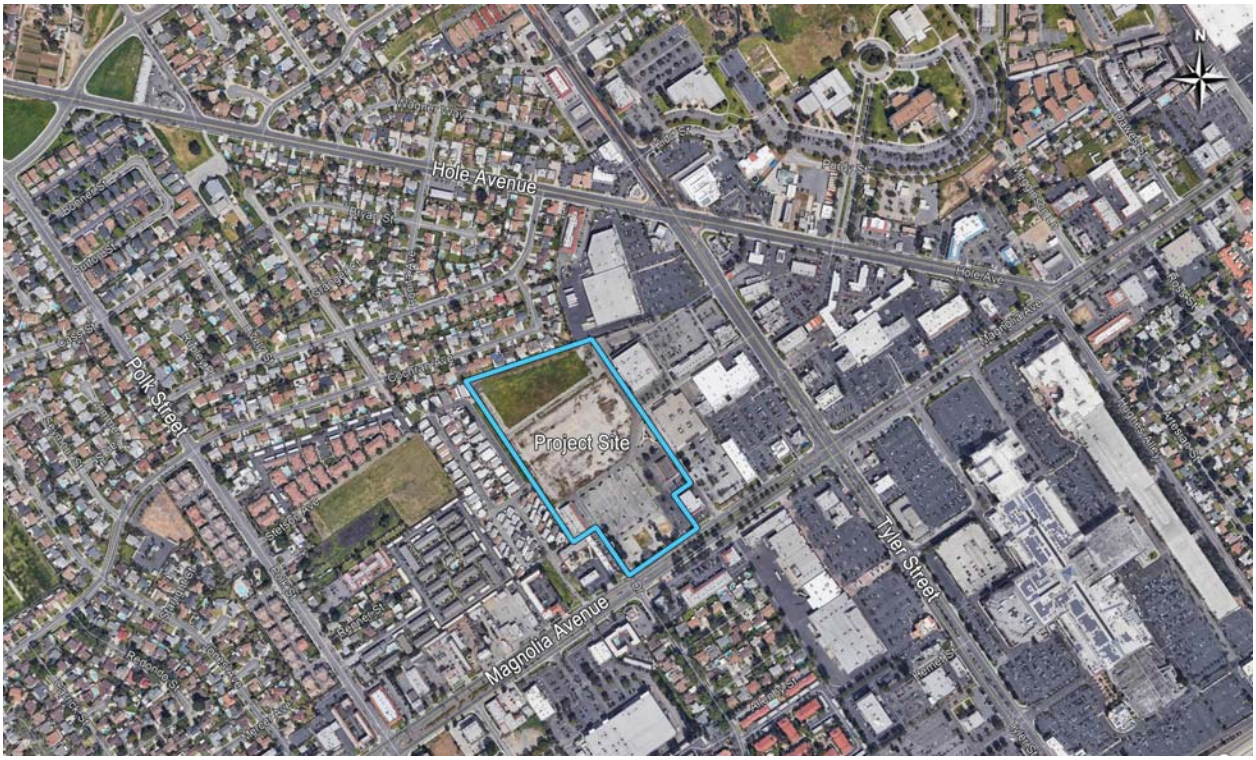
Appendix J

Preliminary Drainage Study

Preliminary Drainage Study

Magnolia Flats

Magnolia Avenue and Banbury Drive
Riverside, California



February 18, 2020

Prepared for

Realm

Prepared by

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Consulting Engineers - Surveyors - Planners

ATTESTATION

This report has been prepared by, and under the direction of, the undersigned, a duly Registered Civil Engineer in the State of California. Except as noted, the undersigned attests to the technical information contained herein, and has judged to be acceptable the qualifications of any technical specialists providing engineering data for this report, upon which findings, conclusions, and recommendations are based.

James H. Kawamura, P.E.
Registered Civil Engineer No. C30560
Exp. 3/31/22

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Section 1 Purpose and Scope

The drainage study presents an analysis of the hydrologic effects that may be associated with the proposed mixed-use development located northeast of the intersection of Magnolia Avenue and Banbury Drive, in the City of Riverside. The study details the general project characteristics, the design, criteria, and methodology applied to the analysis of the area in terms of drainage and associated conveyance facilities.

The plans and specifications in the drainage study are not for construction purposes; the contractor shall refer to final approved construction documents for plans and specifications.

Section 2 Project Information

2.1 Project Description

The proposed *Magnolia Flats* multifamily residential project entails an existing parking lot and commercial buildings. The project totals 16.58 acres and includes 450 multi-family residential units.

2.1.1 Project Location

The project site is located on the northwest corner of Magnolia Avenue and Banbury Drive in Riverside and it is bounded by single home residential to the north, mobile homes to the west, commercial buildings to the east, and Magnolia Avenue to the south. Figure 1 below illustrates an aerial perspective of the project and surroundings and Figure 2 illustrates the proposed site plan.

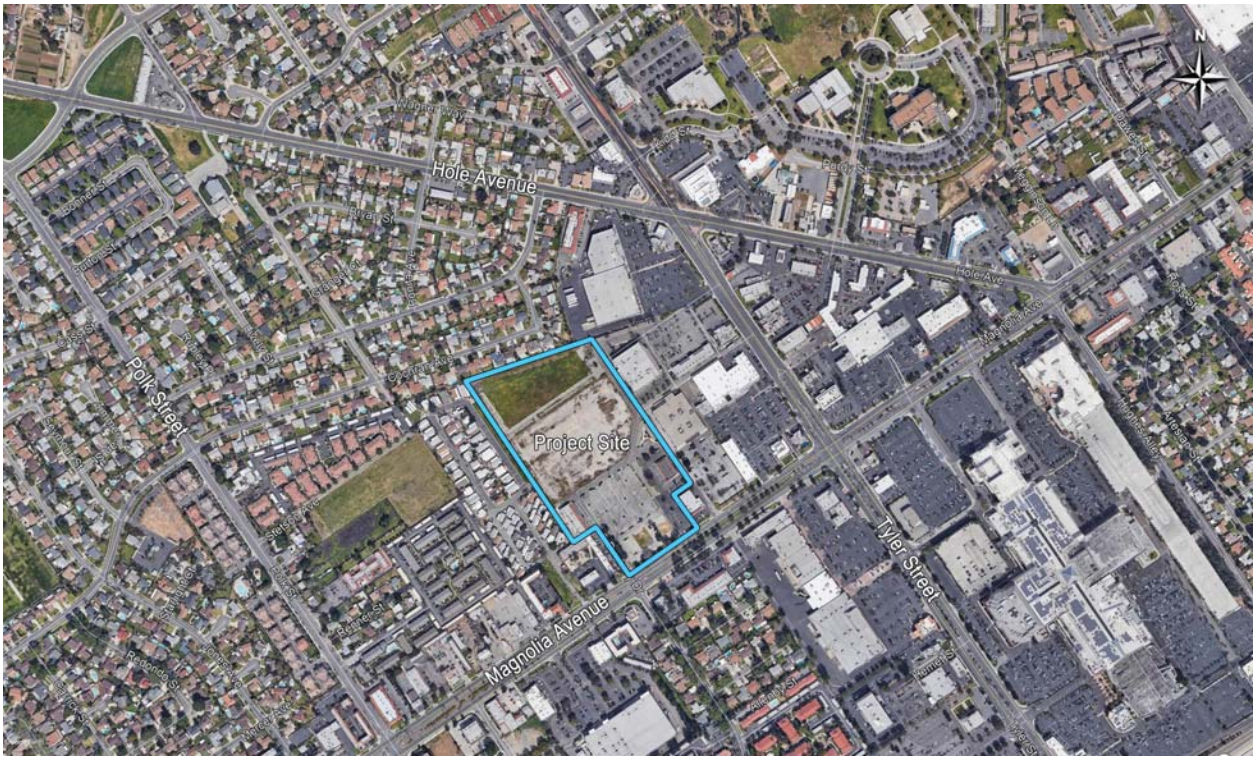


Figure 1 – Aerial Perspective of Project Site

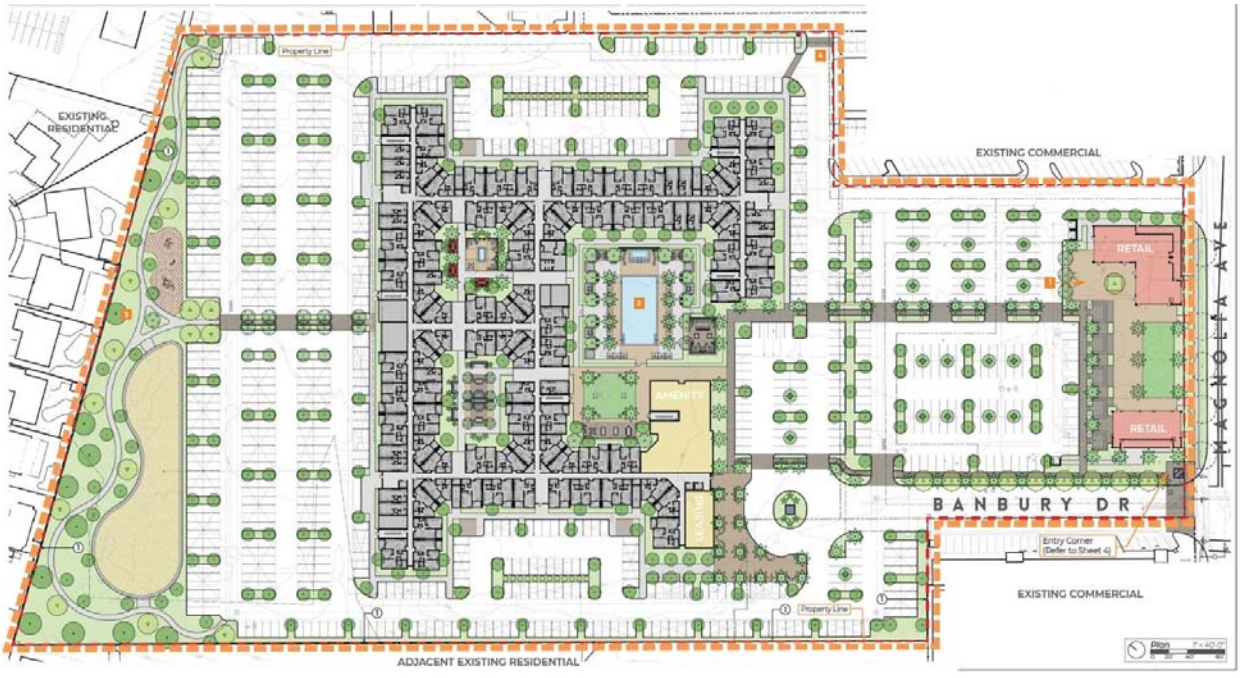


Figure 2 – Site Plan

2.2 Hydrologic Setting

This section summarizes the area's size and location in the context of the larger watershed perspective, topography, soil and vegetation conditions, percent impervious area, natural and infrastructure drainage features, and other relevant hydrologic and environmental factors to be protected specific to the project area's watershed.

2.2.1 Watershed

The proposed project is located within the 2,650 square miles Santa Ana watershed and drains to the Santa Ana River. The watershed includes portions of Lost Angeles, Riverside Counties, and San Bernardino County.

2.2.2 Existing Topography, Drainage Patterns, and Facilities (Narrative)

The existing site topography has a an elevation change of approximately 4 feet from the northeasterly corner near the property line to the southwesterly portion along the existing wall and approximately 6 feet from the southeasterly corner near Magnolia Avenue to the northwesterly portion along the property line. The existing project condition had been occupied by a retail center that was later demolished on the northwest portion of the site. The southeast portion of the site is mainly paved with asphalt concrete in poor to fair condition. Majority of the runoff on the property flows towards the westerly corner entering into another property. The remaining storm water flows along existing gutters until it reaches into a catch basin at the corner of the parking lot near Magnolia Avenue. The catch basin connects into the County of Riverside maintained storm drain system.

2.2.4 Adjacent Land Use

The project area is bounded by single home residential to the north, mobile homes to the west, commercial buildings to the east, and Magnolia Avenue to the south.

2.2.4 Soil Conditions

According to the Geotechnical Investigation report prepared by Geotechnical Professionals, Inc. (GPI) dated November 12, 2019 the site contains dry to slightly moist, silty sands. The sands become denser with depth. Groundwater was encountered at a depth of 57 feet below grade in the borings and it is located in a seismic hazard zone for liquefaction.

2.2.5 Downstream Conditions

This section summarizes the existing downstream conditions and any conditions of concern with respect to erosion and/or sedimentation due to the proposed project.

There is no evidence of significant erosion currently at the project site. The proposed development is not expected to have negative impacts downstream since stormwater will be treated and infiltrated on-site.

2.2.6 Impervious Cover

The proposed project will have a net increase in total impervious area compared to the existing condition of the site. Currently, the project site is being occupied by 2 1-story existing buildings, exposed soil, vegetation, and a surface parking lot with a total imperviousness percentage of 45% and perviousness of 54%. The proposed mixed-use project site's overall total imperviousness percentage is 83% and perviousness is 17%.

2.3 Proposed Runoff Management Facilities

The proposed facilities managing runoff from the area include:

- ❑ Water quality treatment control Best Management Practices (BMPs) – Specifically, An Aquashield Aqua-Swirl Hydrodynamic Separator.

- ❑ A storm drainage system will collect the runoff and route to a Drywell System for infiltration.

Section 3 Design Criteria and Methodology

This section summarizes the design criteria and methodology applied during the drainage analysis of the project site. The design criteria and methodology follows the Riverside County Flood Control and Water Conservation District Hydrology Manual (April 1978).

3.1 Design Criteria

3.1.1 Drainage Design Criteria

Local storm drain facilities have been designed to conform to accommodate the 100-year storm event.

3.2 Methodology

3.2.1 Rational Method

Runoff calculations for this study were accomplished using the Riverside County Flood Control and Water Conservation district Hydrology Manual, which uses a method where runoff is assumed to be directly proportional to rainfall and area, less losses for infiltration and depression storage. Flows were computed based on the rational formula:

$$Q=CiA$$

Where... Q = Peak discharge (cfs);
C = runoff coefficient, based on land use and soil type;
i = Rainfall intensity (in/hr);
A = watershed area (acre)

The runoff coefficient represents the ratio of rainfall that runs off the watershed versus the portion that infiltrates to the soil or is held in depression storage. The runoff coefficient is dependent on the land use coverage and soil type. The Riverside County Hydrology Manual methodology assumes hydrologic Soil Type B for all soils near the project site (see Appendix).

The watershed time of concentration at any given point is defined as the time it would theoretically take runoff to travel from the most upstream point in the watershed to a concentration point, as estimated by the Time of Concentration Nomograph for Initial Subarea (see Appendix section of the report for the nomographs).

Intensity for this site was determined by the intensity-duration curves from the Riverside County Hydrology Manual. The runoff coefficient represents the ratio of rainfall that runs off the watershed versus the portion that infiltrates to the soil or is held in depression storage. The runoff coefficient (C) is dependent on rainfall intensity (I), soil infiltration rate (Fp), and impervious/pervious area fractions (Ai and Ap).

A set of peak discharges were computed for the existing and proposed conditions respectively, to better compare the two conditions.

Rational Method calculations were accomplished using hand calculations. Peak discharges were computed for 100-year hypothetical storm return frequencies and can be seen in the hydrology and drainage analysis section of this report. The output results of the calculations can be found in the Appendix section of this report.

Section 4 Hydrology and Drainage Analysis

This section summarizes the quantitative hydrologic analysis of the existing and proposed conditions of the site.

4.1 Area

The site property encompasses 22.1 acres, which was used for both existing and proposed conditions. The property also collects 3.9 acres offsite from the northeasterly side of the project site.

4.2 Summary of Drainage Delineation

Existing Analysis

To analyze the existing conditions, the site was broken into five subareas; A -E (see Appendix for the Existing Hydrology Map).

Point of Discharge #1:

System 1: Subareas EX-A and EX-B, sheet flows northwest towards the retaining wall located on the south westerly property line and discharges into a mobile park area, to the gutter, and gets collected by the private storm drain system of that property.

Point of Discharge #2:

System 1: The offsite subareas EX-C, EX-D, and onsite subarea EX-E runoff flows down along the existing gutters, curbs, and gets collected by an existing catch basin located on a surface parking lot to the south near Banbury Drive and drains into an existing 42-inch County owned storm drain system on Magnolia Avenue.

Proposed Analysis

To further analyze the proposed conditions the site was broken into ten subareas; A-J (see Appendix for the Proposed Hydrology Map).

Point of Discharge #1:

System 1: Subarea A (offsite area), sheet flows along the existing gutter and is collected by a proposed grated catch basin located on the northwest corner.

System 2: Subareas B, C, D, E, F, H, and I the diverted low flows will drain to an Aqua-Swirl Hydrodynamic Separator unit for pre-treatment, then to a drywell system for infiltration. All high flows will bypass the treatment and flow into the proposed storm drain system; discharging into the County line on Magnolia Avenue.

System 3: Subareas G (offsite area), the run-on from this offsite enters the project property site.

Point of Discharge #2:

System 1: Subarea J (offsite area), the existing drainage pattern will be redirected therefore the runoff will travel along the proposed ribbon gutter and discharge onto Magnolia Avenue.

5.2 *Summary of Results*

The tables below summarize the results of the existing and proposed conditions.

Existing Conditions – 100 Year Storm Event				
Discharge Point	**Subareas**	**Area (acres)**	**TC Value**	**Q_{100} (cfs)**
1	A,B	11.03	11.9	29.48
2	C,D,E	9.61	12.1	25.37

$Q_{total,\ site}$= 54.85cfs $Q_{total,\ runon}$= 14.20 cfs

Proposed Conditions – 100 Year Storm Event				
Discharge Point	**Subareas**	**Area (acres)**	**TC Value**	**Q_{100} (cfs)**
1	A,B,D,E,F,G, H, I	19.14	12.5	52.13
2	J	1.51	11.0	3.91

$Q_{total,\ site}$= 52.13 cfs $Q_{total,\ runon}$= 11.84 cfs $Q_{offsite}$ = 3.91 cfs

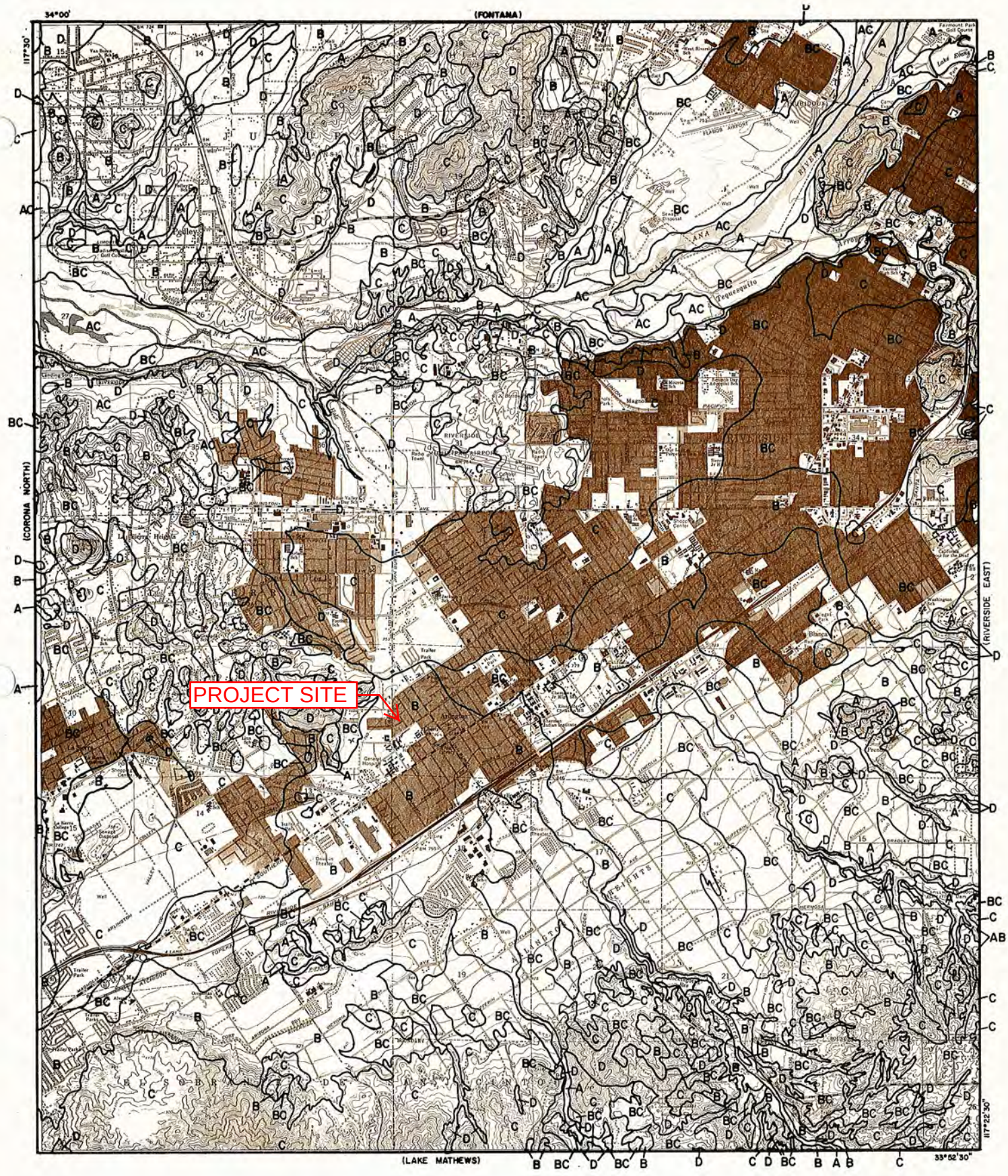
$Q_{total,\ site}$= Total flow rate into project site
$Q_{total,\ runon}$= Total run-on flow rate from offsite into project site area
$Q_{offsite}$ = Total flow rate from offsite area

4.3 Conclusion

The proposed conditions has a lower flow rate of 52.13 cfs compared to the existing flow rate of 54.85 cfs due to modifying the existing drainage patterns and therefore will mitigate the existing flooding conditions. The proposed stormwater runoff will be picked up by the private storm drain system, into an Aqua-Swirl Hydrodynamic Separator for pre-treatment and will be routed to a drywell system for on-site infiltration. All flows that exceed the mitigation volume will be routed to the proposed storm drain system and will be discharged into the County's storm drain system on Magnolia Avenue.

APPENDIX

Soils Group Map



LEGEND

—— SOILS GROUP BOUNDARY

A SOILS GROUP DESIGNATION

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HYDROLOGY MANUAL

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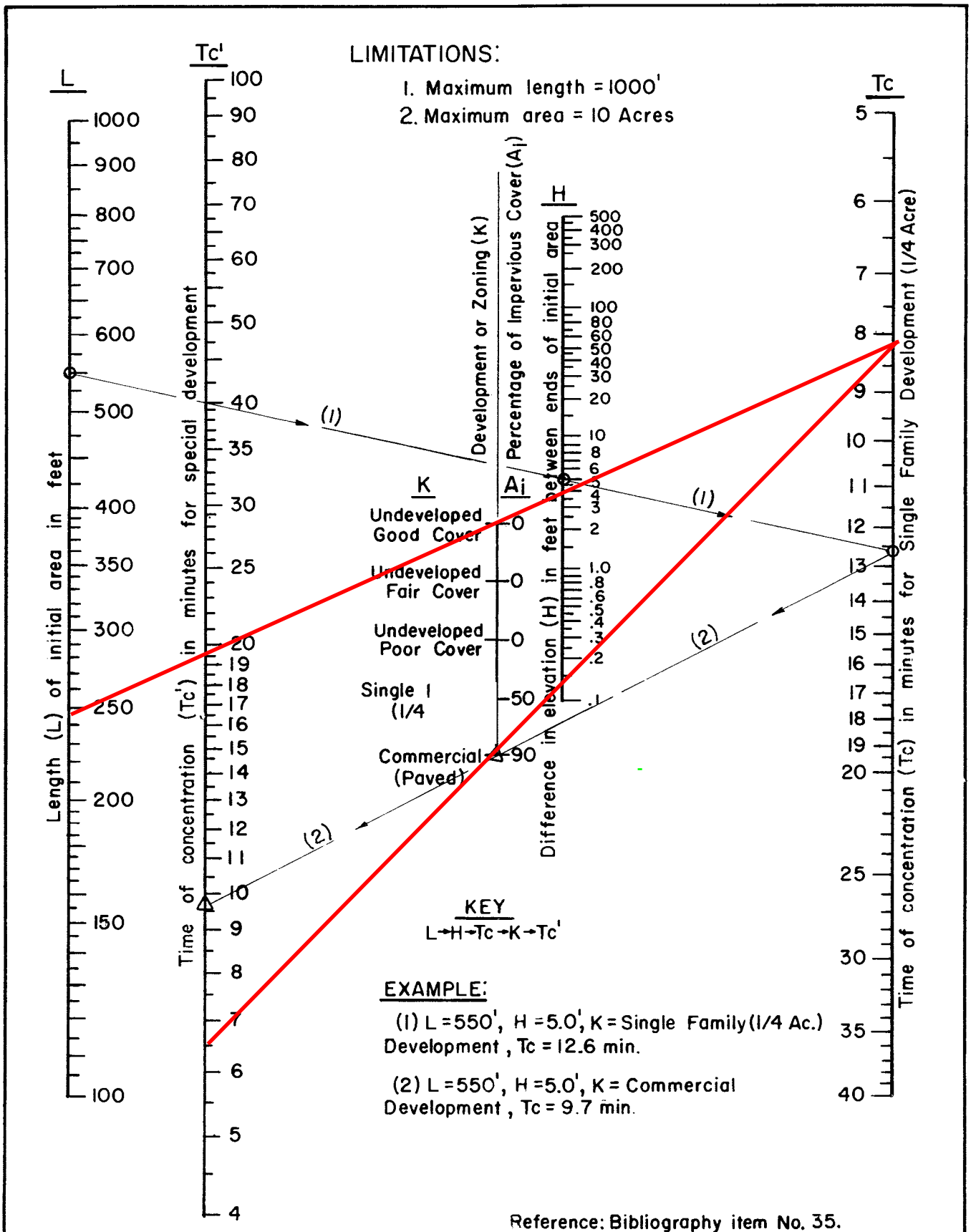
HYDROLOGIC SOILS GROUP MAP FOR RIVERSIDE—WEST

Time of Concentration Nomographs



Reference: Bibliography item No. 35.

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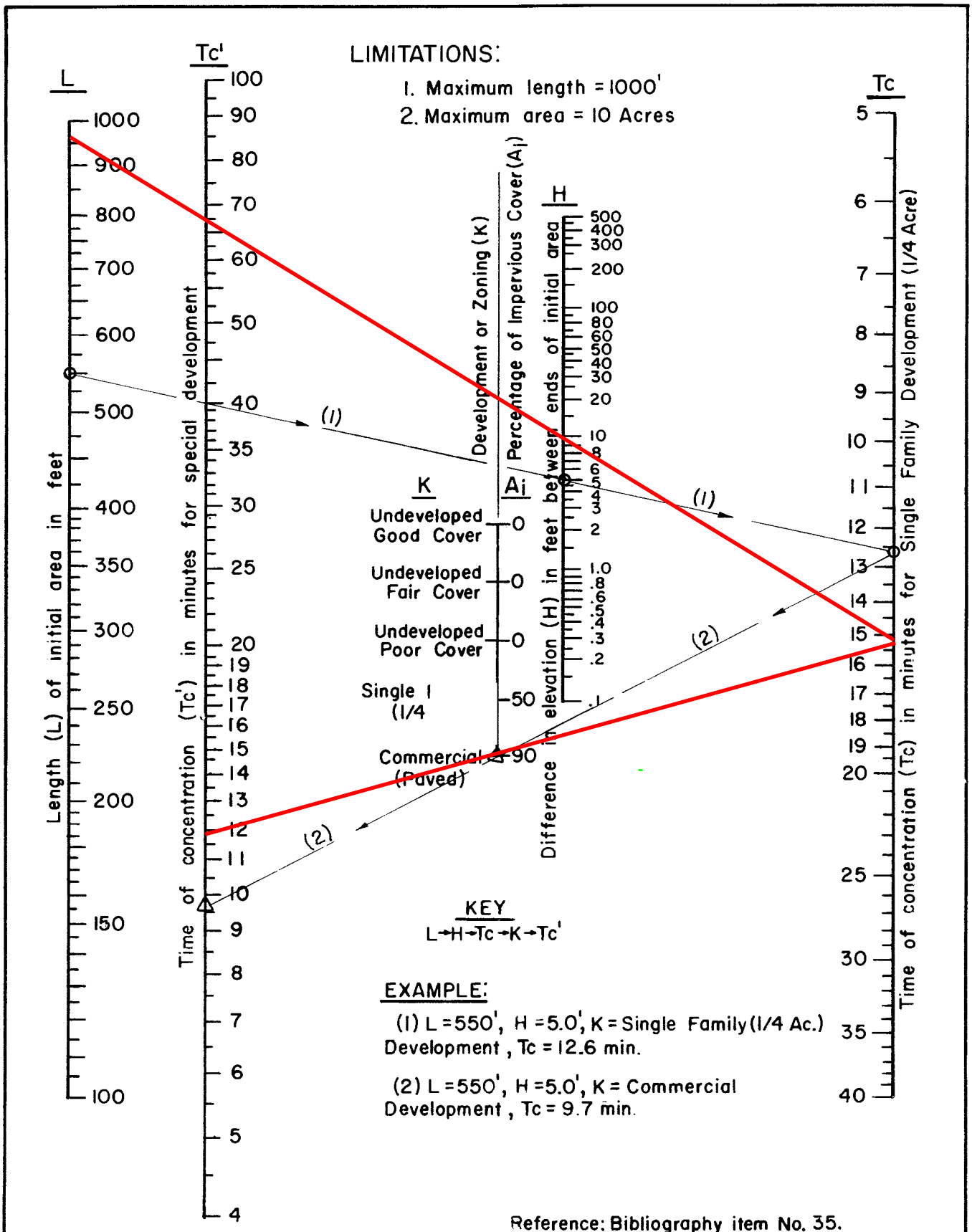
HYDROLOGY MANUAL

TIME OF CONCENTRATION
FOR INITIAL SUBAREA

PLATE D-3



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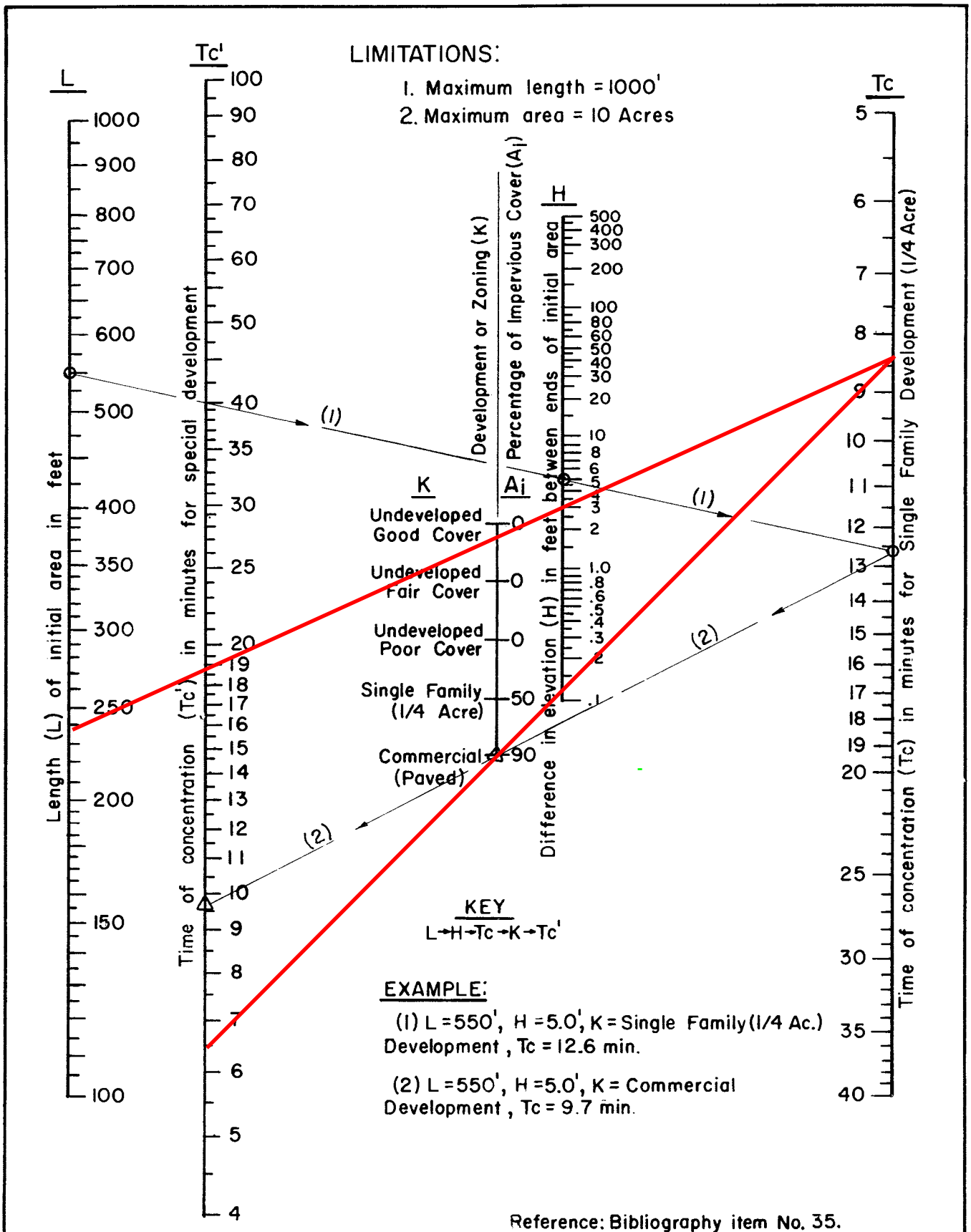

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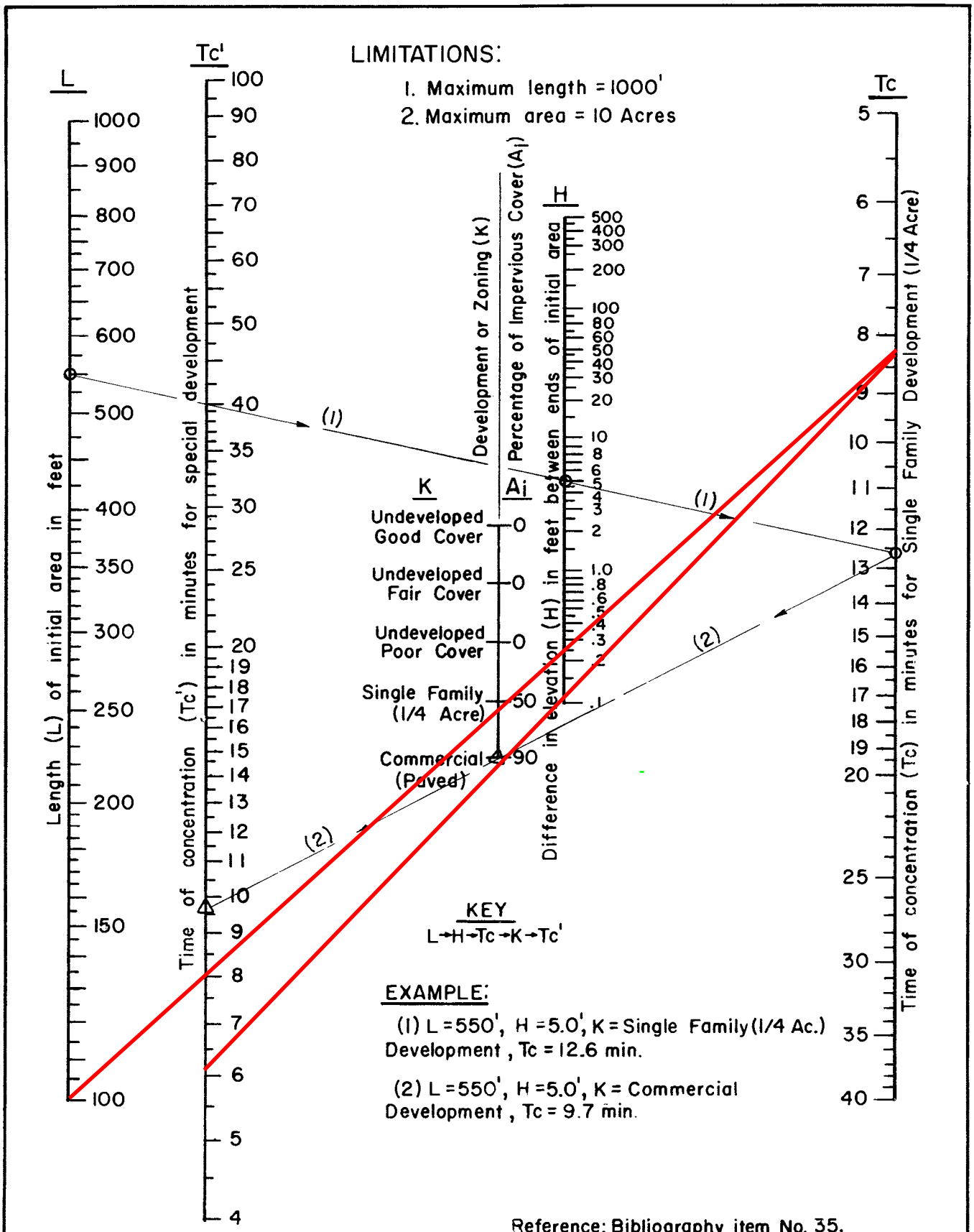

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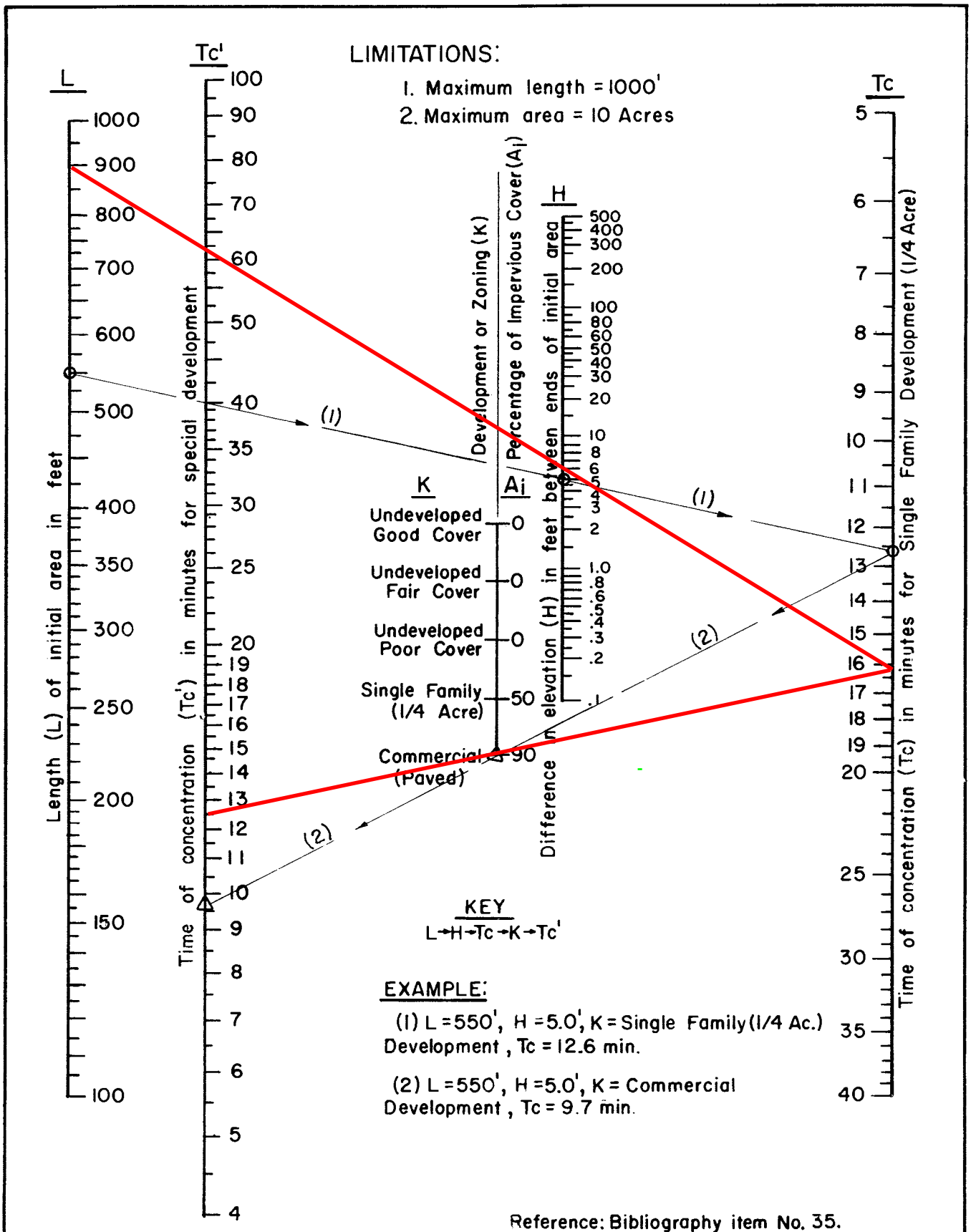

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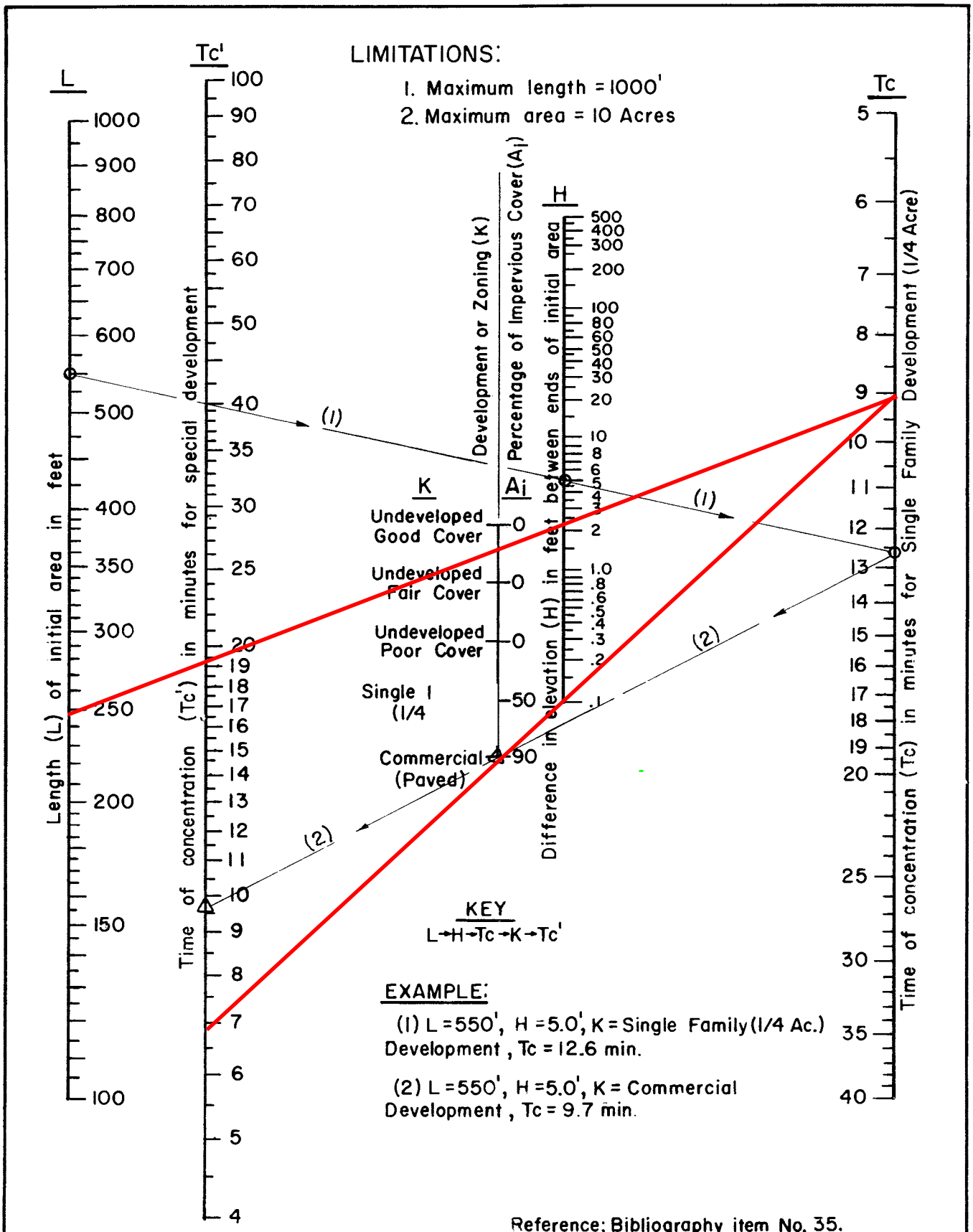

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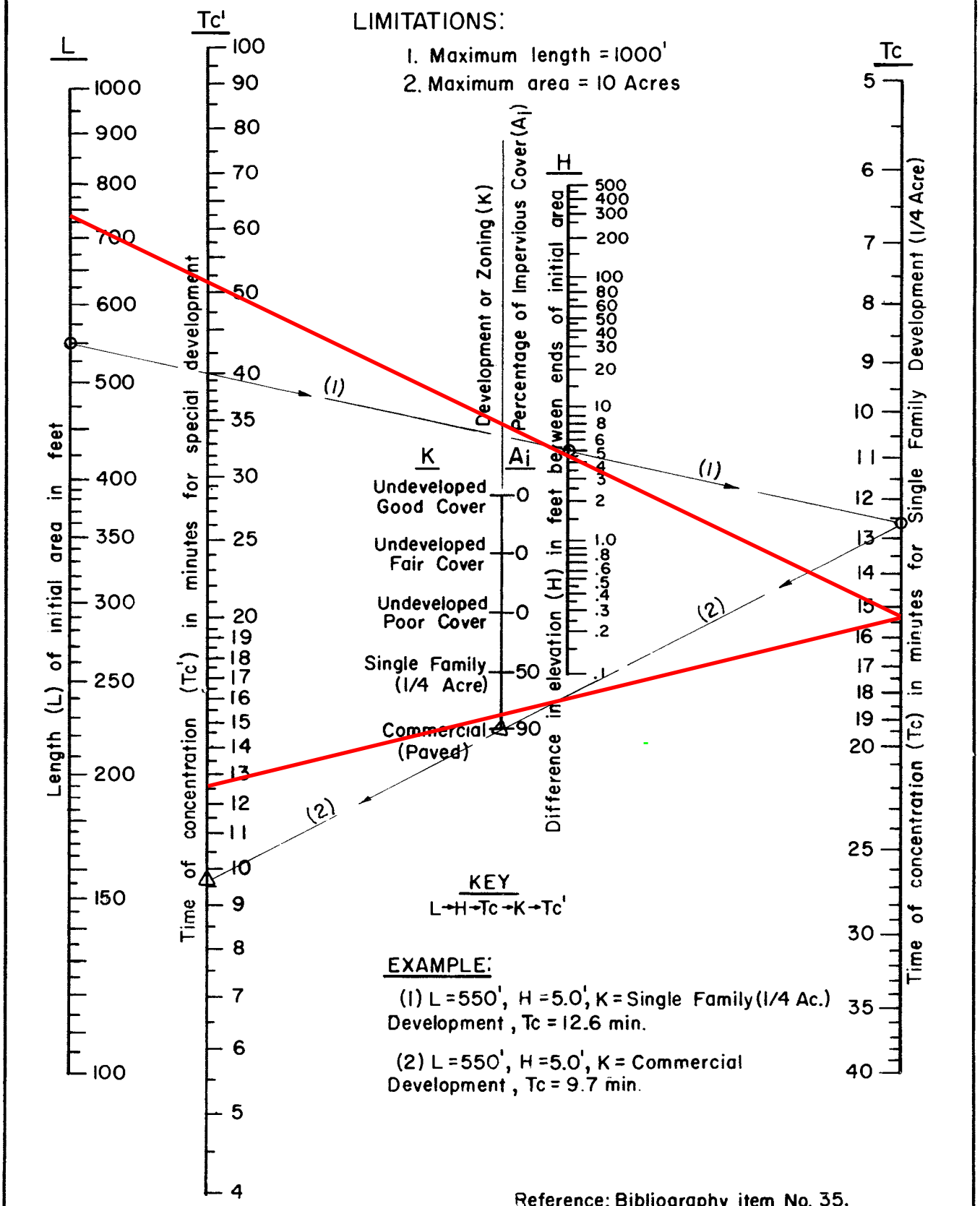

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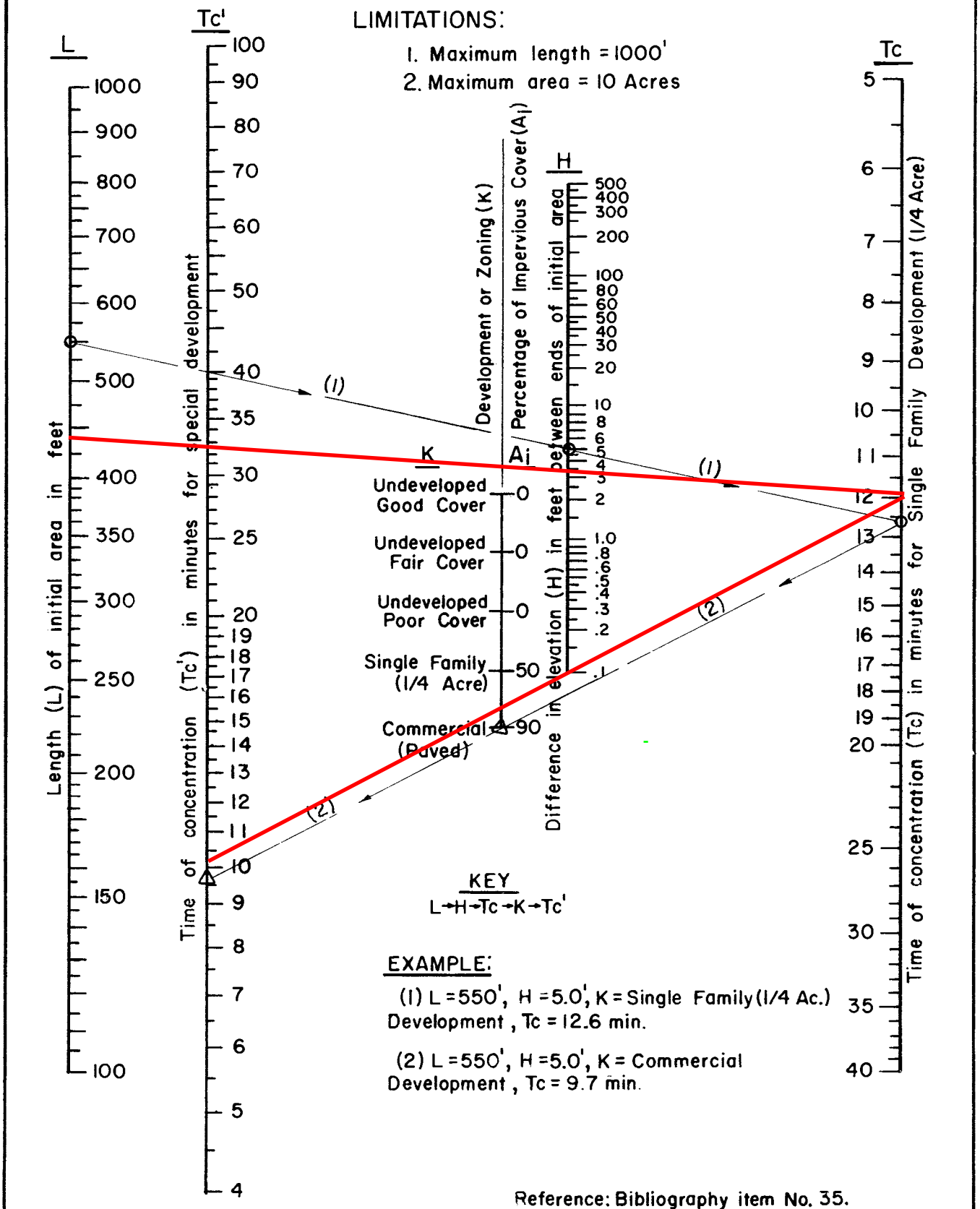

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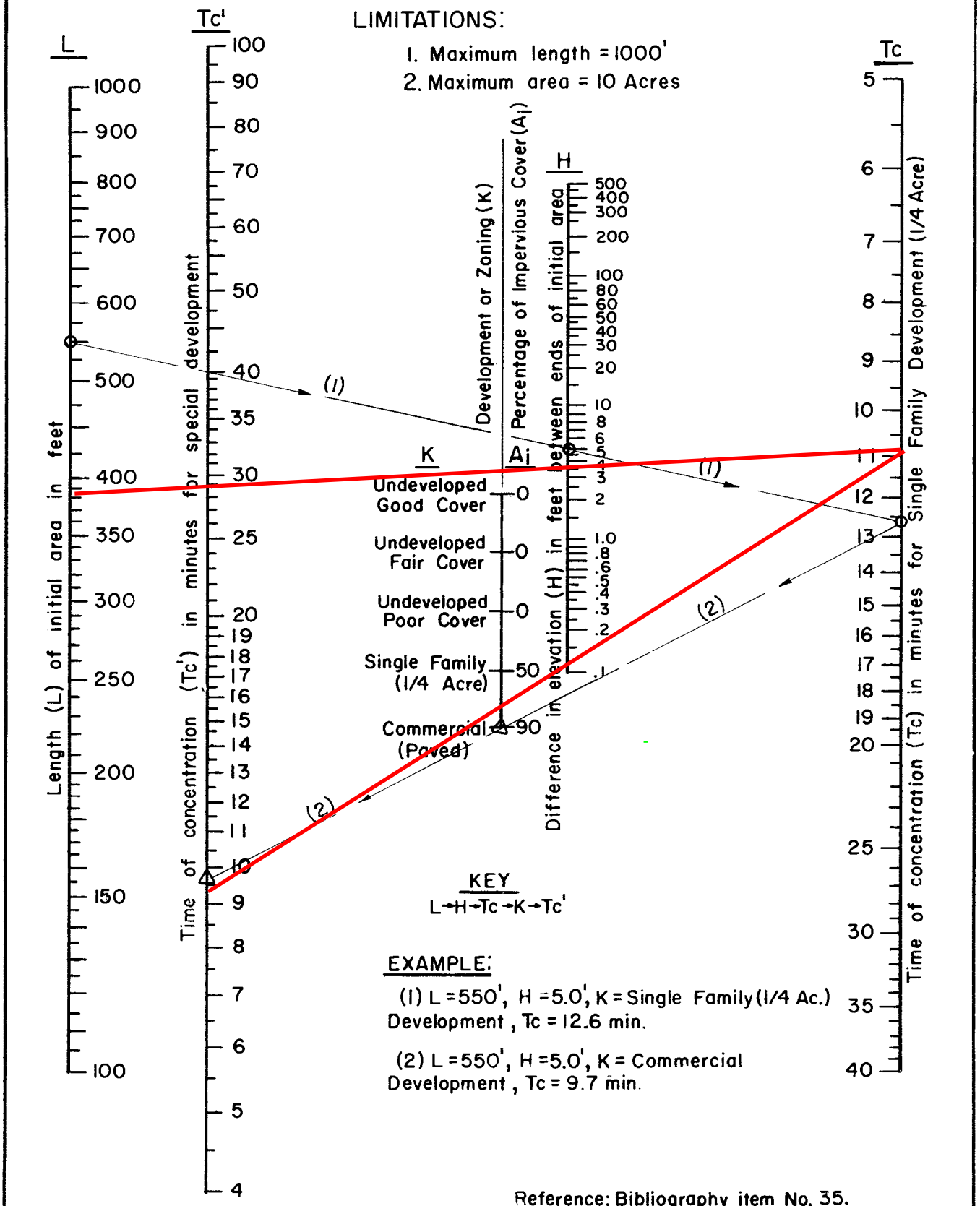

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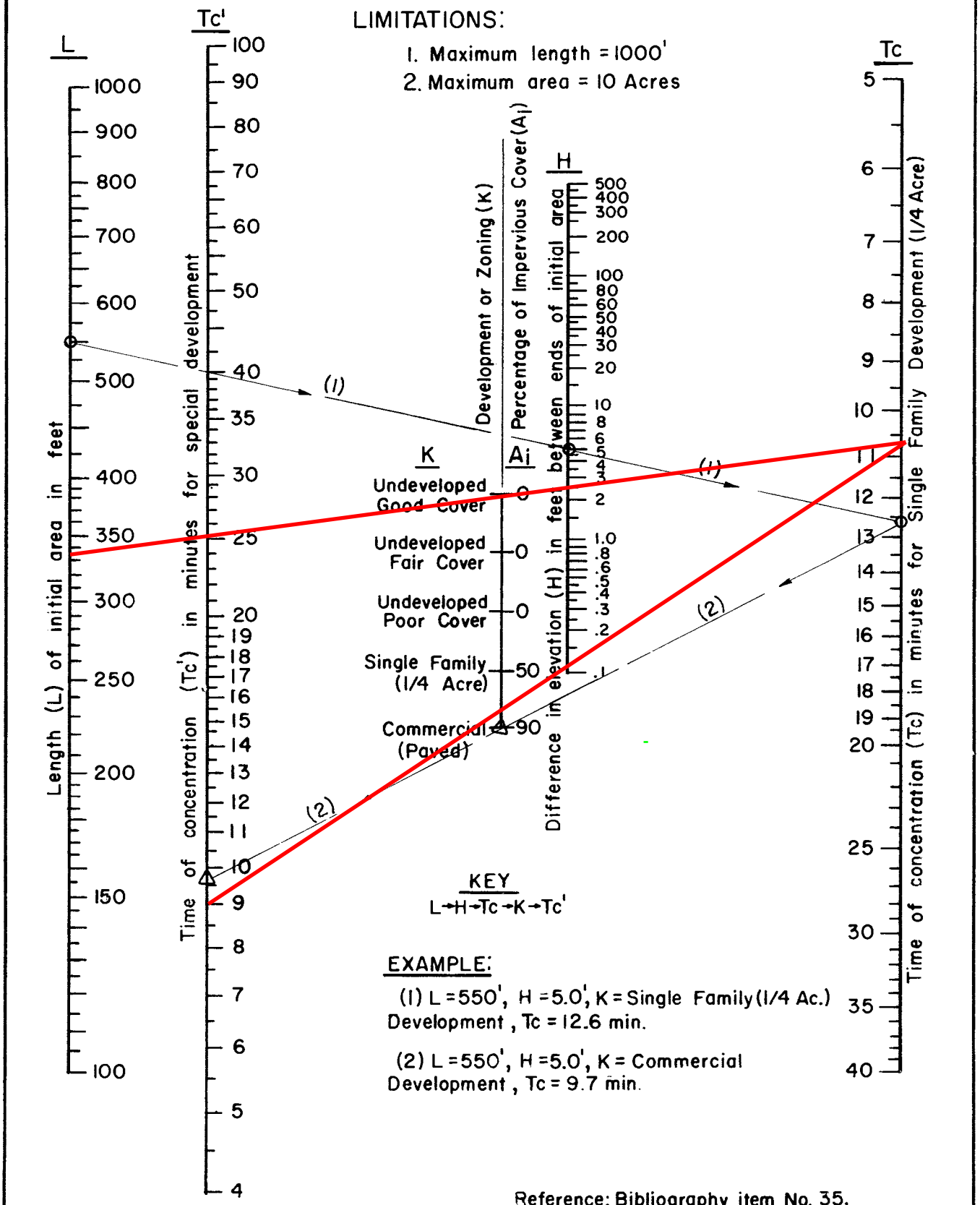

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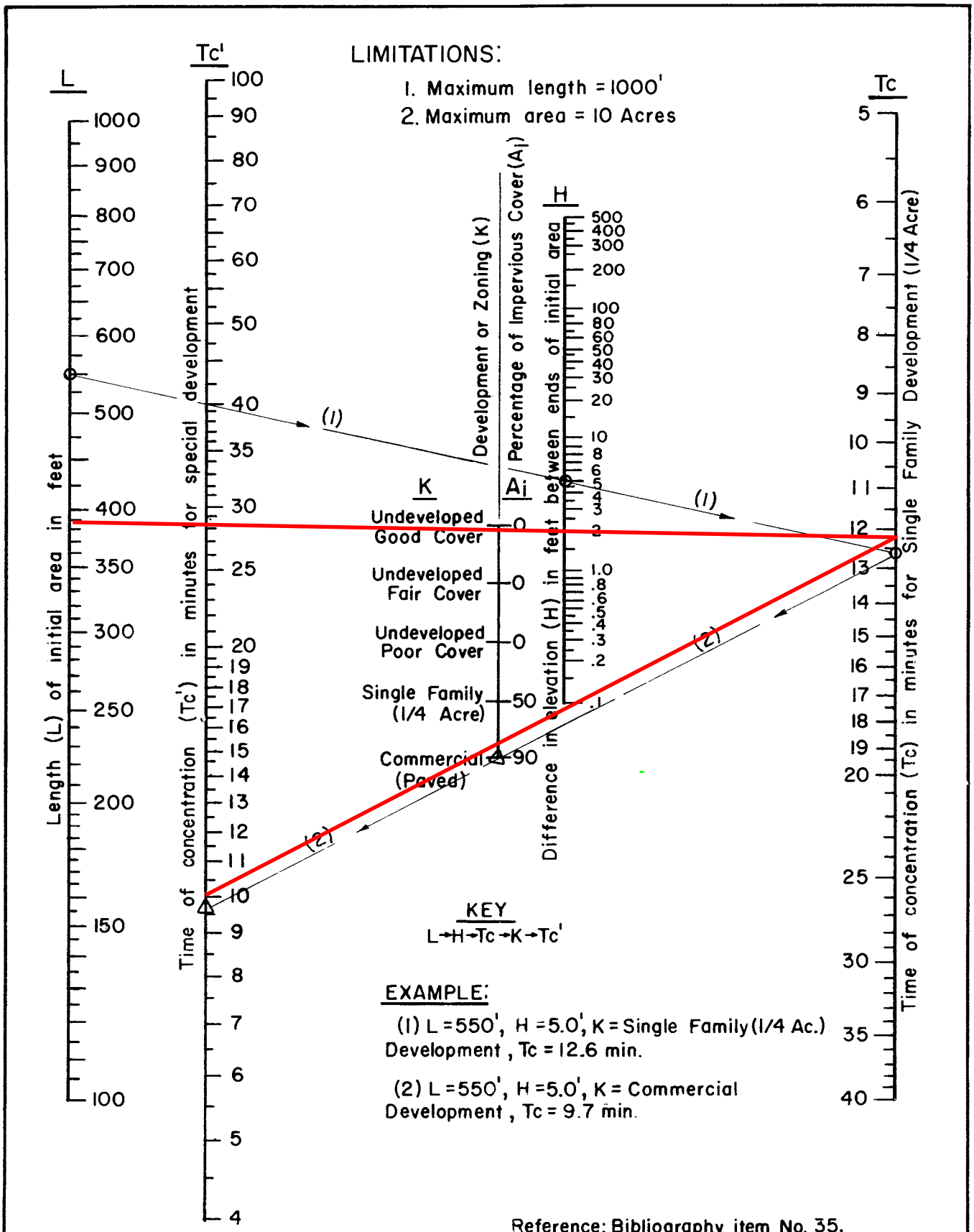

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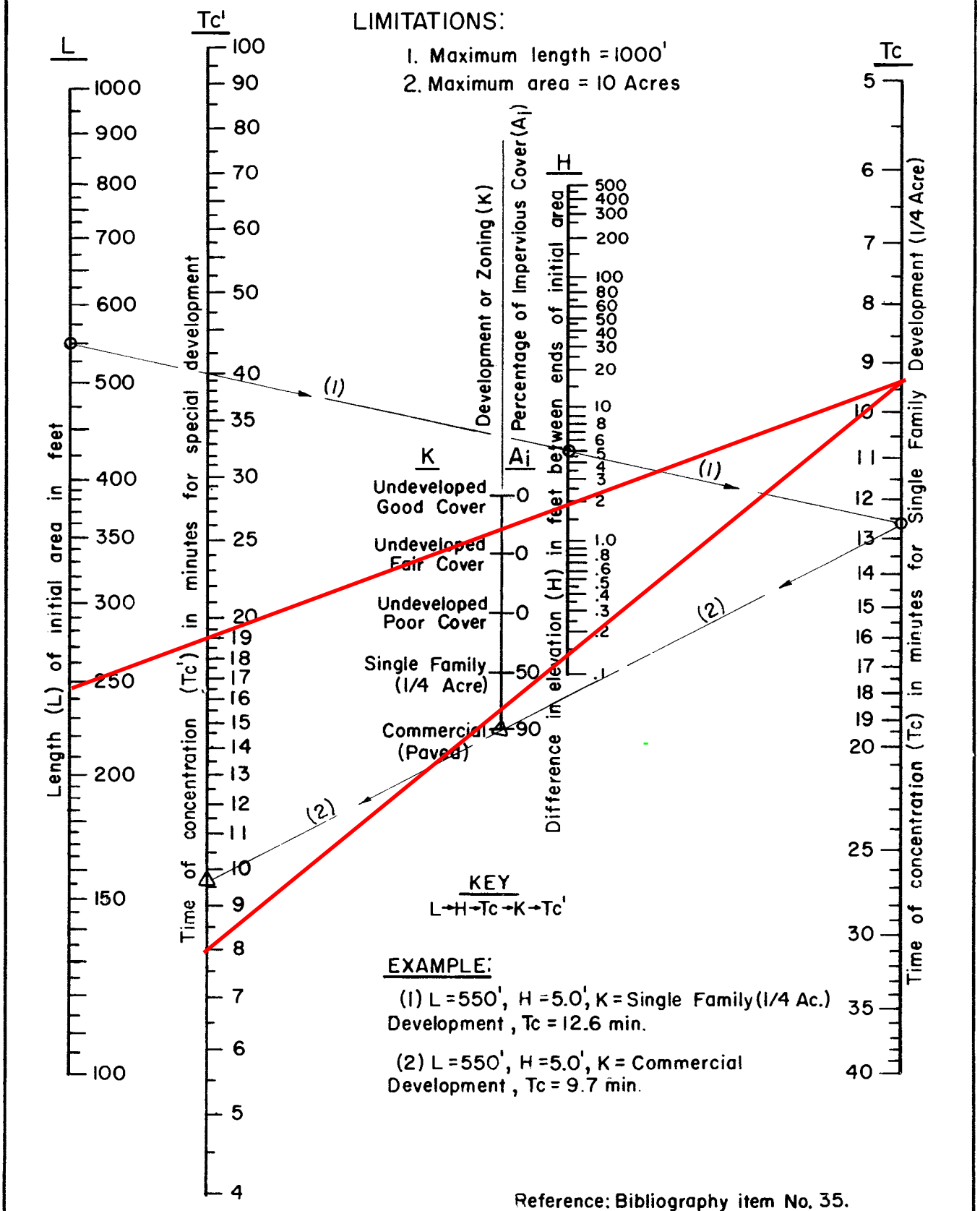

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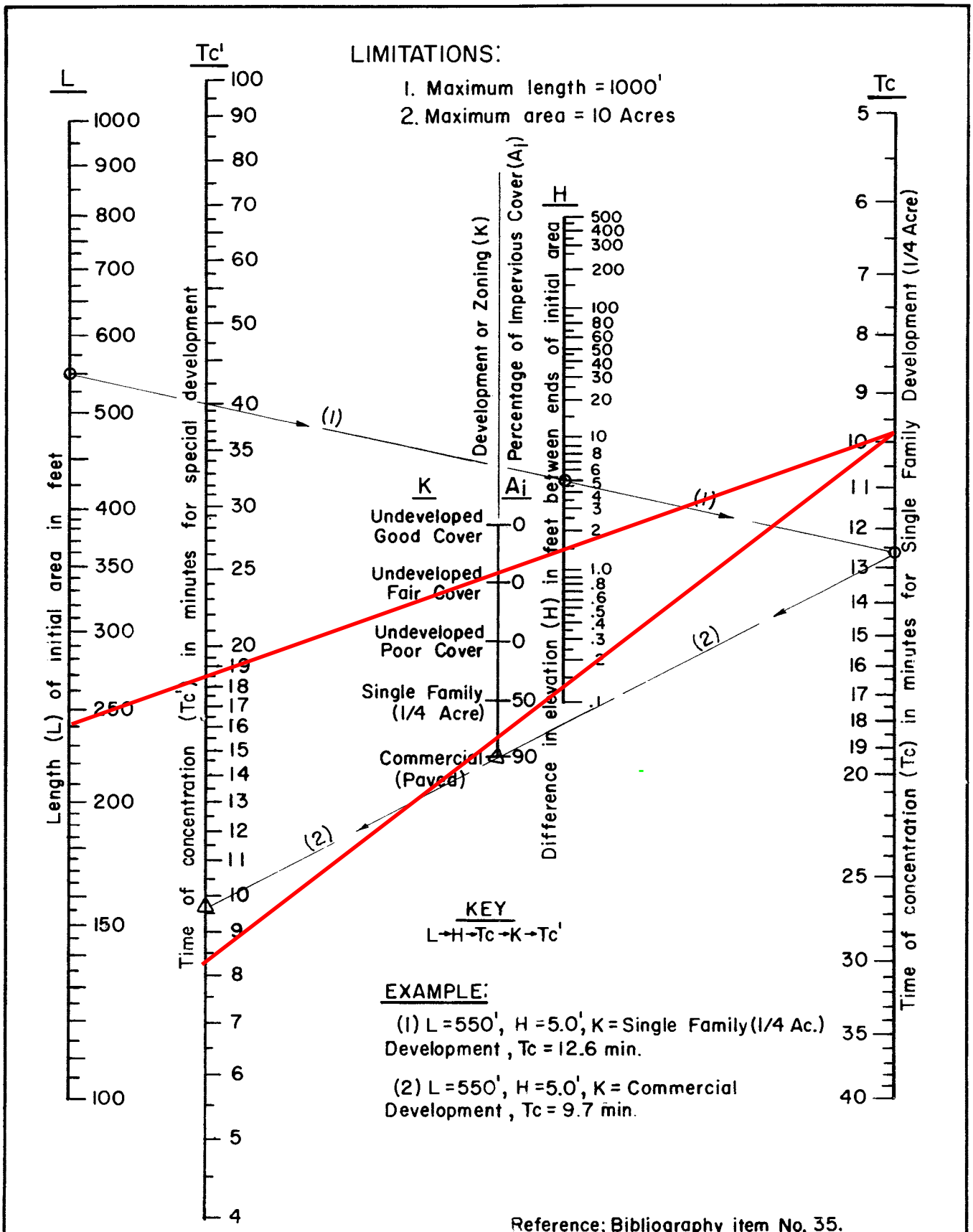

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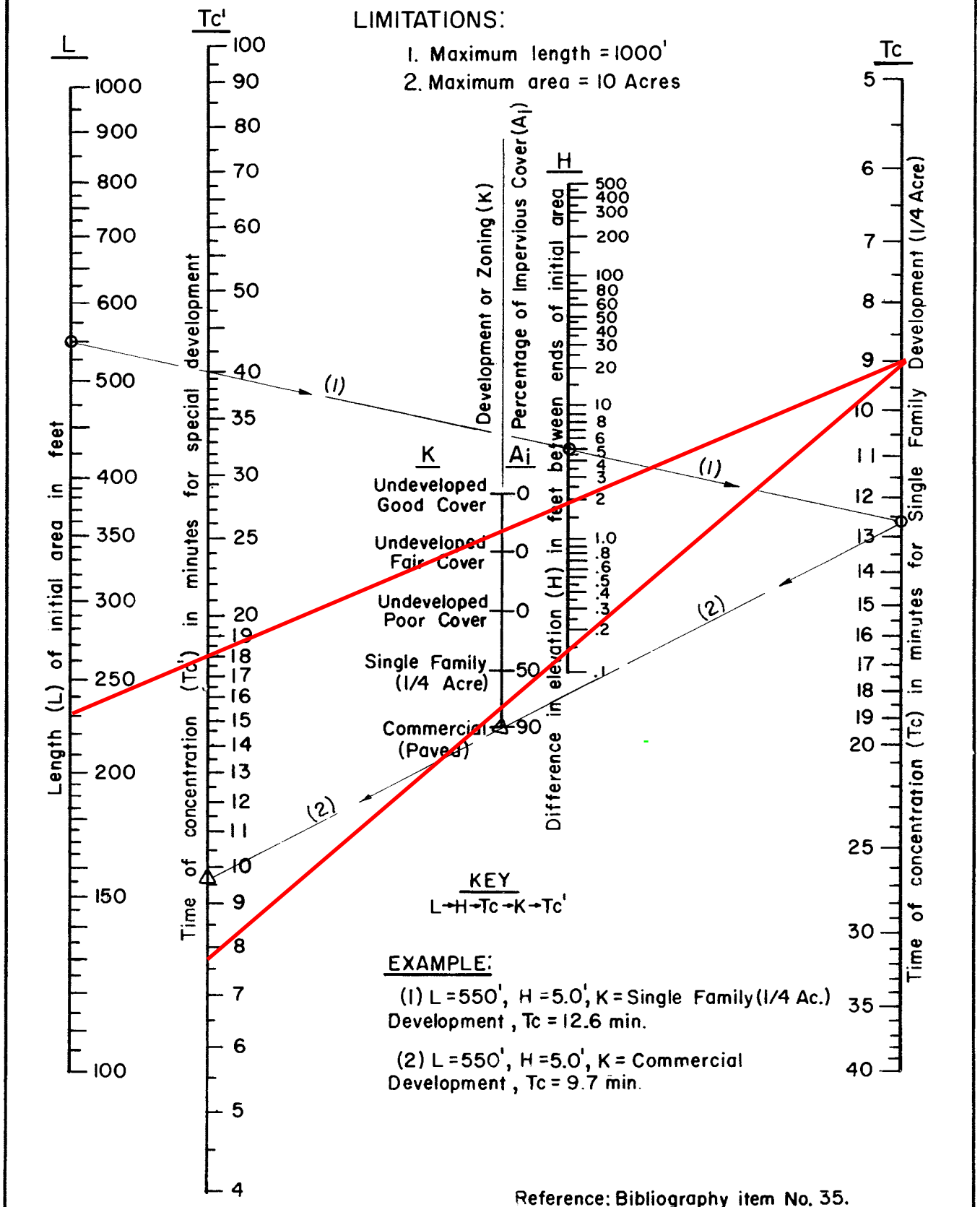

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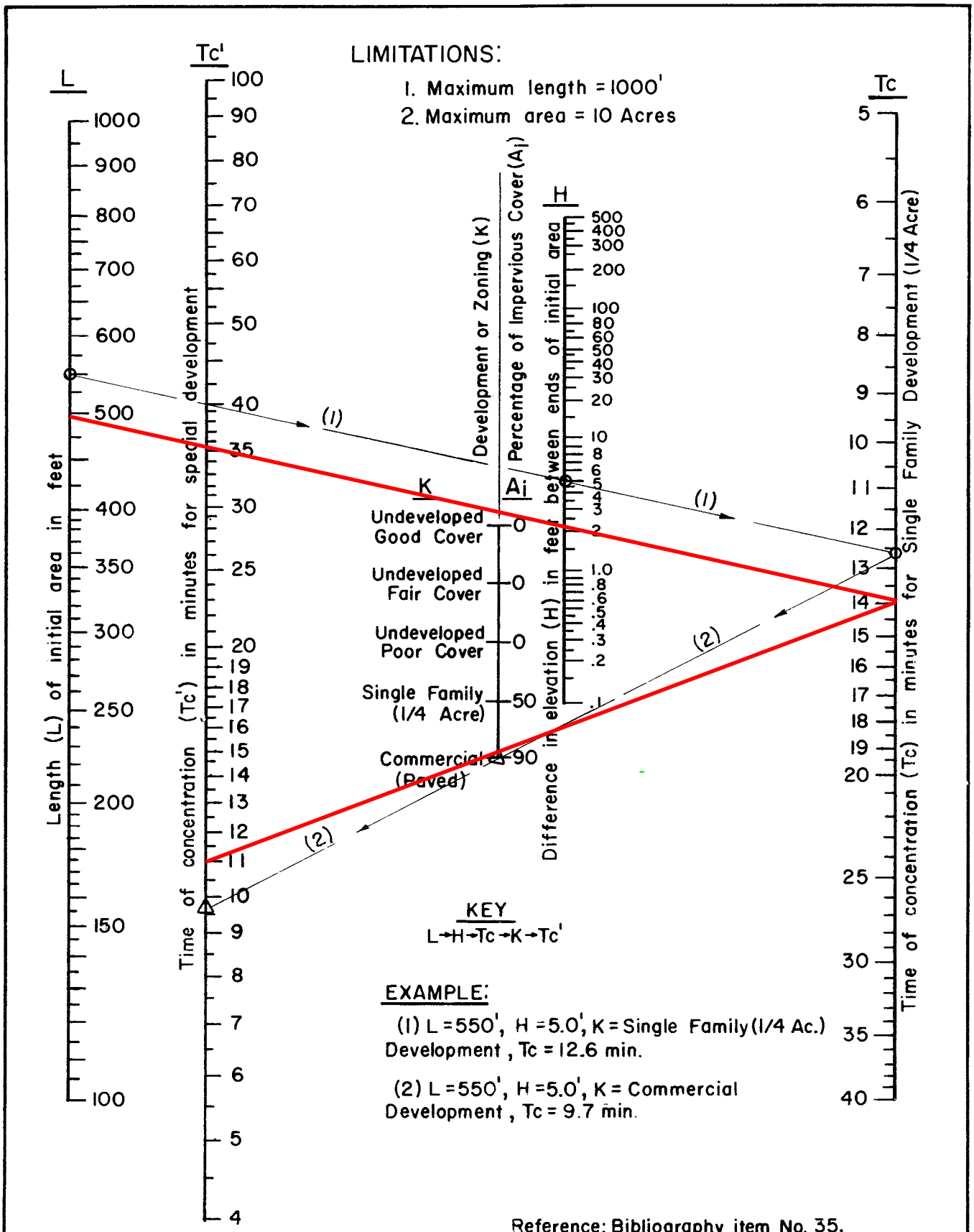

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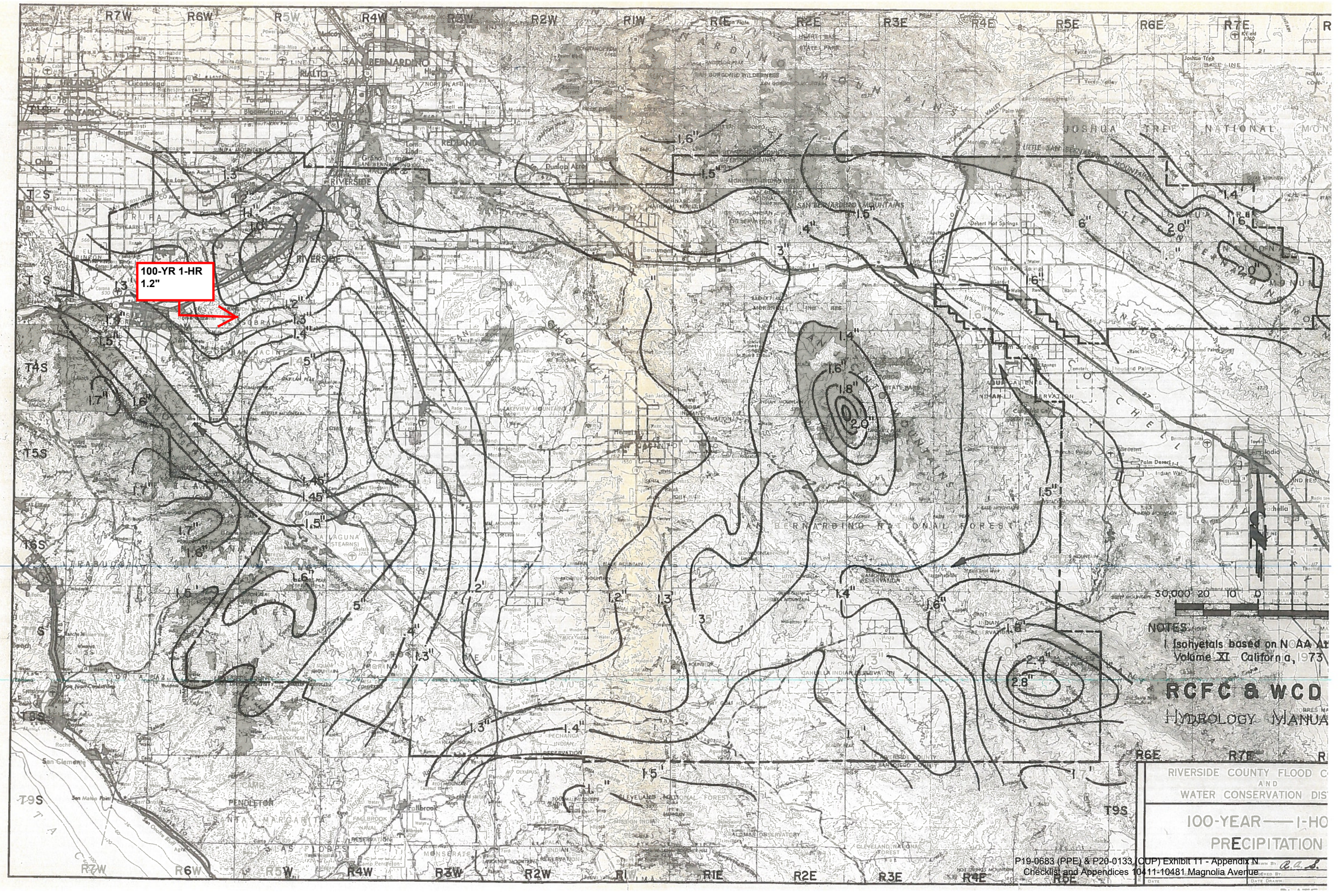
PLATE D-3

100 Year – 1 hour Isohyetal Map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PRECIPITATION
P19-0683 (PPE) & P20-0133 (CUP) Exhibit 11 - Appendix N
Checklist and Appendices 10411-10481 Magnolia Avenue

Intensity Duration Curves Data

RCFC & WCD

HYDROLOGY MANUAL

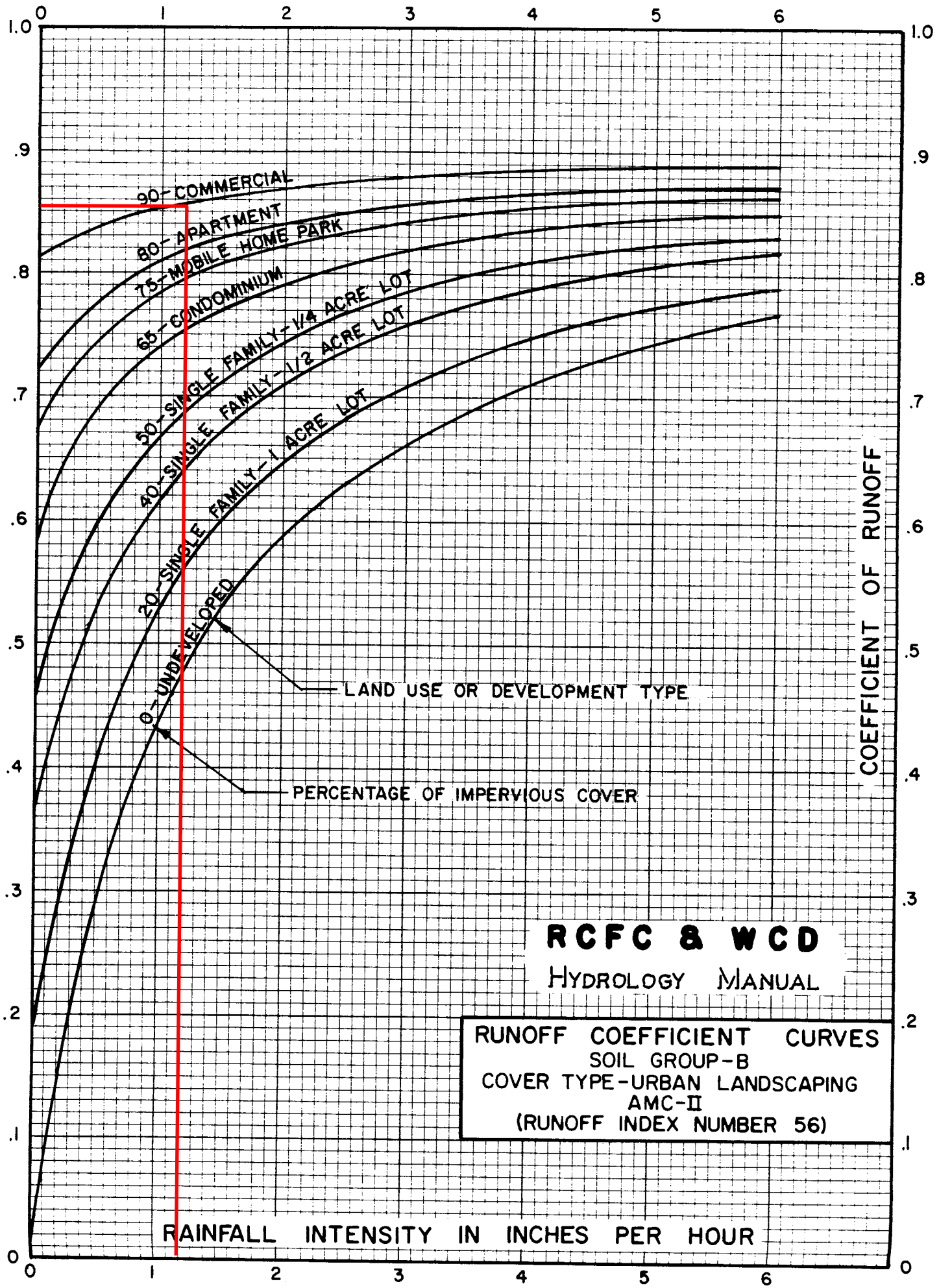
RAINFALL INTENSITY–INCHES PER HOUR

RIVERSIDE			RIVERSIDE (FOOTHILL AREAS)			RUBIDOUX			SAN JACINTO			SUN CITY		
DURATION MINUTES	FREQUENCY 10 YEAR	100 YEAR	DURATION MINUTES	FREQUENCY 10 YEAR	100 YEAR	DURATION MINUTES	FREQUENCY 10 YEAR	100 YEAR	DURATION MINUTES	FREQUENCY 10 YEAR	100 YEAR	DURATION MINUTES	FREQUENCY 10 YEAR	100 YEAR
5	2.75	3.92	5	3.14	4.71	5	3.18	4.71	5	2.81	4.16	5	3.25	4.85
6	2.48	3.55	6	2.84	4.26	6	2.87	4.26	6	2.56	3.79	6	2.95	4.40
7	2.28	3.26	7	2.61	3.91	7	2.64	3.91	7	2.37	3.51	7	2.72	4.06
8	2.12	3.03	8	2.42	3.63	8	2.45	3.63	8	2.22	3.29	8	2.53	3.78
9	1.99	2.84	9	2.27	3.41	9	2.30	3.41	9	2.09	3.10	9	2.38	3.55
10	1.88	2.68	10	2.14	3.21	10	2.17	3.21	10	1.98	2.94	10	2.25	3.36
11	1.78	2.54	11	2.03	3.05	11	2.06	3.05	11	1.89	2.80	11	2.14	3.19
12	1.70	2.42	12	1.94	2.91	12	1.96	2.91	12	1.81	2.68	12	2.04	3.05
13	1.62	2.32	13	1.86	2.78	13	1.88	2.78	13	1.74	2.58	13	1.96	2.92
14	1.56	2.23	14	1.78	2.67	14	1.80	2.67	14	1.68	2.48	14	1.88	2.81
15	1.50	2.14	15	1.71	2.57	15	1.74	2.57	15	1.62	2.40	15	1.81	2.71
16	1.45	2.07	16	1.66	2.48	16	1.68	2.48	16	1.57	2.32	16	1.75	2.62
17	1.40	2.00	17	1.60	2.40	17	1.62	2.40	17	1.52	2.25	17	1.70	2.54
18	1.36	1.94	18	1.55	2.33	18	1.57	2.33	18	1.48	2.19	18	1.65	2.46
19	1.32	1.88	19	1.51	2.26	19	1.52	2.26	19	1.44	2.13	19	1.60	2.39
20	1.28	1.83	20	1.46	2.20	20	1.48	2.20	20	1.40	2.08	20	1.56	2.33
22	1.22	1.74	22	1.39	2.08	22	1.41	2.08	22	1.34	1.98	22	1.48	2.21
24	1.16	1.66	24	1.32	1.99	24	1.34	1.99	24	1.28	1.90	24	1.41	2.11
26	1.11	1.58	26	1.27	1.90	26	1.28	1.90	26	1.23	1.82	26	1.36	2.03
28	1.06	1.52	28	1.22	1.82	28	1.23	1.82	28	1.19	1.76	28	1.30	1.95
30	1.02	1.46	30	1.17	1.76	30	1.19	1.76	30	1.15	1.70	30	1.26	1.88
32	.99	1.41	32	1.13	1.70	32	1.14	1.70	32	1.11	1.64	32	1.21	1.81
34	.96	1.37	34	1.09	1.64	34	1.11	1.64	34	1.08	1.59	34	1.18	1.76
36	.93	1.32	36	1.06	1.59	36	1.07	1.59	36	1.05	1.55	36	1.14	1.70
38	.90	1.29	38	1.03	1.54	38	1.04	1.54	38	1.02	1.51	38	1.11	1.66
40	.87	1.25	40	1.00	1.50	40	1.01	1.50	40	.99	1.47	40	1.08	1.61
45	.82	1.17	45	.94	1.41	45	.95	1.41	45	.94	1.39	45	1.01	1.51
50	.77	1.11	50	.88	1.33	50	.90	1.33	50	.89	1.31	50	.96	1.43
55	.73	1.05	55	.84	1.26	55	.85	1.26	55	.85	1.25	55	.91	1.36
60	.70	1.00	60	.80	1.20	60	.81	1.20	60	.81	1.20	60	.87	1.30
65	.67	.96	65	.77	1.15	65	.78	1.15	65	.78	1.15	65	.83	1.25
70	.64	.92	70	.73	1.10	70	.74	1.10	70	.75	1.11	70	.80	1.20
75	.62	.88	75	.71	1.06	75	.72	1.06	75	.72	1.07	75	.77	1.15
80	.60	.85	80	.68	1.02	80	.69	1.02	80	.70	1.04	80	.75	1.12
85	.58	.83	85	.66	.99	85	.67	.99	85	.68	1.01	85	.72	1.08
SLOPE = .550			SLOPE = .550			SLOPE = .550			SLOPE = .500			SLOPE = .530		

STANDARD INTENSITY–DURATION CURVES DATA

PLATE D-4.1(5 of 6)

Runoff Coefficient Curves



RCFC & WCD

HYDROLOGY MANUAL

RUNOFF COEFFICIENT CURVES
SOIL GROUP - B
COVER TYPE - URBAN LANDSCAPING
AMC - II
(RUNOFF INDEX NUMBER 56)

PLATE D-5.2

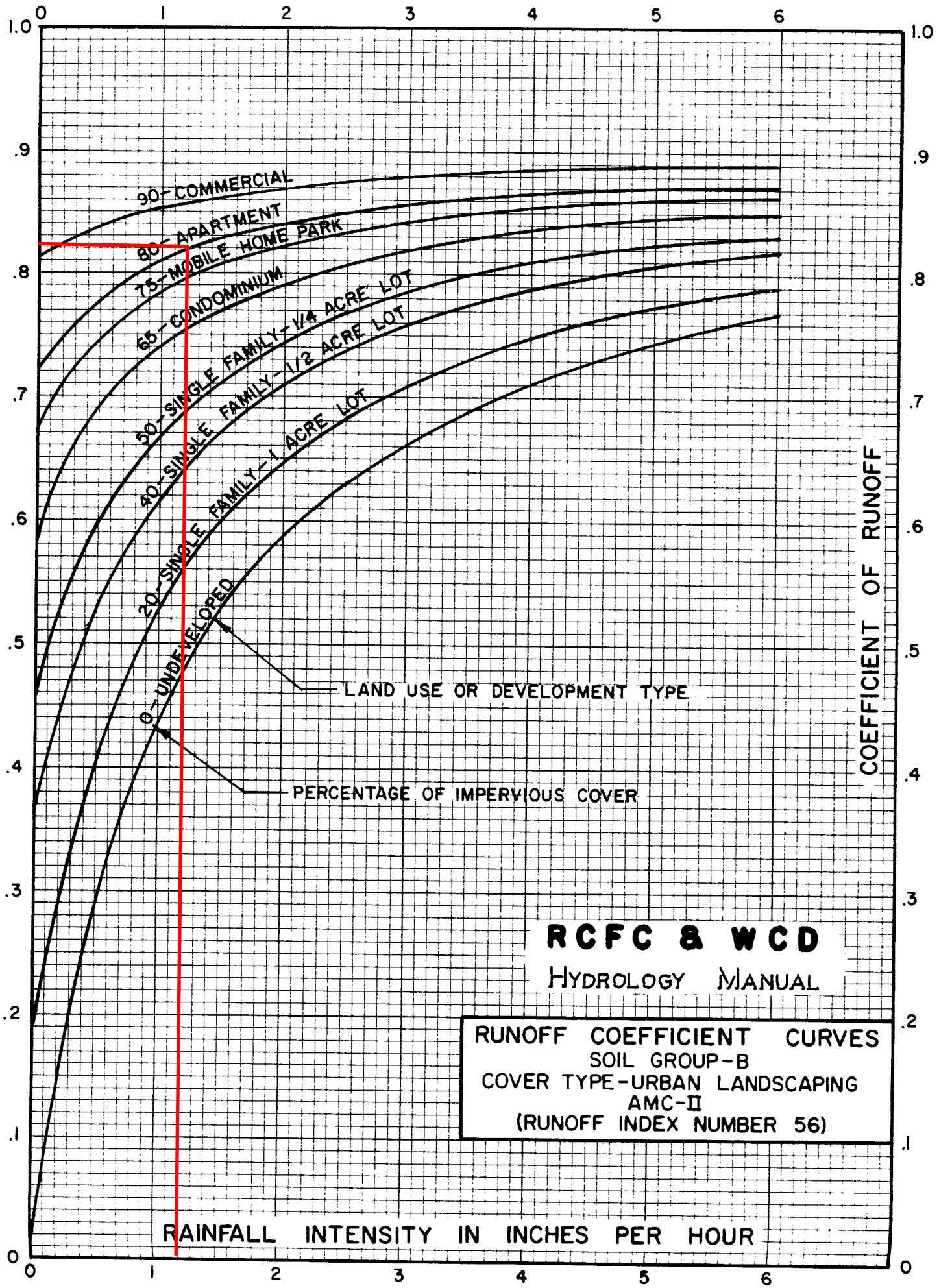

90-COMMERCIAL
80-APARTMENT
75-MOBILE HOME PARK
65-CONDOMINIUM
50-SINGLE FAMILY-1/4 ACRE LOT
40-SINGLE FAMILY-1/2 ACRE LOT
20-SINGLE FAMILY-1 ACRE LOT
0-UNDEVELOPED
LAND USE OR DEVELOPMENT TYPE
PERCENTAGE OF IMPERVIOUS COVER
COEFFICIENT OF RUNOFF
RAINFALL INTENSITY IN INCHES PER HOUR
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1
2
3
4
5
6
RCFC & WCD
HYDROLOGY MANUAL
RUNOFF COEFFICIENT CURVES
SOIL GROUP-B
COVER TYPE-URBAN LANDSCAPING
AMC-II
(RUNOFF INDEX NUMBER 56)

PLATE D-5.2

Existing/Proposed Hydrology Calculations

EXISTING DEVELOPMENT

RATIONAL METHOD CALCULATIONS[1]

Project: Magnolia Flats - Riverside

FREQUENCY: 100 Year Storm Event													
Drainage Area	**Soil Group Type[2]**	**Development Type**	**Area (sqft)**	**Area (ac)**	**Rainfall Intensity[3] (in/hour)**	**Runoff [4] Coefficient**	**Q_{100} (cfs)**	**∑ Q (cfs)**	**S**	**L (ft)**	**Time of Concentration[5] (minutes)**	**∑ T (min)**	**Remarks**
EX-A	B	Commercial	92674	2.13	4.1	0.85	7.37		0.49%	248	6.5		Initital Subarea - Surface Flow
								29.48				18.4	A+B
EX-B	B	Commercial	387883	8.90	2.9	0.85	22.11		1.10%	956	11.9		Initital Subarea - Surface Flow
EX-C	B	Commercial	65722	1.51	4.1	0.85	5.27		1.20%	237	6.4		Initital Subarea - Surface Flow
								6.83				12.5	C+D
EX-D	B	Commercial	18897	0.43	4.2	0.85	1.56		0.27%	99	6.1		Initital Subarea - Surface Flow
EX-E	B	Commercial	334207	7.67	2.8	0.85	18.54		0.66%	897	12.5		Initital Subarea - Surface Flow
								25.37				25.0	C+D+E

Notes:

1. Riverside County Flood Control and Water Conservation District Hydrology Manual, April 1978
2. Plate C-1.15, RCFC & WCD 1978
3. Plate D-4.1 (pg. 5 of 6) & D-4.4, RCFC & WCD 1978
4. Plate D-5.2, RCFC & WCD 1978
5. Plate D-3 for Initial Sub-Area, RCFC & WCD 1978

PROPOSED DEVELOPMENT

RATIONAL METHOD CALCULATIONS[1]

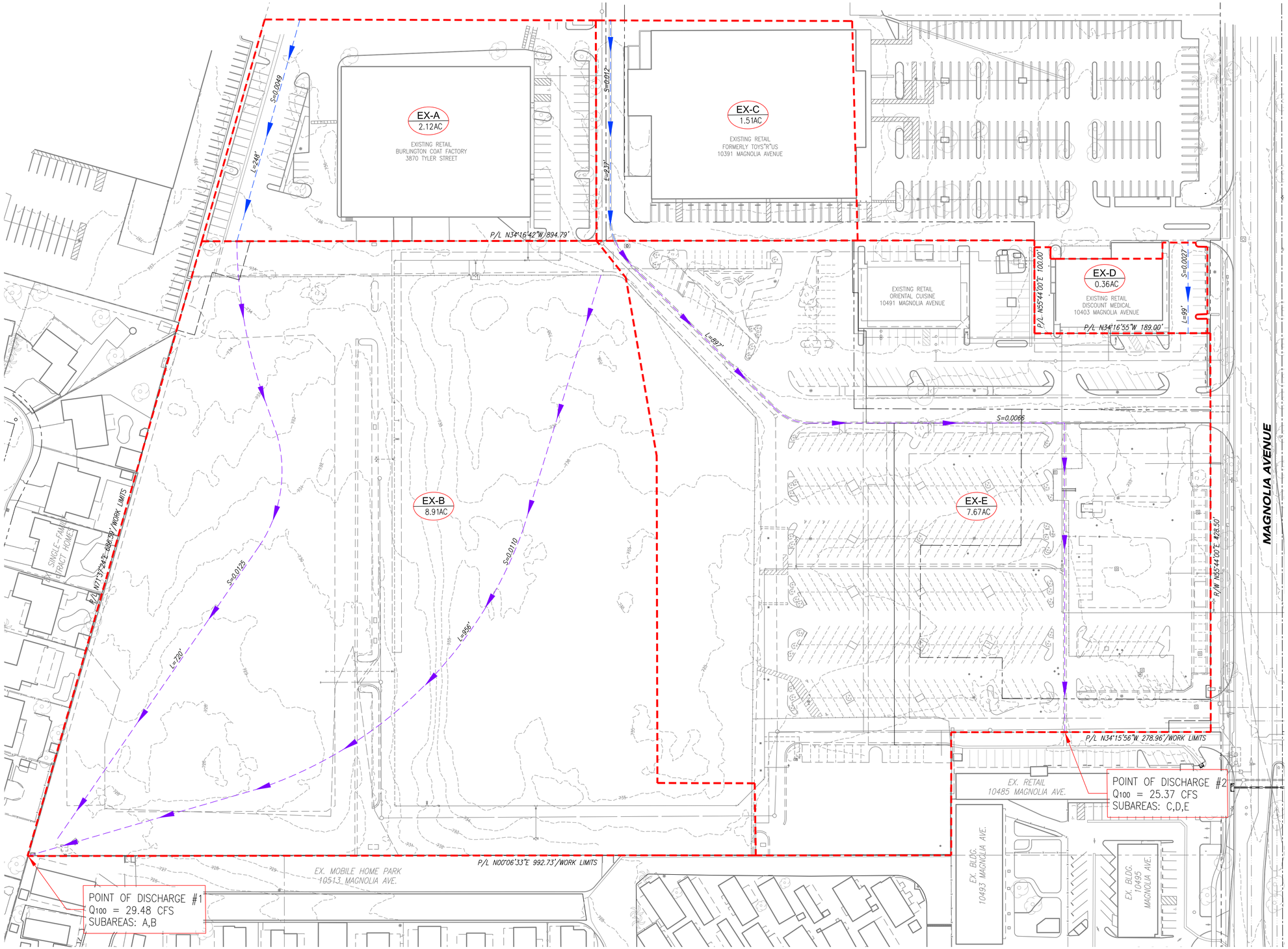
Project: Magnolia Flats - Riverside

FREQUENCY: 100 Year Storm Event														
Drainage Area	**Soil Group Type**[2]	**Development Type**	**Area (sqft)**	**Area (ac)**	**Rainfall Intensity**[3] **(in/hour)**	**Runoff**[4] **Coefficient**	**Q_{100} (cfs)**	**∑ Q (cfs)**	**Slope**	**Velocity (fps)**	**L**	**Time of Concentration**[5] **(minutes)**	**∑ T (min)**	**Remarks**
A	B	Commercial	92674.0	2.13	3.9	0.85	7.13		0.69%	7.1	247	6.9		Grated Catch Basin
								15.89					19.4	A+B
B	B	Residential	163733.0	3.76	2.8	0.82	8.76		0.64%	7.9	746	12.5		Grated Catch Basin
								27.94					29.7	B+C
C	B	Residential	201720.0	4.63	3.2	0.82	12.04		70.00%	5.8	439	10.3		Catch Basin
D	B	Residential	86385.0	1.98	3.3	0.82	5.41		0.91%	4.7	392	9.4		Catch Basin
								13.28					18.4	D+E
E	B	Residential	122696.0	2.82	3.4	0.82	7.87		1.98%	5.2	111	9.0		Grated Catch Basin
								16.47					28.4	E+F
F	B	Residential	52775.0	1.21	3.2	0.82	3.19		0.50%	4.1	386	10.0		Catch Basin
G	B	Commercial	66470.0	1.53	3.6	0.85	4.71		0.81%	-	245	8.0		Street Flow
								6.59					16.4	G+H
H	B	Residential	28095.0	0.64	3.5	0.82	1.87		0.62%	5.7	241	8.4		Grated Catch Basin
													24.0	G+I
I	B	Residential	16068.0	0.37	3.7	0.82	1.13		0.86%	13.6	230	7.6		Catch Basin
								52.13					82.1	A+B+C+D+E+F+G+H+I
J	B	Commercial	65754.0	1.51	3.1	0.85	3.91		0.26%	-	499	11.0		Ribbon Gutter (Magnolia Avenue)

Notes:

1. Riverside County Flood Control and Water Conservation District Hydrology Manual, April 1978
2. Plate C-1.15, RCFC & WCD 1978
3. Plate D-4.1 (pg. 5 of 6) & D-4.4, RCFC & WCD 1978
4. Plate D-5.2, RCFC & WCD 1978
5. Plate D-3 for Initial Sub-Area, RCFC & WCD 1978

Existing/Proposed Hydrology Map



LEGEND

- SUBAREA BOUNDARY
- SURFACE FLOW PATH ONSITE
- SURFACE FLOW PATH OFFSITE
- X / X.XXAC — SUBAREA LABEL

0 25 50 100 150

SCALE: 1"=50' DATE: 2/18/20

MAGNOLIA FLATS

REALM

EXISTING CONDITIONS HYDROLOGY MAP

RIVERSIDE, CALIFORNIA

PREPARED BY:
KHR ASSOCIATES
CONSULTING ENGINEERS/SURVEYORS/PLANNERS
17530 Von Karman Ave. - Suite 200 Tel (949) 756-6440
Irvine, California 92614

P19-0683 (PPE) & P20-0133 (CUP) Exhibit 11 - Appendix N
Checklist and Appendices 10411-10481 Magnolia Avenue

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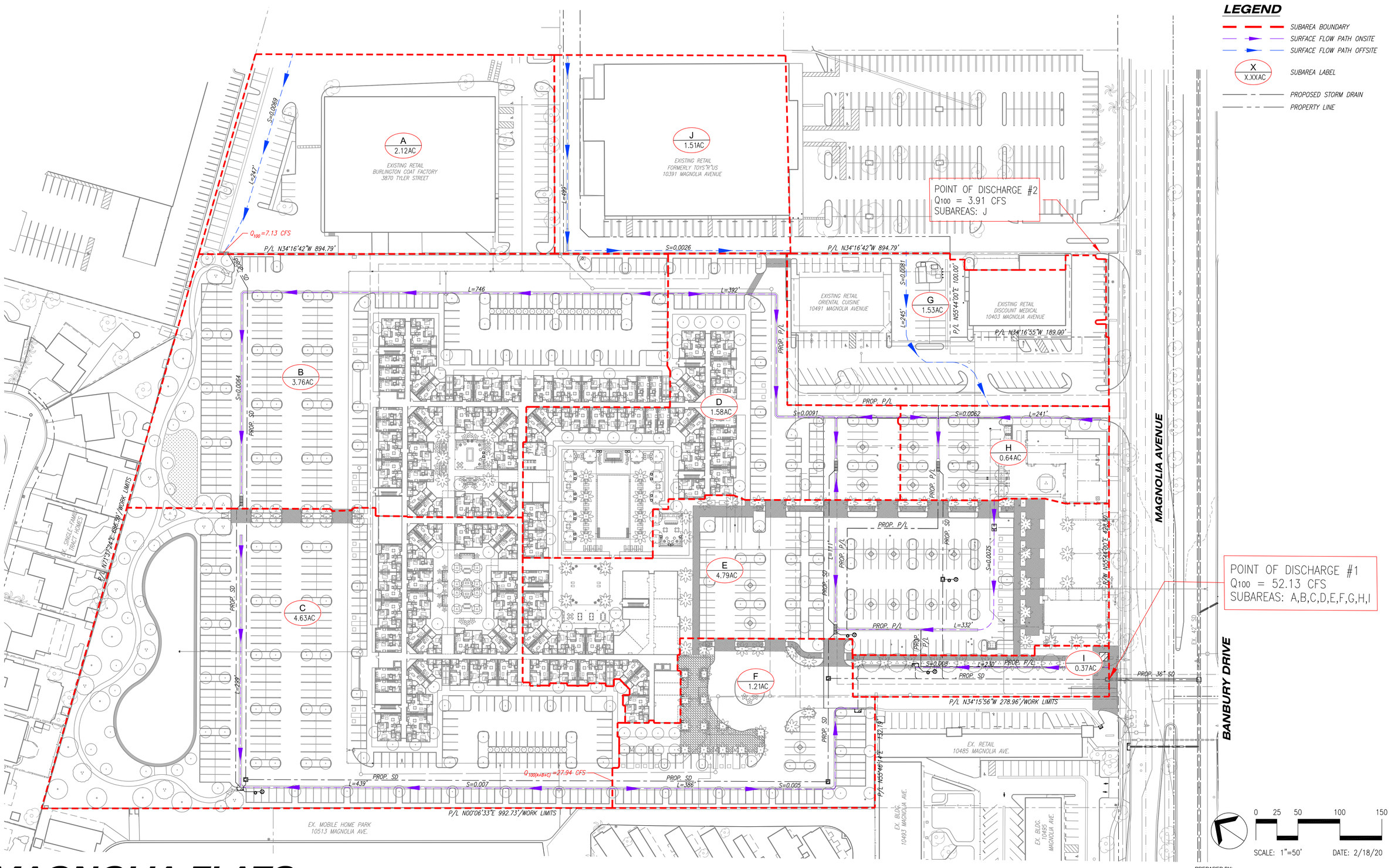

MAGNOLIA FLATS

REALM

PROPOSED CONDITIONS HYDROLOGY MAP

RIVERSIDE, CALIFORNIA

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