CE 3372 WATER SYSTEMS DESIGN

LECTURE 17: STORM-WATER CONDUIT DESIGN

PURPOSES

- CONDUITS CONVEY FLOW FROM ONE LOCATION TO ANOTHER
  - PIPES
  - CULVERTS
  - OPEN CHANNELS

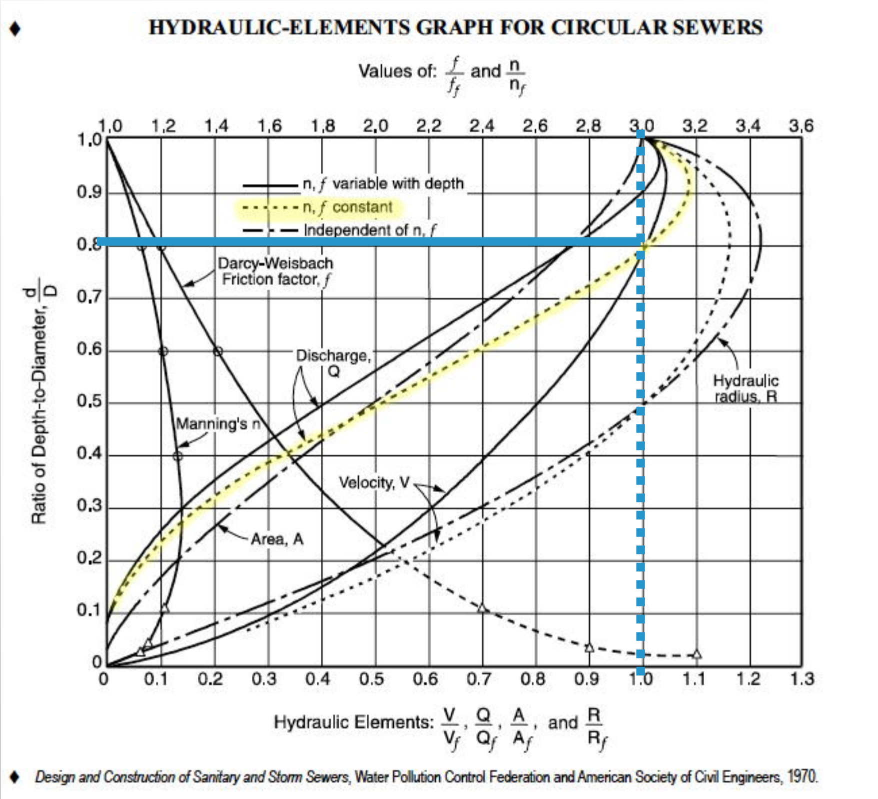
CONDUIT DESIGN

- SELECT SIZE, MATERIAL, AND SLOPE
  - STORM SEWER – USUALLY DESIRE TO OPERATE WITH FREE SURFACE (AS AN OPEN CHANNEL)
  - SANITARY SEWER – SIMILAR USUALLY WANT A FREE SURFACE
  - SIZE (DIAMETER) IS DICTATED BY
    - FLOW REQUIRED
    - BURIAL DEPTH RELATIVE TO DROP AVAILABLE

METHODS

- A GOOD PRELIMINARY DESIGN CAN BE OBTAINED USING A COMBINATION OF THE RATIONAL EQUATION AND MANNING'S EQUATION
  - DONE WITHOUT REGARD TO DOWNSTREAM BOUNDARY CONDITIONS
  - NEEDS TO BE CHECKED USING A HYDRAULIC MODEL (LIKE SWMM)

PRELIMINARY DESIGN



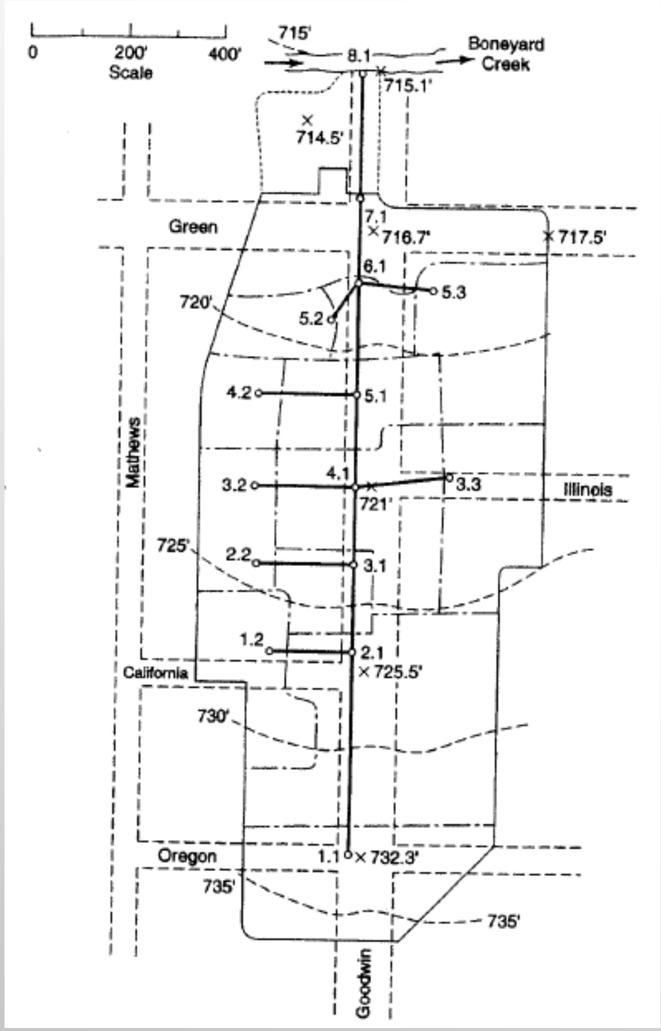
- DETERMINE DISCHARGE IN EACH PIPE.
- SIZE USING MANNING'S EQUATION

  (… IN US CUSTOMARY)

$$D = 1.333\left(\frac{Qn}{S^{1/2}}\right)^{3/8}$$

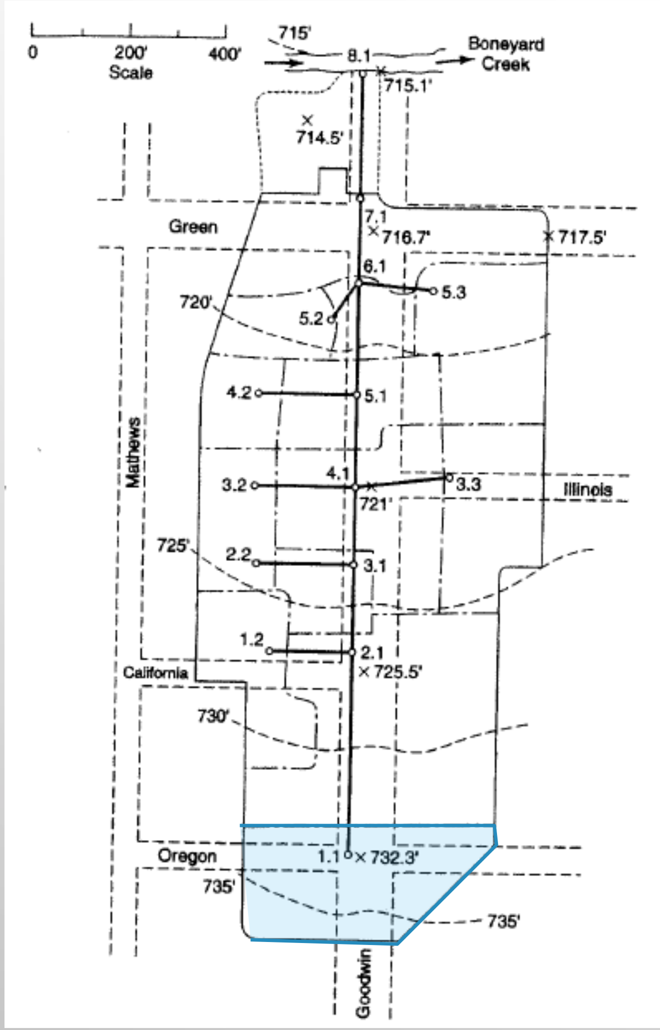
- ASSUMES FULL, BUT PIPES WILL HAVE FREE SURFACE

PRELIMINARY DESIGN



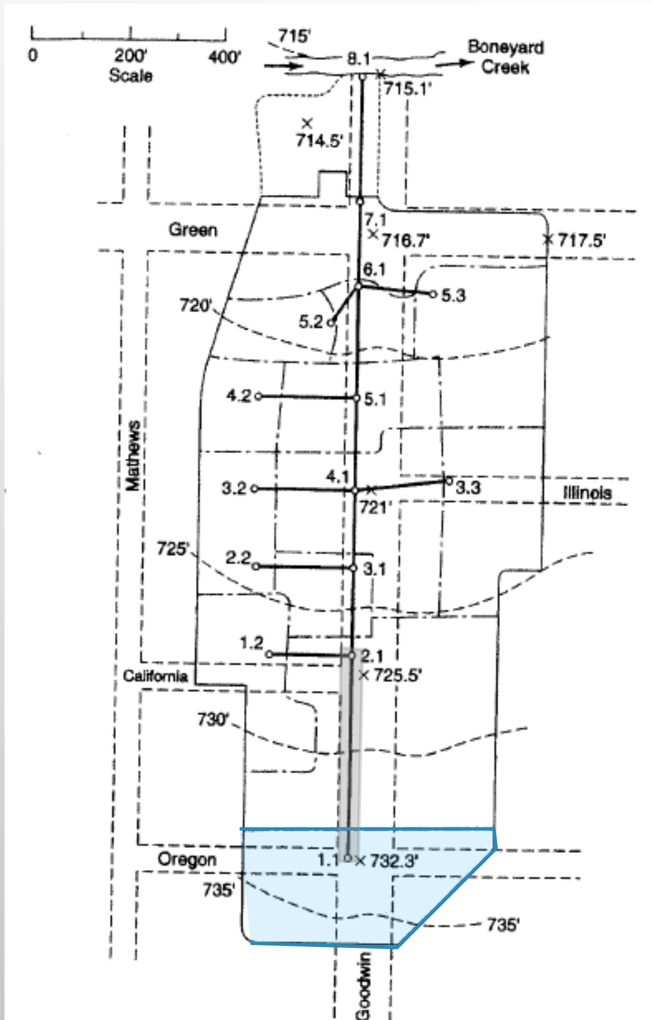
- LAYOUT OF SYSTEM
    - DRAINAGE AREA AND INLETS
    - PIPES
    - OUTFALL
    - ELEVATIONS

PRELIMINARY DESIGN



- DRAINAGE AREAS AND INLETS
  - DETERMINE INLET TIME OF CONCENTRATION
  - DETERMINE DRAINAGE AREA RUNOFF COEFFICIENT

PRELIMINARY DESIGN



- PIPES (START UPSTREAM)
  - SELECT PIPE SIZE
    - DESIGN GUIDELINES
    - DISCHARGE CRITERIA

$$D = 1.333\left(\frac{Qn}{\sqrt{S}}\right)^{3/8}$$

    - VELOCITY CRITERIA

Adjust

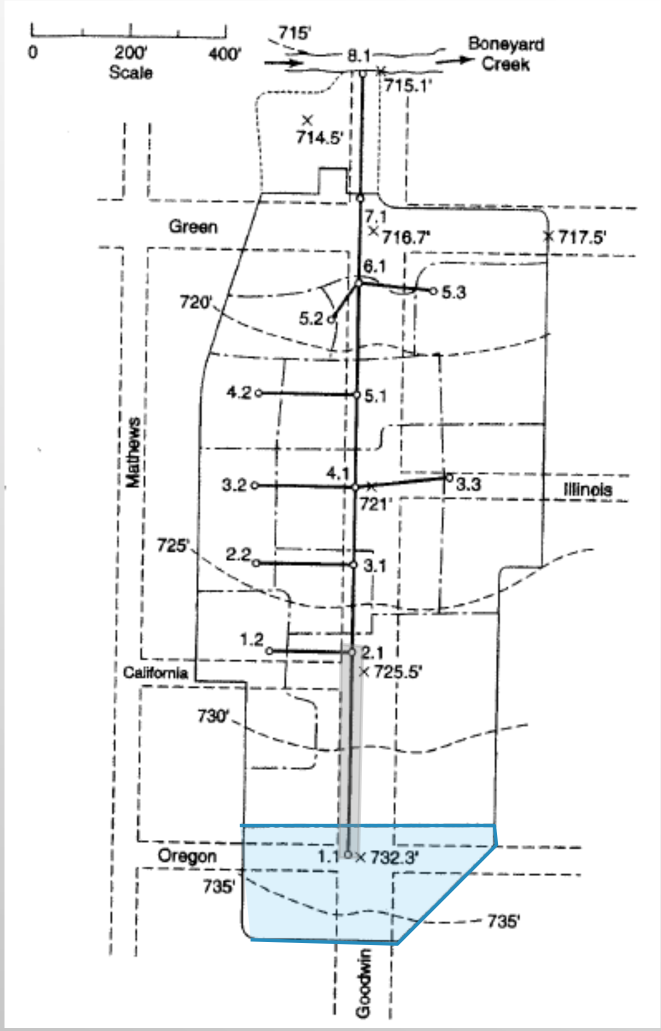
$$V = \frac{1.49}{n}\left(\frac{D}{4}\right)^{2/3}\sqrt{S}$$

From criterion

  - DETERMINE PIPE TRAVEL TIME

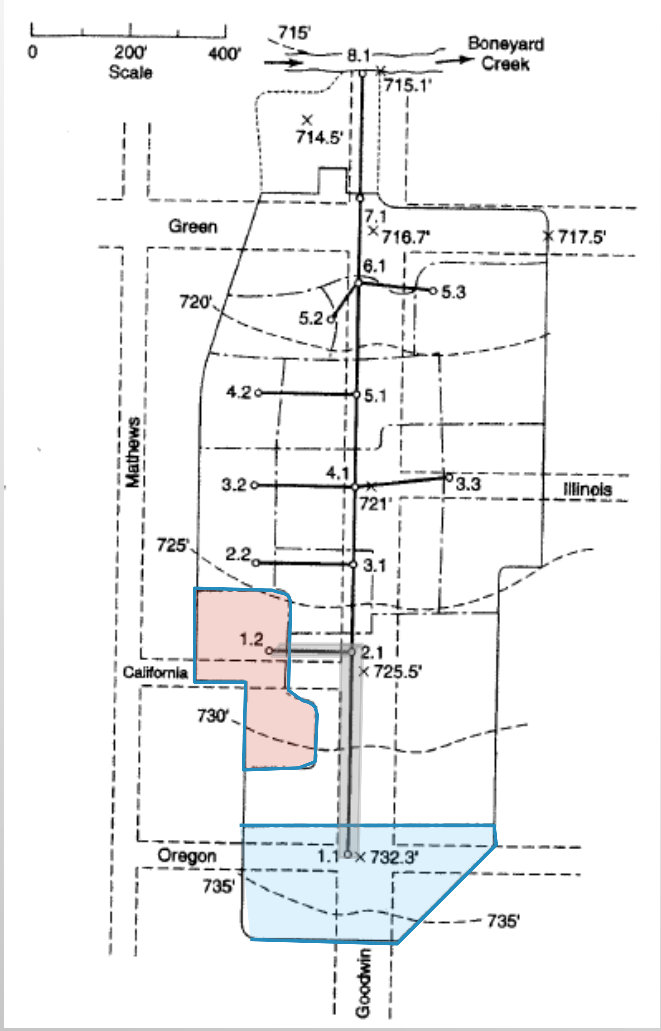
$$t = distance/V$$

PRELIMINARY DESIGN



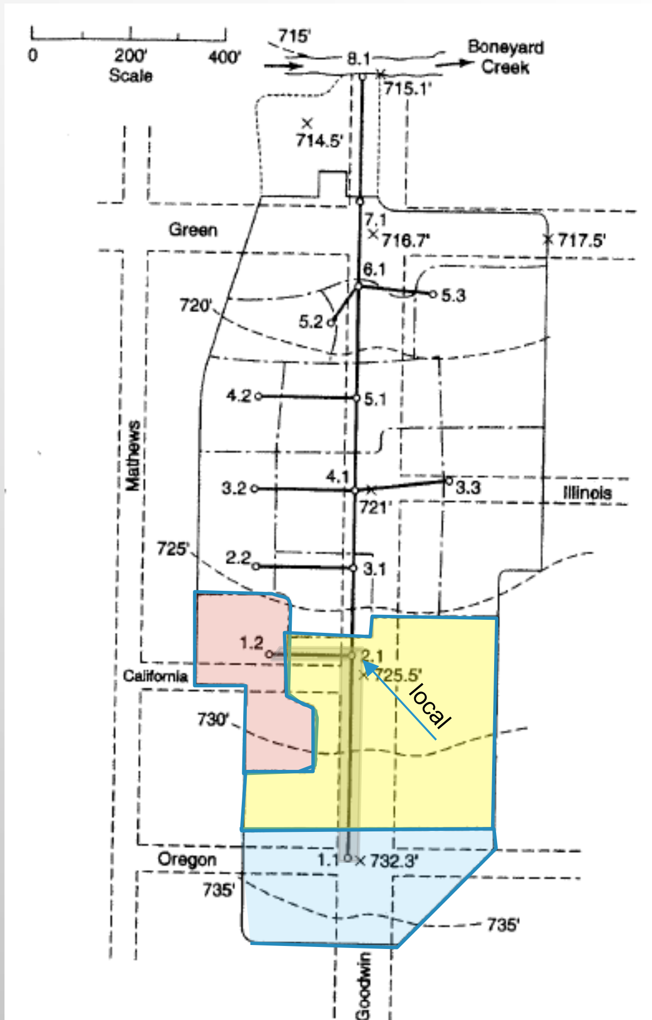
- AT MOST UPSTREAM INLET
  - COMPUTE Q_P=CIA TO THE INLET FROM INLET TIME
  - SIZE PIPE FROM THIS INLET TO HOLD Q_P
  - ADD PIPE TRAVEL TIME TO INLET TIME
  - MOVE TO NEXT NODE

PRELIMINARY DESIGN



- AT NEXT UPSTREAM INLET
  - COMPUTE Q_P=CIA TO THE INLET FROM INLET TIME
  - SIZE PIPE FROM THIS INLET TO HOLD Q_P
  - ADD PIPE TRAVEL TIME TO INLET TIME
  - MOVE TO NEXT NODE

PRELIMINARY DESIGN

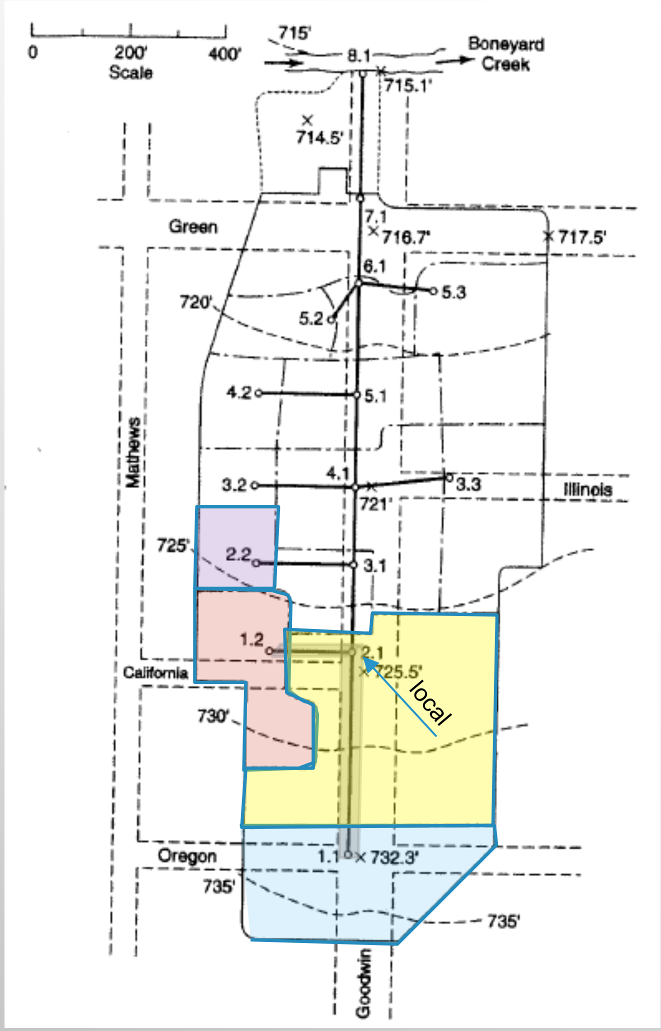


- AT JUNCTION AND INLET
  - CHOOSE LARGEST OF:
  1. LOCAL INLET TIME
  2. UPSTREAM NODE+TRAVEL TIME
- COMPUTE Q_P LEAVING THE JUNCTION FROM:

$$Q_p = (CA_{local} + \sum CA_{upstream})i$$

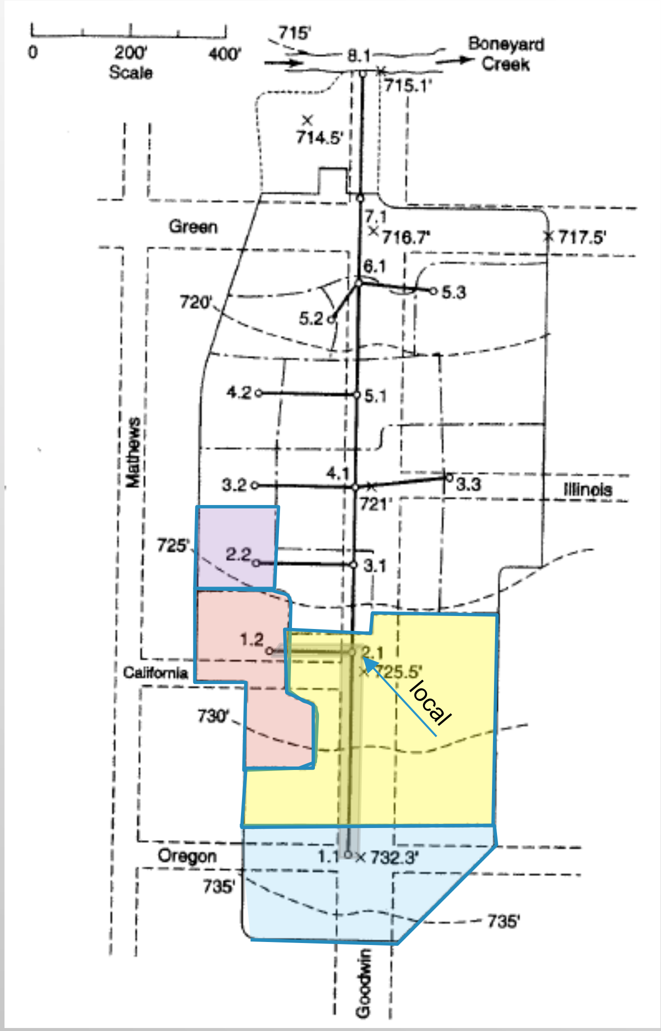
- SIZE NEXT PIPE FROM THIS Q_P

PRELIMINARY DESIGN



- CONTINUE DOWNSTREAM IN SAME FASHION (FROM UPSTREAM TO JUNCTION) UNTIL REACH OUTLET
- ACCUMULATE CA VALUES AND TC AS MOVE DOWNSTREAM
- CHECKS INCLUDE THAT ALL AREAS ADD UP TO TOTAL AREA
- T_C SHOULD BE INCREASING IN VALUE AS MOVE DOWNSTREAM

PRELIMINARY DESIGN



- AT OUTLET SHOULD HAVE:
  - PIPE SIZES
  - PIPE DISCHARGES
- NEXT CHECK HYDRAULICS
  - SWMM – ENTER Q_{INLET} DIRECTLY AND CHECK PIPE HYDRAULICS
  - SWMM – APPROXIMATE RATIONAL IN SWMM TO CHECK A DESIGN HYETOGRAPH
  - USE SWMM RESULTS TO ADJUST DESIGN AND PRODUCE A HGL DRAWING

NEXT TIME

- STORAGE NODE (DETAILS)
  - USED TO MIMIC DETENTION PONDS
  - USED TO MIMIC LIFT-STATION WET-WELL SUMPS