of the hydrologic assessment were used to provide preliminary design geometry for proposed pipes and channels, as well as to evaluate the approximate capacity of the existing channel at representative locations. Calculations are provided in Appendix 3 that show the approximate capacity of the existing channel, just before flows overtop channel banks and access floodplains. Analysis was performed using Manning's equation applied at individual cross sections of interest that were surveyed by Waterways. Hydraulic roughness (Manning's "n") values were assigned at each location based on observations, photographs, and engineering judgement. Channel slope was estimated from the long profile survey. Results of the analysis are provided in Table 2.

Most locations appear to have less than 10-year capacity. Most notably, cross section M (where sandbags are being used to contain floodwaters) can only pass 55% of the 10-year event before overtopping its banks. Cross section K shows the capacity of a typical gabion weir, roughly four feet wide by 1 foot deep at the crest. Again, the capacity is only 64% of a 10-year storm peak. Many of these weirs are failing due to flanking, largely the result of this undersized geometry.

Cross Section A shows that the channel near the downstream end of the park has a capacity in excess of the 10-year event. Localized flooding that has been observed in this area is likely due to tributary drainages coming from Area 1 and Area 2.

Our analysis did not extend outside the park to include downstream storm drains. Backwater effects of undersized downstream conveyance structures, if present, may influence this result.

TABLE 2: Hydraulic Modeling Results

Cross Section ID/ Station	Description	Channel Capacity at Top of Bank (cfs)	Calculated Peak Flow (cfs) for Varying Return Periods		
			Q_{10}	Q_{50}	Q_{100}
A (3+21)	VEGETATED EARTH SWALE TYPICAL OF CONDITIONS WITHIN DOWNSTREAM REACH OF PARK	122	117.2	174.1	190.9
D (10+73)	VEGETATED EARTH SWALE LOCATED DOWNSTREAM OF CONCRETE FORD. CHANNEL ALIGNEMENT AT TOE OF HILLSLOPE	82	117.2	174.1	190.9
G (16+82)	VEGETATED CHANNEL INCISED ALONG ROAD WHERE TREES ARE THREATENED BY BANK EROSION	112	97.3	142.1	155.3
K (23+19)	CREST OF GABION WEIR	23	35.8	54.4	59.9
M (25+54)	CONSTRICTED CROSS SECTION NEAR RESIDENCE WITH SANDBAGS ON RIGHT BANK (SANDBAGS NOT MODELED)	20	35.8	54.4	59.9

CONCEPT LEVEL TREATMENT RECOMENDATIONS

Preliminary treatment recommendations are presented at a concept level for project sites selected based on observed conditions, modeling results, or input received during meetings with the project advisory committee. These concept level designs have been overlain on the topographic basemaps or cross section surveys for review. The designs have been developed sufficiently to review existing conditions and evaluate opportunities and constraints to repair alternatives. Additional mapping, analysis, and design effort would be required to provide plans at a detail suitable for permit applications or implementation. The project schedule did not allow the site to be reviewed during winter conditions. As a result, we may have missed some areas of concern, especially where the channel gradient is low and the floodplain is relatively flat within the downstream reaches of the project.

Potential projects are presented below, from downstream to upstream.

Site #1 - Park Entrance at Rio (Sheets C3and C3A)

The park entrance is reported to experience local flooding during winter months. At present, runoff enters this area from four sources, including two roadside ditches that run along the service road (Serra Trail), an asphalt swale discharging from Rio Way, and as ponded or sheet runoff from the depressed

area to the north of the Serra Trail. The area is drained by an 18 inch culvert that starts on the north side of the road and discharges to a shallow and discontinuous grass lined swale that eventually meets with Mission Creek. The inlet elevation of the culvert and the shallow grade of the swale are very near the grade of the road, and do not take advantage of the available fall to the creek bed. As a result, the area is poorly drained.

Proposed repairs should seek to alleviate ponding on the road surface with a minimal amount of disturbance to the adjacent wetland or riparian areas. Further, the preferred option should not significantly lower local groundwater elevations.

We have presented two alternative solutions. Each alternative includes raising the access road by approximately 6 inches, over a distance of roughly 650 feet. This may not seem like a significant change, but it would greatly reduce ponding and saturation of the roads surface without damaging adjacent sensitive areas, and would minimize ongoing maintenance requirements at ditches.

The additional actions recommended under each of the two alternatives are influenced by a proposed drainage realignment further upstream within the Preserve, as shown in Sheet C4. As a result of actions shown on C4, additional drainage will be entering the area to the west of the Serra Trail near the Preserve entrance, where flooding is already a concern.

Alternative 1 (Sheet C3) would install a new drop inlet and 24 inch diameter culvert to convey these flows under the Serra Trail. Beginning at the culvert outlet, a newly excavated wetland swale would convey runoff to the creek. The swale would be excavated deeper than the current ditch line to take better advantage of the available fall to the creek. Although the initial construction of the swale would require removal of several small oak trees, the final project would result in a net increase in wet meadow. The swale construction would also necessitate relocation of a concrete slab and bench and two signs. The raised road surface would continue through the park entrance gate to allow for improved conveyance of street drainage to minimize ponding on the path.

Alternative 2 (Sheet C3A) varies in that it would use a subsurface pipe to convey flows from the new drop inlet at the west side of the Serra Trail. A second inlet would capture ditch flow from the north as it flows along the east side of the Serra Trail. The pipe alignment would be constructed below the existing path that heads east toward the creek, avoiding impacts to adjacent natural areas. Local grades would necessitate slightly raising the path to provide adequate cover for the pipe. A more detailed study would be required to guarantee the feasibility of this alternative as there is limited fall available from the west side of the Serra Trail to the creek invert. The pipe's outlet would need to be placed very near to the channel bed, introducing the risk of backwater effects or plugging with sediment.

A third alternative (not drawn) would raise the trail surface and asphalt approach, and would replace the culvert beneath the trail, but would not address drainage to the east. This alternative would address nuisance flooding associated with street runoff by replacing the existing asphalt water bar with a more functional drain directing flows off of the trail. The alternative would improve capacity for high flows to cross under the trail within the new culvert, allowing for Project #3 to proceed as described below. The drawback to this approach is that the trail section from the entrance to the creek (near the bridge) may still experience flooding during larger storms. There may be an opportunity to also raise this section of

trail slightly, but additional survey would be required to ensure that doing so would not block drainage from the north.

Site #2 - Pedestrian Boardwalk (Sheets C1 & C7)

Near station 6+50, an existing unimproved trail crosses the low point of the valley in an area that is reported to experience occasional flooding under existing conditions. This flooding would be exacerbated by the actions shown on sheet C4. We recommend installation of a raised boardwalk here to provide improved year round access and minimize the environmental footprint of the Preserve's access paths. A profile of the proposed boardwalk is shown on Sheet C7. The required length would be approximately 120 lf. Installation of a boardwalk would benefit year-round pedestrian access, but would limit vehicular access and require modification of existing maintenance techniques. If vehicular access is required at this location, an alternative means of access improvement can be explored.

Site #3 - Tributary Crossing and Trail Junction (Sheet C4)

Sheet C4 shows a confluence of trails along the western side of the valley bottom, where a tributary drainage from the west is causing erosion and sedimentation of various trail segments. High sediment loads from outside the Preserve are currently routed down a ditch in an easterly direction and then settling out along the west side of the Serra Trail, where the profile flattens. The result has been flooding of the Serra Trail due to ditch blockages, as well as erosion of the ditch leading to the Serra Trail.

The proposed repair would consist of rerouting the drainage to the South, where it can dissipate and deposit sediment within the valley low to the west of the Serra Trail, ultimately crossing the Serra Trail near the Preserve entrance. The feasibility of this approach would need to be confirmed by additional topographic mapping within the densely vegetated area west of the Serra Trail. However, several cross sections already surveyed here show this as a promising alternative that could provide flow attenuation and sediment storage opportunities with low maintenance requirements.

Where the drainage crosses the path at the west edge of the valley, either a culvert or a concrete ford would be recommended. Either approach would need to extend somewhat up the slope to capture runoff before it hits the road shoulder. This area is at the head of an alluvial fan and may otherwise avulse and miss the pipe or ford inlet.

Photo 1: Sedimentation of ditch near station 8+00

Site #4 - Concrete Ford and Trail Re-route Site (Sheet C5)

Sheet C5 shows an area where several trails meet. Two separate concerns are addressed with the proposed repairs. The first concern is that an existing concrete ford was constructed over a larger than necessary footprint within the channel and the downstream end has become exposed by incision processes. The downstream half of the structure no longer appears necessary and can be removed to allow the natural stream channel to be restored. Demolition of the portion of the ford would require installation of a concrete cutoff wall at the point of demolition and construction of a "roughened channel" composed of boulders, cobble, gravel and fines) to transition to the downstream channel profile.

Removal of the concrete ford would discourage foot travel along the left bank of the channel just downstream of the ford, where the creek bank is denuded and eroding due to foot traffic along a narrow and unsafe section of trail. At present, the trail traverses along the top of bank immediately adjacent to the channel for approximately 75 feet before climbing up the eastern slope of the valley. The result has been degradation of the stream bank and local vegetation.

The second component of the work would be to decommission and restore this section of trail and reroute the alignment across a pedestrian bridge and through a redwood grove where benches have been placed. This trail realignment presents an opportunity to route pedestrians through a unique portion of the Preserve that is less sensitive to disturbance than the current path along the streambanks.

Photo #2: Looking upstream at Site #4, Concrete Ford.

Site #5 - Bank Erosion along Serra Trail (Sheets C1 and C7)

Bank erosion and channel incision were observed along a straight reach of channel between station 14+00 and station 21+00. AS can be seen from the profile on Sheet C2, the channel has started to climb somewhat at this location and has become slightly entrenched relative to the floodplain. The channel has begun to undermine trees along the road shoulder, as shown in photo #3 below.

The channel will continue to incise and further erode the banks if left untreated in this location, ultimately undermining the Serra Trail. Meanwhile, sediment storage and floodplain functions are diminished by the entrenched condition that prevents floods from accessing the floodplain. Erosive forces are magnified by the straightened planform and deepened cross section, which increases shear and velocity over natural conditions.

Sheet C1 shows the potential to realign the channel here to provide a little more breathing room and establish a profile and cross section that better connects floodwaters to the floodplain. Sheet C7 shows a typical cross section within this reach. Note that the valley low point is well to the west of the current channel alignment, as a sign that the channel alignment is likely artificially straightened here.

Photo 3: Looking in southerly direction along Serra Trail. Note creek immediately adjacent to the road and trees beginning to fail into creek as a result of channel incision and bank erosion.

A realigned channel could be constructed with a much smaller cross section, allowing more regular inundation of the floodplain, improved groundwater recharge, sediment storage, and flood attenuation. Trees along the current channel alignment would be protected, and future channel bank maintenance requirements would be greatly minimized. Additional mapping would be required to ensure there would be no unanticipated consequences from reintroducing flows to the floodplain, such as unwanted flooding downstream or risk to infrastructure or mature native riparian trees within the proposed alignment. The alignment shown is schematic and subject to revision pending further analysis.

If further analysis and design prove this option to be infeasible, another variant would be to raise the existing channel in place to achieve similar effects. Raising the channel could be accomplished by constructing intermittent raised riffle sections and by breaching the right bank to allow better access to the floodplain. Existing trees along the banks could be buttressed and protected in place with fill.

Site #6 - Bridge Replacement and Headcut Mitigation at Confluence (Sheet C6)

Sheet C6 depicts the confluence of the main channel with a primary tributary from the west, near the end of 11th Avenue. As seen best on the long profile (Sheet C2), this is the location with the valley profile transitions from relatively flat slope averaging 1.4% to a steeper slope averaging 7%. A large headcut (knick-point) of six to eight feet in height is migrating upstream and currently arrested at station 22+40, just below the bridge on the main channel. The headcut has already progressed up the western tributary to the location of a bridge crossing that currently acts as grade control. The bridge is undersized for the design flow of 97.6 cfs, and causes a constriction that currently exacerbates erosion

and channel instability in this area. The narrow opening is further at risk of plugging and causing more damage. Channel banks downstream of the two bridges and beyond the confluence are overly steepened from recent incision, despite past efforts to stabilize the channel with rock.

Photo 4: Example of boulder weirs used to raise a channel profile to support an existing bridge (Murtaugh Creek, OR)

Stabilization of this area may need to extend one hundred feet or more downstream of the confluence in order to create a stable channel profile that prevents the headcut from migrating further upstream and destabilize the bridge, channel banks, or upstream improvements. Stabilization could be accomplished by replacing the bridge over the western tributary, laying back steep channel banks that are currently eroding, revegetating the area, and establishing grade control for the channel profile through weirs or a fully reconstructed channel, as shown.

The Preserve boundary limits are unclear within this area. A boundary survey is recommended here to better define opportunities and constraints.

Site #7 - Flooding at Station 25+50

One location within the upstream reaches of the Preserve (approx. station 25+50) shows evidence of recent flooding, based on the presence of sandbags along the right bank of the channel opposite a residence (Photo 5). At cross section M, shown on Sheet C10, one can clearly see the undersized channel cross section area available for flood conveyance. As noted above, the channel capacity here is

only approximately 55% of the 10-year flood peak. The profile (Sheet C2) shows that the area of concern is immediately upstream of a gabion weir with a height of nearly 4 ft. The likely solution here would require locally lowering and/or widening the channel to accommodate high flows, possibly modifying or removing the existing gabion grade control. This action may require installation of a structural wall or rock slope protection to preserve the yard and/or path. The location of the Preserve boundary is uncertain in this vicinity. The entire channel may be located on private property.

Photo 5: Looking west across channel at flood-prone area (station 25+50)

Site #8 - Headcuts in upper reaches (Existing conditions shown on Sheet C2)

The reach upstream of the confluence with the western tributary is characterized by steep valley walls and a highly confined channel at a very uniform average slope of 7%, with dozens of constructed grade control structures and debris jams forming drops of varying heights. Bank failures were apparent in many areas due to channel incision and subsequent widening, though the channel appears to have been temporarily arrested at the current profile. Though many of the existing drop structures are undersized, poorly constructed, or in disrepair, they are working together to provide hydraulic roughness and energy dissipation, as well as a physical structure to maintain the current profile grade.

The existing weirs are primarily composed of stone, timber, or gabion baskets, of varying geometry. Only the gabion weirs – of which there were over ten located- appear to have been installed under a coordinated effort, with a relatively uniform design approach. However, these weirs are nearly all undersized and showing signs of failure. The typical failure mode is by flanking, due to their undersized

geometry (Photo 6, below). For instance, the ten year flow at this location, a flow commonly used to size such features, is approximately 40 cfs. A weir crest opening would need to be 3 feet wide at the base, with a depth of 2 feet to contain this flow, assuming 1h:1v side slopes. Many of the weirs were less than half this size.

Photo 6: Looking Upstream at a failing gabion weir with a spillway that is undersized for even moderate storm events.

Though we mapped a profile through each structure, the analysis of each weir was beyond the resources of this study. Further, it is uncertain where the Preserve boundary crosses the channel at many locations along this upper reach. We recommend that the City perform a boundary survey and determine land ownership within this reach before making further plans to stabilize the channel. Eventually, the existing weirs will fail and landowners will individually begin to experience related bank erosion, sometimes threatening structures. A comprehensive approach to monitoring and, if necessary, stabilizing the reach would benefit all.

Options for stabilization could include reconstructing weirs as they fail or proactively installing additional grade control structures between existing weirs. Natural approaches such as log weirs have been used with some success, but generally don't provide the same level of protection as stone, masonry, concrete, or similar hard structures. Gabions are a very desirable short term solution, if properly designed and installed. Benefits include their ease of installation at sites with access constraints and the

ability for hand labor crews to construct them. The primary drawback to gabions is the fact that they typically do not last more than 40 years in a stream environment.

REGULATORY – PERMITTING REQUIREMENTS

Permit Requirements and Environmental Issues

The goal of the project recommendations is to implement measures to stabilize the existing perennial stream, reduce erosion and sedimentation and to enhance overall habitat conditions in the riparian corridor along the stream, consistent with goals and policies in the Preserve Master Plan and recommendations in the Baseline Biological Assessment (Nedeff, 2016). The conceptual recommendations include eight repair measures that could be implemented at separate times and/or in combination, two of which would require additional survey and study for feasibility. Federal, state and local permits and approvals are anticipated to be required for most of the recommended activities. An overview of required permits is provided in the following section. Anticipated required permits and key issues for each recommended repair are summarized on Table 3.

U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers (Corps) exercises regulatory jurisdiction over certain activities within waters of the United States. The Corps receives its statutory authority from Section 404 of the Clean Water Act, which regulates placement of dredged or fill material in jurisdictional waters of the United States, and Section 10 of the Rivers and Harbors Act of 1899, which regulates the construction of any structure in or over any navigable water of the United States or any work affecting the course, location, condition, or capacity of such waters. Some of the recommended repairs involve the placement of fill material within non-navigable waters[1] of the United States associated with work in stream channels.

General permits are authorizations that are issued for a category or categories of activities that are similar in nature and do not cause more than minimal individual and cumulative adverse environmental effects. Nationwide Permits (NWPs) are a type of general permit issued by the Corps. Multiple NWPs could potentially be used to authorize the work needed to implement the recommendations in this report, including NWP 13, Bank Stabilization; NWP 27, Aquatic Habitat Restoration, Enhancement, and Establishment Activities; NWP 31, Maintenance of Existing Flood Control Facilities; NWP 42, Recreational Facilities; and NWP 46, Discharges in Ditches. The various work components could potentially be viewed as separate single and complete projects, each qualifying for a separate NWP authorization. If the work is considered one single and complete project, and multiple NWPs are used, the acreage loss of waters of the United States must not exceed the acreage limit of the NWP with the highest specified acreage limit, which is 1 acre for a NWP 46; NWP 42 has a limit of 0.5 acre. NWP 13 and 27 do not have a specified acreage limit.

[1] According to federal regulations, "navigable" waters of the United States are those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce.

TABLE 3. Summary of Recommendations and Potential Permit Requirements

Recommended Repair	Anticipated Permit				Issues
	ACOE	CDFW	RWQCB	CDP	
1. Park Entrance – Raise Road				X	• Avoid / minimize construction impacts to adjacent wetland and riparian habitat and creek water quality
Alt 1 – Swale and new drop inlet	X	X	X	X	• Avoid / minimize construction impacts to adjacent wetland and riparian habitat and creek water quality • Minor tree removal • Wetland enhancement
Alt 2- Subsurface drain and new inlets	X	X	X	X	• Avoid / minimize construction impacts to adjacent wetland and riparian habitat and creek water quality
2. Pedestrian Boardwalk					• Avoid / minimize construction impacts to adjacent wetland and riparian habitat and creek water quality
3. Reroute existing drainage with new culvert	X	X	X	X	• Avoid / minimize construction impacts to adjacent wetland and riparian habitat and creek water quality
4. Removal of concrete ford and decommission and restore existing trail segment and reroute trail with new pedestrian bridge	X	X	X	X	• Avoid / minimize construction impacts to adjacent wetland and riparian habitat and creek water quality
5. Channel Realignment	X	X	X	X	• Additional mapping required • Avoid/minimize riparian habitat impacts
6. Bridge Replacement over tributary, channel bank bio-remediation	X	X	X	X	• Avoid / minimize construction impacts to adjacent wetland and riparian habitat and creek water quality • Cultural resources review may be necessary
7. Channel modification	X	X	X	X	• Not known if in Preserve boundaries • NWP 31 potentially applicable if channel flood control activities have been previously authorized by the Corps.
8. Upstream bank failures and existing weir failures – further study recommended					• Bio-engineered approaches are preferred by regulatory agencies • No specific recommendations at this time except for further survey work to determine potential options

DATA REQUIRED: For all activities requiring permits and associated notification to the Corps, an application must be submitted, using standard ENG Form 4345. The application must include a complete description of the proposed activity including necessary drawings or plans; the location, purpose and need for the proposed activity; scheduling; the names and addresses of adjoining property owners; the location and dimensions of adjacent structures; and a list of authorizations required by other federal, state, or local agencies.

RELATED LAWS

- Endangered Species Act: If a project may affect federally listed species or their critical habitat, consultation with U.S. Fish and Wildlife Service (USFWS) and/or the National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS) will be required. One federally-listed plant species has been identified at the Preserve: Yadon's rein orchid (*Piperia yadonii*). The City as the applicant would need to provide the Corps with a Biological Assessment (BA) or biological technical report identifying and analyzing the potential impacts to listed species. The Corps will initiate and conduct the Section 7 consultation.
- Section 401 Water Quality Certification: Water quality certifications are required for projects that require federal permits. The proposed Project will need to obtain the required certification from the California Central Coast Regional Water Quality Control Board (RWQCB) before the Corps can issue the 404 permit.
- Historic Properties: If the proposed activity would involve any property listed or eligible for listing in the National Register of Historic Places, consultation with the State Historic Preservation Officer will be required. The applicant would need to provide the Corps with a cultural resources report identifying and analyzing the potential effects to potential historic resources, e.g., structures that are over 45 years old. The Corps will initiate and conduct the consultation.

FEES: Local government agencies are not required to pay any fee in connection with permits.

Regional Water Quality Control Board

The California State Water Resources Control Board (SWRCB) oversees the policy objectives of the nine Regional Water Quality Control Boards (RWQCBs). The RWQCBs exercise jurisdiction over water quality in waters of the United States within their respective regions and administer Section 401 Water Quality Certification and Section 402 National Pollutant Discharge Elimination System (NPDES) permits pursuant to the Clean Water Act to ensure projects meet state water quality standards to regulate point source discharges of pollutants to waters of the United States. The RWQCBs also regulate impacts to waters of the state, including point-source and diffused-source discharges to land and groundwater, under California's Porter-Cologne Water Quality Control Act.

A Section 401 Water Quality Certification from the Central Coast RWQCB, Region 3 is anticipated to be necessary for the proposed improvements. Section 401 of the Clean Water Act requires any applicant for a federal license or permit to conduct any activity that may result in a discharge of a pollutant into waters of the United States to obtain a certification from the State in which the discharge originates or would originate, that the discharge will comply with the applicable effluent limitations and water quality standards. The RWQCB protects all waters in its regulatory scope, but has special responsibility for wetlands, riparian areas, and headwaters because these water bodies have high resource value, are vulnerable to filling, and are not systematically protected by other programs. Basin-level analysis focuses on pollutant removal, floodwater retention, and habitat connectivity.

DATA REQUIRED: Issuance of a Section 401 Certification requires information demonstrating the project will comply with state water quality standards and aquatic resources protection requirements. A Section 401 permit application should include information including a detailed project description, discussion of avoidance and minimization of impacts to waters of the state, impacts analysis, discussion of beneficial uses, identification of pollutants of concern and short- and long-term best management practices (BMPs) to minimize discharge of pollutants, and all associated figures (vicinity maps, project site maps, construction cross-sections, and others).

ANALYSIS REQUIRED: Analysis by the RWQCB is intended to authorize and regulate discharges into waters of the United States and waters of the State. The RWQCB will evaluate the Project's potential impacts on aquatic resources and ensure the applicant has demonstrated that: 1) a sequence of actions has been taken to first avoid, then to minimize, and lastly compensate (if required) for adverse impacts to waters of the state; 2) the potential impacts will not contribute to a net loss of the overall abundance, diversity, and condition of aquatic resources in a watershed; 3) the discharge of dredged or fill material will not violate water quality standards and will be consistent with all applicable water quality control plans and policies for water quality control; and 4) the discharge of dredged or fill material will not cause or contribute to significant degradation of waters of the State.

FEES: RWQCB fees are determined based on acreage of fill and excavation impacts within waters of the United States and waters of the State.

California Department of Fish and Wildlife

The California Department of Fish and Wildlife (CDFW) regulates impacts to rivers, streams, and lakes in California. Fish and Game Code Section 1602 requires notification to CDFW prior to commencing any activity that may: substantially divert or obstruct the natural flow of any river, stream or lake; substantially change or use any material from the bed, channel or bank of any river, stream, or lake; or deposit debris, waste or other materials that could pass into any river, stream, or lake. The waters included in the definition of a river, stream or lake include those that are episodic as well as those that are perennial. This includes ephemeral streams, desert washes, and watercourses with a subsurface flow.

A Section 1602 Lake or Streambed Alteration Agreement (LSA Agreement) is anticipated to be required for the project due to work within CDFW's jurisdiction which could substantially adversely affect an existing fish or wildlife resource. CDFW will include measures in the LSA Agreement to protect fish and wildlife resources including administrative measures, avoidance and minimization measures, and reporting measures.

DATA REQUIRED: The LSA Agreement application should include a project description, discussion of avoidance and minimization of impacts, a wetland delineation, impacts to sensitive plants and wildlife, a copy of the CEQA document, the application filing/processing fee, all associated figures (vicinity maps, project site map, construction/grading cross sections, mitigation area, etc.), and copies of the wetlands permit application submitted to the Corps and RWQCB.

ANALYSIS REQUIRED: Analysis by CDFW is required when it determines the activity may substantially adversely affect existing fish or wildlife resources. The LSA Agreement includes measures necessary to protect existing fish and wildlife resources. Negotiation with CDFW may include CDFW staff suggesting project modifications that would eliminate or reduce harmful impacts to fish and wildlife resources. Documentation of compliance with CEQA is required before CDFW can issue a LSA Agreement.

FEES: CDFW fees are determined based on the cost of Project work within CDFW jurisdiction.

RELATED LAWS

- California Endangered Species Act:Take of species listed as endangered, threatened, candidate, threatened, endangered (or state rare in the case of plants), may be authorized by CDFW under Section 2081(b) of the California Fish and Game Code if that take is incidental to otherwise lawful activities and if certain conditions are met. No state-listed species have been identified at the Preserve; two California species of special concern have been identified: Monterey dusky-footed woodrat and past observations of Monarch butterfly winter roosts.

Coastal Development Permit

A 5-year permit for park maintenance and management activities was approved by the California Coastal Commission (CCC) in 1997 to implement recommendations of the Master Plan. The primary maintenance activities included removal of invasive vegetation; trail consolidation or extension; and stream channel maintenance involving removal of obstructions to natural stream flow and placement of very limited rock slope protection (rip-rap) to reduce erosion.

The City's Local Coastal Program (LCP) was certified in 2004, which gave the City has authority to issue a Coastal Development Permit (CDP) for private or public projects within the City's coastal zone. The Mission Trail Nature Preserve Master Plan was incorporated into the City's General Plan/LCP. In 2016, the City approved a CDP for a five-year, renewable CDP for maintenance work in the Preserve in accordance with the Mission Trail Nature Preserve Master Plan. The CDP provides authorization for regular maintenance activities such as road clearance, hazardous tree removal, mowing and trail maintenance, as well as invasive species removal. The scope of the CDP also includes stream bank repair and removal of debris or fallen trees in stream channels as needed.

Most of the Preserve is identified as an "environmentally sensitive habitat area" (ESHA), including the following: Monterey pine forest; central coast arroyo willow riparian forest; coastal terrace prairie; wet meadow; and known occurrences of special-status plant and wildlife species, including Monterey dusky footed woodrat, which is a state and/or federal species of special concern (Carmel-by-the-Sea, June 2003).

Preliminary discussions with City Community Planning and Building Department staff indicate that the City would be responsible for issuing a CDP for recommended projects. Once the recommendations are finalized, they can be reviewed with the City's Community Planning and Building Department to determine if any actions would fall under the existing 5-year CDP that authorizes specified maintenance

activities, although it appears that most recommendations would not fall under the scope of regular maintenance activities.

Permitting Strategy

The permitting process can be streamlined if projects can be grouped together in one application. Design plans will be needed for all of the required permit applications. The first step would be to coordinate and facilitate agency pre-application consultation. The ACOE holds monthly inter-agency pre-application meetings and invites federal and state agencies, including CDFW and RWQCB. This meeting provides an initial opportunity to review the project with the agencies and understand agency concerns and/or permit requirements, so they are addressed in the permit application package. It also allows ACOE staff and other relevant agencies to provide direction on important project elements, such as methods and timing of work, avoidance and minimization measures, and other construction and post-construction Best Management Practices. The City would then be in the position to develop Project materials that address these concerns in advance to aid in streamlining agency review and processing of the applications.

IMPLEMENTATION AND PRELIMINARY CONSIDERATIONS FOR PRIORITIZATION

Project implementation order may be influenced by numerous factors, including but not limited to project benefits, implementation and maintenance budgets, permit considerations, land ownership, or risk. The following observations are provided for consideration and discussion.

- Projects #1 and #3 are low risk, and are straightforward in terms of design, permitting, and implementation. However, Project #3 should not proceed without Project #1. The flows routed from the realigned tributary drainage at Project #3 would otherwise exacerbate flooding in the area of Project #1.
- Project #2 provides seasonal access improvements, but is not “necessary” given that there are alternate access routes and this project could be considered lower priority. However, implementation of Project #3 would worsen existing conditions at Site #2 if project #2 was not implemented. In the absence of this improvement, seasonal closures of this informal trail could be implemented.
- Project #4 can be considered a stand-alone project. Design and implementation should be straightforward. This project is not dependent on any other projects. Delaying this project would not introduce significant additional risk. Removal of a portion of the concrete ford and restoration of the creek would be a positive habitat/resource enhancement. Project #4 includes cast in place concrete and structural work, and it may be advantageous to combine with Site #6.
- Project #5 is a stand-alone project. Delayed implementation of #5 may lead to loss of a few existing mature trees and/or additional maintenance or repairs to the adjacent road. The feasibility of this project should be verified with additional topographic and tree location surveys to evaluate re-alignment options to minimize/avoid riparian habitat and construction-related impacts. Given the scale, permitting and mitigation requirements could be more complex for this project than the other recommendations. If a preferable alignment is not identified near the

proposed location shown, in-place enhancements such as riffle-augmentation (i.e., raise channel in place) may be preferable.

- Project #6 is expensive and relatively complex, but is important to prevent ongoing channel incision, bank erosion, and potential failure of the existing bridge. Thus, this one of the most critical projects.
- The relative priority of Project #7 is difficult to determine without an accurate boundary survey. This project appears relatively simple to design and implement, but may be entirely outside the City's ownership and would primarily benefit the adjacent private property.
- The grade control features located within the upstream reach identified as Site #8 are in varying levels of disrepair. The long profile survey identified over fifteen individual constructed grade control structures. As these structures degrade, the channel will continue to erode. Ideally, this reach should be treated as a whole, based on the outcome of a detailed study that evaluates risk to adjacent homes. This is a complex project that may require a longer planning schedule. Aside from the discontinuity at site #6, the profile within this reach is a relatively straight grade. We did not observe one site that presented itself as a higher priority in need of immediate attention.

Preliminary Recommendations for Project Implementation Sequencing

Based on our understanding of opportunities and constraints and the City's expressed goals, we have provided the following preliminary recommendations for implementation order. We have divided the projects into two general categories based on whether they primarily provide maintenance or risk reduction versus ecological restoration or park enhancement. Several of the projects (e.g., project 3) address both risk reduction and restoration or enhancement goals.

Table 4: Risk Reduction and Repair Projects

PRIORITY	PROJECT SITE	FACTORS INFLUENCING RANKING
1	1	SIGNIFICANT FUNCTIONAL IMPROVEMENT TO HIGH USE AREA. PROJECT IS REQUIRED IN ORDER TO IMPLEMENT #3. RELATIVELY LOW COST AND EASE OF PERMITTING.
2	3	REDUCES MAINTENANCE REQUIREMENTS AND IMPROVES FUNCTIONALITY OF TRAIL/ROAD. PROVIDES ECOLOGICAL ENHANCEMENTS IN ADDITION TO REDUCED MAINTENANCE. LOW COST AND EASE OF PERMITTING.
3	6	PROJECT PROVIDES SIGNIFICANT RISK REDUCTION AGAINST FUTURE EROSION, BUT COMES AT HIGH COST. THERE REMAINS UNCERTAINTY REGARDING LAND OWNERSHIP.
4	8	PROJECT PROVIDES GREAT BENEFITS AND RISK REDUCTION, BUT THERE IS A SIGNIFICANT AMOUNT OF PLANNING AND COORDINATION REQUIRED GIVEN THE MULTIPLE LAND OWNERS INVOLVED.

Table 5: Restoration and Enhancement Projects

RECOMMENDED IMPLEMENTATION ORDER	PROJECT SITE	FACTORS INFLUENCING RANKING
1	5	Appears to provide greatest ecological benefit and is time-dependent due to threat to existing trees.
2	4	Provides significant ecological benefits as well as functional, safety, and aesthetic improvements. Project is not time-dependent since the damage here has already been done.
3	2	Provides recreational enhancement and possibly some ecological improvements, but not to the extent of other projects.

PROJECT COSTS

Preliminary Engineer's Construction Cost Estimates are provided below in Table 6. Since project designs have only been developed to a concept level of detail, these estimates should be considered to represent "order of magnitude" values. Estimates are based on the scope and details reflected in the concept designs, and reflect our experience on recently completed projects of similar scale and complexity. The prices do not reflect cost savings that might be realized if individual projects were grouped to reduce mobilization, administrative, and related costs. The prices assume prevailing wage. Actual costs may vary considerably, given the significant number of unknowns at the concept level.

The cost of Project #8 cannot be estimated until further analysis is completed to determine the appropriate scale of the repair work required, which will vary based on geologic/geotechnical considerations, land ownership, and risk. Costs have been estimated for that analysis.

The cost of environmental review (CEQA) and regulatory permitting would be an additional cost if the City elects to hire a consultant for these tasks rather than complete with City staff. It is likely that categorical exemptions could be used for most recommendations. Permitting includes preparation of application and application materials, and likely will require technical reports including biological resources and cultural resources evaluations, and a formal jurisdictional delineation. Costs for permitting can typically range from $20,000 to $35,000 or more depending on the extent of needed biological reviews. Costs could be higher for Project #5, which would likely require a mitigation and restoration plan with multi-year monitoring for revegetation along a realigned channel.

Table 6: Project Design and Implementation Costs

		APPROXIMATE COSTS	
PROJECT AREA	PROJECT COMPONENTS	DESIGN	IMPLEMENTATION & ESTABLISHMENT
1 (Alt 1)	RAISE ENTRANCE ROAD, INSTALL NEW CULVERT BELOW ENTRANCE ROAD, CONSTRUCT OPEN SWALE TO CREEK	$17,000	$90,000
1 (Alt 2)	RAISE ENTRANCE ROAD, INSTALL NEW CULVERT BELOW ENTRANCE ROAD, CONSTRUCT PIPE TO CREEK	$17,000	$95,000
1 (Alt 3)	RAISE ENTRANCE ROAD, INSTALL NEW CULVERT BELOW ENTRANCE ROAD	$15,000	$75,000
2	CONSTRUCT APPROX. 100 LF PEDESTRIAN BOARDWALK	$8,000	$40,000
3	INSTALL CULVERT OR ROCKED FORD AND REALIGN TRIBUTARY DRAINAGE, INSTALL SMALL DITCH CULVERT AND PERFORM DITCH MAINTENANCE	$7,500	$22,500
4	DEMOLISH PORTION OF EXISTING FORD, RESTORE DOWNSTREAM REACH OF CHANNEL, REALIGN TRAIL, CONSTRUCT PEDESTRIAN BRIDGE, RESTORE OLD TRAIL ALIGNMENT	$17,500	$100,000
5	REALIGN APPROX. 700 LF OF CHANNEL. RESTORE OLD CHANNEL BED, REVEGETATE DISTURBED AREAS	$27,500	$300,000
6	REPLACE EXISTING UNDERSIZED BRIDGE, RESTORE DOWNSTREAM CHANNEL AND ARMOR REACH TO PREVENT FURTHER INCISION UPSTREAM	$25,000	$230,000
7	REMOVE EXISITING WEIR, LOWER CHANNEL, STABILIZE NEW CHANNEL BED AND BANKS	$9,500	$30,000
8	PERFORM BOUNDARY SURVEY, DETAILED TOPOGRAPHY, GEOLOGIC & GEOTECHNICAL INVESTIGATION. PRIORITIZE A PHASED REPAIR PLAN, AND PREPARE PRELIMINARY AND FINAL DESIGNS FOR GRADE CONTROL.	$50,000	N/A

Attachment A: Site Plans and Details

SITE #8. HEADCUTS IN UPPER REACHES. STATIONS: 22+50 – 39+00

SITE #7. FLOODING AT STATION 25+50

SITE #6. BRIDGE REPLACEMENT AND HEADCUT MITIGATION AT CONFLUENCE. REPLACE EXISTING UNDERSIZED BRIDGE AND AGGRADE DOWNSTREAM CHANNEL TO MITIGATE INCISION PER DETAILED SITE PLAN AREA 4 SHEET C6

SITE #5. BANK EROSION ALONG SIERRA TRAIL. POTENTIAL CHANNEL REALIGNMENT TO PROTECT EXISTING TREES, REDUCE EROSION AND RESTORE FLOODPLAIN PROCESSES PER CROSS SECTION 1 SHEET C7

SITE #4. CONCRETE FORD AND TRAIL RE-ROUTE. INSTALL PEDESTRIAN BRIDGE, REALIGN TRAIL, AND REMOVE PORTION OF EXISTING CONCRETE FORD PER DETAILED SITE PLAN AREA 3 SHEET C5

SITE #3. TRIBUTARY CROSSING AND TRAIL JUNCTION. REALIGN TRIBUTARY DRAINAGE PER DETAILED SITE PLAN AREA 2 SHEET C4

SITE #2. INSTALL PEDESTRIAN BOARDWALK, PER CROSS-SECTION 1 SHEET C7

SITE #1. PARK ENTRANCE AT RIO. RAISE ROAD SURFACE AND INSTALL NEW STORM DRAIN, PER DETAILED SITE PLAN AREA 1 SHEET C3 + C3A

SITE OVERVIEW
SCALE: 1" = 100'

LEGEND

- EXISTING CONTOURS (BY OTHERS)
- EXISTING CREEK ALIGNMENT
- PRIMARY CREEK TRIBUTARIES
- PRIMARY VEHICULAR ACCESS PATH
- EXISTING TRAIL (BY OTHERS)
- EDGE OF PAVEMENT
- PROJECT PARCEL BOUNDARY (BY OTHERS)
- STORM DRAIN LINE
- STORM DRAIN MANHOLE
- POTENTIAL CHANNEL REALIGNMENT

SHEET INDEX

ABBREVIATIONS

CC	CONCRETE
CMP	CORRUGATED METAL PIPE
DIA.	DIAMETER
E	EXISTING
ELEV.	ELEVATION
ETW	EDGE OF TRAVELED WAY
FL	FLOWLINE
INV.	INVERT
TWG	THALWEG
TYP.	TYPICAL

TREE SPECIES

CYP	CYPRESS
EUC	EUCALYPTUS
P	PINE
R	REDWOOD

GENERAL NOTES

1. TOPOGRAPHIC MAPPING WAS PERFORMED BY:
   WATERWAYS CONSULTING, INC.
   509A SWIFT STREET
   SANTA CRUZ, CA 95060
   SURVEY DATES: AUGUST 29, SEPTEMBER 12, 21, 25 2018.
2. ELEVATION DATUM: GPS TIES TO NAVD88 USING THE LEICA GEOSYSTEMS SMARTNET GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) NETWORK.
3. BASIS OF BEARINGS: GPS TIES TO NAD83 CALIFORNIA STATE PLANE, ZONE 3 USING THE LEICA GEOSYSTEMS SMARTNET GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) NETWORK.
4. LIDAR DATA SOURCE:
   CITY OF CARMEL-BY-THE-SEA.
5. THIS IS NOT A BOUNDARY SURVEY. PARCEL BOUNDARY AND ROAD RIGHT OF WAY SHOWN ARE FOR REFERENCE ONLY. SOURCE:
   CITY OF CARMEL-BY-THE-SEA.

SECTION AND DETAIL CONVENTION

SECTION OR DETAIL IDENTIFICATION (NUMBER OR LETTER)

5
C2|C3

REFERENCE SHEET FROM WHICH DETAIL OR SECTION IS TAKEN.

REFERENCE SHEET ON WHICH SECTION OR DETAIL IS SHOWN.

WATERWAYS CONSULTING INC.
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PH:(831)421-9291 // FAX:(888)819-6847
WWW.WATWAYS.COM

PRELIMINARY
NOT FOR CONSTRUCTION

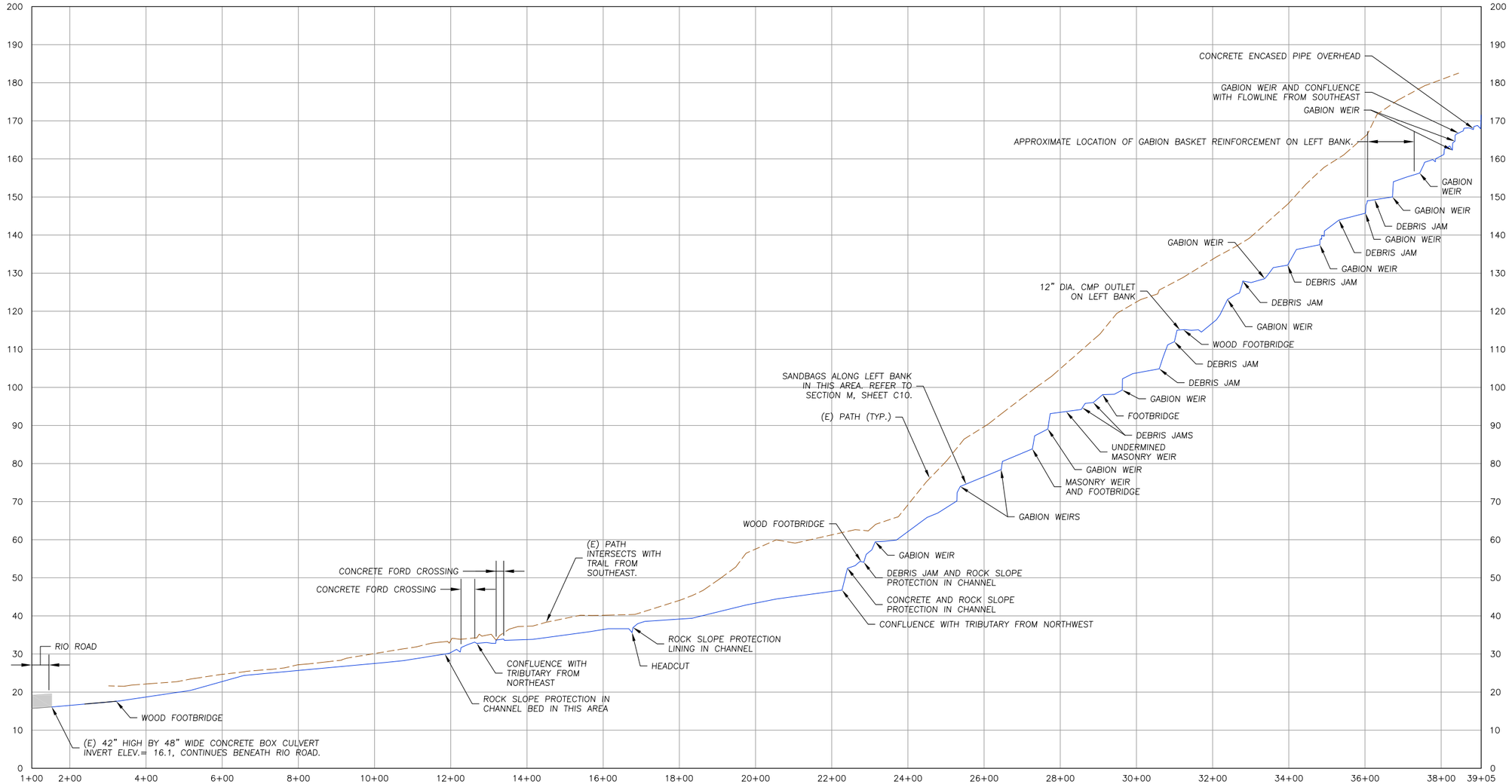
PREPARED AT THE REQUEST OF:
CITY OF
CARFMEL-BY-THE-SEA

OVERVIEW

MISSION NATURE TRAIL STREAM CHANNEL STABILITY STUDY

DESIGNED BY:	–
DRAWN BY:	S.R.
CHECKED BY:	M.W.W.
DATE:	10/10/18
JOB NO.:	18-028

BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"



PROFILE
SCALE: 1" = 150'H ; 1" = 15'V

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PREPARED AT THE REQUEST OF:
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PROFILE

MISSION NATURE TRAIL
STREAM CHANNEL
STABILITY STUDY

DESIGNED BY:	–
DRAWN BY:	S.R.
CHECKED BY:	M.W.W.
DATE:	10/10/18
JOB NO.:	18-028

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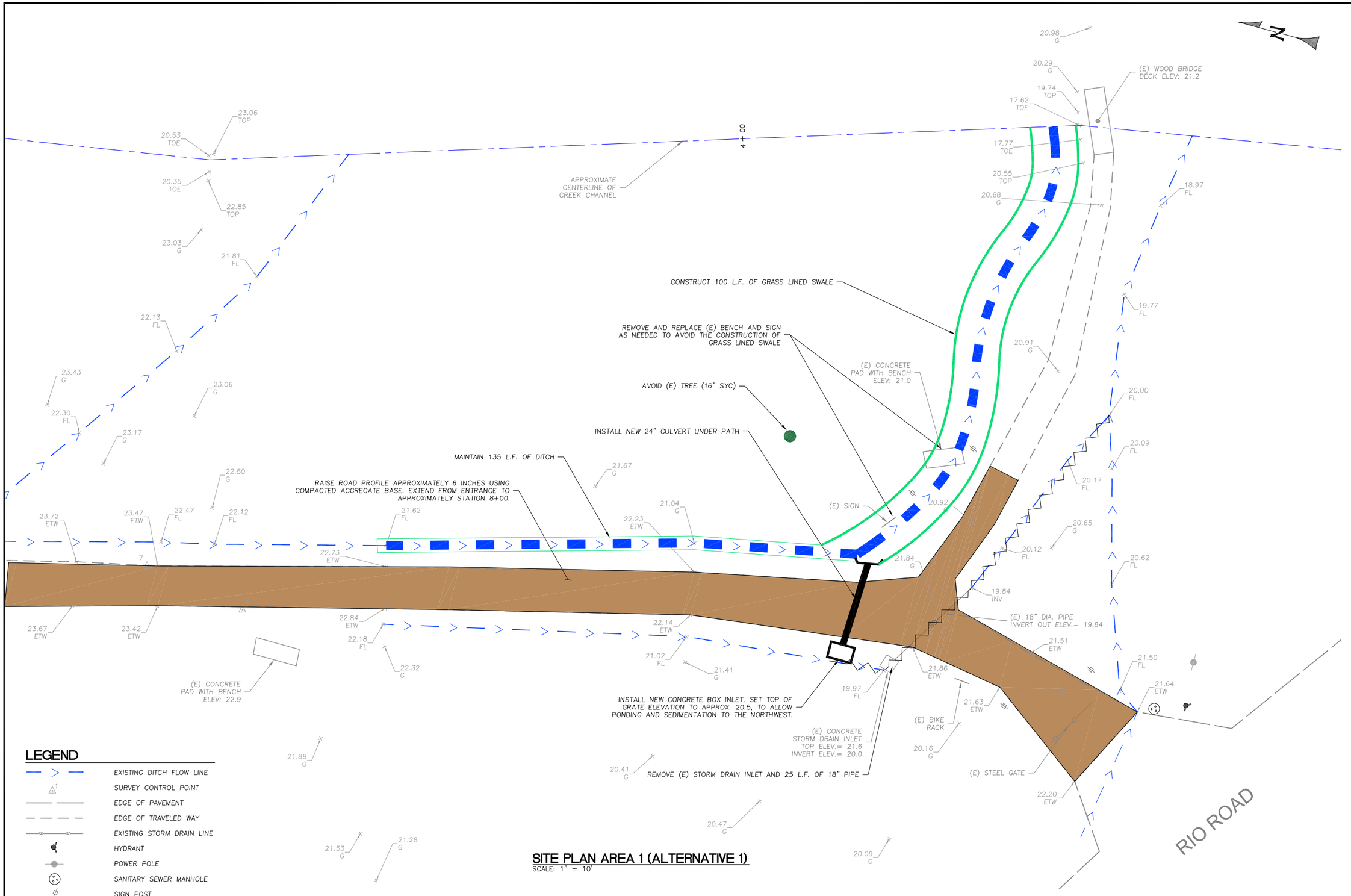
0 1"



LEGEND

- EXISTING DITCH FLOW LINE
- SURVEY CONTROL POINT
- EDGE OF PAVEMENT
- EDGE OF TRAVELED WAY
- EXISTING STORM DRAIN LINE
- HYDRANT
- POWER POLE
- SANITARY SEWER MANHOLE
- SIGN POST

SITE PLAN AREA 1 (ALTERNATIVE 1)

SCALE: 1" = 10'

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SITE PLAN
AREA 1
ALTERNATIVE 1

MISSION NATURE TRAIL
STREAM CHANNEL
STABILITY STUDY

DESIGNED BY:	–
DRAWN BY:	S.R.
CHECKED BY:	M.W.W.
DATE:	10/10/18
JOB NO.:	18-028

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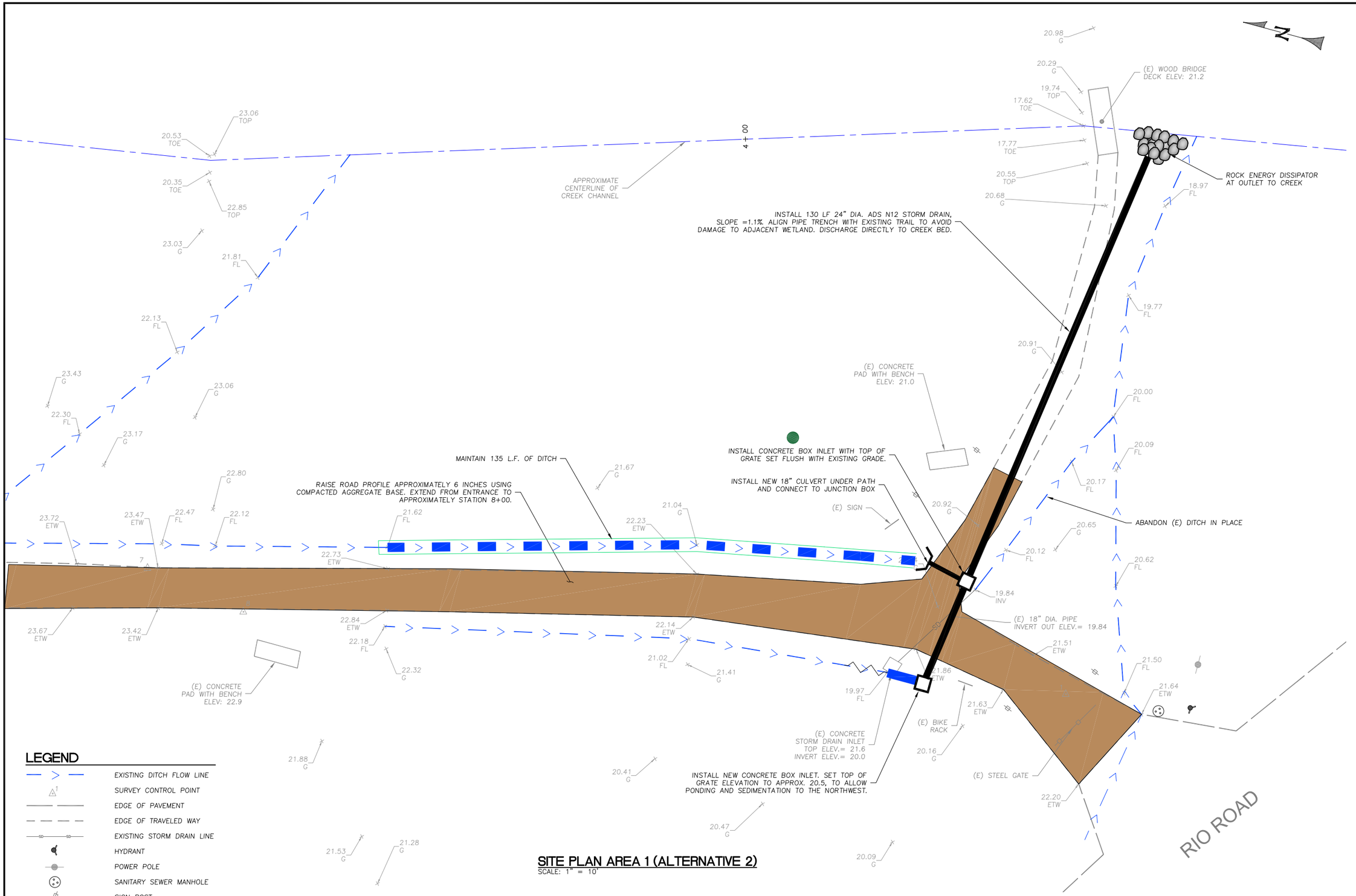
0 1"

C3 | 3 OF 12



SITE PLAN AREA 1 (ALTERNATIVE 2)

SCALE: 1" = 10'

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NOT FOR CONSTRUCTION

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CARMEL-BY-THE-SEA

SITE PLAN
AREA 1
ALTERNATIVE 2

MISSION NATURE TRAIL
STREAM CHANNEL
STABILITY STUDY

DESIGNED BY:	M.W.W.
DRAWN BY:	S.R.
CHECKED BY:	M.W.W.
DATE:	10/10/18
JOB NO.:	18-028

BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"

LEGEND

- EXISTING DITCH FLOW LINE
- SURVEY CONTROL POINT
- EDGE OF TRAVELED WAY
- SANITARY SEWER MANHOLE
- EXISTING TREE

REALIGN EXISTING DITCH TO CONFORM TO NEW CULVERT INLET

INSTALL 24" DIA.CULVERT. EXTEND OUTLET TO LOW GROUND TO THE SOUTHWEST, AS SHOWN. ALTERNATIVELY, USE A ROCKED FORD CROSSING TO MINIMIZE FILL REQUIREMENTS.

FILL EXISTING DITCH AND RAISE PATH PROFILE LOCALLY

RAISE EXISTING THROUGHWAY BY 18"

NOTE: DISCHARGE FROM CULVERT WILL NOW FLOW SOUTH TO NEW BOX INLET AT PARK ENTRANCE.

CONSTRUCT LOW EARTHEN BERM TO REFLECT DRAINAGE (IF ROCKED FOR ALTERNATIVE IS SELECTED IN LIEU OF PIPE).

REALIGN DITCH TO CONFORM TO CULVERT OUTLET

THIS PORTION OF DITCH IS CURRENTLY PERFORMING WELL

EXCAVATE DITCH LINE TO REMOVE ACCUMULATED SEDIMENT. REMOVE EXISTING EARTHEN BERM ALONG WEST SIDE OF DITCH SO THAT PONDED WATER CAN MIGRATE TO THE WEST IF NECESSARY.

INSTALL 18" DIAMETER BY 30 LF CULVERT TO CONVEY DITCH LINE FROM NORTH TO SOUTH UNDER PATH. RAISE PATH LOCALLY TO PROVIDE NECESARY COVER.

PERFORM DITCH MAINTENANCE TO REESTABLISH DRAINAGE.

SITE PLAN AREA 3

SCALE: 1" = 10'

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WWW.WATWAYS.COM

PRELIMINARY
NOT FOR CONSTRUCTION

PREPARED AT THE REQUEST OF:
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SITE PLAN
AREA 3

MISSION NATURE TRAIL
STREAM CHANNEL
STABILITY STUDY

DESIGNED BY:	–
DRAWN BY:	S.R.
CHECKED BY:	M.W.W.
DATE:	10/10/18
JOB NO.:	18-028

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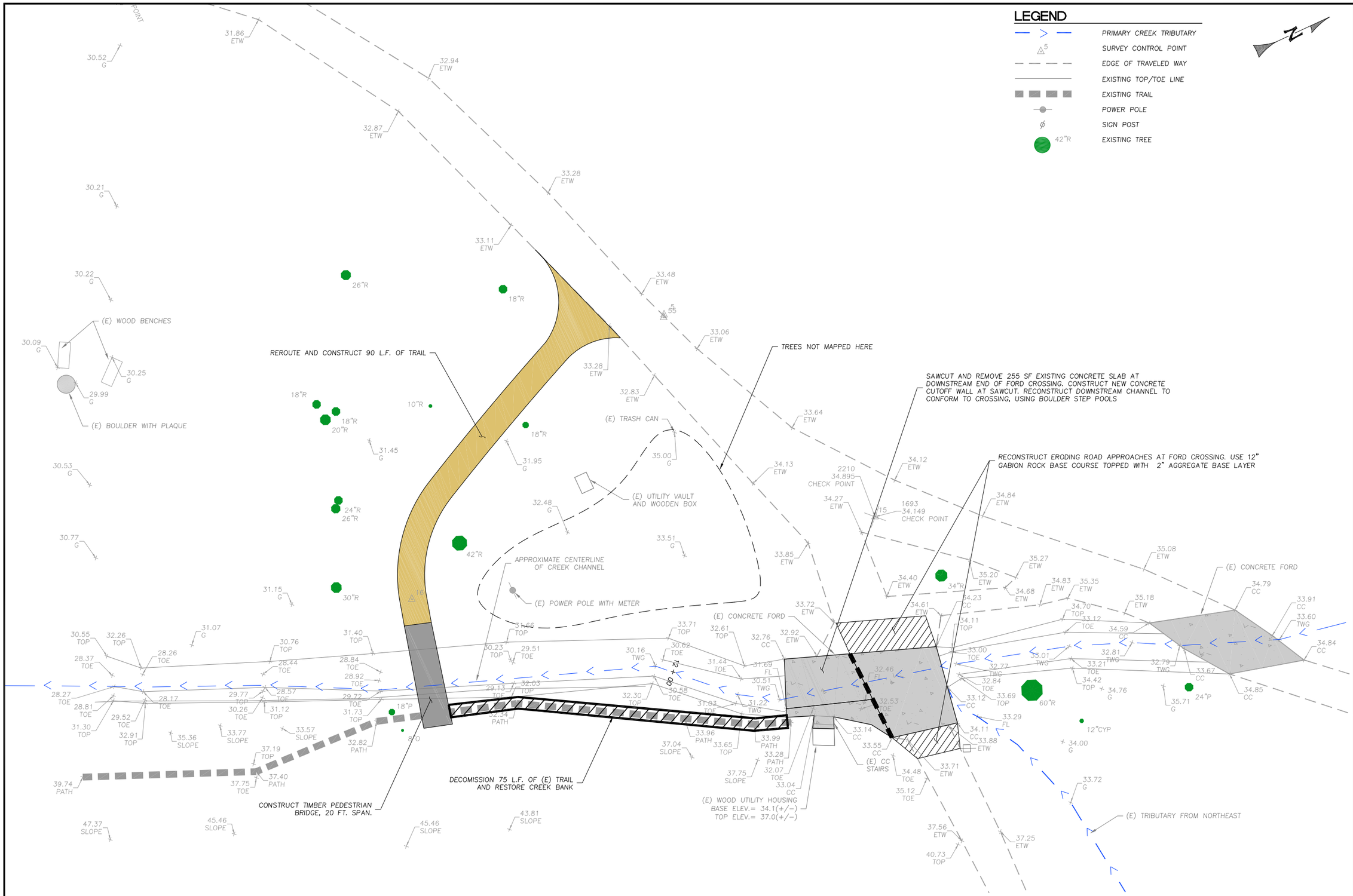
0 1"



SITE PLAN AREA 4
SCALE: 1" = 10'

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PH:(831)421-9291 // FAX:(888)819-6847
WWW.WATWAYS.COM

PRELIMINARY
NOT FOR CONSTRUCTION

PREPARED AT THE REQUEST OF:
CITY OF
CARFMEL-BY-THE-SEA

SITE PLAN
AREA 4

MISSION NATURE TRAIL
STREAM CHANNEL
STABILITY STUDY

DESIGNED BY:	–
DRAWN BY:	S.R.
CHECKED BY:	M.W.W.
DATE:	10/10/18
JOB NO.:	18-028

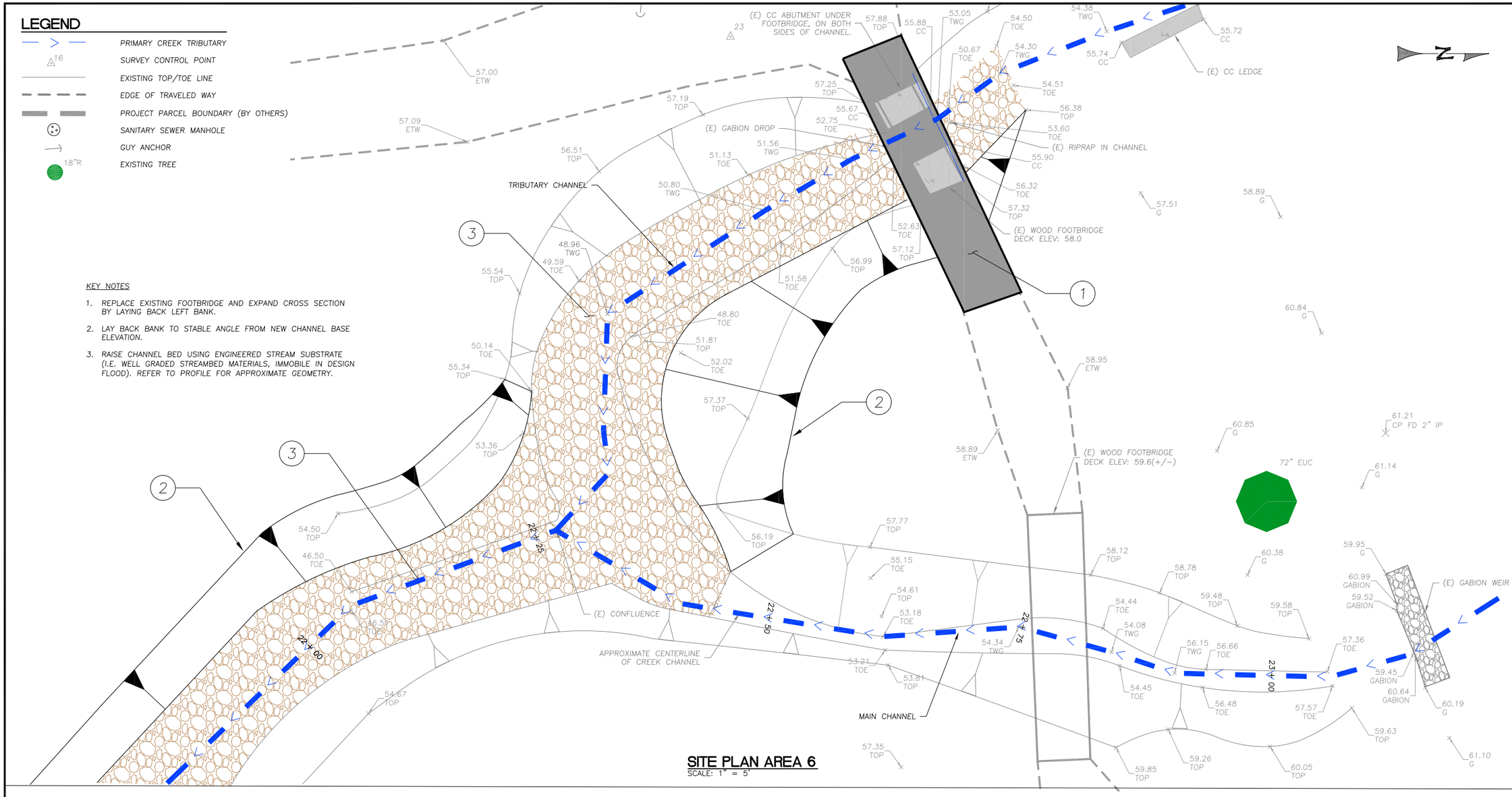
BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"

LEGEND

- PRIMARY CREEK TRIBUTARY
- SURVEY CONTROL POINT (16)
- EXISTING TOP/TOE LINE
- EDGE OF TRAVELED WAY
- PROJECT PARCEL BOUNDARY (BY OTHERS)
- SANITARY SEWER MANHOLE
- GUY ANCHOR
- EXISTING TREE (18"R)

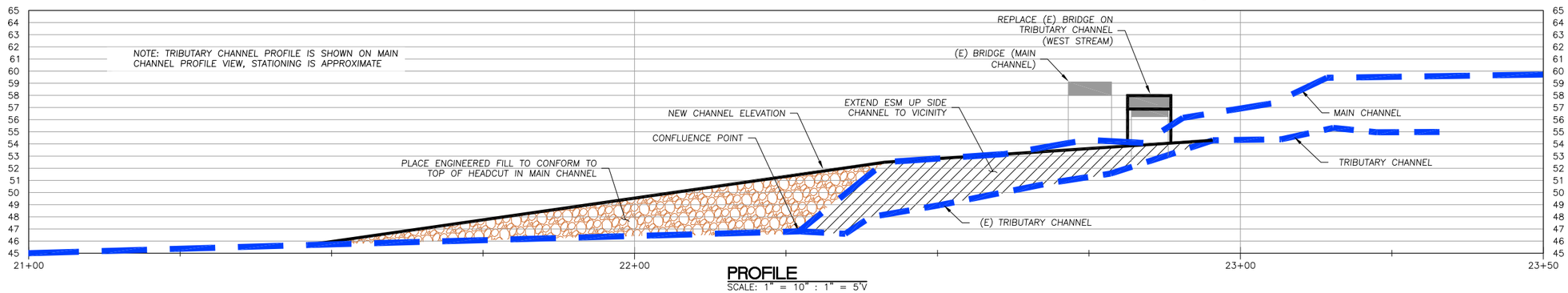
KEY NOTES

1. REPLACE EXISTING FOOTBRIDGE AND EXPAND CROSS SECTION BY LAYING BACK LEFT BANK.
2. LAY BACK BANK TO STABLE ANGLE FROM NEW CHANNEL BASE ELEVATION.
3. RAISE CHANNEL BED USING ENGINEERED STREAM SUBSTRATE (I.E. WELL GRADED STREAMBED MATERIALS, IMMOBILE IN DESIGN FLOOD). REFER TO PROFILE FOR APPROXIMATE GEOMETRY.



SITE PLAN AREA 6

SCALE: 1" = 5'



PROFILE

SCALE: 1" = 10' : 1" = 5'V

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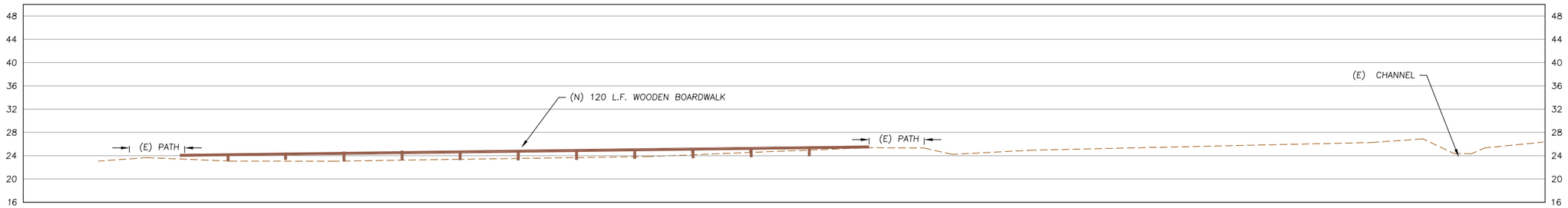
SITE PLAN
AREA 6

MISSION NATURE TRAIL
STREAM CHANNEL
STABILITY STUDY

DESIGNED BY:	–
DRAWN BY:	S.R.
CHECKED BY:	M.W.W.
DATE:	10/10/18
JOB NO.:	18-028

BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"

C6



SECTION
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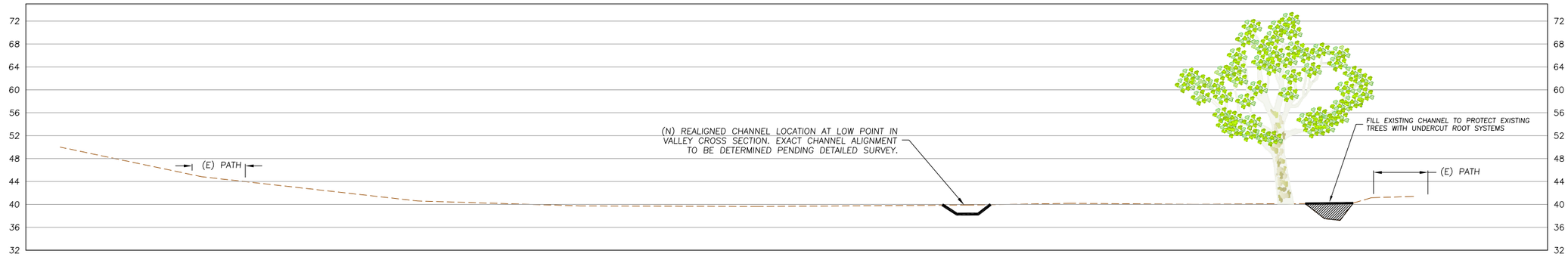
1 C1|C7



SECTION
SCALE: 1" = 10'
2 C1|C7

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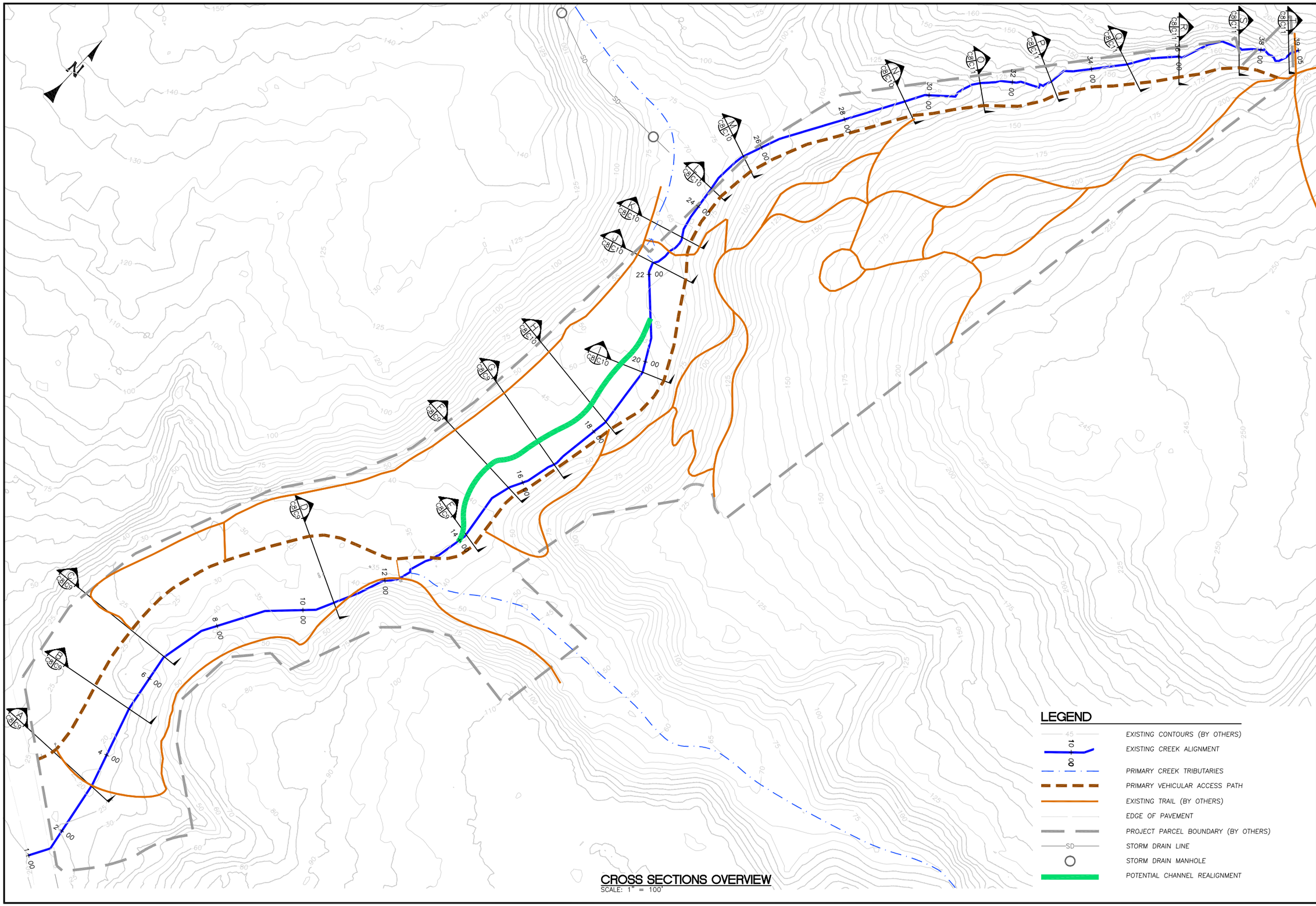
SECTIONS
(1 + 2)

MISSION NATURE TRAIL
STREAM CHANNEL
STABILITY STUDY

DESIGNED BY:	–
DRAWN BY:	S.R.
CHECKED BY:	M.W.W.
DATE:	10/10/18
JOB NO.:	18-028

BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"



CROSS SECTIONS OVERVIEW
SCALE: 1" = 100'

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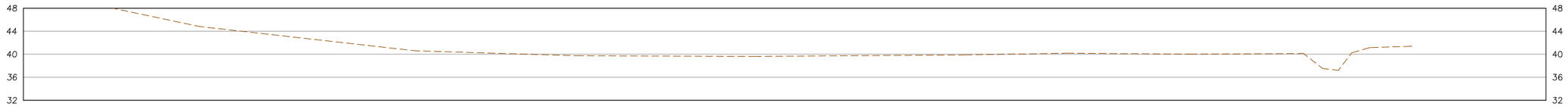
CROSS SECTIONS OVERVIEW

MISSION NATURE TRAIL STREAM CHANNEL STABILITY STUDY

DESIGNED BY:	–
DRAWN BY:	S.R.
CHECKED BY:	M.W.W.
DATE:	10/10/18
JOB NO.:	18-028

BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"



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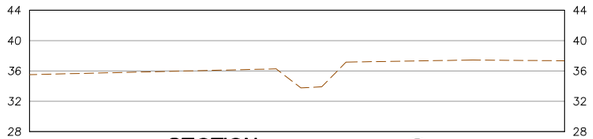
G C8 C9

SECTION
SCALE: 1" = 10'
F C8 C9



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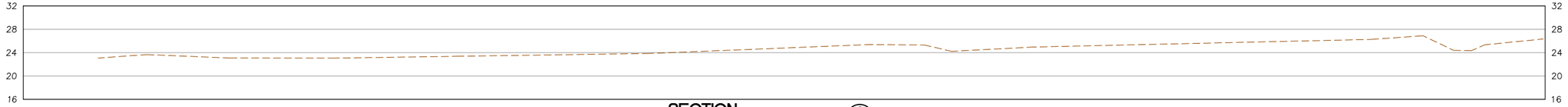
E C8 C9

SECTION
SCALE: 1" = 10'
D C8 C9



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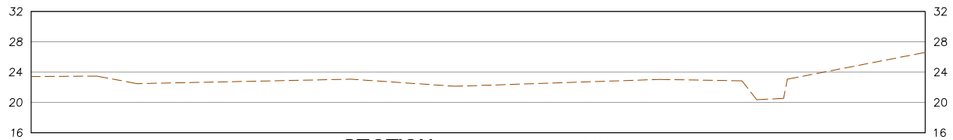
C C8 C9



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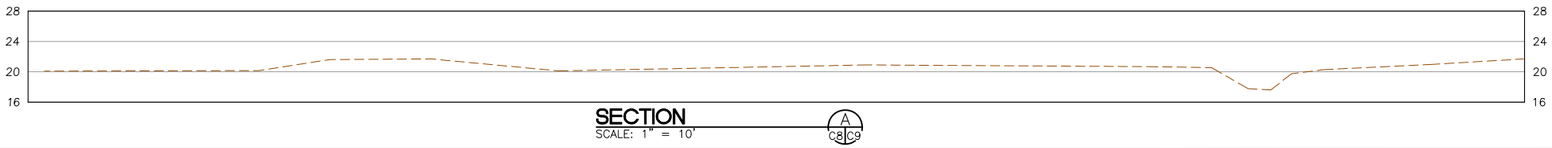

SECTION
SCALE: 1" = 10'
A C8 C9

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CROSS SECTIONS (A - G)

MISSION NATURE TRAIL
STREAM CHANNEL
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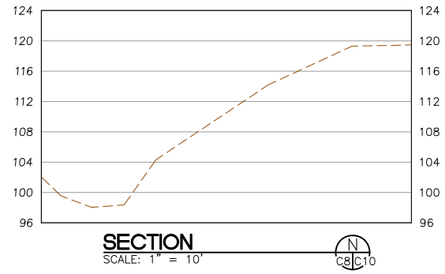
CHECKED BY:	M.W.W.
DATE:	10/10/18
JOB NO.:	18-028

BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"



SECTION
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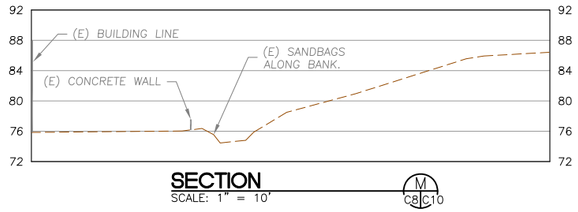
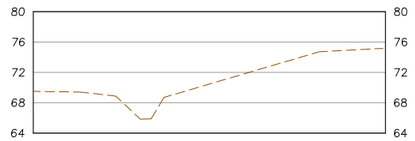


SECTION
SCALE: 1" = 10'
M C8 C10



SECTION
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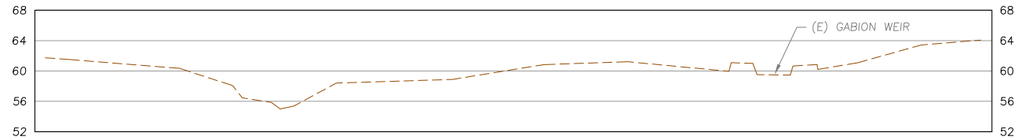
L C8 C10



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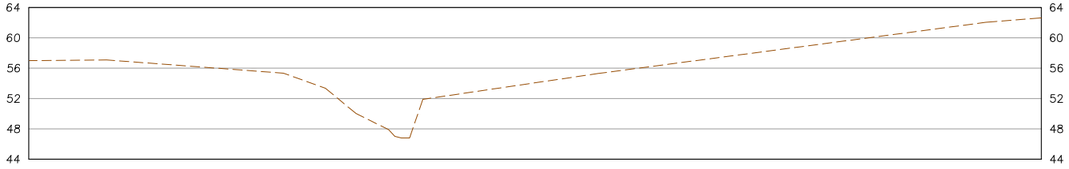

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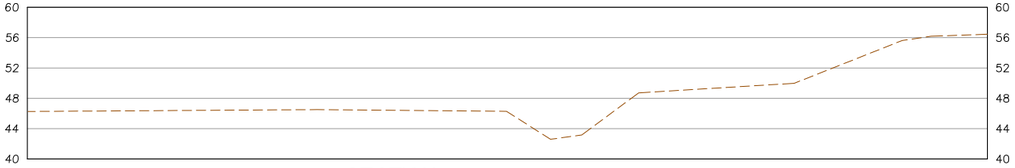

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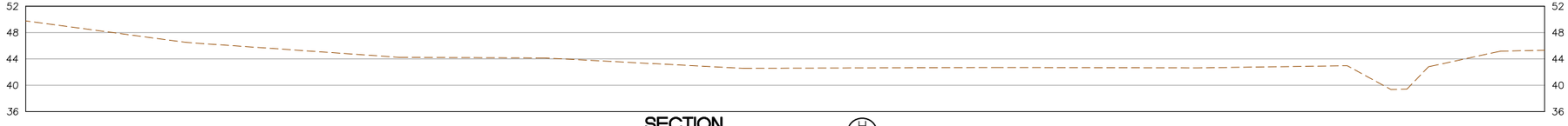

SECTION
SCALE: 1" = 10'
H C8 C10

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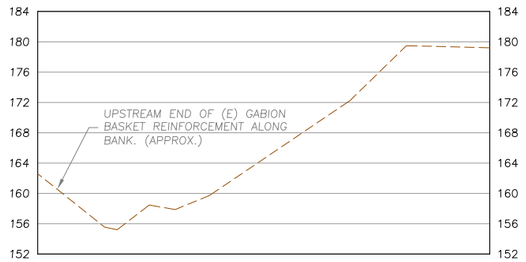
CROSS SECTIONS (H - N)

MISSION NATURE TRAIL
STREAM CHANNEL
STABILITY STUDY

DESIGNED BY: –
DRAWN BY: S.R.
CHECKED BY: M.W.W.
DATE: 10/10/18
JOB NO.: 18-028

BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"



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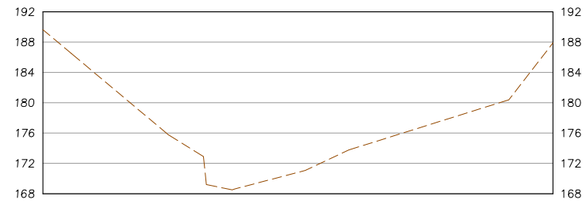

SECTION
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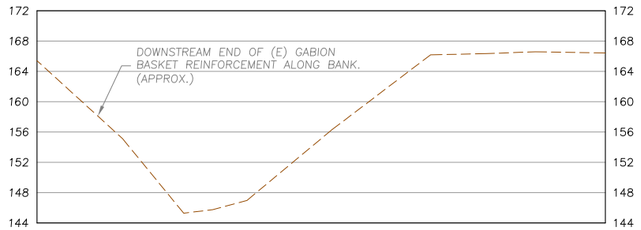

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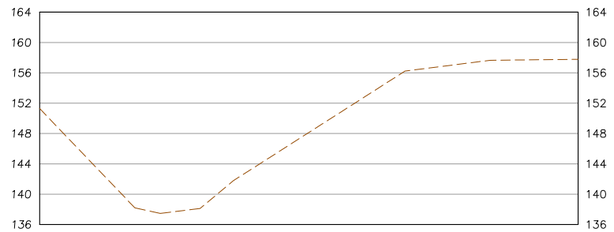

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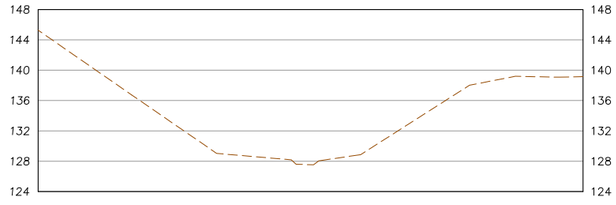
Q C8 C11



SECTION
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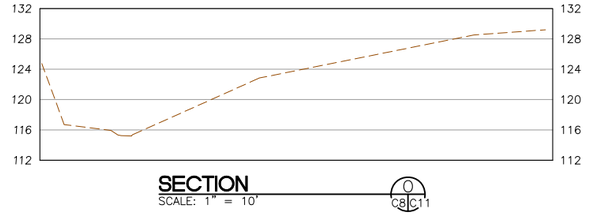
P C7 C11



SECTION
SCALE: 1" = 10'
O C8 C11

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CROSS SECTIONS (O - T)

MISSION NATURE TRAIL
STREAM CHANNEL
STABILITY STUDY

DESIGNED BY:	–
DRAWN BY:	S.R.
CHECKED BY:	M.W.W.
DATE:	10/10/18
JOB NO.:	18-028

BAR IS ONE INCH ON ORIGINAL DRAWING, ADJUST SCALES FOR REDUCED PLOTS
0 1"

Appendix 1: Hydrologic Modeling

MISSION TRAIL CREEK ASSESSMENT
STORMWATER BASIN MAP

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Basin O-1
Basin CAR-5
Basin O-2a
Basin O-2b
Basin CAR-8a
Basin CAR-8b
Basin CAR-8c
Basin 8d
Basin O-3
Basin O-4
Basin CAR-9
Basin CAR-10a
Basin CAR-10b
Basin CAR-10c

PIPE OUTFALLS TO CHANNEL
IN CHANNEL
IN PIPE
N CHANNEL
N PIPE
ROUTE VIA PIPE IN FUTURE

Jun-A
Jun-B
Jun-C
Jun-D
Jun-E

HWY 1 / CABRILLO HWY
VALLEY WAY
1ST AVE
CARPENTER ST
OCEAN AVE
FOREST RD
GUADALUPE ST
CRESPI AVE
VICENTE AVE
MOUNTAIN VIEW AVE
FLANDERS WAY
8TH AVE
7TH AVE
JUNIPERO ST
TORRES ST
SAN CARLOS ST
HATTON RD
MARTIN RD
MESA DR
TERRACE WAY
LADERA DR
11TH AVE
RIDGEWOOD RD
RIO ROAD
MISSION ST
SANTA LUCIA AVE
13TH AVE

LEGEND

- APPROXIMATE LOT LINES (FROM GIS)
- SUB-BASIN BOUNDARY
- CREEK ALIGNMENT (SURVEYED)
- Jun-X — POINT OF INTEREST LABEL
- DESC — FLOW ARROW INDICATING WHERE BASIN ENTERS SYSTEM IN MODEL (SEE AUTODESK STORM AND SANITARY ANALYSIS REPORT FOR MORE INFORMATION)

STORMWATER BASIN MAP

SCALE: 1" = 600'

BAR IS ONE INCH ON ORIGINAL DRAWING. ADJUST SCALES FOR REDUCED PLOTS

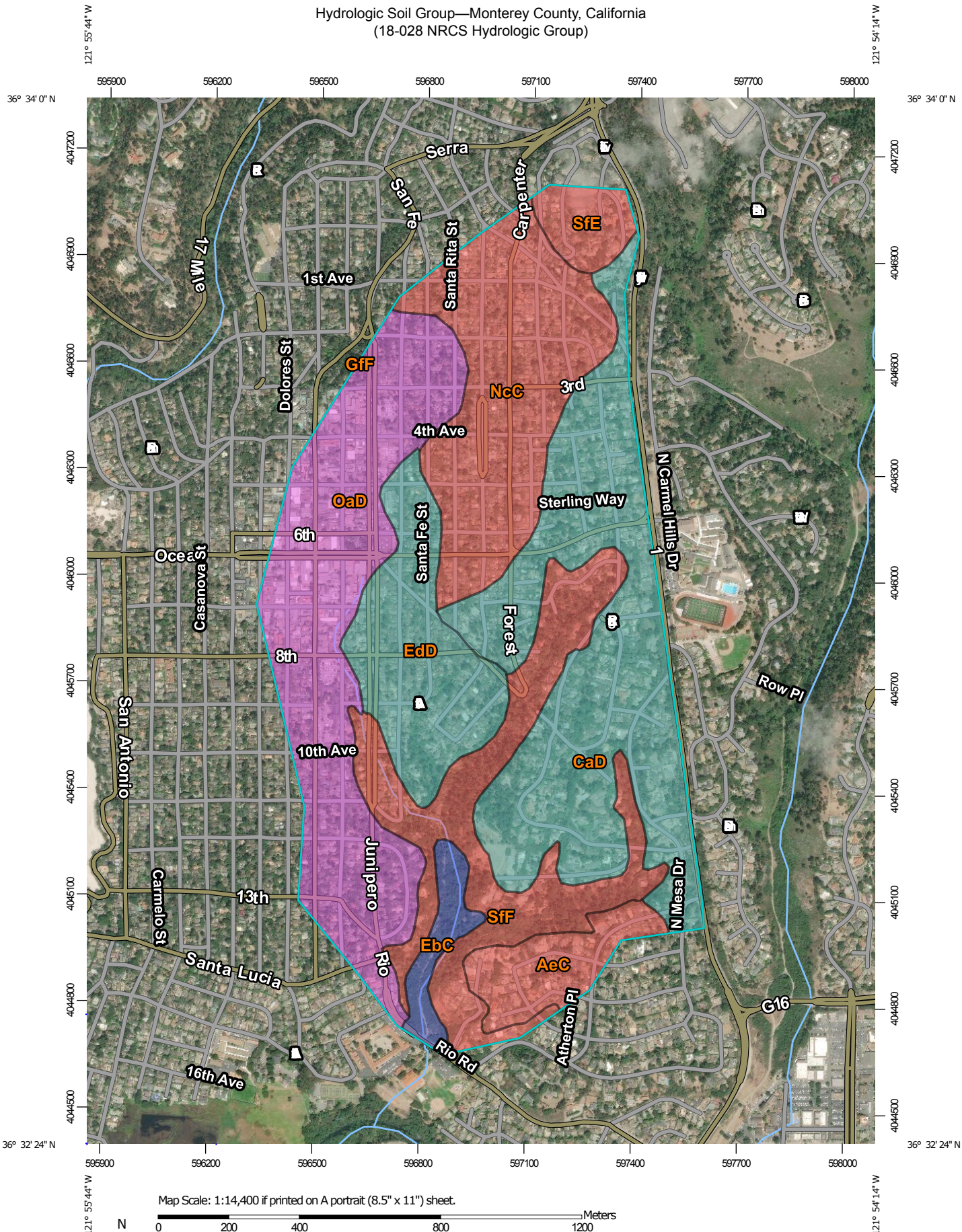
0 1"

FIGURE
1-A

Appendix 1-B:

NRCS Hydrologic Soil Report

Hydrologic Soil Group—Monterey County, California
(18-028 NRCS Hydrologic Group)



MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

Soil Survey Area: Monterey County, California
Survey Area Data: Version 15, Sep 17, 2018

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

Date(s) aerial images were photographed: Dec 31, 2009—Sep 15, 2017

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AeC	Antioch very fine sandy loam, 2 to 9 percent slopes	D	23.7	4.4%
CaD	Chamise channery loam, 9 to 15 percent slopes, MLRA 15	C	139.1	26.0%
EbC	Elder very fine sandy loam, 2 to 9 percent slopes	B	12.3	2.3%
EdD	Elkhorn fine sandy loam, 9 to 15 percent slopes	C	55.8	10.4%
GfF	Gazos silt loam, 30 to 50 percent slopes	C	0.1	0.0%
NcC	Narlon loamy fine sand, 2 to 9 percent slopes	D	88.6	16.5%
OaD	Oceano loamy sand, 2 to 15 percent slopes	A	124.4	23.2%
SfE	Santa Lucia channery clay loam, 15 to 30 percent slopes, MLRA 15	D	13.3	2.5%
SfF	Santa Lucia channery clay loam, 30 to 50 percent slopes, MLRA 15	D	78.2	14.6%
Totals for Area of Interest			**535.3**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Appendix 1-C:

Tables

Table 1: Mission Trail Stormwater Sub-Basin Curve Number Calculations

Discharge Point	Discharge Description	Sub-discharge Point	Basin	Area (sq.ft.)	Area (acre)	Hydrologic Soil Group	Pervious CN	% Developed	Developed Area CN	Average CN	Notes
-	Upstream end of aligment		O-1	2,106,429	48.36	C			83	83	Avg lot size 1/4 acre
Jun-A	Upstream end of steep section		CAR-8a	466,353	10.71	C/D			91	91	Avg lot size <1/8 acre
			O-2a	749,813	17.21	D	79	67%	87	84	Avg lot size 1/4 acre
			O-2b	911,780	20.93	C			83	83	Avg lot size 1/4 acre
Jun-B	Carmel outfall & downstream end of steep section		CAR-8b	1,228,697	28.21	Drainage: D Upland: C	79	50%	90	85	Avg lot size <1/8 acre
Jun-C	Little bridge		CAR-5	3,421,882	78.56	C/D			91	91	Avg lot size <1/8 acre
			CAR-8c	3,513,081	80.65	A/C			81	81	Avg lot size <1/8 acre
			CAR-8d	84,785	1.95	C/D			91	91	Avg lot size <1/8 acre
Jun-D	Bridge		CAR-9	834,223	19.15	Drainage: B Upland: D	60	38%	92	72	Avg lot size <1/8 acre
			CAR-O3	3,162,327	72.60	C			83	83	Avg lot size 1/4 acre
Jun-E	Downstream culvert/end of alignment	Area 2 culvert	CAR-10a	220,906	5.07	Drainage: B Upland: D	60	66%	92	81	Avg lot size <1/8 acre
		Area 1 culvert	CAR-10b	936,710	21.50	A	36	90%	77	73	Avg lot size <1/8 acre
			CAR-10c	549,567	12.62	Drainage: B Upland: D	60	50%	87	74	Avg lot size 1/4 acre
			O-4	340,815	7.82	D			87	87	Avg lot size 1/4 acre

Note: CN Values from Table 2-2a of USDA NRCS Urban Hydrology for Small Watershed TR-55

Table 2: Mission Trail Stormwater Flow Summary

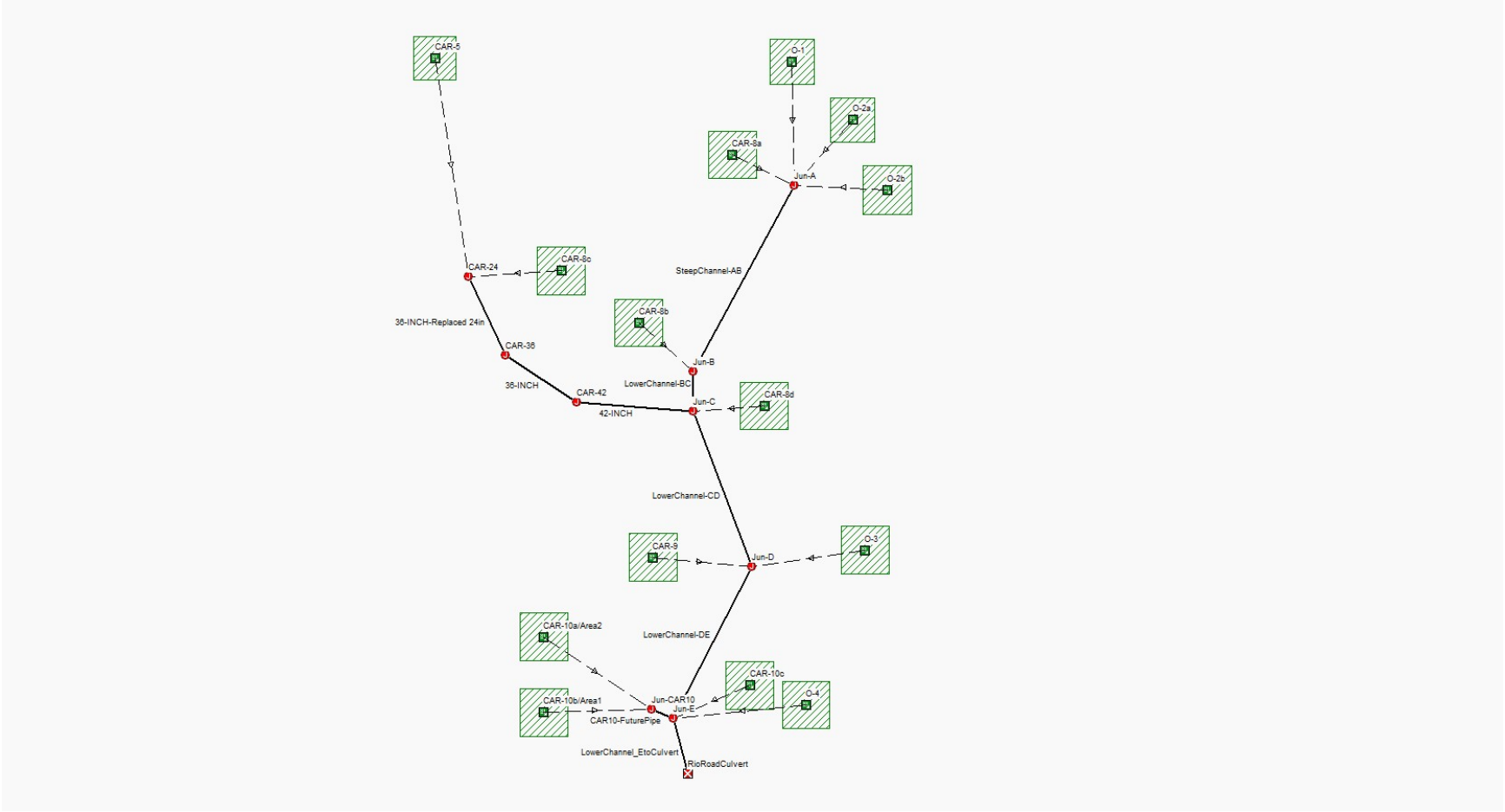
	Storm Event Peak flow (cfs)			
Point of Interest	**2-year**	**10-year**	**50-year**	**100-year**
Jun-A	6.09	27.71	42.09	46.36
Jun-B	8.04	35.80	54.39	59.91
Jun-C	27.02	97.31	142.13	155.30
Jun-D	30.65	117.23	174.08	190.87
Jun-E	31.28	124.10	186.31	204.81
Area 1	0.22	2.05	4.24	4.95
Area 2	0.18	1.22	1.95	2.16
Area 1 & 2 Combined	0.32	3.21	6.18	7.11

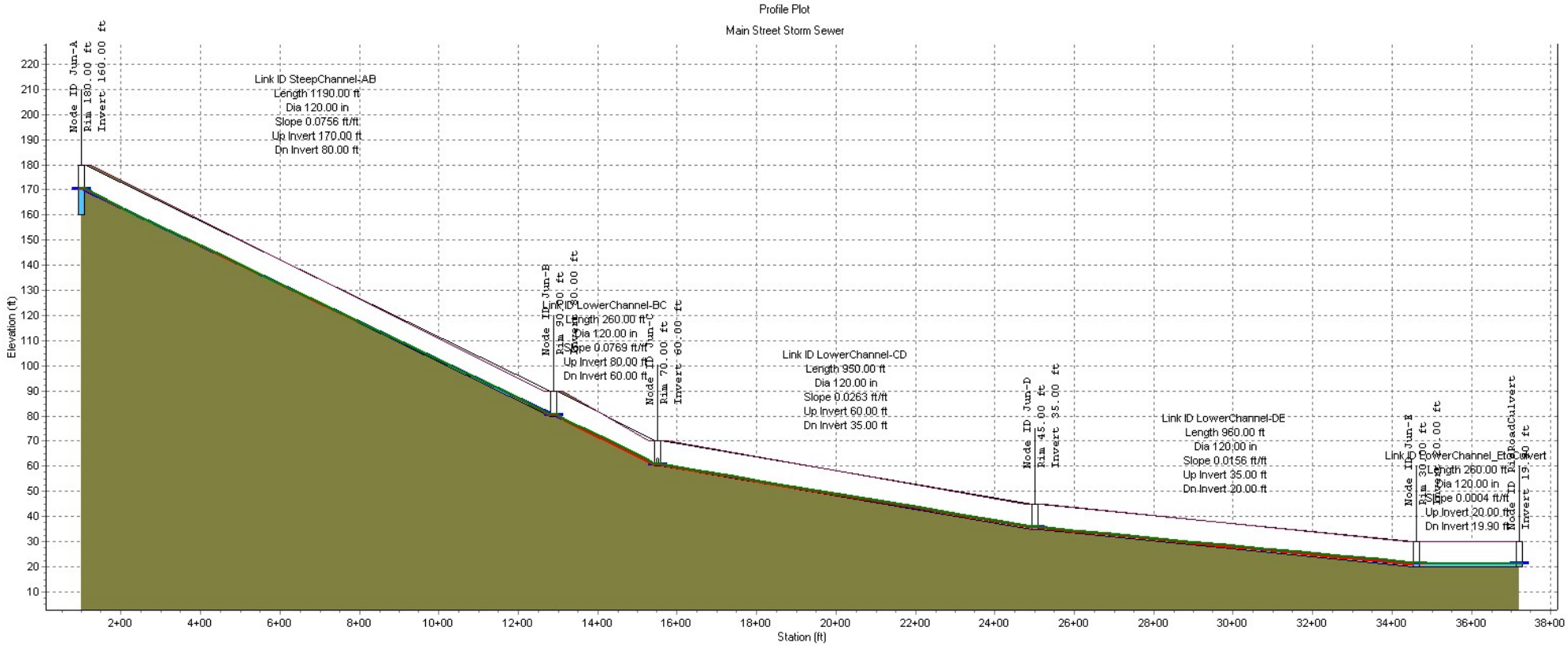
Assumptions:

- SCS Type 1A 24-hr storm for Pebble Beach used
- SBUH used on all sub-basins
- Minimum TOC of 5 minutes
- Pipe inverts and slopes assumed based on surface topography.
- Initial modeling revealed that the 24" pipe located at the corner of Ocean Avenue, Junipero Avenue, and Mountain View Avenue in Carmel's sub-basin CAR-8 is undersized, causing surcharging of the catch basins in Ocean Ave and a net loss out of the system due to overland flow. It was assumed that the existing 24" pipe will be upsized to a 36" pipe in the future, so the pipe was modeled 36" pipe. Note this only affects the 24" portion of the pipe system. The downstream 36" and 42" portions were modeled as 36" and 42" pipes, respectively. See the Storm and Sanitary Analysis results for more information.

Appendix 1-D:

Storm and Sanitary Analysis Reports


CAR-5
O-1
O-2a
CAR-8a
Jun-A
O-2b
CAR-24
CAR-8c
SteepChannel-AB
36-INCH-Replaced 24in
CAR-8b
CAR-36
Jun-B
36-INCH
LowerChannel-BC
CAR-42
Jun-C
CAR-8d
42-INCH
LowerChannel-CD
CAR-9
Jun-D
O-3
CAR-10a/Area2
LowerChannel-DE
CAR-10c
CAR-10b/Area1
Jun-CAR10
Jun-E
O-4
CAR10-FuturePipe
LowerChannel_EtoCulvert
RioRoadCulvert



Node ID:	Jun-A	Jun-B	Jun-C	Jun-D	Jun-E	RioRoadCulvert
Rim (ft):	180.00	90.00	70.00	45.00	30.00	
Invert (ft):	160.00	80.00	60.00	35.00	20.00	19.90
Min Pipe Cover (ft):	0.00	0.00	0.00	0.00	0.00	
Max HGL (ft):	170.33	80.33	60.72	35.68	21.37	21.27

Link ID:	SteepChannel-AB	LowerChannel-BC	LowerChannel-CD	LowerChannel-DE	LowerChannel_EtoCulvert
Length (ft):	1190.00	260.00	950.00	960.00	260.00
Dia (in):	120.00	120.00	120.00	120.00	120.00
Slope (ft/ft):	0.0756	0.0769	0.0263	0.0156	0.0004
Up Invert (ft):	170.00	80.00	60.00	35.00	20.00
Dn Invert (ft):	80.00	60.00	35.00	20.00	19.90
Max Q (cfs):	6.08	8.04	26.86	30.42	31.13
Max Vel (ft/s):	3.14	4.71	4.31	3.66	0.92
Max Depth (ft):	0.33	0.31	0.59	0.68	1.37

Autodesk® Storm and Sanitary Analysis 2016 - Version 10.1.53 (Build 1)

****
Project Description
****
File Name ..... 18-028 SSA-Storm Modeling-Upsized-181221.SPF

****
Analysis Options
****
Flow Units ..... cfs
Subbasin Hydrograph Method. Santa Barbara UH
Time of Concentration..... SCS TR-55
Link Routing Method ..... Kinematic Wave
Storage Node Exfiltration.. Constant rate, wetted area
Starting Date OCT-15-2018 00:00:00
Ending Date OCT-17-2018 00:00:00
Report Time Step 00:00:10

****
Element Count
****
Number of rain gages 1
Number of subbasins 14
Number of nodes 10
Number of links 9

****
Raingage Summary
****

Gage ID	Data Source	Data Type	Recording Interval min
PebbleBeach	002-year	CUMULATIVE	6.00

****
Subbasin Summary
****

Subbasin ID	Total Area ft²	Imperv. Area %	Raingage
CAR-10a/Area2	220905.11	0.00	PebbleBeach
CAR-10b/Area1	936706.23	0.00	PebbleBeach
CAR-10c	549564.77	0.00	PebbleBeach
CAR-5	3421768.38	0.00	PebbleBeach
CAR-8a	466351.13	0.00	PebbleBeach
CAR-8b	1228692.05	0.00	PebbleBeach
CAR-8c	3513067.02	0.00	PebbleBeach
CAR-8d	84784.75	0.00	PebbleBeach
CAR-9	834219.64	0.00	PebbleBeach
O-1	2106420.50	0.00	PebbleBeach
O-2a	749809.98	0.00	PebbleBeach
O-2b	911776.34	0.00	PebbleBeach
O-3	3162314.26	0.00	PebbleBeach
O-4	340813.63	0.00	PebbleBeach

****
Node Summary

****

Node ID	Element Type	Invert Elevation ft	Maximum Elev. ft	Ponded Area ft²	External Inflow
CAR-24	JUNCTION	226.50	230.00	4.00	
CAR-36	JUNCTION	184.00	190.00	4.00	
CAR-42	JUNCTION	123.00	130.00	4.00	
Jun-A	JUNCTION	170.00	180.00	0.00	
Jun-B	JUNCTION	80.00	90.00	0.00	
Jun-C	JUNCTION	60.00	70.00	0.00	
Jun-CAR10	JUNCTION	21.00	25.00	0.00	
Jun-D	JUNCTION	35.00	45.00	0.00	
Jun-E	JUNCTION	20.00	30.00	0.00	
RioRoadCulvert	OUTFALL	19.90	29.90	0.00	

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length ft	Slope %	Manning's Roughness
36-INCH	CAR-36	CAR-42	CONDUIT	1107.0	5.5104	0.0150
36-INCH-Replaced 24in	CAR-24	CAR-36	CONDUIT	1149.0	3.6989	0.0150
42-INCH	CAR-42	Jun-C	CONDUIT	1153.0	5.4640	0.0150
CAR10-FuturePipe	Jun-CAR10	Jun-E	CONDUIT	50.0	2.0000	0.0150
LowerChannel_EtoCulvert	Jun-E	RioRoadCulvert	CHANNEL	260.0	0.0385	0.0250
LowerChannel-BC	Jun-B	Jun-C	CHANNEL	260.0	7.6923	0.0250
LowerChannel-CD	Jun-C	Jun-D	CHANNEL	950.0	2.6316	0.0250
LowerChannel-DE	Jun-D	Jun-E	CHANNEL	960.0	1.5625	0.0250
SteepChannel-AB	Jun-A	Jun-B	CHANNEL	1190.0	7.5630	0.0400

****
Cross Section Summary
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Link ID	Shape	Depth/ Diameter ft	Width ft	No. of Barrels	Cross Sectional Area ft²	Full Flow Hydraulic Radius ft	Design Flow Capacity cfs
36-INCH	CIRCULAR	3.00	3.00	1	7.07	0.75	135.69
36-INCH-Replaced 24in	CIRCULAR	3.00	3.00	1	7.07	0.75	111.17
42-INCH	CIRCULAR	3.50	3.50	1	9.62	0.88	203.82
CAR10-FuturePipe	CIRCULAR	1.25	1.25	1	1.23	0.31	7.92
LowerChannel_EtoCulvert	TRIANGULAR	10.00	365.00	1	1825.00	4.99	6214.43
LowerChannel-BC	TRIANGULAR	10.00	365.00	1	1825.00	4.99	87885.25
LowerChannel-CD	TRIANGULAR	10.00	365.00	1	1825.00	4.99	51403.88
LowerChannel-DE	TRIANGULAR	10.00	365.00	1	1825.00	4.99	39609.35
SteepChannel-AB	TRIANGULAR	10.00	365.00	1	1825.00	4.99	

54464.74

Runoff Quantity Continuity	Volume acre-ft	Depth inches
Total Precipitation	53.166	1.500
Surface Runoff	15.846	0.447
Continuity Error (%)	0.000	

Flow Routing Continuity	Volume acre-ft	Volume Mgallons
External Inflow	0.000	0.000
External Outflow	15.834	5.160
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.001	

Composite Curve Number Computations Report

Subbasin CAR-10a/Area2

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	220905.11		81.00

Subbasin CAR-10b/Area1

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	936706.23		73.00

Subbasin CAR-10c

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	549564.77		74.00

Subbasin CAR-5

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	3421768.38		91.00

Subbasin CAR-8a

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	466351.13		91.00

Subbasin CAR-8b

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	1228692.05		85.00

Subbasin CAR-8c

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	3513067.02		85.00

Subbasin CAR-8d

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	84784.75		91.00

Subbasin CAR-9

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	834219.64		72.00

Subbasin O-1

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	2106420.50		83.00

Subbasin O-2a

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	749809.98		84.00

Subbasin O-2b

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	911776.34		83.00

Subbasin O-3

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	3162314.26		83.00

Subbasin O-4

Soil/Surface Description	Area (ft²)	Soil Group	CN

Composite Area & Weighted CN	340813.63	87.00

****
Runoff Coefficient Computations Report
****

Subbasin CAR-10a/Area2

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	220905.11	-	0.72
Composite Area & Weighted Runoff Coeff.	220905.11		0.72

Subbasin CAR-10b/Area1

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	936706.23	-	0.72
Composite Area & Weighted Runoff Coeff.	936706.23		0.72

Subbasin CAR-10c

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	549564.77	-	0.72
Composite Area & Weighted Runoff Coeff.	549564.77		0.72

Subbasin CAR-5

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	4718448.95	-	0.72
Composite Area & Weighted Runoff Coeff.	4718448.95		0.72

Subbasin CAR-8a

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	466351.13	-	0.72
Composite Area & Weighted Runoff Coeff.	466351.13		0.72

Subbasin CAR-8b

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	1228692.05	-	0.72
Composite Area & Weighted Runoff Coeff.	1228692.05		0.72

Subbasin CAR-8c

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.

-	3513067.02	-	0.72
Composite Area & Weighted Runoff Coeff.	3513067.02		0.72

Subbasin CAR-8d

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	84784.75	-	0.72
Composite Area & Weighted Runoff Coeff.	84784.75		0.72

Subbasin CAR-9

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	834219.64	-	0.72
Composite Area & Weighted Runoff Coeff.	834219.64		0.72

Subbasin O-1

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	2106420.50	-	0.72
Composite Area & Weighted Runoff Coeff.	2106420.50		0.72

Subbasin O-2a

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	749809.98	-	0.72
Composite Area & Weighted Runoff Coeff.	749809.98		0.72

Subbasin O-2b

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	911776.34	-	0.72
Composite Area & Weighted Runoff Coeff.	911776.34		0.72

Subbasin O-3

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	3162314.26	-	0.72
Composite Area & Weighted Runoff Coeff.	3162314.26		0.72

Subbasin O-4

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	340813.63	-	0.72
Composite Area & Weighted Runoff Coeff.	340813.63		0.72

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  ************************************************
  SCS TR-55 Time of Concentration Computations Report
  ************************************************

  Sheet Flow Equation
  -------------------

          Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

          Where:

          Tc = Time of Concentration (hrs)
          n  = Manning's Roughness
          Lf = Flow Length (ft)
          P  = 2 yr, 24 hr Rainfall (inches)
          Sf = Slope (ft/ft)

  Shallow Concentrated Flow Equation
  ----------------------------------

          V  = 16.1345 * (Sf^0.5) (unpaved surface)
          V  = 20.3282 * (Sf^0.5) (paved surface)
          V  = 15.0 * (Sf^0.5) (grassed waterway surface)
          V  = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
          V  = 9.0 * (Sf^0.5) (cultivated straight rows surface)
          V  = 7.0 * (Sf^0.5) (short grass pasture surface)
          V  = 5.0 * (Sf^0.5) (woodland surface)
          V  = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
          Tc = (Lf / V) / (3600 sec/hr)

          Where:

          Tc = Time of Concentration (hrs)
          Lf = Flow Length (ft)
          V  = Velocity (ft/sec)
          Sf = Slope (ft/ft)

  Channel Flow Equation
  ---------------------

          V  = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
          R  = Aq / Wp
          Tc = (Lf / V) / (3600 sec/hr)

          Where:

          Tc = Time of Concentration (hrs)
          Lf = Flow Length (ft)
          R  = Hydraulic Radius (ft)
          Aq = Flow Area (ft²)
          Wp = Wetted Perimeter (ft)
          V  = Velocity (ft/sec)
          Sf = Slope (ft/ft)
          n  = Manning's Roughness

  -------------------------
  Subbasin CAR-10a/Area2
  -------------------------

  Sheet Flow Computations
  -----------------------
                                              Subarea A           Subarea B           Subarea
C
          Manning's Roughness:                     0.04                0.00
0.00
          Flow Length (ft):                       65.00                0.00
0.00
```

Slope (%):	0.77	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.21	0.00	0.00
Computed Flow Time (minutes):	5.16	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.04	0.00
Flow Length (ft):	1180.00	884.00	0.00
Channel Slope (%):	8.05	7.49	0.00
Cross Section Area (ft²):	0.38	3660.00	0.00
Wetted Perimeter (ft):	1.58	732.00	0.00
Velocity (ft/sec):	12.47	29.81	0.00
Computed Flow Time (minutes):	1.58	0.49	0.00

Total TOC (minutes):	3.62

Subbasin CAR-10b/Area1

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	111.00	0.00	0.00
Slope (%):	1.80	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.33	0.00	0.00
Computed Flow Time (minutes):	5.64	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	2186.00	0.00	0.00
Channel Slope (%):	5.43	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00

Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	10.24	0.00	0.00
Computed Flow Time (minutes):	3.56	0.00	0.00

Total TOC (minutes): 9.19

Subbasin CAR-10c

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	106.00	0.00	0.00
Slope (%):	0.94	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.25	0.00	0.00
Computed Flow Time (minutes):	7.04	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.04	0.00
Flow Length (ft):	954.00	884.00	0.00
Channel Slope (%):	8.91	7.49	0.00
Cross Section Area (ft²):	0.75	3660.00	0.00
Wetted Perimeter (ft):	1.58	732.00	0.00
Velocity (ft/sec):	20.82	29.81	0.00
Computed Flow Time (minutes):	0.76	0.49	0.00

Total TOC (minutes): 4.15

Subbasin CAR-5

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C

Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	108.00	0.00	0.00
Slope (%):	0.93	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.25	0.00	0.00
Computed Flow Time (minutes):	7.18	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.01	0.00
Flow Length (ft):	2487.00	2541.00	0.00
Channel Slope (%):	6.90	6.49	0.00
Cross Section Area (ft²):	0.38	3.14	0.00
Wetted Perimeter (ft):	1.58	6.28	0.00
Velocity (ft/sec):	11.54	18.39	0.00
Computed Flow Time (minutes):	3.59	2.30	0.00

Total TOC (minutes):	6.54

Subbasin CAR-8a

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	108.00	0.00	0.00
Slope (%):	1.85	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.33	0.00	0.00
Computed Flow Time (minutes):	5.45	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	1264.00	0.00	0.00

Channel Slope (%):	1.37	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	5.14	0.00	0.00
Computed Flow Time (minutes):	4.10	0.00	0.00
Total TOC (minutes):	9.55		

Subbasin CAR-8b

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	102.00	0.00	0.00
Slope (%):	0.98	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.25	0.00	0.00
Computed Flow Time (minutes):	6.72	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	1419.00	0.00	0.00
Channel Slope (%):	10.29	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	14.09	0.00	0.00
Computed Flow Time (minutes):	1.68	0.00	0.00
Total TOC (minutes):	8.40		

Subbasin CAR-8c

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	102.00	0.00	0.00
Slope (%):	0.98	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.25	0.00	0.00
Computed Flow Time (minutes):	6.72	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	1136.00	0.00	0.00
Channel Slope (%):	10.12	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	13.98	0.00	0.00
Computed Flow Time (minutes):	1.35	0.00	0.00

Total TOC (minutes):	8.07

Subbasin CAR-8d

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	300.00	0.00	0.00
Slope (%):	0.98	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.31	0.00	0.00
Computed Flow Time (minutes):	15.92	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C

Manning's Roughness:	0.08	0.00	0.00
Flow Length (ft):	416.00	0.00	0.00
Channel Slope (%):	21.36	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	3.30	0.00	0.00
Computed Flow Time (minutes):	2.10	0.00	0.00

Total TOC (minutes): 18.03

Subbasin CAR-9

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	300.00	0.00	0.00
Slope (%):	1.00	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.32	0.00	0.00
Computed Flow Time (minutes):	15.80	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	463.00	0.00	0.00
Channel Slope (%):	16.20	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	17.68	0.00	0.00
Computed Flow Time (minutes):	0.44	0.00	0.00

Total TOC (minutes): 16.23

Subbasin O-1

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	80.00	0.00	0.00
Slope (%):	1.33	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.27	0.00	0.00
Computed Flow Time (minutes):	4.90	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.04	0.00
Flow Length (ft):	5294.00	1069.00	0.00
Channel Slope (%):	1.60	7.48	0.00
Cross Section Area (ft²):	0.38	3660.00	0.00
Wetted Perimeter (ft):	1.58	732.00	0.00
Velocity (ft/sec):	5.56	29.79	0.00
Computed Flow Time (minutes):	15.88	0.60	0.00

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Total TOC (minutes): 10.68

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Subbasin O-2a

User-Defined TOC override (minutes): 5.00

Subbasin O-2b

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	123.00	0.00	0.00
Slope (%):	1.63	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	

1.50			
	Velocity (ft/sec):	0.32	0.00
0.00			
	Computed Flow Time (minutes):	6.37	0.00
0.00			

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	2136.00	0.00	0.00
Channel Slope (%):	8.43	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	12.76	0.00	0.00
Computed Flow Time (minutes):	2.79	0.00	0.00

Total TOC (minutes):	9.16

Subbasin O-3

User-Defined TOC override (minutes):	5.00

Subbasin O-4

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	170.00	0.00	0.00
Slope (%):	0.29	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.17	0.00	0.00
Computed Flow Time (minutes):	16.45	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.04	0.00
Flow Length (ft):	1607.00	884.00	0.00
Channel Slope (%):	5.91	7.49	

```
0.00
          Cross Section Area (ft²):                    0.38             3660.00
0.00
          Wetted Perimeter (ft):                       1.58              732.00
0.00
          Velocity (ft/sec):                          10.68               29.81
0.00
          Computed Flow Time (minutes):                2.51                0.49
0.00

=============================================================================================
          Total TOC (minutes):                         9.73

=============================================================================================
```

****
Subbasin Runoff Summary
****

Subbasin ID	Total Precip in	Total Runoff in	Peak Runoff cfs	Weighted Curve Number	Time of Concentration days	Time of Concentration hh:mm:ss
CAR-10a/Area2	1.50	0.31	0.18	81.000	0	00:05:00
CAR-10b/Area1	1.50	0.13	0.22	73.000	0	00:09:11
CAR-10c	1.50	0.15	0.14	74.000	0	00:05:00
CAR-5	1.50	0.74	13.23	91.000	0	00:06:32
CAR-8a	1.50	0.74	1.72	91.000	0	00:09:33
CAR-8b	1.50	0.45	2.05	85.000	0	00:08:24
CAR-8c	1.50	0.45	5.90	85.000	0	00:08:04
CAR-8d	1.50	0.74	0.27	91.000	0	00:18:01
CAR-9	1.50	0.11	0.18	72.000	0	00:16:13
O-1	1.50	0.38	2.34	83.000	0	00:10:40
O-2a	1.50	0.41	1.14	84.000	0	00:05:00
O-2b	1.50	0.38	1.05	83.000	0	00:09:09
O-3	1.50	0.38	3.98	83.000	0	00:05:00
O-4	1.50	0.54	0.75	87.000	0	00:09:43

****
Node Depth Summary
****

Node ID	Average Depth Attained ft	Maximum Depth Attained ft	Maximum HGL Attained ft	Time of Max Occurrence days	Time of Max Occurrence hh:mm	Total Flooded Volume acre-in	Total Time Flooded minutes	Retention Time hh:mm:ss
CAR-24	0.17	0.84	227.34	0	08:00	0	0	0:00:00
CAR-36	0.17	0.84	184.84	0	08:01	0	0	0:00:00
CAR-42	0.15	0.76	123.76	0	08:02	0	0	0:00:00
Jun-A	0.09	0.33	170.33	0	08:06	0	0	0:00:00
Jun-B	0.09	0.33	80.33	0	08:08	0	0	0:00:00
Jun-C	0.15	0.72	60.72	0	08:03	0	0	0:00:00
Jun-CAR10	0.05	0.17	21.17	0	18:06	0	0	0:00:00
Jun-D	0.17	0.68	35.68	0	08:06	0	0	0:00:00
Jun-E	0.35	1.37	21.37	0	08:10	0	0	0:00:00
RioRoadCulvert	0.35	1.37	21.27	0	08:13	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral Inflow cfs	Peak Inflow cfs	Time of Peak Inflow Occurrence days	hh:mm	Maximum Flooding Overflow cfs	Time of Peak Flooding Occurrence days	hh:mm
CAR-24	JUNCTION	19.14	19.14	0	08:00	0.00		
CAR-36	JUNCTION	0.00	19.04	0	08:01	0.00		
CAR-42	JUNCTION	0.00	19.00	0	08:02	0.00		
Jun-A	JUNCTION	6.09	6.09	0	08:06	0.00		
Jun-B	JUNCTION	2.05	8.04	0	08:07	0.00		
Jun-C	JUNCTION	0.27	27.02	0	08:03	0.00		
Jun-CAR10	JUNCTION	0.32	0.32	0	18:06	0.00		
Jun-D	JUNCTION	3.98	30.65	0	08:06	0.00		
Jun-E	JUNCTION	0.75	31.28	0	08:10	0.00		
RioRoadCulvert	OUTFALL	0.00	31.14	0	08:13	0.00		

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cfs	Peak Inflow cfs
RioRoadCulvert	43.15	9.25	31.14
System	43.15	9.25	31.14

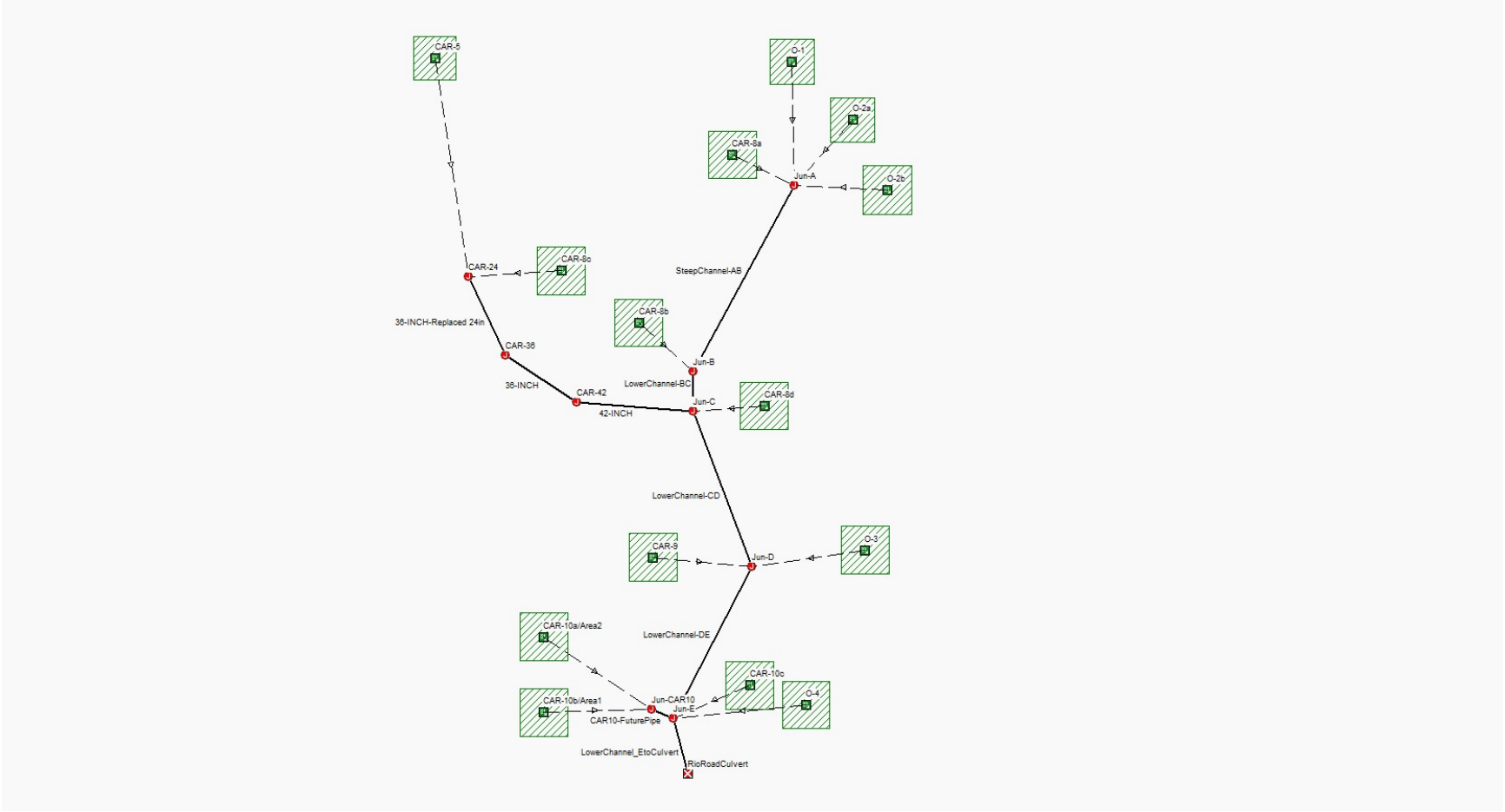
****
Link Flow Summary
****

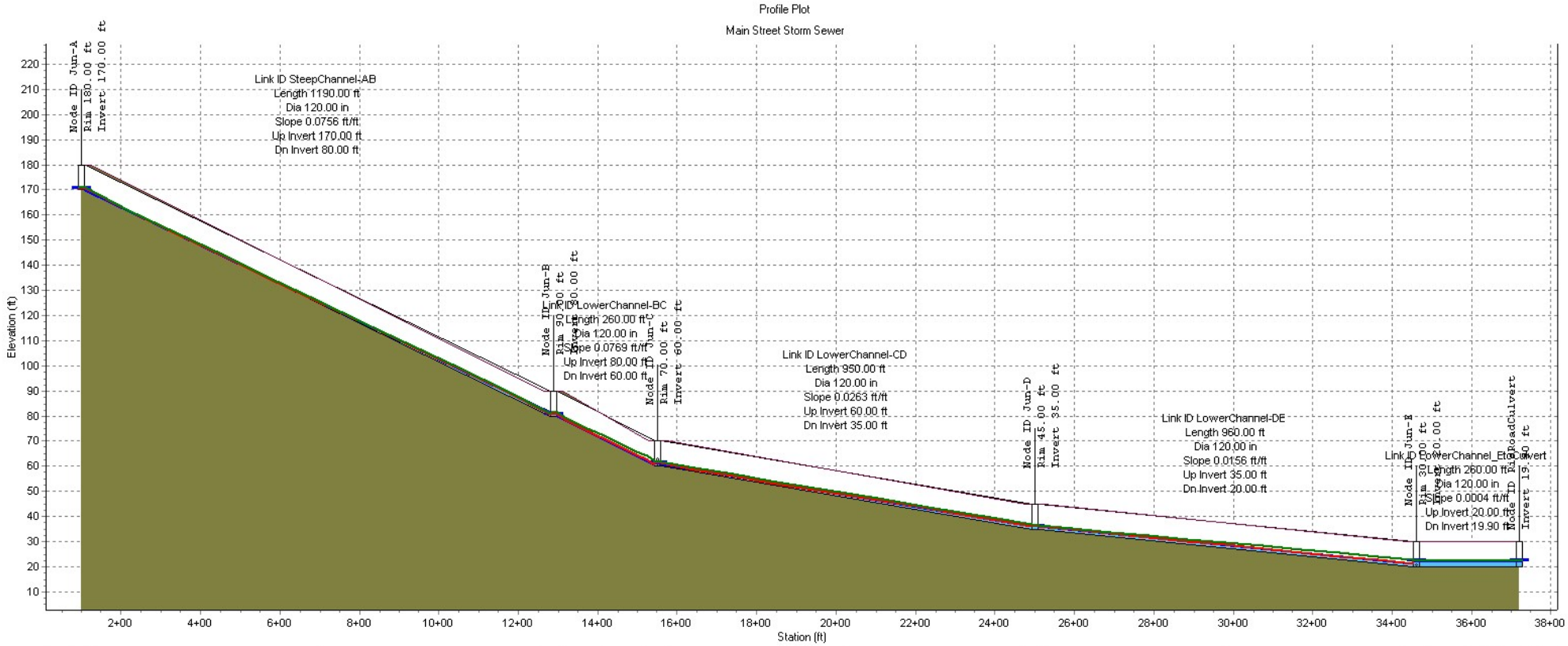
Link ID	Element Type	Time of Peak Flow Occurrence days	hh:mm	Maximum Velocity Attained ft/sec	Length Factor	Peak Flow during Analysis cfs	Design Flow Capacity cfs	Ratio of Maximum /Design Flow	Ratio of Maximum Depth	Total Time minutes	Reported Condition
36-INCH	CONDUIT	0	08:02	13.56	1.00	19.00	135.69	0.14	0.25	0	Calculated
36-INCH-Replaced 24in	CONDUIT	0	08:01	11.78	1.00	19.04	111.17	0.17	0.28	0	Calculated
42-INCH	CONDUIT	0	08:03	13.31	1.00	18.97	203.82	0.09	0.21	0	Calculated
CAR10-FuturePipe	CONDUIT	0	18:06	3.15	1.00	0.32	7.92	0.04	0.14	0	Calculated
LowerChannel_EtoCulvert	CHANNEL	0	08:13	0.92	1.00	31.14	6214.43	0.01	0.14	0	Calculated
LowerChannel-BC	CHANNEL	0	08:08	4.71	1.00	8.04	87885.25	0.00	0.03	0	Calculated
LowerChannel-CD	CHANNEL	0	08:06	4.32	1.00	26.86	51403.88	0.00	0.06	0	Calculated
LowerChannel-DE	CHANNEL	0	08:10	3.66	1.00	30.44	39609.35	0.00	0.07	0	Calculated

```
  SteepChannel-AB      CHANNEL      0  08:08      3.14    1.00        6.08    54464.74      0.00
0.03           0  Calculated


  ********************************
  Highest Flow Instability Indexes
  ********************************
  All links are stable.


  Analysis began on:  Wed Dec 26 09:01:54 2018
  Analysis ended on:  Wed Dec 26 09:01:55 2018
  Total elapsed time: 00:00:01
```


CAR-5
O-1
O-2a
CAR-8a
Jun-A
O-2b
CAR-24
CAR-8c
SteepChannel-AB
CAR-8b
36-INCH-Replaced 24in
CAR-36
Jun-B
36-INCH
LowerChannel-BC
CAR-42
Jun-C
CAR-8d
42-INCH
LowerChannel-CD
CAR-9
Jun-D
O-3
CAR-10a/Area2
LowerChannel-DE
CAR-10c
CAR-10b/Area1
Jun-CAR10
Jun-E
O-4
CAR10-FuturePipe
LowerChannel_EtoCulvert
RioRoadCulvert



Node ID:	Jun-A	Jun-B	Jun-C	Jun-D	Jun-E	RioRoadCulvert
Rim (ft):	180.00	90.00	70.00	45.00	30.00	
Invert (ft):	170.00	80.00	60.00	35.00	20.00	19.90
Min Pipe Cover (ft):	0.00	0.00	0.00	0.00	0.00	
Max HGL (ft):	170.58	80.58	61.31	36.13	22.30	22.20

Link ID:	SteepChannel-AB	LowerChannel-BC	LowerChannel-CD	LowerChannel-DE	LowerChannel_EtoCulvert
Length (ft):	1190.00	260.00	950.00	960.00	260.00
Dia (in):	120.00	120.00	120.00	120.00	120.00
Slope (ft/ft):	0.0756	0.0769	0.0263	0.0156	0.0004
Up Invert (ft):	170.00	80.00	60.00	35.00	20.00
Dn Invert (ft):	80.00	60.00	35.00	20.00	19.90
Max Q (cfs):	27.34	35.79	97.00	116.95	123.86
Max Vel (ft/s):	4.54	6.84	5.91	5.10	1.29
Max Depth (ft):	0.58	0.54	0.95	1.12	2.30

Autodesk® Storm and Sanitary Analysis 2016 - Version 10.1.53 (Build 1)

****
Project Description
****
File Name ..... 18-028 SSA-Storm Modeling-Upsized-181221.SPF

****
Analysis Options
****
Flow Units ..... cfs
Subbasin Hydrograph Method. Santa Barbara UH
Time of Concentration..... SCS TR-55
Link Routing Method ..... Kinematic Wave
Storage Node Exfiltration.. Constant rate, wetted area
Starting Date OCT-15-2018 00:00:00
Ending Date OCT-17-2018 00:00:00
Report Time Step 00:00:10

****
Element Count
****
Number of rain gages 1
Number of subbasins 14
Number of nodes 10
Number of links 9

****
Raingage Summary
****

Gage ID	Data Source	Data Type	Recording Interval min
PebbleBeach	010-year	CUMULATIVE	6.00

****
Subbasin Summary
****

Subbasin ID	Total Area ft²	Imperv. Area %	Raingage
CAR-10a/Area2	220905.11	0.00	PebbleBeach
CAR-10b/Area1	936706.23	0.00	PebbleBeach
CAR-10c	549564.77	0.00	PebbleBeach
CAR-5	3421768.38	0.00	PebbleBeach
CAR-8a	466351.13	0.00	PebbleBeach
CAR-8b	1228692.05	0.00	PebbleBeach
CAR-8c	3513067.02	0.00	PebbleBeach
CAR-8d	84784.75	0.00	PebbleBeach
CAR-9	834219.64	0.00	PebbleBeach
O-1	2106420.50	0.00	PebbleBeach
O-2a	749809.98	0.00	PebbleBeach
O-2b	911776.34	0.00	PebbleBeach
O-3	3162314.26	0.00	PebbleBeach
O-4	340813.63	0.00	PebbleBeach

****
Node Summary

****

Node ID	Element Type	Invert Elevation ft	Maximum Elev. ft	Ponded Area ft²	External Inflow
CAR-24	JUNCTION	226.50	230.00	4.00	
CAR-36	JUNCTION	184.00	190.00	4.00	
CAR-42	JUNCTION	123.00	130.00	4.00	
Jun-A	JUNCTION	170.00	180.00	0.00	
Jun-B	JUNCTION	80.00	90.00	0.00	
Jun-C	JUNCTION	60.00	70.00	0.00	
Jun-CAR10	JUNCTION	21.00	25.00	0.00	
Jun-D	JUNCTION	35.00	45.00	0.00	
Jun-E	JUNCTION	20.00	30.00	0.00	
RioRoadCulvert	OUTFALL	19.90	29.90	0.00	

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length ft	Slope %	Manning's Roughness
36-INCH	CAR-36	CAR-42	CONDUIT	1107.0	5.5104	0.0150
36-INCH-Replaced 24in	CAR-24	CAR-36	CONDUIT	1149.0	3.6989	0.0150
42-INCH	CAR-42	Jun-C	CONDUIT	1153.0	5.4640	0.0150
CAR10-FuturePipe	Jun-CAR10	Jun-E	CONDUIT	50.0	2.0000	0.0150
LowerChannel_EtoCulvert	Jun-E	RioRoadCulvert	CHANNEL	260.0	0.0385	0.0250
LowerChannel-BC	Jun-B	Jun-C	CHANNEL	260.0	7.6923	0.0250
LowerChannel-CD	Jun-C	Jun-D	CHANNEL	950.0	2.6316	0.0250
LowerChannel-DE	Jun-D	Jun-E	CHANNEL	960.0	1.5625	0.0250
SteepChannel-AB	Jun-A	Jun-B	CHANNEL	1190.0	7.5630	0.0400

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter ft	Width ft	No. of Barrels	Cross Sectional Area ft²	Full Flow Hydraulic Radius ft	Design Flow Capacity cfs
36-INCH	CIRCULAR	3.00	3.00	1	7.07	0.75	135.69
36-INCH-Replaced 24in	CIRCULAR	3.00	3.00	1	7.07	0.75	111.17
42-INCH	CIRCULAR	3.50	3.50	1	9.62	0.88	203.82
CAR10-FuturePipe	CIRCULAR	1.25	1.25	1	1.23	0.31	7.92
LowerChannel_EtoCulvert	TRIANGULAR	10.00	365.00	1	1825.00	4.99	6214.43
LowerChannel-BC	TRIANGULAR	10.00	365.00	1	1825.00	4.99	87885.25
LowerChannel-CD	TRIANGULAR	10.00	365.00	1	1825.00	4.99	51403.88
LowerChannel-DE	TRIANGULAR	10.00	365.00	1	1825.00	4.99	39609.35
SteepChannel-AB	TRIANGULAR	10.00	365.00	1	1825.00	4.99	

54464.74

Runoff Quantity Continuity	Volume acre-ft	Depth inches
Total Precipitation	97.471	2.750
Surface Runoff	47.732	1.347
Continuity Error (%)	0.000	

Flow Routing Continuity	Volume acre-ft	Volume Mgallons
External Inflow	0.000	0.000
External Outflow	47.700	15.544
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.001	

****
Composite Curve Number Computations Report
****

Subbasin CAR-10a/Area2

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	220905.11		81.00

Subbasin CAR-10b/Area1

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	936706.23		73.00

Subbasin CAR-10c

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	549564.77		74.00

Subbasin CAR-5

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	3421768.38		91.00

Subbasin CAR-8a

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	466351.13		91.00

Subbasin CAR-8b

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	1228692.05		85.00

Subbasin CAR-8c

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	3513067.02		85.00

Subbasin CAR-8d

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	84784.75		91.00

Subbasin CAR-9

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	834219.64		72.00

Subbasin O-1

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	2106420.50		83.00

Subbasin O-2a

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	749809.98		84.00

Subbasin O-2b

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	911776.34		83.00

Subbasin O-3

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	3162314.26		83.00

Subbasin O-4

Soil/Surface Description	Area (ft²)	Soil Group	CN

Composite Area & Weighted CN	340813.63	87.00

****
Runoff Coefficient Computations Report
****

Subbasin CAR-10a/Area2

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	220905.11	-	0.72
Composite Area & Weighted Runoff Coeff.	220905.11		0.72

Subbasin CAR-10b/Area1

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	936706.23	-	0.72
Composite Area & Weighted Runoff Coeff.	936706.23		0.72

Subbasin CAR-10c

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	549564.77	-	0.72
Composite Area & Weighted Runoff Coeff.	549564.77		0.72

Subbasin CAR-5

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	4718448.95	-	0.72
Composite Area & Weighted Runoff Coeff.	4718448.95		0.72

Subbasin CAR-8a

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	466351.13	-	0.72
Composite Area & Weighted Runoff Coeff.	466351.13		0.72

Subbasin CAR-8b

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	1228692.05	-	0.72
Composite Area & Weighted Runoff Coeff.	1228692.05		0.72

Subbasin CAR-8c

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.

-	3513067.02	-	0.72
Composite Area & Weighted Runoff Coeff.	3513067.02		0.72

Subbasin CAR-8d

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	84784.75	-	0.72
Composite Area & Weighted Runoff Coeff.	84784.75		0.72

Subbasin CAR-9

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	834219.64	-	0.72
Composite Area & Weighted Runoff Coeff.	834219.64		0.72

Subbasin O-1

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	2106420.50	-	0.72
Composite Area & Weighted Runoff Coeff.	2106420.50		0.72

Subbasin O-2a

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	749809.98	-	0.72
Composite Area & Weighted Runoff Coeff.	749809.98		0.72

Subbasin O-2b

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	911776.34	-	0.72
Composite Area & Weighted Runoff Coeff.	911776.34		0.72

Subbasin O-3

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	3162314.26	-	0.72
Composite Area & Weighted Runoff Coeff.	3162314.26		0.72

Subbasin O-4

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	340813.63	-	0.72
Composite Area & Weighted Runoff Coeff.	340813.63		0.72

```
  ************************************************
  SCS TR-55 Time of Concentration Computations Report
  ************************************************

  Sheet Flow Equation
  -------------------

          Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

          Where:

          Tc = Time of Concentration (hrs)
          n  = Manning's Roughness
          Lf = Flow Length (ft)
          P  = 2 yr, 24 hr Rainfall (inches)
          Sf = Slope (ft/ft)

  Shallow Concentrated Flow Equation
  ----------------------------------

          V  = 16.1345 * (Sf^0.5) (unpaved surface)
          V  = 20.3282 * (Sf^0.5) (paved surface)
          V  = 15.0 * (Sf^0.5) (grassed waterway surface)
          V  = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
          V  = 9.0 * (Sf^0.5) (cultivated straight rows surface)
          V  = 7.0 * (Sf^0.5) (short grass pasture surface)
          V  = 5.0 * (Sf^0.5) (woodland surface)
          V  = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
          Tc = (Lf / V) / (3600 sec/hr)

          Where:

          Tc = Time of Concentration (hrs)
          Lf = Flow Length (ft)
          V  = Velocity (ft/sec)
          Sf = Slope (ft/ft)

  Channel Flow Equation
  ---------------------

          V  = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
          R  = Aq / Wp
          Tc = (Lf / V) / (3600 sec/hr)

          Where:

          Tc = Time of Concentration (hrs)
          Lf = Flow Length (ft)
          R  = Hydraulic Radius (ft)
          Aq = Flow Area (ft²)
          Wp = Wetted Perimeter (ft)
          V  = Velocity (ft/sec)
          Sf = Slope (ft/ft)
          n  = Manning's Roughness

  -------------------------
  Subbasin CAR-10a/Area2
  -------------------------

  Sheet Flow Computations
  -----------------------
                                              Subarea A           Subarea B           Subarea
C
          Manning's Roughness:                     0.04                0.00
0.00
          Flow Length (ft):                       65.00                0.00
0.00
```

Slope (%):	0.77	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.21	0.00	0.00
Computed Flow Time (minutes):	5.16	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.04	0.00
Flow Length (ft):	1180.00	884.00	0.00
Channel Slope (%):	8.05	7.49	0.00
Cross Section Area (ft²):	0.38	3660.00	0.00
Wetted Perimeter (ft):	1.58	732.00	0.00
Velocity (ft/sec):	12.47	29.81	0.00
Computed Flow Time (minutes):	1.58	0.49	0.00

Total TOC (minutes):	3.62

Subbasin CAR-10b/Area1

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	111.00	0.00	0.00
Slope (%):	1.80	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.33	0.00	0.00
Computed Flow Time (minutes):	5.64	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	2186.00	0.00	0.00
Channel Slope (%):	5.43	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00

Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	10.24	0.00	0.00
Computed Flow Time (minutes):	3.56	0.00	0.00

Total TOC (minutes): 9.19

Subbasin CAR-10c

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	106.00	0.00	0.00
Slope (%):	0.94	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.25	0.00	0.00
Computed Flow Time (minutes):	7.04	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.04	0.00
Flow Length (ft):	954.00	884.00	0.00
Channel Slope (%):	8.91	7.49	0.00
Cross Section Area (ft²):	0.75	3660.00	0.00
Wetted Perimeter (ft):	1.58	732.00	0.00
Velocity (ft/sec):	20.82	29.81	0.00
Computed Flow Time (minutes):	0.76	0.49	0.00

Total TOC (minutes): 4.15

Subbasin CAR-5

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C

Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	108.00	0.00	0.00
Slope (%):	0.93	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.25	0.00	0.00
Computed Flow Time (minutes):	7.18	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.01	0.00
Flow Length (ft):	2487.00	2541.00	0.00
Channel Slope (%):	6.90	6.49	0.00
Cross Section Area (ft²):	0.38	3.14	0.00
Wetted Perimeter (ft):	1.58	6.28	0.00
Velocity (ft/sec):	11.54	18.39	0.00
Computed Flow Time (minutes):	3.59	2.30	0.00

Total TOC (minutes):	6.54

Subbasin CAR-8a

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	108.00	0.00	0.00
Slope (%):	1.85	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.33	0.00	0.00
Computed Flow Time (minutes):	5.45	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	1264.00	0.00	0.00

Channel Slope (%):	1.37	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	5.14	0.00	0.00
Computed Flow Time (minutes):	4.10	0.00	0.00

Total TOC (minutes):	9.55

Subbasin CAR-8b

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	102.00	0.00	0.00
Slope (%):	0.98	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.25	0.00	0.00
Computed Flow Time (minutes):	6.72	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	1419.00	0.00	0.00
Channel Slope (%):	10.29	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	14.09	0.00	0.00
Computed Flow Time (minutes):	1.68	0.00	0.00

Total TOC (minutes):	8.40

Subbasin CAR-8c

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	102.00	0.00	0.00
Slope (%):	0.98	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.25	0.00	0.00
Computed Flow Time (minutes):	6.72	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	1136.00	0.00	0.00
Channel Slope (%):	10.12	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	13.98	0.00	0.00
Computed Flow Time (minutes):	1.35	0.00	0.00

Total TOC (minutes): 8.07

Subbasin CAR-8d

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	300.00	0.00	0.00
Slope (%):	0.98	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.31	0.00	0.00
Computed Flow Time (minutes):	15.92	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C

Manning's Roughness:	0.08	0.00	0.00
Flow Length (ft):	416.00	0.00	0.00
Channel Slope (%):	21.36	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	3.30	0.00	0.00
Computed Flow Time (minutes):	2.10	0.00	0.00

Total TOC (minutes): 18.03

Subbasin CAR-9

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	300.00	0.00	0.00
Slope (%):	1.00	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.32	0.00	0.00
Computed Flow Time (minutes):	15.80	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	463.00	0.00	0.00
Channel Slope (%):	16.20	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	17.68	0.00	0.00
Computed Flow Time (minutes):	0.44	0.00	0.00

Total TOC (minutes): 16.23

Subbasin O-1

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	80.00	0.00	0.00
Slope (%):	1.33	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.27	0.00	0.00
Computed Flow Time (minutes):	4.90	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.04	0.00
Flow Length (ft):	5294.00	1069.00	0.00
Channel Slope (%):	1.60	7.48	0.00
Cross Section Area (ft²):	0.38	3660.00	0.00
Wetted Perimeter (ft):	1.58	732.00	0.00
Velocity (ft/sec):	5.56	29.79	0.00
Computed Flow Time (minutes):	15.88	0.60	0.00

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Total TOC (minutes): 10.68

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Subbasin O-2a

User-Defined TOC override (minutes): 5.00

Subbasin O-2b

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	123.00	0.00	0.00
Slope (%):	1.63	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	

1.50			
	Velocity (ft/sec):	0.32	0.00
0.00			
	Computed Flow Time (minutes):	6.37	0.00
0.00			

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	2136.00	0.00	0.00
Channel Slope (%):	8.43	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	12.76	0.00	0.00
Computed Flow Time (minutes):	2.79	0.00	0.00

Total TOC (minutes):	9.16

Subbasin O-3

User-Defined TOC override (minutes):	5.00

Subbasin O-4

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	170.00	0.00	0.00
Slope (%):	0.29	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.17	0.00	0.00
Computed Flow Time (minutes):	16.45	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.04	0.00
Flow Length (ft):	1607.00	884.00	0.00
Channel Slope (%):	5.91	7.49	

0.00

Cross Section Area (ft²):	0.38	3660.00

0.00

Wetted Perimeter (ft):	1.58	732.00

0.00

Velocity (ft/sec):	10.68	29.81

0.00

Computed Flow Time (minutes):	2.51	0.49

0.00

Total TOC (minutes):	9.73

****
Subbasin Runoff Summary
****

Subbasin ID	Total Precip in	Total Runoff in	Peak Runoff cfs	Weighted Curve Number	Time of Concentration days	Time of Concentration hh:mm:ss
CAR-10a/Area2	2.75	1.12	1.22	81.000	0	00:05:00
CAR-10b/Area1	2.75	0.71	2.05	73.000	0	00:09:11
CAR-10c	2.75	0.75	1.51	74.000	0	00:05:00
CAR-5	2.75	1.84	36.12	91.000	0	00:06:32
CAR-8a	2.75	1.84	4.74	91.000	0	00:09:33
CAR-8b	2.75	1.38	8.68	85.000	0	00:08:24
CAR-8c	2.75	1.38	24.96	85.000	0	00:08:04
CAR-8d	2.75	1.84	0.75	91.000	0	00:18:01
CAR-9	2.75	0.66	1.34	72.000	0	00:16:13
O-1	2.75	1.25	12.31	83.000	0	00:10:40
O-2a	2.75	1.31	5.17	84.000	0	00:05:00
O-2b	2.75	1.25	5.49	83.000	0	00:09:09
O-3	2.75	1.25	20.28	83.000	0	00:05:00
O-4	2.75	1.52	2.70	87.000	0	00:09:43

****
Node Depth Summary
****

Node ID	Average Depth Attained ft	Maximum Depth Attained ft	Maximum HGL Attained ft	Time of Max Occurrence days	Time of Max Occurrence hh:mm	Total Flooded Volume acre-in	Total Time Flooded minutes	Retention Time hh:mm:ss
CAR-24	0.28	1.59	228.09	0	08:00	0	0	0:00:00
CAR-36	0.28	1.59	185.59	0	08:00	0	0	0:00:00
CAR-42	0.26	1.41	124.41	0	08:01	0	0	0:00:00
Jun-A	0.14	0.58	170.58	0	08:00	0	0	0:00:00
Jun-B	0.14	0.58	80.58	0	08:02	0	0	0:00:00
Jun-C	0.25	1.31	61.31	0	08:02	0	0	0:00:00
Jun-CAR10	0.12	0.55	21.55	0	08:00	0	0	0:00:00
Jun-D	0.27	1.13	36.13	0	08:03	0	0	0:00:00
Jun-E	0.55	2.30	22.30	0	08:05	0	0	0:00:00
RioRoadCulvert	0.55	2.30	22.20	0	08:07	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral Inflow cfs	Peak Inflow cfs	Time of Peak Inflow Occurrence days	hh:mm	Maximum Flooding Overflow cfs	Time of Peak Flooding Occurrence days	hh:mm
CAR-24	JUNCTION	61.07	61.07	0	08:00	0.00		
CAR-36	JUNCTION	0.00	60.96	0	08:00	0.00		
CAR-42	JUNCTION	0.00	60.89	0	08:01	0.00		
Jun-A	JUNCTION	27.71	27.71	0	08:00	0.00		
Jun-B	JUNCTION	8.68	35.80	0	08:02	0.00		
Jun-C	JUNCTION	0.75	97.31	0	08:02	0.00		
Jun-CAR10	JUNCTION	3.21	3.21	0	08:00	0.00		
Jun-D	JUNCTION	21.48	117.23	0	08:03	0.00		
Jun-E	JUNCTION	4.21	124.10	0	08:05	0.00		
RioRoadCulvert	OUTFALL	0.00	123.86	0	08:07	0.00		

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cfs	Peak Inflow cfs
RioRoadCulvert	47.31	25.41	123.86
System	47.31	25.41	123.86

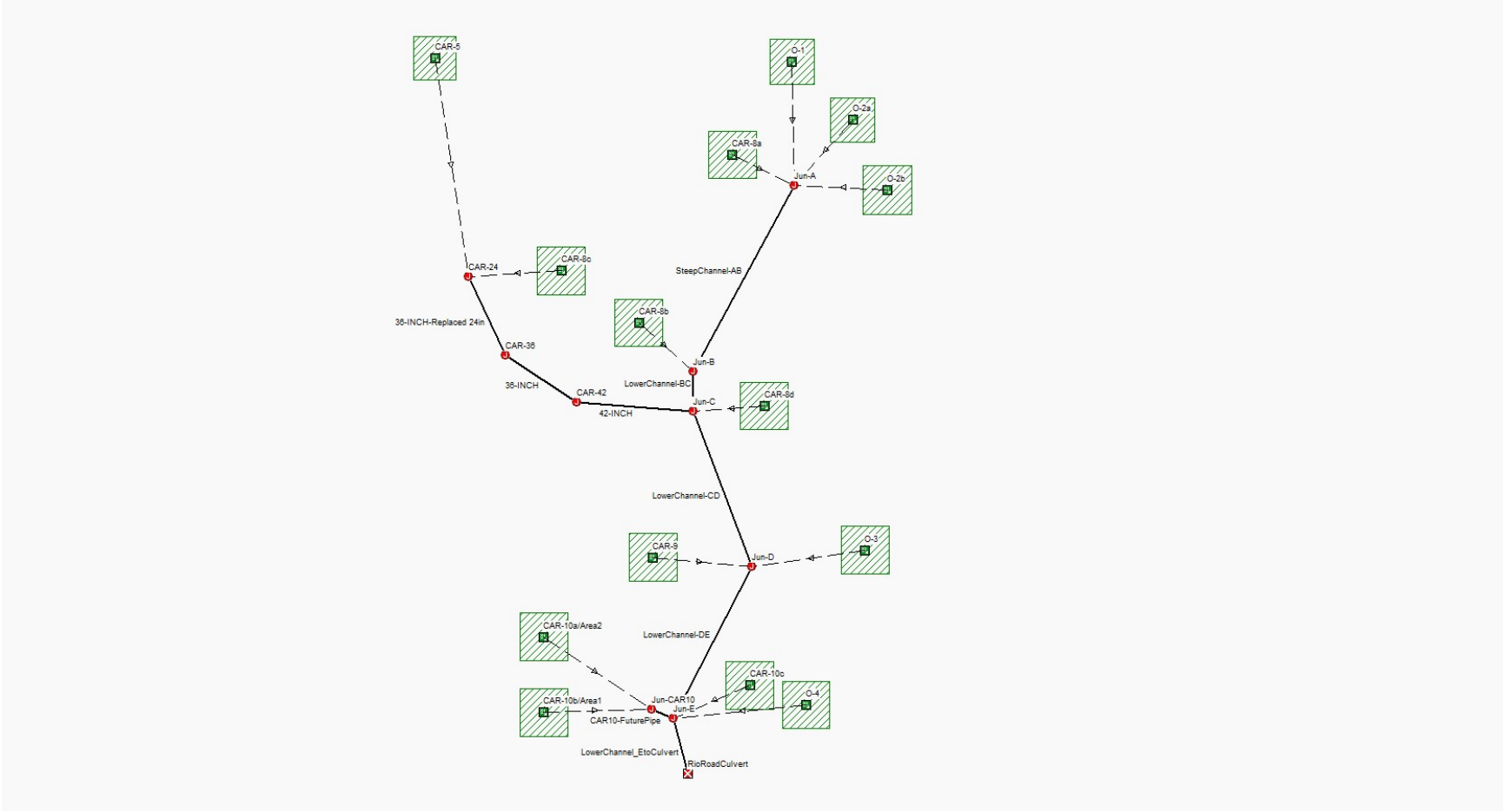
****
Link Flow Summary
****

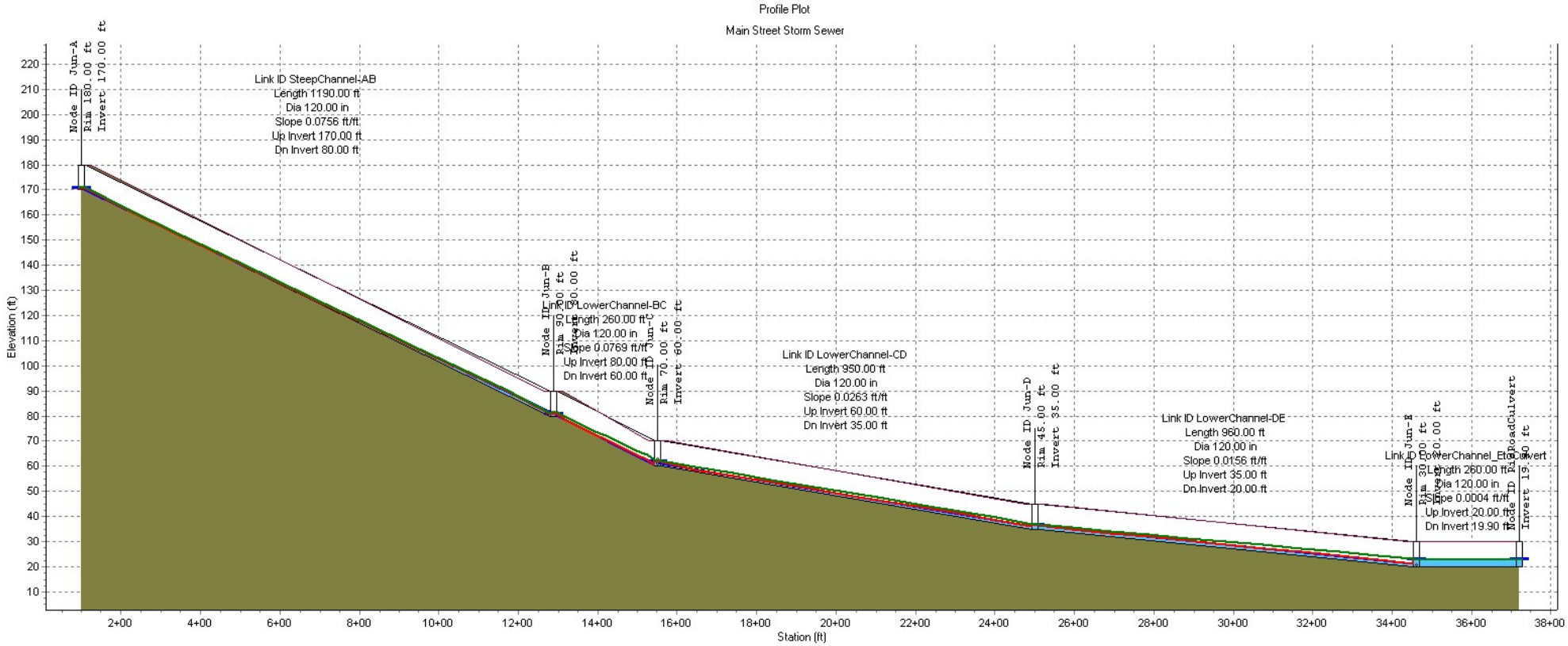
Link ID	Element Type	Time of Peak Flow Occurrence days	hh:mm	Maximum Velocity Attained ft/sec	Length Factor	Peak Flow during Analysis cfs	Design Flow Capacity cfs	Ratio of Maximum /Design Flow	Total Reported Condition Time Surcharged minutes	Ratio of Maximum Depth
36-INCH	CONDUIT	0	08:01	18.72	1.00	60.89	135.69	0.45	0 Calculated	0.47
36-INCH-Replaced 24in	CONDUIT	0	08:00	16.14	1.00	60.96	111.17	0.55	0 Calculated	0.53
42-INCH	CONDUIT	0	08:02	18.53	1.00	60.82	203.82	0.30	0 Calculated	0.37
CAR10-FuturePipe	CONDUIT	0	08:00	6.11	1.00	3.20	7.92	0.40	0 Calculated	0.44
LowerChannel_EtoCulvert	CHANNEL	0	08:07	1.29	1.00	123.86	6214.43	0.02	0 Calculated	0.23
LowerChannel-BC	CHANNEL	0	08:02	6.84	1.00	35.79	87885.25	0.00	0 Calculated	0.05
LowerChannel-CD	CHANNEL	0	08:04	5.91	1.00	97.00	51403.88	0.00	0 Calculated	0.10
LowerChannel-DE	CHANNEL	0	08:05	5.10	1.00	116.95	39609.35	0.00	0 Calculated	0.11

```
  SteepChannel-AB      CHANNEL      0  08:02      4.54    1.00       27.34    54464.74      0.00
0.06           0  Calculated


  ********************************
  Highest Flow Instability Indexes
  ********************************
  All links are stable.


  Analysis began on:  Wed Dec 26 08:57:44 2018
  Analysis ended on:  Wed Dec 26 08:57:45 2018
  Total elapsed time: 00:00:01
```


CAR-5
O-1
O-2a
CAR-8a
Jun-A
O-2b
CAR-24
CAR-8c
SteepChannel-AB
CAR-8b
36-INCH-Replaced 24in
CAR-36
Jun-B
36-INCH
LowerChannel-BC
CAR-42
Jun-C
CAR-8d
42-INCH
LowerChannel-CD
CAR-9
Jun-D
O-3
CAR-10a/Area2
LowerChannel-DE
CAR-10c
CAR-10b/Area1
Jun-CAR10
Jun-E
O-4
CAR10-FuturePipe
LowerChannel_EtoCulvert
RioRoadCulvert



Node ID:	Jun-A	Jun-B	Jun-C	Jun-D	Jun-E	RioRoadCulvert
Rim (ft):	180.00	90.00	70.00	45.00	30.00	
Invert (ft):	170.00	80.00	60.00	35.00	20.00	19.90
Min Pipe Cover (ft):	0.00	0.00	0.00	0.00	0.00	
Max HGL (ft):	170.68	80.68	61.59	36.31	22.68	22.58

Link ID:	SteepChannel-AB	LowerChannel-BC	LowerChannel-CD	LowerChannel-DE	LowerChannel_EtoCulvert
Length (ft):	1190.00	260.00	950.00	960.00	260.00
Dia (in):	120.00	120.00	120.00	120.00	120.00
Slope (ft/ft):	0.0756	0.0769	0.0263	0.0156	0.0004
Up Invert (ft):	170.00	80.00	60.00	35.00	20.00
Dn Invert (ft):	80.00	60.00	35.00	20.00	19.90
Max Q (cfs):	41.65	54.38	141.83	173.86	186.02
Max Vel (ft/s):	5.02	7.60	6.50	5.63	1.43
Max Depth (ft):	0.68	0.63	1.10	1.31	2.68

Autodesk® Storm and Sanitary Analysis 2016 - Version 10.1.53 (Build 1)

****
Project Description
****
File Name ..... 18-028 SSA-Storm Modeling-Upsized-181221.SPF

****
Analysis Options
****
Flow Units ..... cfs
Subbasin Hydrograph Method. Santa Barbara UH
Time of Concentration..... SCS TR-55
Link Routing Method ..... Kinematic Wave
Storage Node Exfiltration.. Constant rate, wetted area
Starting Date OCT-15-2018 00:00:00
Ending Date OCT-17-2018 00:00:00
Report Time Step 00:00:10

****
Element Count
****
Number of rain gages 1
Number of subbasins 14
Number of nodes 10
Number of links 9

****
Raingage Summary
****

Gage ID	Data Source	Data Type	Recording Interval min
PebbleBeach	050-year	CUMULATIVE	6.00

****
Subbasin Summary
****

Subbasin ID	Total Area ft²	Imperv. Area %	Raingage
CAR-10a/Area2	220905.11	0.00	PebbleBeach
CAR-10b/Area1	936706.23	0.00	PebbleBeach
CAR-10c	549564.77	0.00	PebbleBeach
CAR-5	3421768.38	0.00	PebbleBeach
CAR-8a	466351.13	0.00	PebbleBeach
CAR-8b	1228692.05	0.00	PebbleBeach
CAR-8c	3513067.02	0.00	PebbleBeach
CAR-8d	84784.75	0.00	PebbleBeach
CAR-9	834219.64	0.00	PebbleBeach
O-1	2106420.50	0.00	PebbleBeach
O-2a	749809.98	0.00	PebbleBeach
O-2b	911776.34	0.00	PebbleBeach
O-3	3162314.26	0.00	PebbleBeach
O-4	340813.63	0.00	PebbleBeach

****
Node Summary

****

Node ID	Element Type	Invert Elevation ft	Maximum Elev. ft	Ponded Area ft²	External Inflow
CAR-24	JUNCTION	226.50	230.00	4.00	
CAR-36	JUNCTION	184.00	190.00	4.00	
CAR-42	JUNCTION	123.00	130.00	4.00	
Jun-A	JUNCTION	170.00	180.00	0.00	
Jun-B	JUNCTION	80.00	90.00	0.00	
Jun-C	JUNCTION	60.00	70.00	0.00	
Jun-CAR10	JUNCTION	21.00	25.00	0.00	
Jun-D	JUNCTION	35.00	45.00	0.00	
Jun-E	JUNCTION	20.00	30.00	0.00	
RioRoadCulvert	OUTFALL	19.90	29.90	0.00	

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length ft	Slope %	Manning's Roughness
36-INCH	CAR-36	CAR-42	CONDUIT	1107.0	5.5104	0.0150
36-INCH-Replaced 24in	CAR-24	CAR-36	CONDUIT	1149.0	3.6989	0.0150
42-INCH	CAR-42	Jun-C	CONDUIT	1153.0	5.4640	0.0150
CAR10-FuturePipe	Jun-CAR10	Jun-E	CONDUIT	50.0	2.0000	0.0150
LowerChannel_EtoCulvert	Jun-E	RioRoadCulvert	CHANNEL	260.0	0.0385	0.0250
LowerChannel-BC	Jun-B	Jun-C	CHANNEL	260.0	7.6923	0.0250
LowerChannel-CD	Jun-C	Jun-D	CHANNEL	950.0	2.6316	0.0250
LowerChannel-DE	Jun-D	Jun-E	CHANNEL	960.0	1.5625	0.0250
SteepChannel-AB	Jun-A	Jun-B	CHANNEL	1190.0	7.5630	0.0400

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter ft	Width ft	No. of Barrels	Cross Sectional Area ft²	Full Flow Hydraulic Radius ft	Design Flow Capacity cfs
36-INCH	CIRCULAR	3.00	3.00	1	7.07	0.75	135.69
36-INCH-Replaced 24in	CIRCULAR	3.00	3.00	1	7.07	0.75	111.17
42-INCH	CIRCULAR	3.50	3.50	1	9.62	0.88	203.82
CAR10-FuturePipe	CIRCULAR	1.25	1.25	1	1.23	0.31	7.92
LowerChannel_EtoCulvert	TRIANGULAR	10.00	365.00	1	1825.00	4.99	6214.43
LowerChannel-BC	TRIANGULAR	10.00	365.00	1	1825.00	4.99	87885.25
LowerChannel-CD	TRIANGULAR	10.00	365.00	1	1825.00	4.99	51403.88
LowerChannel-DE	TRIANGULAR	10.00	365.00	1	1825.00	4.99	39609.35
SteepChannel-AB	TRIANGULAR	10.00	365.00	1	1825.00	4.99	

54464.74

Runoff Quantity Continuity	Volume acre-ft	Depth inches
Total Precipitation	122.282	3.450
Surface Runoff	68.200	1.924
Continuity Error (%)	0.000	

Flow Routing Continuity	Volume acre-ft	Volume Mgallons
External Inflow	0.000	0.000
External Outflow	68.168	22.213
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

Composite Curve Number Computations Report

Subbasin CAR-10a/Area2

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	220905.11		81.00

Subbasin CAR-10b/Area1

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	936706.23		73.00

Subbasin CAR-10c

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	549564.77		74.00

Subbasin CAR-5

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	3421768.38		91.00

Subbasin CAR-8a

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	466351.13		91.00

Subbasin CAR-8b

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	1228692.05		85.00

Subbasin CAR-8c

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	3513067.02		85.00

Subbasin CAR-8d

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	84784.75		91.00

Subbasin CAR-9

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	834219.64		72.00

Subbasin O-1

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	2106420.50		83.00

Subbasin O-2a

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	749809.98		84.00

Subbasin O-2b

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	911776.34		83.00

Subbasin O-3

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	3162314.26		83.00

Subbasin O-4

Soil/Surface Description	Area (ft²)	Soil Group	CN

Composite Area & Weighted CN	340813.63	87.00

****
Runoff Coefficient Computations Report
****

Subbasin CAR-10a/Area2

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	220905.11	-	0.72
Composite Area & Weighted Runoff Coeff.	220905.11		0.72

Subbasin CAR-10b/Area1

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	936706.23	-	0.72
Composite Area & Weighted Runoff Coeff.	936706.23		0.72

Subbasin CAR-10c

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	549564.77	-	0.72
Composite Area & Weighted Runoff Coeff.	549564.77		0.72

Subbasin CAR-5

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	4718448.95	-	0.72
Composite Area & Weighted Runoff Coeff.	4718448.95		0.72

Subbasin CAR-8a

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	466351.13	-	0.72
Composite Area & Weighted Runoff Coeff.	466351.13		0.72

Subbasin CAR-8b

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	1228692.05	-	0.72
Composite Area & Weighted Runoff Coeff.	1228692.05		0.72

Subbasin CAR-8c

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.

-	3513067.02	-	0.72
Composite Area & Weighted Runoff Coeff.	3513067.02		0.72

Subbasin CAR-8d

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	84784.75	-	0.72
Composite Area & Weighted Runoff Coeff.	84784.75		0.72

Subbasin CAR-9

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	834219.64	-	0.72
Composite Area & Weighted Runoff Coeff.	834219.64		0.72

Subbasin O-1

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	2106420.50	-	0.72
Composite Area & Weighted Runoff Coeff.	2106420.50		0.72

Subbasin O-2a

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	749809.98	-	0.72
Composite Area & Weighted Runoff Coeff.	749809.98		0.72

Subbasin O-2b

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	911776.34	-	0.72
Composite Area & Weighted Runoff Coeff.	911776.34		0.72

Subbasin O-3

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	3162314.26	-	0.72
Composite Area & Weighted Runoff Coeff.	3162314.26		0.72

Subbasin O-4

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	340813.63	-	0.72
Composite Area & Weighted Runoff Coeff.	340813.63		0.72

```
  ************************************************
  SCS TR-55 Time of Concentration Computations Report
  ************************************************

  Sheet Flow Equation
  -------------------

          Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

          Where:

          Tc = Time of Concentration (hrs)
          n  = Manning's Roughness
          Lf = Flow Length (ft)
          P  = 2 yr, 24 hr Rainfall (inches)
          Sf = Slope (ft/ft)

  Shallow Concentrated Flow Equation
  ----------------------------------

          V  = 16.1345 * (Sf^0.5) (unpaved surface)
          V  = 20.3282 * (Sf^0.5) (paved surface)
          V  = 15.0 * (Sf^0.5) (grassed waterway surface)
          V  = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
          V  = 9.0 * (Sf^0.5) (cultivated straight rows surface)
          V  = 7.0 * (Sf^0.5) (short grass pasture surface)
          V  = 5.0 * (Sf^0.5) (woodland surface)
          V  = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
          Tc = (Lf / V) / (3600 sec/hr)

          Where:

          Tc = Time of Concentration (hrs)
          Lf = Flow Length (ft)
          V  = Velocity (ft/sec)
          Sf = Slope (ft/ft)

  Channel Flow Equation
  ---------------------

          V  = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
          R  = Aq / Wp
          Tc = (Lf / V) / (3600 sec/hr)

          Where:

          Tc = Time of Concentration (hrs)
          Lf = Flow Length (ft)
          R  = Hydraulic Radius (ft)
          Aq = Flow Area (ft²)
          Wp = Wetted Perimeter (ft)
          V  = Velocity (ft/sec)
          Sf = Slope (ft/ft)
          n  = Manning's Roughness

  -------------------------
  Subbasin CAR-10a/Area2
  -------------------------

  Sheet Flow Computations
  -----------------------
                                              Subarea A           Subarea B           Subarea
C
          Manning's Roughness:                     0.04                0.00
0.00
          Flow Length (ft):                       65.00                0.00
0.00
```

Slope (%):	0.77	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.21	0.00	0.00
Computed Flow Time (minutes):	5.16	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.04	0.00
Flow Length (ft):	1180.00	884.00	0.00
Channel Slope (%):	8.05	7.49	0.00
Cross Section Area (ft²):	0.38	3660.00	0.00
Wetted Perimeter (ft):	1.58	732.00	0.00
Velocity (ft/sec):	12.47	29.81	0.00
Computed Flow Time (minutes):	1.58	0.49	0.00

Total TOC (minutes):	3.62

Subbasin CAR-10b/Area1

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	111.00	0.00	0.00
Slope (%):	1.80	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.33	0.00	0.00
Computed Flow Time (minutes):	5.64	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	2186.00	0.00	0.00
Channel Slope (%):	5.43	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00

Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	10.24	0.00	0.00
Computed Flow Time (minutes):	3.56	0.00	0.00

Total TOC (minutes): 9.19

Subbasin CAR-10c

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	106.00	0.00	0.00
Slope (%):	0.94	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.25	0.00	0.00
Computed Flow Time (minutes):	7.04	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.04	0.00
Flow Length (ft):	954.00	884.00	0.00
Channel Slope (%):	8.91	7.49	0.00
Cross Section Area (ft²):	0.75	3660.00	0.00
Wetted Perimeter (ft):	1.58	732.00	0.00
Velocity (ft/sec):	20.82	29.81	0.00
Computed Flow Time (minutes):	0.76	0.49	0.00

Total TOC (minutes): 4.15

Subbasin CAR-5

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C

Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	108.00	0.00	0.00
Slope (%):	0.93	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.25	0.00	0.00
Computed Flow Time (minutes):	7.18	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.01	0.00
Flow Length (ft):	2487.00	2541.00	0.00
Channel Slope (%):	6.90	6.49	0.00
Cross Section Area (ft²):	0.38	3.14	0.00
Wetted Perimeter (ft):	1.58	6.28	0.00
Velocity (ft/sec):	11.54	18.39	0.00
Computed Flow Time (minutes):	3.59	2.30	0.00

Total TOC (minutes):	6.54

Subbasin CAR-8a

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	108.00	0.00	0.00
Slope (%):	1.85	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.33	0.00	0.00
Computed Flow Time (minutes):	5.45	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	1264.00	0.00	0.00

Channel Slope (%):	1.37	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	5.14	0.00	0.00
Computed Flow Time (minutes):	4.10	0.00	0.00

Total TOC (minutes): 9.55

Subbasin CAR-8b

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	102.00	0.00	0.00
Slope (%):	0.98	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.25	0.00	0.00
Computed Flow Time (minutes):	6.72	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	1419.00	0.00	0.00
Channel Slope (%):	10.29	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	14.09	0.00	0.00
Computed Flow Time (minutes):	1.68	0.00	0.00

Total TOC (minutes): 8.40

Subbasin CAR-8c

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	102.00	0.00	0.00
Slope (%):	0.98	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.25	0.00	0.00
Computed Flow Time (minutes):	6.72	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	1136.00	0.00	0.00
Channel Slope (%):	10.12	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	13.98	0.00	0.00
Computed Flow Time (minutes):	1.35	0.00	0.00

Total TOC (minutes):	8.07

Subbasin CAR-8d

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	300.00	0.00	0.00
Slope (%):	0.98	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.31	0.00	0.00
Computed Flow Time (minutes):	15.92	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C

Manning's Roughness:	0.08	0.00	0.00
Flow Length (ft):	416.00	0.00	0.00
Channel Slope (%):	21.36	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	3.30	0.00	0.00
Computed Flow Time (minutes):	2.10	0.00	0.00

Total TOC (minutes): 18.03

Subbasin CAR-9

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	300.00	0.00	0.00
Slope (%):	1.00	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.32	0.00	0.00
Computed Flow Time (minutes):	15.80	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	463.00	0.00	0.00
Channel Slope (%):	16.20	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	17.68	0.00	0.00
Computed Flow Time (minutes):	0.44	0.00	0.00

Total TOC (minutes): 16.23

Subbasin O-1

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	80.00	0.00	0.00
Slope (%):	1.33	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.27	0.00	0.00
Computed Flow Time (minutes):	4.90	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.04	0.00
Flow Length (ft):	5294.00	1069.00	0.00
Channel Slope (%):	1.60	7.48	0.00
Cross Section Area (ft²):	0.38	3660.00	0.00
Wetted Perimeter (ft):	1.58	732.00	0.00
Velocity (ft/sec):	5.56	29.79	0.00
Computed Flow Time (minutes):	15.88	0.60	0.00

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Total TOC (minutes): 10.68

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Subbasin O-2a

User-Defined TOC override (minutes): 5.00

Subbasin O-2b

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	123.00	0.00	0.00
Slope (%):	1.63	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	

1.50			
	Velocity (ft/sec):	0.32	0.00
0.00			
	Computed Flow Time (minutes):	6.37	0.00
0.00			

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	2136.00	0.00	0.00
Channel Slope (%):	8.43	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	12.76	0.00	0.00
Computed Flow Time (minutes):	2.79	0.00	0.00

Total TOC (minutes):	9.16

Subbasin O-3

User-Defined TOC override (minutes):	5.00

Subbasin O-4

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	170.00	0.00	0.00
Slope (%):	0.29	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.17	0.00	0.00
Computed Flow Time (minutes):	16.45	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.04	0.00
Flow Length (ft):	1607.00	884.00	0.00
Channel Slope (%):	5.91	7.49	

```
0.00
          Cross Section Area (ft²):                    0.38             3660.00
0.00
          Wetted Perimeter (ft):                       1.58              732.00
0.00
          Velocity (ft/sec):                          10.68               29.81
0.00
          Computed Flow Time (minutes):                2.51                0.49
0.00

=============================================================================================================
          Total TOC (minutes):                         9.73

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```

****
Subbasin Runoff Summary
****

Subbasin ID	Total Precip in	Total Runoff in	Peak Runoff cfs	Weighted Curve Number	Time of Concentration days	Time of Concentration hh:mm:ss
CAR-10a/Area2	3.45	1.67	1.94	81.000	0	00:05:00
CAR-10b/Area1	3.45	1.15	4.24	73.000	0	00:09:11
CAR-10c	3.45	1.21	2.96	74.000	0	00:05:00
CAR-5	3.45	2.49	49.59	91.000	0	00:06:32
CAR-8a	3.45	2.49	6.52	91.000	0	00:09:33
CAR-8b	3.45	1.97	13.03	85.000	0	00:08:24
CAR-8c	3.45	1.97	37.44	85.000	0	00:08:04
CAR-8d	3.45	2.49	1.03	91.000	0	00:18:01
CAR-9	3.45	1.09	3.02	72.000	0	00:16:13
O-1	3.45	1.82	19.19	83.000	0	00:10:40
O-2a	3.45	1.89	7.84	84.000	0	00:05:00
O-2b	3.45	1.82	8.53	83.000	0	00:09:09
O-3	3.45	1.82	31.28	83.000	0	00:05:00
O-4	3.45	2.14	3.93	87.000	0	00:09:43

****
Node Depth Summary
****

Node ID	Average Depth Attained ft	Maximum Depth Attained ft	Maximum HGL Attained ft	Time of Max Occurrence days	Time of Max Occurrence hh:mm	Total Flooded Volume acre-in	Total Time Flooded minutes	Retention Time hh:mm:ss
CAR-24	0.34	2.00	228.50	0	08:00	0	0	0:00:00
CAR-36	0.34	2.00	186.00	0	08:00	0	0	0:00:00
CAR-42	0.31	1.75	124.75	0	08:01	0	0	0:00:00
Jun-A	0.16	0.68	170.68	0	08:00	0	0	0:00:00
Jun-B	0.16	0.68	80.68	0	08:02	0	0	0:00:00
Jun-C	0.29	1.59	61.59	0	08:01	0	0	0:00:00
Jun-CAR10	0.16	0.83	21.83	0	08:00	0	0	0:00:00
Jun-D	0.31	1.31	36.31	0	08:02	0	0	0:00:00
Jun-E	0.63	2.68	22.68	0	08:04	0	0	0:00:00
RioRoadCulvert	0.64	2.68	22.58	0	08:06	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral Inflow cfs	Peak Inflow cfs	Time of Peak Inflow Occurrence days	hh:mm	Maximum Flooding Overflow cfs	Time of Peak Flooding Occurrence days	hh:mm
CAR-24	JUNCTION	87.02	87.02	0	08:00	0.00		
CAR-36	JUNCTION	0.00	86.90	0	08:00	0.00		
CAR-42	JUNCTION	0.00	86.81	0	08:01	0.00		
Jun-A	JUNCTION	42.09	42.09	0	08:00	0.00		
Jun-B	JUNCTION	13.03	54.39	0	08:01	0.00		
Jun-C	JUNCTION	1.03	142.13	0	08:01	0.00		
Jun-CAR10	JUNCTION	6.18	6.18	0	08:00	0.00		
Jun-D	JUNCTION	34.15	174.08	0	08:02	0.00		
Jun-E	JUNCTION	6.89	186.31	0	08:04	0.00		
RioRoadCulvert	OUTFALL	0.00	186.02	0	08:06	0.00		

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cfs	Peak Inflow cfs
RioRoadCulvert	48.50	35.43	186.02
System	48.50	35.43	186.02

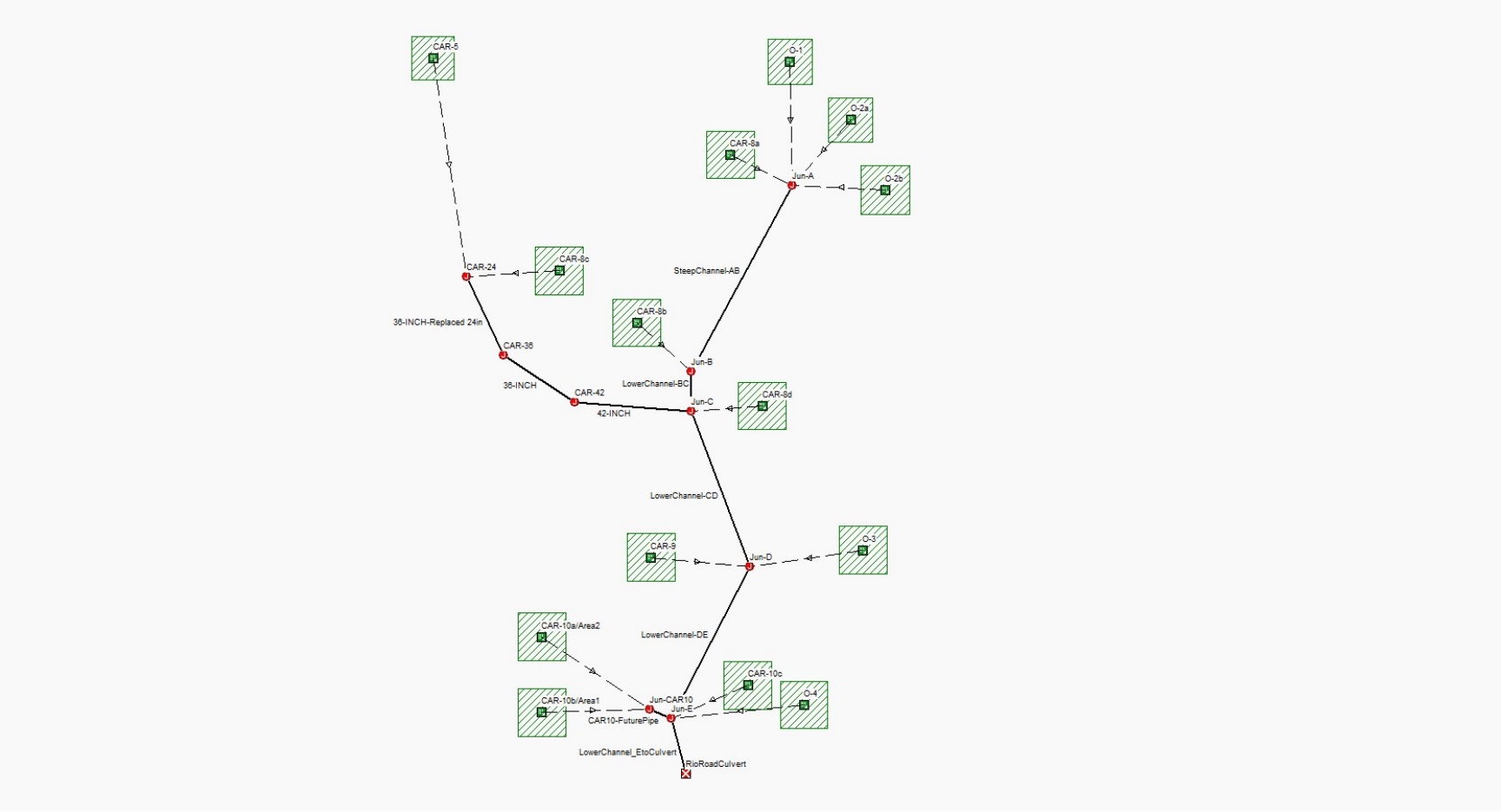
****
Link Flow Summary
****

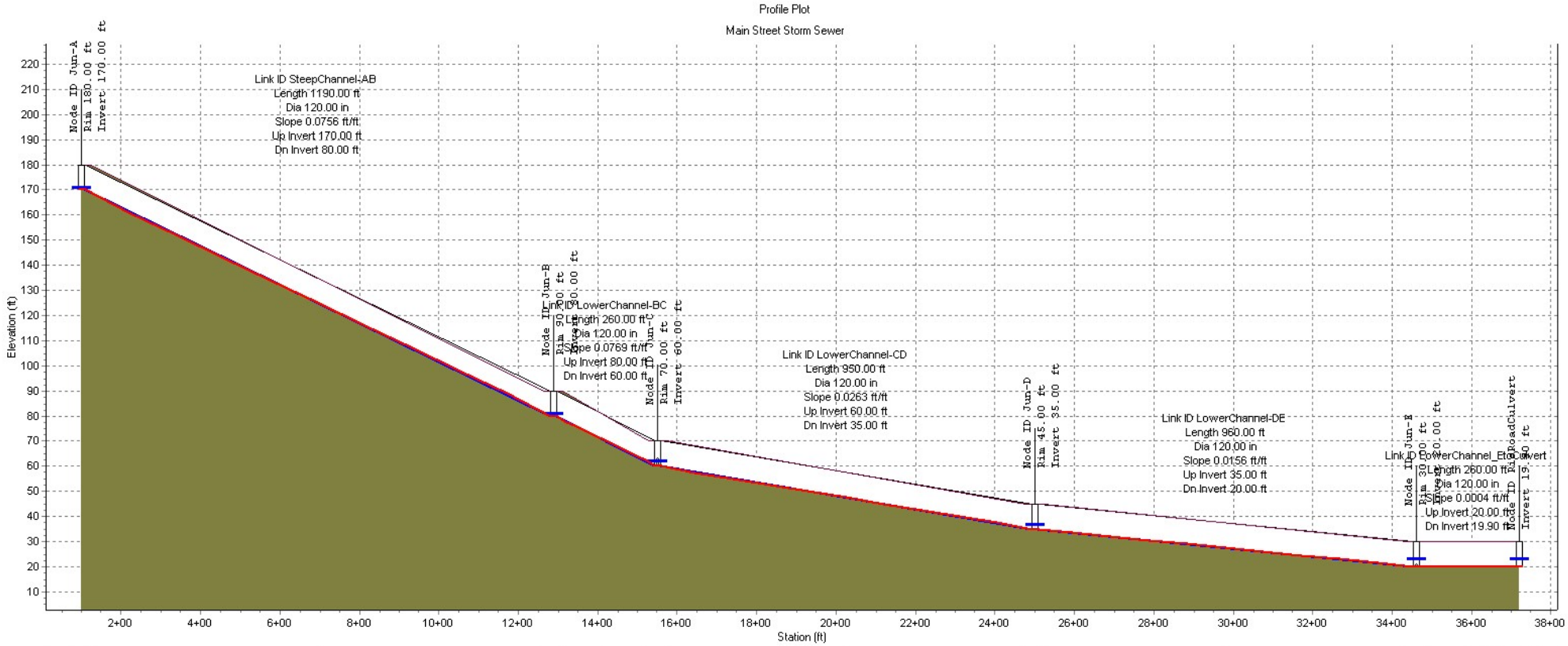
Link ID	Element Type	Time of Peak Flow Occurrence days	hh:mm	Maximum Velocity Attained ft/sec	Length Factor	Peak Flow during Analysis cfs	Design Flow Capacity cfs	Ratio of Maximum /Design Flow	Total Reported Condition	Time Surcharged minutes	Maximum Depth
36-INCH	CONDUIT	0	08:01	20.40	1.00	86.81	135.69	0.64	0	Calculated	0.58
36-INCH-Replaced 24in	CONDUIT	0	08:00	17.47	1.00	86.90	111.17	0.78	0	Calculated	0.66
42-INCH	CONDUIT	0	08:01	20.38	1.00	86.75	203.82	0.43	0	Calculated	0.46
CAR10-FuturePipe	CONDUIT	0	08:00	7.14	1.00	6.18	7.92	0.78	0	Calculated	0.66
LowerChannel_EtoCulvert	CHANNEL	0	08:06	1.43	1.00	186.02	6214.43	0.03	0.27	0	Calculated
LowerChannel-BC	CHANNEL	0	08:02	7.60	1.00	54.38	87885.25	0.00	0	Calculated	0.06
LowerChannel-CD	CHANNEL	0	08:03	6.50	1.00	141.83	51403.88	0.00	0	Calculated	0.11
LowerChannel-DE	CHANNEL	0	08:04	5.63	1.00	173.86	39609.35	0.00	0	Calculated	0.13

```
  SteepChannel-AB      CHANNEL      0  08:02      5.02    1.00       41.65    54464.74      0.00
0.07           0  Calculated


  ******************************
  Highest Flow Instability Indexes
  ******************************
  All links are stable.


  Analysis began on:  Wed Dec 26 08:55:31 2018
  Analysis ended on:  Wed Dec 26 08:55:33 2018
  Total elapsed time: 00:00:02
```


CAR-5
O-1
O-2a
CAR-8a
Jun-A
O-2b
CAR-24
CAR-8c
SteepChannel-AB
CAR-8b
36-INCH-Replaced 24in
CAR-36
Jun-B
36-INCH
LowerChannel-BC
CAR-42
Jun-C
CAR-8d
42-INCH
LowerChannel-CD
CAR-9
Jun-D
O-3
CAR-10a/Area2
LowerChannel-DE
CAR-10c
CAR-10b/Area1
Jun-CAR10
Jun-E
O-4
CAR10-FuturePipe
LowerChannel_EtoCulvert
RioRoadCulvert



Node ID:	Jun-A	Jun-B	Jun-C	Jun-D	Jun-E	RioRoadCulvert
Rim (ft):	180.00	90.00	70.00	45.00	30.00	
Invert (ft):	170.00	80.00	60.00	35.00	20.00	19.90
Min Pipe Cover (ft):	0.00	0.00	0.00	0.00	0.00	
Max HGL (ft):	170.68	80.68	61.59	36.31	22.68	22.58

Link ID:	SteepChannel-AB	LowerChannel-BC	LowerChannel-CD	LowerChannel-DE	LowerChannel_EtoCulvert
Length (ft):	1190.00	260.00	950.00	960.00	260.00
Dia (in):	120.00	120.00	120.00	120.00	120.00
Slope (ft/ft):	0.0756	0.0769	0.0263	0.0156	0.0004
Up Invert (ft):	170.00	80.00	60.00	35.00	20.00
Dn Invert (ft):	80.00	60.00	35.00	20.00	19.90
Max Q (cfs):	41.65	54.38	141.83	173.86	186.02
Max Vel (ft/s):	5.02	7.60	6.50	5.63	1.43
Max Depth (ft):	0.68	0.63	1.10	1.31	2.68

Autodesk® Storm and Sanitary Analysis 2016 - Version 10.1.53 (Build 1)

****
Project Description
****
File Name ..... 18-028 SSA-Storm Modeling-Upsized-181221.SPF

****
Analysis Options
****
Flow Units ..... cfs
Subbasin Hydrograph Method. Santa Barbara UH
Time of Concentration..... SCS TR-55
Link Routing Method ..... Kinematic Wave
Storage Node Exfiltration.. Constant rate, wetted area
Starting Date OCT-15-2018 00:00:00
Ending Date OCT-17-2018 00:00:00
Report Time Step 00:00:10

****
Element Count
****
Number of rain gages 1
Number of subbasins 14
Number of nodes 10
Number of links 9

****
Raingage Summary
****

Gage ID	Data Source	Data Type	Recording Interval min
PebbleBeach	100-year	CUMULATIVE	6.00

****
Subbasin Summary
****

Subbasin ID	Total Area ft²	Imperv. Area %	Raingage
CAR-10a/Area2	220905.11	0.00	PebbleBeach
CAR-10b/Area1	936706.23	0.00	PebbleBeach
CAR-10c	549564.77	0.00	PebbleBeach
CAR-5	3421768.38	0.00	PebbleBeach
CAR-8a	466351.13	0.00	PebbleBeach
CAR-8b	1228692.05	0.00	PebbleBeach
CAR-8c	3513067.02	0.00	PebbleBeach
CAR-8d	84784.75	0.00	PebbleBeach
CAR-9	834219.64	0.00	PebbleBeach
O-1	2106420.50	0.00	PebbleBeach
O-2a	749809.98	0.00	PebbleBeach
O-2b	911776.34	0.00	PebbleBeach
O-3	3162314.26	0.00	PebbleBeach
O-4	340813.63	0.00	PebbleBeach

****
Node Summary

****

Node ID	Element Type	Invert Elevation ft	Maximum Elev. ft	Ponded Area ft²	External Inflow
CAR-24	JUNCTION	226.50	230.00	4.00	
CAR-36	JUNCTION	184.00	190.00	4.00	
CAR-42	JUNCTION	123.00	130.00	4.00	
Jun-A	JUNCTION	170.00	180.00	0.00	
Jun-B	JUNCTION	80.00	90.00	0.00	
Jun-C	JUNCTION	60.00	70.00	0.00	
Jun-CAR10	JUNCTION	21.00	25.00	0.00	
Jun-D	JUNCTION	35.00	45.00	0.00	
Jun-E	JUNCTION	20.00	30.00	0.00	
RioRoadCulvert	OUTFALL	19.90	29.90	0.00	

****
Link Summary
****

Link ID	From Node	To Node	Element Type	Length ft	Slope %	Manning's Roughness
36-INCH	CAR-36	CAR-42	CONDUIT	1107.0	5.5104	0.0150
36-INCH-Replaced 24in	CAR-24	CAR-36	CONDUIT	1149.0	3.6989	0.0150
42-INCH	CAR-42	Jun-C	CONDUIT	1153.0	5.4640	0.0150
CAR10-FuturePipe	Jun-CAR10	Jun-E	CONDUIT	50.0	2.0000	0.0150
LowerChannel_EtoCulvert	Jun-E	RioRoadCulvert	CHANNEL	260.0	0.0385	0.0250
LowerChannel-BC	Jun-B	Jun-C	CHANNEL	260.0	7.6923	0.0250
LowerChannel-CD	Jun-C	Jun-D	CHANNEL	950.0	2.6316	0.0250
LowerChannel-DE	Jun-D	Jun-E	CHANNEL	960.0	1.5625	0.0250
SteepChannel-AB	Jun-A	Jun-B	CHANNEL	1190.0	7.5630	0.0400

****
Cross Section Summary
****

Link ID	Shape	Depth/ Diameter ft	Width ft	No. of Barrels	Cross Sectional Area ft²	Full Flow Hydraulic Radius ft	Design Flow Capacity cfs
36-INCH	CIRCULAR	3.00	3.00	1	7.07	0.75	135.69
36-INCH-Replaced 24in	CIRCULAR	3.00	3.00	1	7.07	0.75	111.17
42-INCH	CIRCULAR	3.50	3.50	1	9.62	0.88	203.82
CAR10-FuturePipe	CIRCULAR	1.25	1.25	1	1.23	0.31	7.92
LowerChannel_EtoCulvert	TRIANGULAR	10.00	365.00	1	1825.00	4.99	6214.43
LowerChannel-BC	TRIANGULAR	10.00	365.00	1	1825.00	4.99	87885.25
LowerChannel-CD	TRIANGULAR	10.00	365.00	1	1825.00	4.99	51403.88
LowerChannel-DE	TRIANGULAR	10.00	365.00	1	1825.00	4.99	39609.35
SteepChannel-AB	TRIANGULAR	10.00	365.00	1	1825.00	4.99	

54464.74

Runoff Quantity Continuity	Volume acre-ft	Depth inches
Total Precipitation	129.370	3.650
Surface Runoff	74.252	2.095
Continuity Error (%)	0.000	

Flow Routing Continuity	Volume acre-ft	Volume Mgallons
External Inflow	0.000	0.000
External Outflow	74.218	24.185
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

Composite Curve Number Computations Report

Subbasin CAR-10a/Area2

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	220905.11		81.00

Subbasin CAR-10b/Area1

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	936706.23		73.00

Subbasin CAR-10c

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	549564.77		74.00

Subbasin CAR-5

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	3421768.38		91.00

Subbasin CAR-8a

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	466351.13		91.00

Subbasin CAR-8b

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	1228692.05		85.00

Subbasin CAR-8c

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	3513067.02		85.00

Subbasin CAR-8d

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	84784.75		91.00

Subbasin CAR-9

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	834219.64		72.00

Subbasin O-1

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	2106420.50		83.00

Subbasin O-2a

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	749809.98		84.00

Subbasin O-2b

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	911776.34		83.00

Subbasin O-3

Soil/Surface Description	Area (ft²)	Soil Group	CN
Composite Area & Weighted CN	3162314.26		83.00

Subbasin O-4

Soil/Surface Description	Area (ft²)	Soil Group	CN

Composite Area & Weighted CN	340813.63	87.00

****
Runoff Coefficient Computations Report
****

Subbasin CAR-10a/Area2

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	220905.11	-	0.72
Composite Area & Weighted Runoff Coeff.	220905.11		0.72

Subbasin CAR-10b/Area1

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	936706.23	-	0.72
Composite Area & Weighted Runoff Coeff.	936706.23		0.72

Subbasin CAR-10c

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	549564.77	-	0.72
Composite Area & Weighted Runoff Coeff.	549564.77		0.72

Subbasin CAR-5

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	4718448.95	-	0.72
Composite Area & Weighted Runoff Coeff.	4718448.95		0.72

Subbasin CAR-8a

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	466351.13	-	0.72
Composite Area & Weighted Runoff Coeff.	466351.13		0.72

Subbasin CAR-8b

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	1228692.05	-	0.72
Composite Area & Weighted Runoff Coeff.	1228692.05		0.72

Subbasin CAR-8c

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.

-	3513067.02	-	0.72
Composite Area & Weighted Runoff Coeff.	3513067.02		0.72

Subbasin CAR-8d

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	84784.75	-	0.72
Composite Area & Weighted Runoff Coeff.	84784.75		0.72

Subbasin CAR-9

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	834219.64	-	0.72
Composite Area & Weighted Runoff Coeff.	834219.64		0.72

Subbasin O-1

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	2106420.50	-	0.72
Composite Area & Weighted Runoff Coeff.	2106420.50		0.72

Subbasin O-2a

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	749809.98	-	0.72
Composite Area & Weighted Runoff Coeff.	749809.98		0.72

Subbasin O-2b

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	911776.34	-	0.72
Composite Area & Weighted Runoff Coeff.	911776.34		0.72

Subbasin O-3

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	3162314.26	-	0.72
Composite Area & Weighted Runoff Coeff.	3162314.26		0.72

Subbasin O-4

Soil/Surface Description	Area (ft²)	Soil Group	Runoff Coeff.
-	340813.63	-	0.72
Composite Area & Weighted Runoff Coeff.	340813.63		0.72

```
  ************************************************
  SCS TR-55 Time of Concentration Computations Report
  ************************************************

  Sheet Flow Equation
  -------------------

          Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

          Where:

          Tc = Time of Concentration (hrs)
          n  = Manning's Roughness
          Lf = Flow Length (ft)
          P  = 2 yr, 24 hr Rainfall (inches)
          Sf = Slope (ft/ft)

  Shallow Concentrated Flow Equation
  ----------------------------------

          V  = 16.1345 * (Sf^0.5) (unpaved surface)
          V  = 20.3282 * (Sf^0.5) (paved surface)
          V  = 15.0 * (Sf^0.5) (grassed waterway surface)
          V  = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
          V  = 9.0 * (Sf^0.5) (cultivated straight rows surface)
          V  = 7.0 * (Sf^0.5) (short grass pasture surface)
          V  = 5.0 * (Sf^0.5) (woodland surface)
          V  = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
          Tc = (Lf / V) / (3600 sec/hr)

          Where:

          Tc = Time of Concentration (hrs)
          Lf = Flow Length (ft)
          V  = Velocity (ft/sec)
          Sf = Slope (ft/ft)

  Channel Flow Equation
  ---------------------

          V  = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
          R  = Aq / Wp
          Tc = (Lf / V) / (3600 sec/hr)

          Where:

          Tc = Time of Concentration (hrs)
          Lf = Flow Length (ft)
          R  = Hydraulic Radius (ft)
          Aq = Flow Area (ft²)
          Wp = Wetted Perimeter (ft)
          V  = Velocity (ft/sec)
          Sf = Slope (ft/ft)
          n  = Manning's Roughness

  -------------------------
  Subbasin CAR-10a/Area2
  -------------------------

  Sheet Flow Computations
  -----------------------
                                              Subarea A           Subarea B           Subarea
C
          Manning's Roughness:                     0.04                0.00
0.00
          Flow Length (ft):                       65.00                0.00
0.00
```

Slope (%):	0.77	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.21	0.00	0.00
Computed Flow Time (minutes):	5.16	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.04	0.00
Flow Length (ft):	1180.00	884.00	0.00
Channel Slope (%):	8.05	7.49	0.00
Cross Section Area (ft²):	0.38	3660.00	0.00
Wetted Perimeter (ft):	1.58	732.00	0.00
Velocity (ft/sec):	12.47	29.81	0.00
Computed Flow Time (minutes):	1.58	0.49	0.00

Total TOC (minutes):	3.62

Subbasin CAR-10b/Area1

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	111.00	0.00	0.00
Slope (%):	1.80	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.33	0.00	0.00
Computed Flow Time (minutes):	5.64	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	2186.00	0.00	0.00
Channel Slope (%):	5.43	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00

Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	10.24	0.00	0.00
Computed Flow Time (minutes):	3.56	0.00	0.00

Total TOC (minutes): 9.19

Subbasin CAR-10c

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	106.00	0.00	0.00
Slope (%):	0.94	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.25	0.00	0.00
Computed Flow Time (minutes):	7.04	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.04	0.00
Flow Length (ft):	954.00	884.00	0.00
Channel Slope (%):	8.91	7.49	0.00
Cross Section Area (ft²):	0.75	3660.00	0.00
Wetted Perimeter (ft):	1.58	732.00	0.00
Velocity (ft/sec):	20.82	29.81	0.00
Computed Flow Time (minutes):	0.76	0.49	0.00

Total TOC (minutes): 4.15

Subbasin CAR-5

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C

Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	108.00	0.00	0.00
Slope (%):	0.93	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.25	0.00	0.00
Computed Flow Time (minutes):	7.18	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.01	0.00
Flow Length (ft):	2487.00	2541.00	0.00
Channel Slope (%):	6.90	6.49	0.00
Cross Section Area (ft²):	0.38	3.14	0.00
Wetted Perimeter (ft):	1.58	6.28	0.00
Velocity (ft/sec):	11.54	18.39	0.00
Computed Flow Time (minutes):	3.59	2.30	0.00

Total TOC (minutes):	6.54

Subbasin CAR-8a

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	108.00	0.00	0.00
Slope (%):	1.85	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.33	0.00	0.00
Computed Flow Time (minutes):	5.45	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	1264.00	0.00	0.00

Channel Slope (%):	1.37	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	5.14	0.00	0.00
Computed Flow Time (minutes):	4.10	0.00	0.00

Total TOC (minutes):	9.55

Subbasin CAR-8b

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	102.00	0.00	0.00
Slope (%):	0.98	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.25	0.00	0.00
Computed Flow Time (minutes):	6.72	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	1419.00	0.00	0.00
Channel Slope (%):	10.29	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	14.09	0.00	0.00
Computed Flow Time (minutes):	1.68	0.00	0.00

Total TOC (minutes):	8.40

Subbasin CAR-8c

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	102.00	0.00	0.00
Slope (%):	0.98	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.25	0.00	0.00
Computed Flow Time (minutes):	6.72	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	1136.00	0.00	0.00
Channel Slope (%):	10.12	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	13.98	0.00	0.00
Computed Flow Time (minutes):	1.35	0.00	0.00

Total TOC (minutes):	8.07

Subbasin CAR-8d

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	300.00	0.00	0.00
Slope (%):	0.98	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.31	0.00	0.00
Computed Flow Time (minutes):	15.92	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C

Manning's Roughness:	0.08	0.00	0.00
Flow Length (ft):	416.00	0.00	0.00
Channel Slope (%):	21.36	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	3.30	0.00	0.00
Computed Flow Time (minutes):	2.10	0.00	0.00

Total TOC (minutes): 18.03

Subbasin CAR-9

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	300.00	0.00	0.00
Slope (%):	1.00	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.32	0.00	0.00
Computed Flow Time (minutes):	15.80	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	463.00	0.00	0.00
Channel Slope (%):	16.20	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	17.68	0.00	0.00
Computed Flow Time (minutes):	0.44	0.00	0.00

Total TOC (minutes): 16.23

Subbasin O-1

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	80.00	0.00	0.00
Slope (%):	1.33	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.27	0.00	0.00
Computed Flow Time (minutes):	4.90	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.04	0.00
Flow Length (ft):	5294.00	1069.00	0.00
Channel Slope (%):	1.60	7.48	0.00
Cross Section Area (ft²):	0.38	3660.00	0.00
Wetted Perimeter (ft):	1.58	732.00	0.00
Velocity (ft/sec):	5.56	29.79	0.00
Computed Flow Time (minutes):	15.88	0.60	0.00

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Total TOC (minutes): 10.68

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Subbasin O-2a

User-Defined TOC override (minutes): 5.00

Subbasin O-2b

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	123.00	0.00	0.00
Slope (%):	1.63	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	

1.50			
	Velocity (ft/sec):	0.32	0.00
0.00			
	Computed Flow Time (minutes):	6.37	0.00
0.00			

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.00	0.00
Flow Length (ft):	2136.00	0.00	0.00
Channel Slope (%):	8.43	0.00	0.00
Cross Section Area (ft²):	0.38	0.00	0.00
Wetted Perimeter (ft):	1.58	0.00	0.00
Velocity (ft/sec):	12.76	0.00	0.00
Computed Flow Time (minutes):	2.79	0.00	0.00

Total TOC (minutes):	9.16

Subbasin O-3

User-Defined TOC override (minutes):	5.00

Subbasin O-4

Sheet Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.04	0.00	0.00
Flow Length (ft):	170.00	0.00	0.00
Slope (%):	0.29	0.00	0.00
2 yr, 24 hr Rainfall (in):	1.50	1.50	1.50
Velocity (ft/sec):	0.17	0.00	0.00
Computed Flow Time (minutes):	16.45	0.00	0.00

Channel Flow Computations

	Subarea A	Subarea B	Subarea C
Manning's Roughness:	0.01	0.04	0.00
Flow Length (ft):	1607.00	884.00	0.00
Channel Slope (%):	5.91	7.49	

```
0.00
          Cross Section Area (ft²):                    0.38             3660.00
0.00
          Wetted Perimeter (ft):                       1.58              732.00
0.00
          Velocity (ft/sec):                          10.68               29.81
0.00
          Computed Flow Time (minutes):                2.51                0.49
0.00

=============================================================================================================
          Total TOC (minutes):                         9.73

=============================================================================================================
```

****
Subbasin Runoff Summary
****

Subbasin ID	Total Precip in	Total Runoff in	Peak Runoff cfs	Weighted Curve Number	Time of Concentration days	Time of Concentration hh:mm:ss
CAR-10a/Area2	3.65	1.83	2.16	81.000	0	00:05:00
CAR-10b/Area1	3.65	1.28	4.95	73.000	0	00:09:11
CAR-10c	3.65	1.34	3.41	74.000	0	00:05:00
CAR-5	3.65	2.68	53.46	91.000	0	00:06:32
CAR-8a	3.65	2.68	7.03	91.000	0	00:09:33
CAR-8b	3.65	2.15	14.31	85.000	0	00:08:24
CAR-8c	3.65	2.15	41.12	85.000	0	00:08:04
CAR-8d	3.65	2.68	1.11	91.000	0	00:18:01
CAR-9	3.65	1.22	3.56	72.000	0	00:16:13
O-1	3.65	1.99	21.25	83.000	0	00:10:40
O-2a	3.65	2.07	8.63	84.000	0	00:05:00
O-2b	3.65	1.99	9.44	83.000	0	00:09:09
O-3	3.65	1.99	34.56	83.000	0	00:05:00
O-4	3.65	2.32	4.29	87.000	0	00:09:43

****
Node Depth Summary
****

Node ID	Average Depth Attained ft	Maximum Depth Attained ft	Maximum HGL Attained ft	Time of Max Occurrence days	Time of Max Occurrence hh:mm	Total Flooded Volume acre-in	Total Time Flooded minutes	Retention Time hh:mm:ss
CAR-24	0.35	2.13	228.63	0	08:00	0	0	0:00:00
CAR-36	0.35	2.12	186.12	0	08:00	0	0	0:00:00
CAR-42	0.32	1.84	124.84	0	08:01	0	0	0:00:00
Jun-A	0.17	0.71	170.71	0	08:00	0	0	0:00:00
Jun-B	0.17	0.70	80.70	0	08:02	0	0	0:00:00
Jun-C	0.31	1.67	61.67	0	08:01	0	0	0:00:00
Jun-CAR10	0.16	0.93	21.93	0	08:00	0	0	0:00:00
Jun-D	0.32	1.35	36.35	0	08:02	0	0	0:00:00
Jun-E	0.66	2.78	22.78	0	08:04	0	0	0:00:00
RioRoadCulvert	0.66	2.78	22.68	0	08:06	0	0	0:00:00

****
Node Flow Summary
****

Node ID	Element Type	Maximum Lateral Inflow cfs	Peak Inflow cfs	Time of Peak Inflow Occurrence days	hh:mm	Maximum Flooding Overflow cfs	Time of Peak Flooding Occurrence days	hh:mm
CAR-24	JUNCTION	94.58	94.58	0	08:00	0.00		
CAR-36	JUNCTION	0.00	94.44	0	08:00	0.00		
CAR-42	JUNCTION	0.00	94.36	0	08:01	0.00		
Jun-A	JUNCTION	46.36	46.36	0	08:00	0.00		
Jun-B	JUNCTION	14.31	59.91	0	08:01	0.00		
Jun-C	JUNCTION	1.11	155.30	0	08:01	0.00		
Jun-CAR10	JUNCTION	7.11	7.11	0	08:00	0.00		
Jun-D	JUNCTION	37.97	190.87	0	08:02	0.00		
Jun-E	JUNCTION	7.70	204.81	0	08:04	0.00		
RioRoadCulvert	OUTFALL	0.00	204.50	0	08:06	0.00		

****
Outfall Loading Summary
****

Outfall Node ID	Flow Frequency (%)	Average Flow cfs	Peak Inflow cfs
RioRoadCulvert	48.75	38.37	204.50
System	48.75	38.37	204.50

****
Link Flow Summary
****

Link ID	Element Type	Time of Peak Flow Occurrence days	hh:mm	Maximum Velocity Attained ft/sec	Length Factor	Peak Flow during Analysis cfs	Design Flow Capacity cfs	Ratio of Maximum /Design Flow	Total Reported Condition Time Surcharged minutes	Ratio of Maximum Depth
36-INCH	CONDUIT	0	08:01	20.78	1.00	94.36	135.69	0.70	0 Calculated	0.61
36-INCH-Replaced 24in	CONDUIT	0	08:00	17.72	1.00	94.44	111.17	0.85	0 Calculated	0.71
42-INCH	CONDUIT	0	08:01	20.82	1.00	94.30	203.82	0.46	0 Calculated	0.48
CAR10-FuturePipe	CONDUIT	0	08:00	7.30	1.00	7.11	7.92	0.90	0 Calculated	0.74
LowerChannel_EtoCulvert	CHANNEL	0	08:06	1.46	1.00	204.50	6214.43	0.03	0 Calculated	0.28
LowerChannel-BC	CHANNEL	0	08:02	7.78	1.00	59.90	87885.25	0.00	0 Calculated	0.06
LowerChannel-CD	CHANNEL	0	08:03	6.64	1.00	154.93	51403.88	0.00	0 Calculated	0.11
LowerChannel-DE	CHANNEL	0	08:04	5.76	1.00	190.70	39609.35	0.00	0 Calculated	0.14

```
  SteepChannel-AB      CHANNEL      0  08:02      5.14    1.00       45.91    54464.74      0.00
0.07           0  Calculated


  ******************************
  Highest Flow Instability Indexes
  ******************************
  All links are stable.


  Analysis began on:  Wed Dec 26 08:46:34 2018
  Analysis ended on:  Wed Dec 26 08:46:35 2018
  Total elapsed time: 00:00:01
```

Appendix 2: Hydraulic Modeling Results at Select Cross Sections

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Dec 27 2018

CROSS SECTION-A

User-defined

Invert Elev (ft)	= 17.62
Slope (%)	= 0.90
N-Value	= 0.030

Calculations

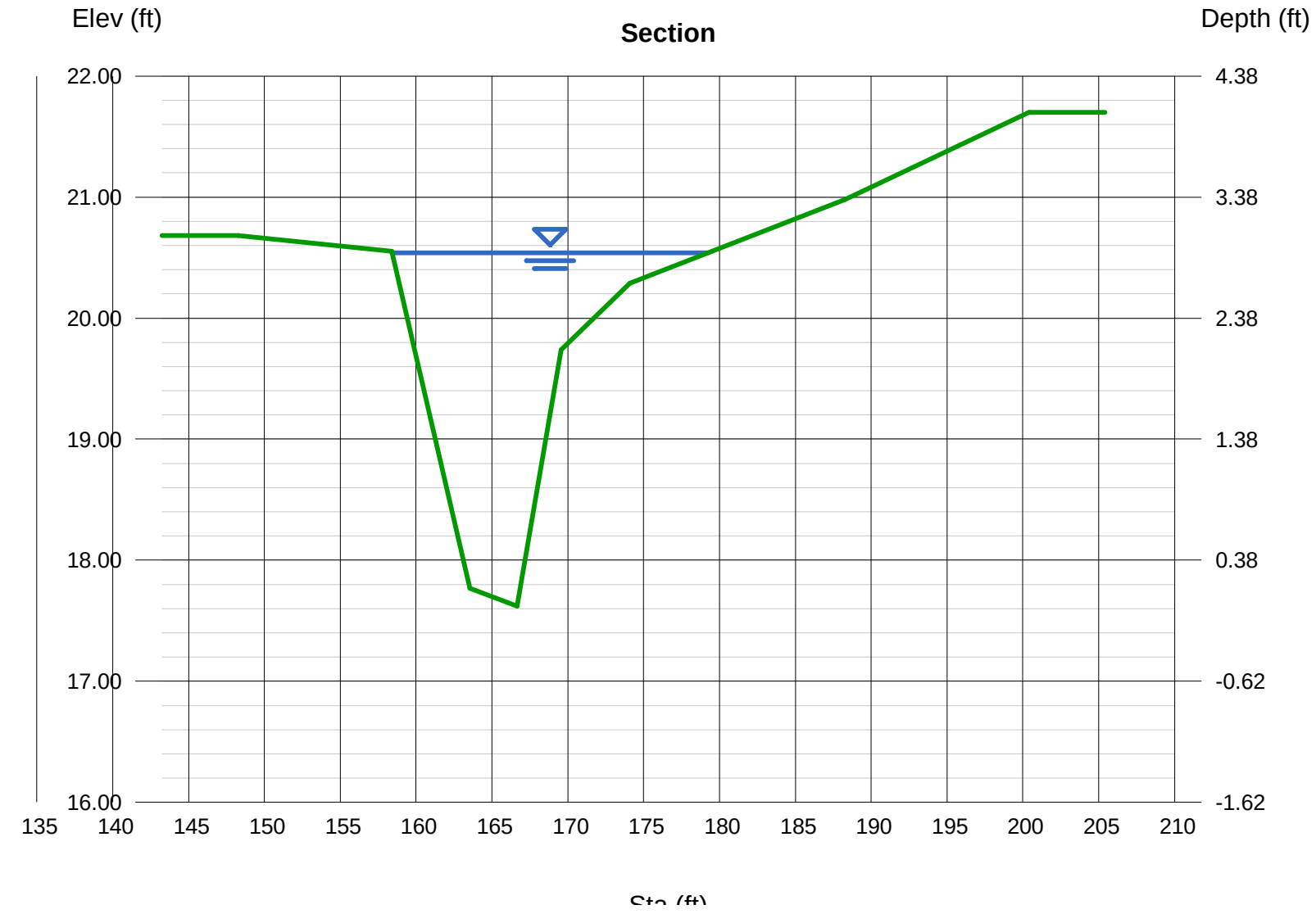
Compute by:	Known Q
Known Q (cfs)	= 122.00

Highlighted

Depth (ft)	= 2.92
Q (cfs)	= 122.00
Area (sqft)	= 24.41
Velocity (ft/s)	= 5.00
Wetted Perim (ft)	= 22.25
Crit Depth, Yc (ft)	= 2.60
Top Width (ft)	= 20.82
EGL (ft)	= 3.31

(Sta, El, n)-(Sta, El, n)...

(148.26, 20.68) -(158.39, 20.55, 0.030) -(163.53, 17.77, 0.030) -(166.65, 17.62, 0.030) -(169.57, 19.74, 0.030) -(174.08, 20.29, 0.030) -(188.29, 20.98, 0.030) -(200.40, 21.70, 0.030)



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Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Dec 27 2018

CROSS SECTION-D

User-defined

Invert Elev (ft)	= 28.27
Slope (%)	= 0.90
N-Value	= 0.030

Calculations

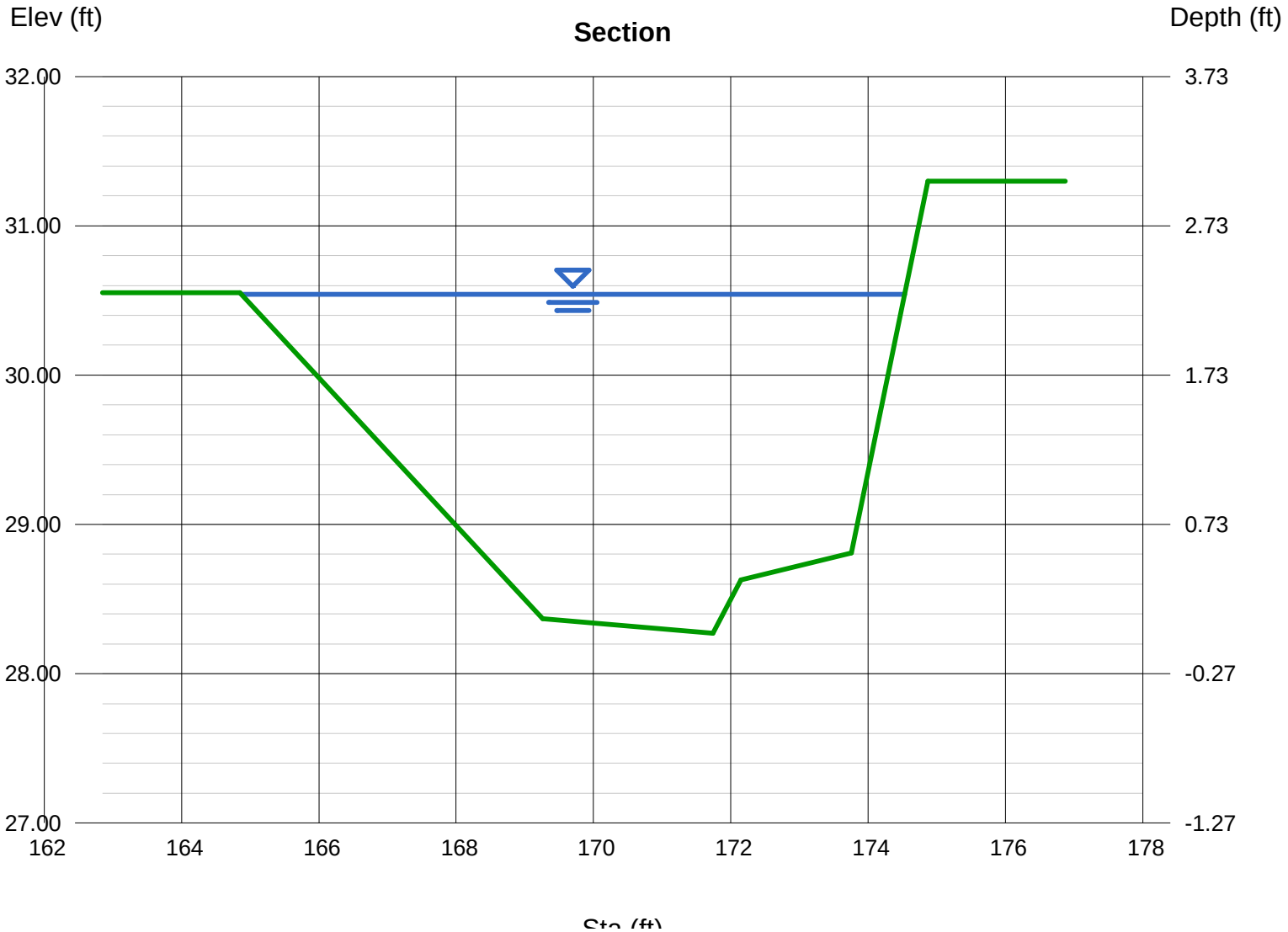
Compute by:	Known Q
Known Q (cfs)	= 82.00

Highlighted

Depth (ft)	= 2.27
Q (cfs)	= 82.00
Area (sqft)	= 14.72
Velocity (ft/s)	= 5.57
Wetted Perim (ft)	= 11.44
Crit Depth, Yc (ft)	= 2.02
Top Width (ft)	= 9.66
EGL (ft)	= 2.75

(Sta, El, n)-(Sta, El, n)...

(164.85, 30.55) -(169.26, 28.37, 0.030) -(171.74, 28.27, 0.030) -(172.15, 28.63, 0.030) -(173.76, 28.81, 0.030) -(174.87, 31.30, 0.030)



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Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Dec 27 2018

CROSS SECTION-G

User-defined

Invert Elev (ft)	= 37.21
Slope (%)	= 1.30
N-Value	= 0.030

Calculations

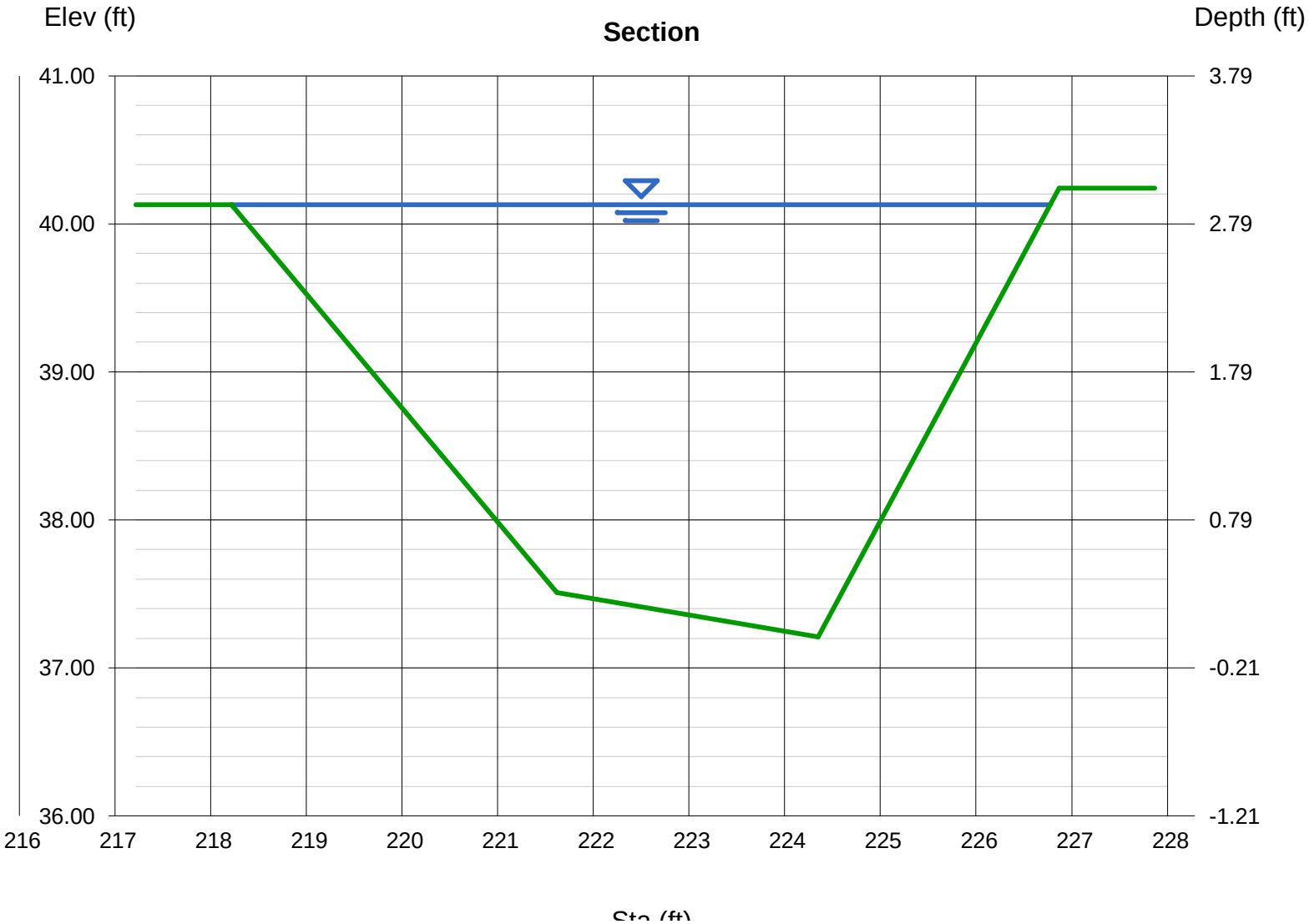
Compute by:	Known Q
Known Q (cfs)	= 112.00

Highlighted

Depth (ft)	= 2.92
Q (cfs)	= 112.00
Area (sqft)	= 15.56
Velocity (ft/s)	= 7.20
Wetted Perim (ft)	= 10.84
Crit Depth, Yc (ft)	= 2.84
Top Width (ft)	= 8.56
EGL (ft)	= 3.73

(Sta, El, n)-(Sta, El, n)...

(218.22, 40.13) -(221.62, 37.51, 0.030) -(224.35, 37.21, 0.030) -(226.87, 40.24, 0.030)



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Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Dec 27 2018

CROSS SECTION-K

User-defined

Invert Elev (ft)	= 59.45
Slope (%)	= 14.00
N-Value	= 0.100

Calculations

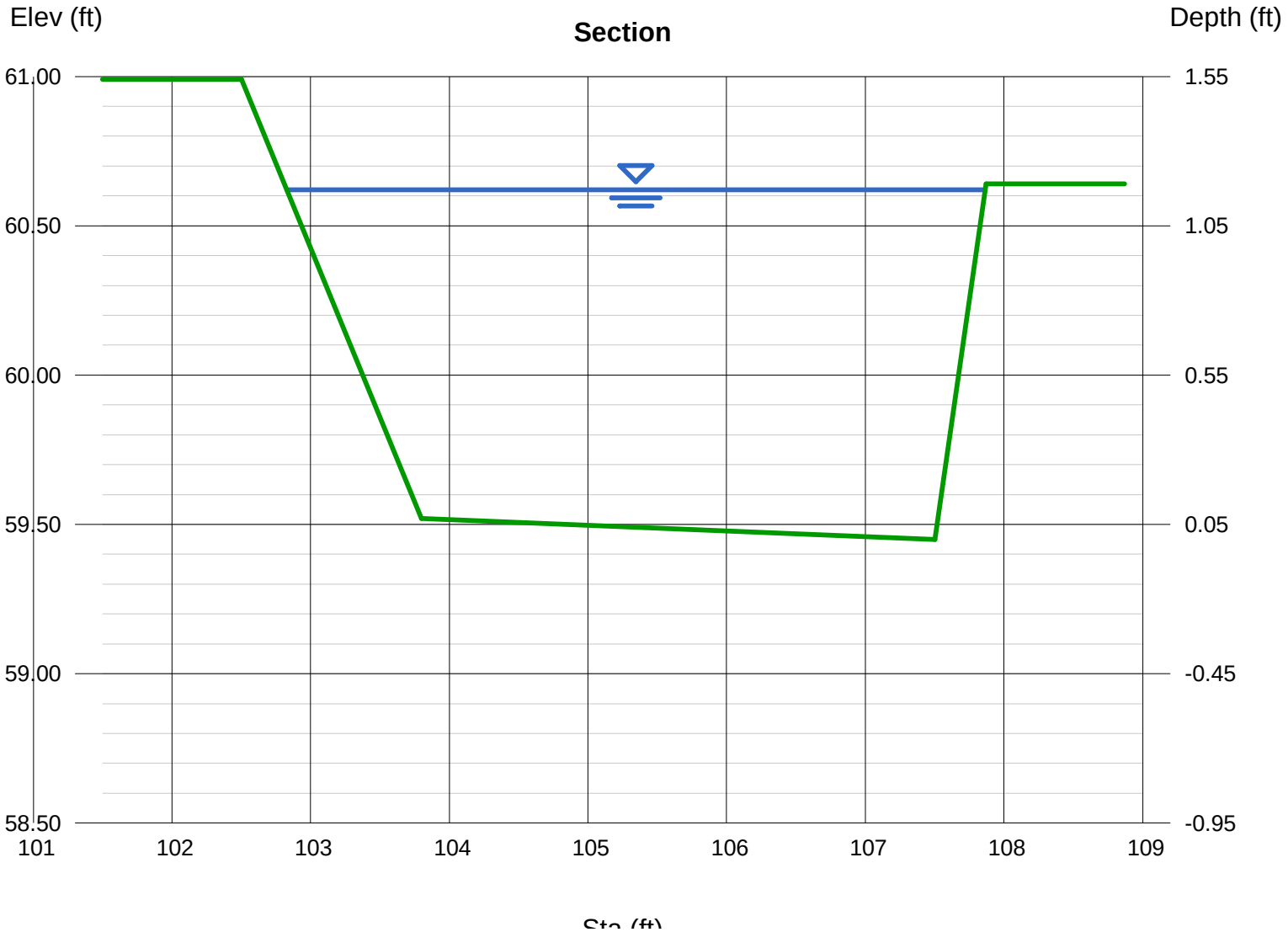
Compute by:	Known Q
Known Q (cfs)	= 23.00

Highlighted

Depth (ft)	= 1.17
Q (cfs)	= 23.00
Area (sqft)	= 4.95
Velocity (ft/s)	= 4.65
Wetted Perim (ft)	= 6.39
Crit Depth, Yc (ft)	= 1.05
Top Width (ft)	= 5.04
EGL (ft)	= 1.51

(Sta, El, n)-(Sta, El, n)...

(102.50, 60.99) -(103.80, 59.52, 0.100) -(107.50, 59.45, 0.100) -(107.87, 60.64, 0.100)



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Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Dec 27 2018

CROSS SECTION-M

User-defined

Invert Elev (ft)	= 74.45
Slope (%)	= 7.20
N-Value	= 0.170

Calculations

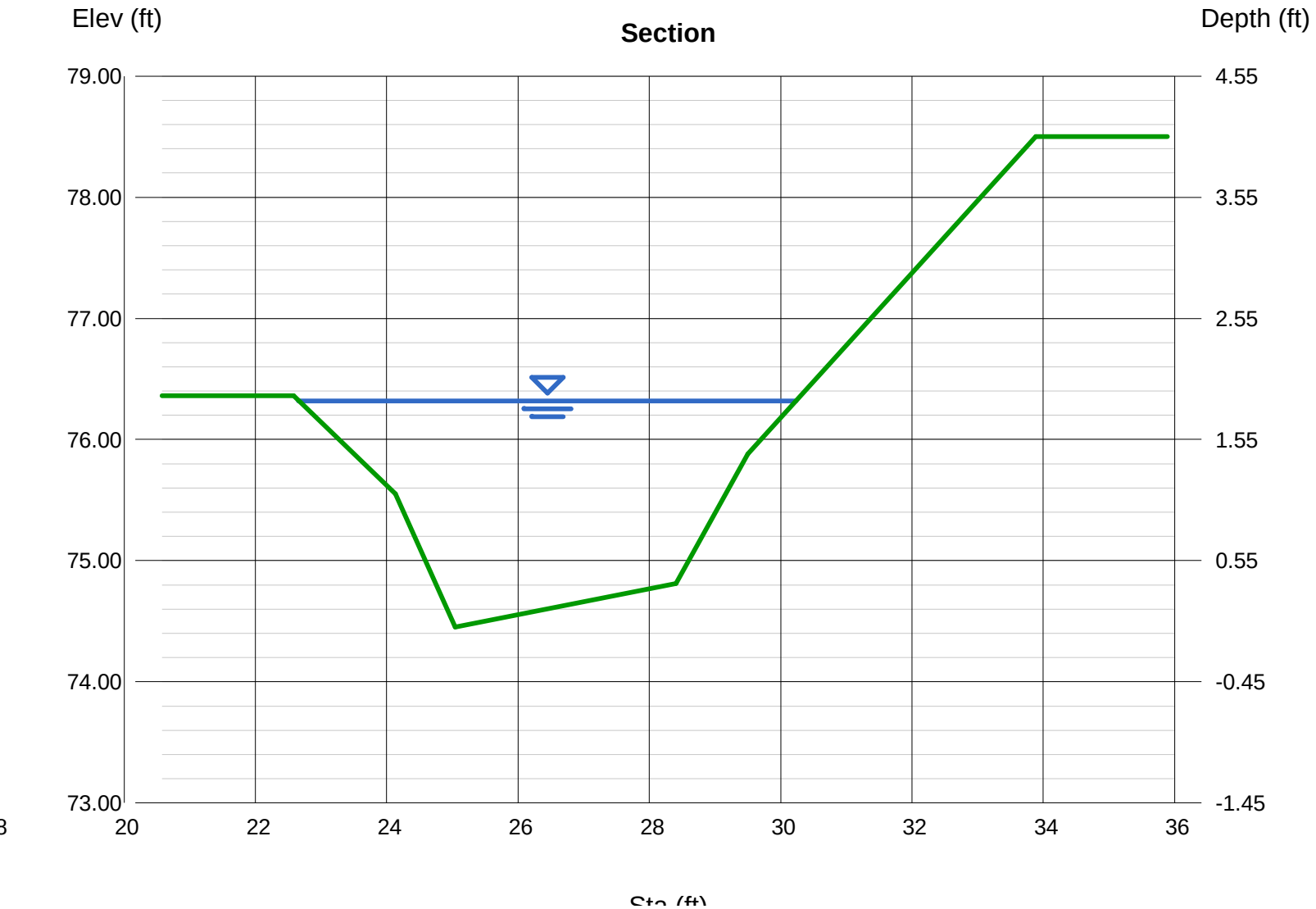
Compute by:	Known Q
Known Q (cfs)	= 20.00

Highlighted

Depth (ft)	= 1.87
Q (cfs)	= 20.00
Area (sqft)	= 8.69
Velocity (ft/s)	= 2.30
Wetted Perim (ft)	= 8.87
Crit Depth, Yc (ft)	= 1.13
Top Width (ft)	= 7.58
EGL (ft)	= 1.95

(Sta, El, n)-(Sta, El, n)...

(22.58, 76.36) -(24.13, 75.55, 0.170) -(25.04, 74.45, 0.170) -(28.41, 74.81, 0.170) -(29.50, 75.88, 0.170) -(33.89, 78.50, 0.170)



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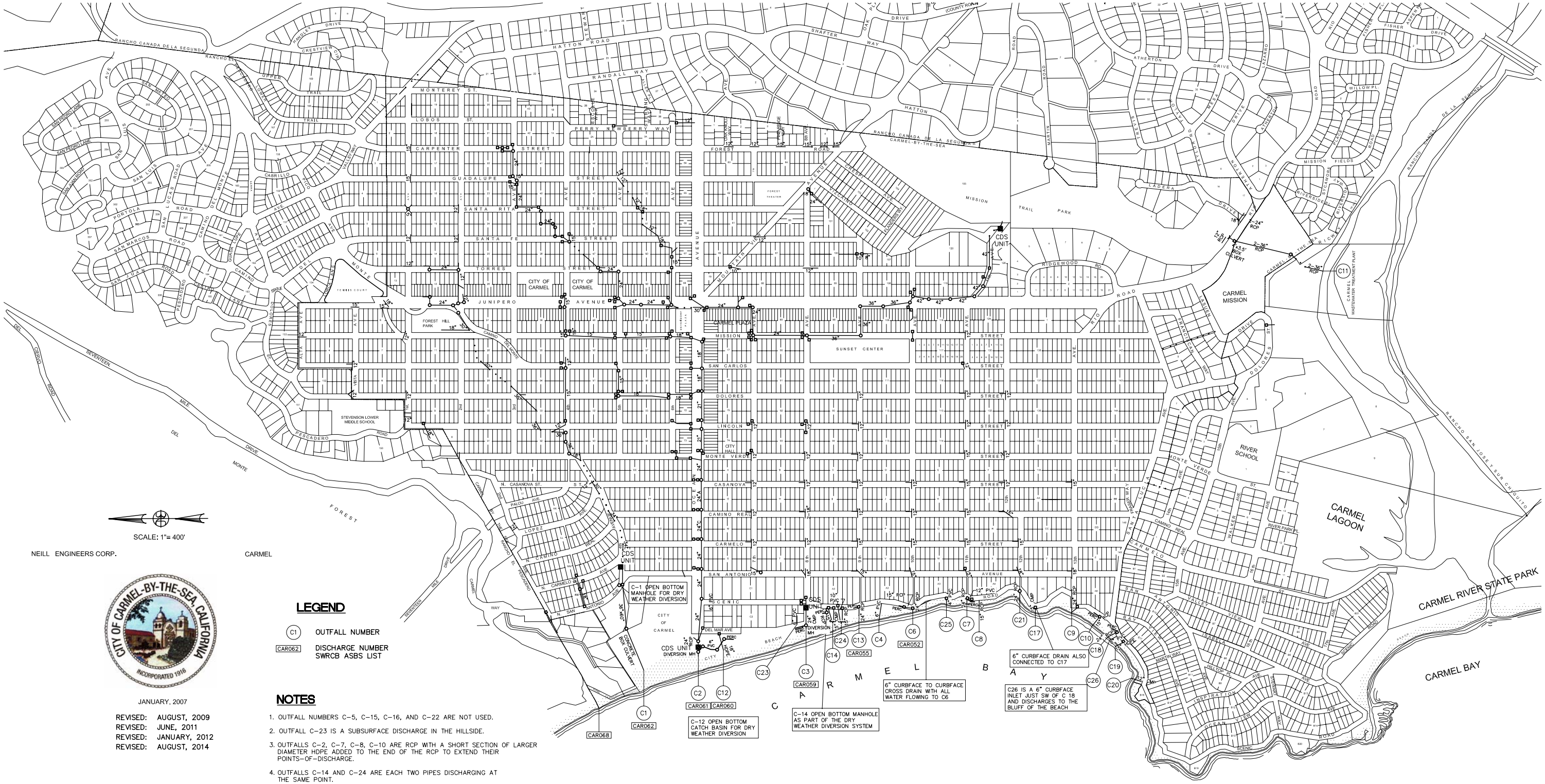
Appendix 3: Regional Drainage Maps by Others

CITY OF CARMEL-BY-THE-SEA
DRAINAGE SYSTEM - EXISTING FACILITIES



SCALE: 1"= 400'

NEILL ENGINEERS CORP. CARMEL

JANUARY, 2007

REVISED: AUGUST, 2009
REVISED: JUNE, 2011
REVISED: JANUARY, 2012
REVISED: AUGUST, 2014

LEGEND

C1 OUTFALL NUMBER

CAR062 DISCHARGE NUMBER SWRCB ASBS LIST

NOTES

1. OUTFALL NUMBERS C-5, C-15, C-16, AND C-22 ARE NOT USED.
2. OUTFALL C-23 IS A SUBSURFACE DISCHARGE IN THE HILLSIDE.
3. OUTFALLS C-2, C-7, C-8, C-10 ARE RCP WITH A SHORT SECTION OF LARGER DIAMETER HDPE ADDED TO THE END OF THE RCP TO EXTEND THEIR POINTS-OF-DISCHARGE.
4. OUTFALLS C-14 AND C-24 ARE EACH TWO PIPES DISCHARGING AT THE SAME POINT.
5. OUTFALLS C-8, C-17S, C-20 AND C-26 HAVE OPEN BOTTOM CATCH BASINS AT CURBFACE DRAIN INLETS FOR DRY WEATHER DIVERSION
6. OUTFALLS C-2, C-3, C-6, C-7, C-10, C-13, C-14 AND C-18 HAVE VARIOUS PERCOLATION TRENCHES (IDENTIFIED AS PERC) FOR DRY WEATHER DIVERSION

Y:\PROJECTS\Veng\CARMEL\CARMEL OLD\8241-CARMEL BASE MAPS\CARMEL-drainage-rev-May-2017.dwg 5-30-17 09:46:46 AM

Catchment Delineations Map - Carmel-by-the-Sea

July 27th, 2017