



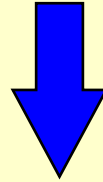
POLITÉCNICA

ESTIMACIÓN DE ISOCRONAS. ÁREA EFECTIVA



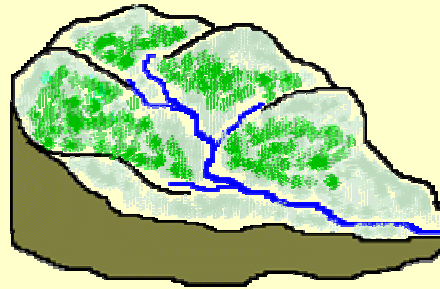
JOSÉ CARLOS ROBREDO SÁNCHEZ
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UNIDAD DOCENTE DE HIDRÁULICA E HIDROLOGÍA
DEPARTAMENTO DE INGENIERÍA FORESTAL
E.T.S. DE INGENIEROS DE MONTES
UNIVERSIDAD POLITÉCNICA DE MADRID

PRECIPITACIONES

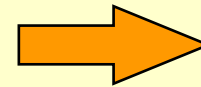


AGUA

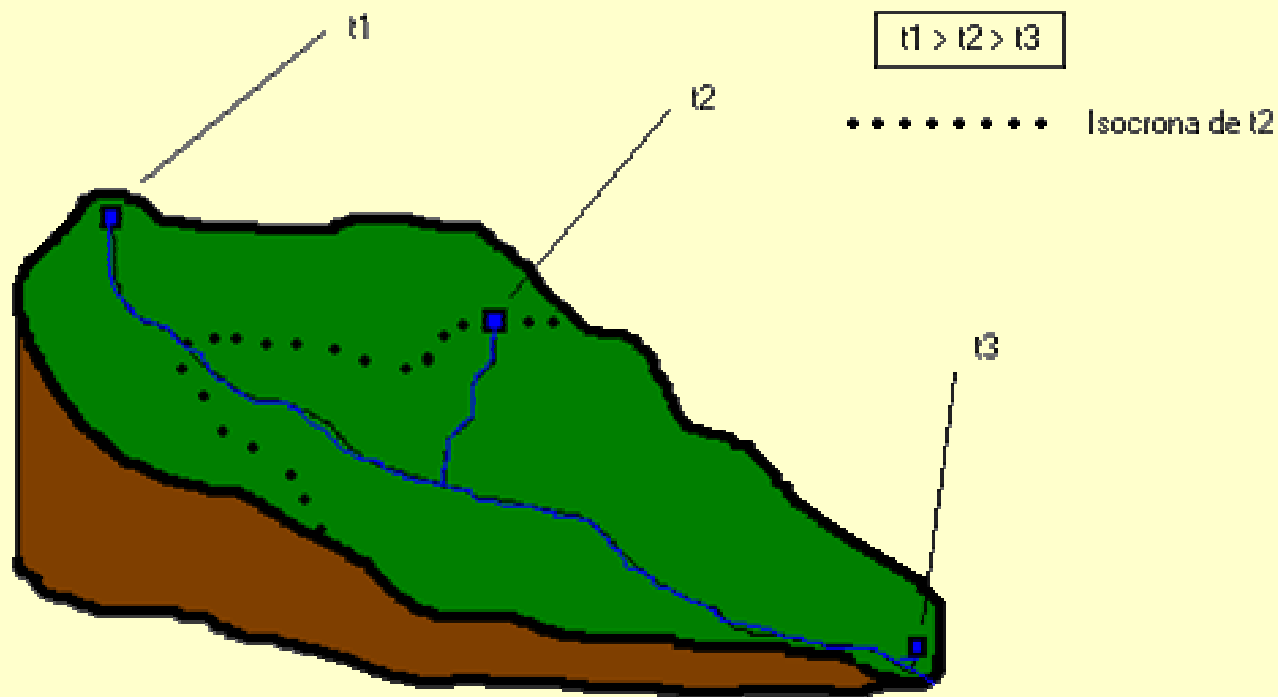
MONTE



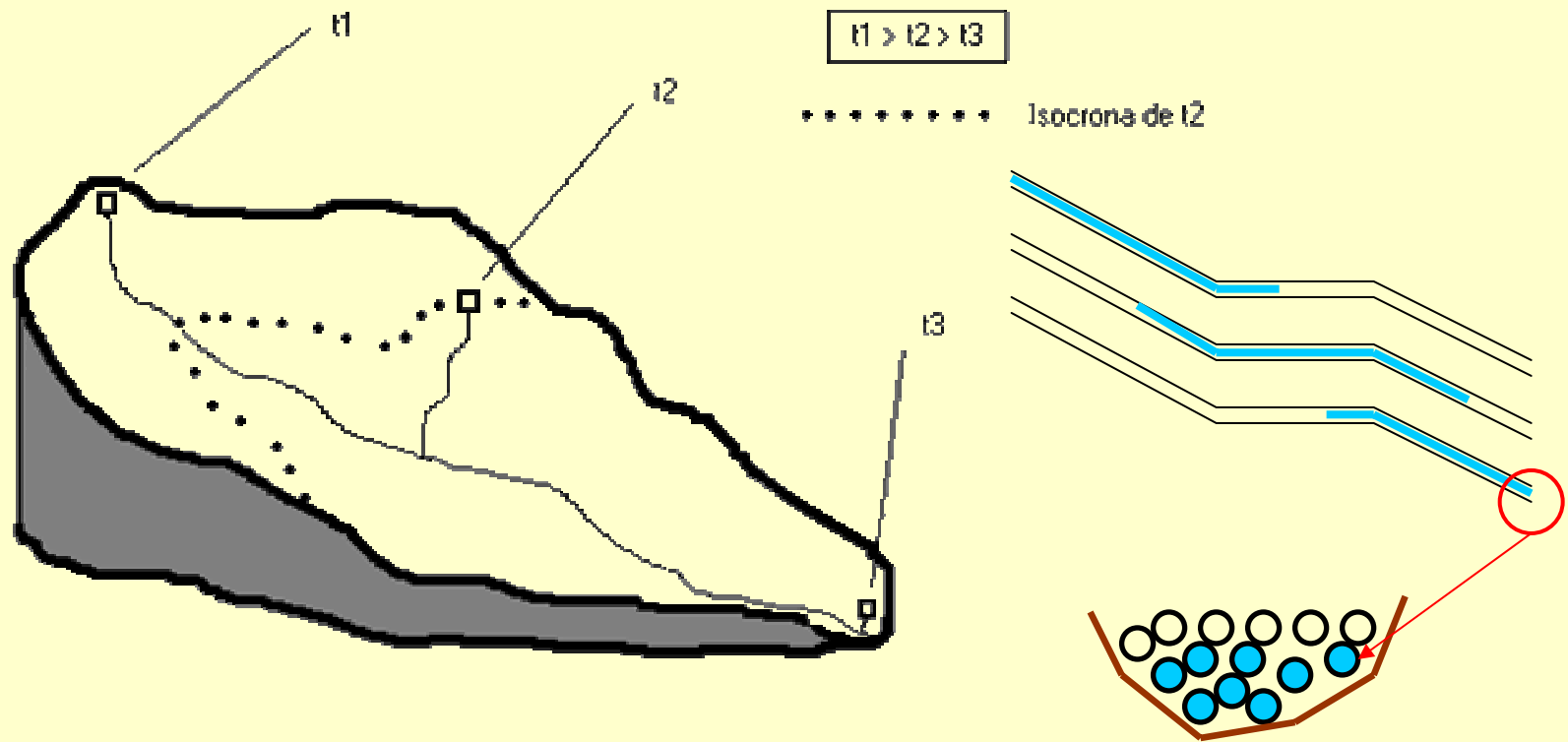
CUENCA
HIDROGRÁFICA



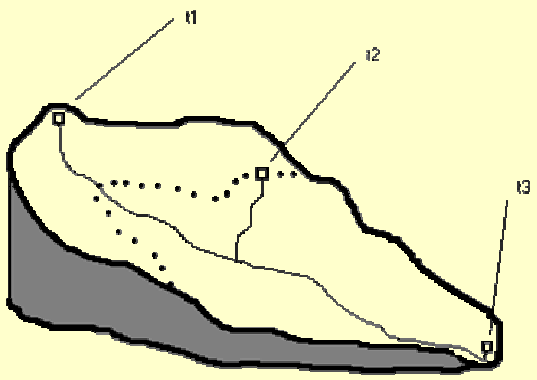
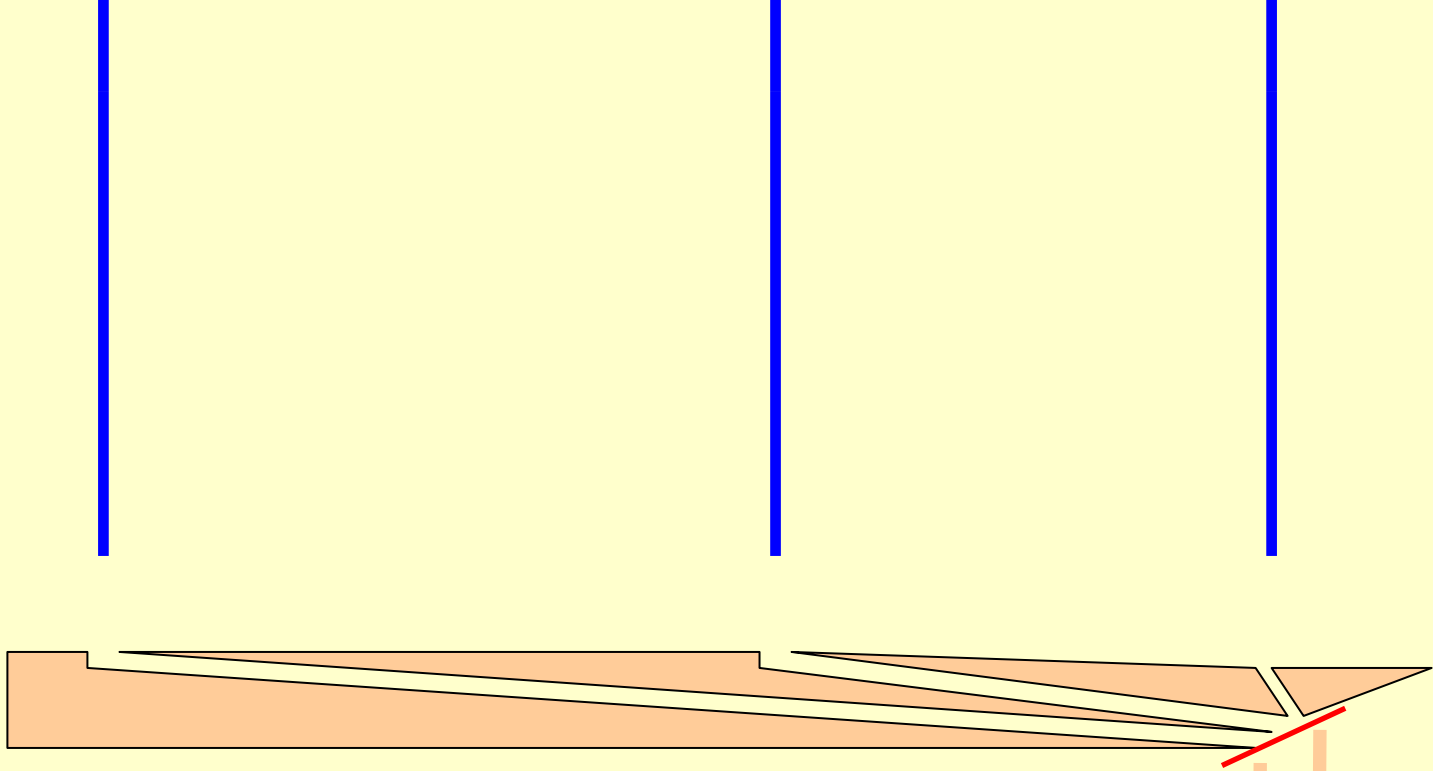
EFFECTOS
SOBRE
ÁREAS
DOMINADAS

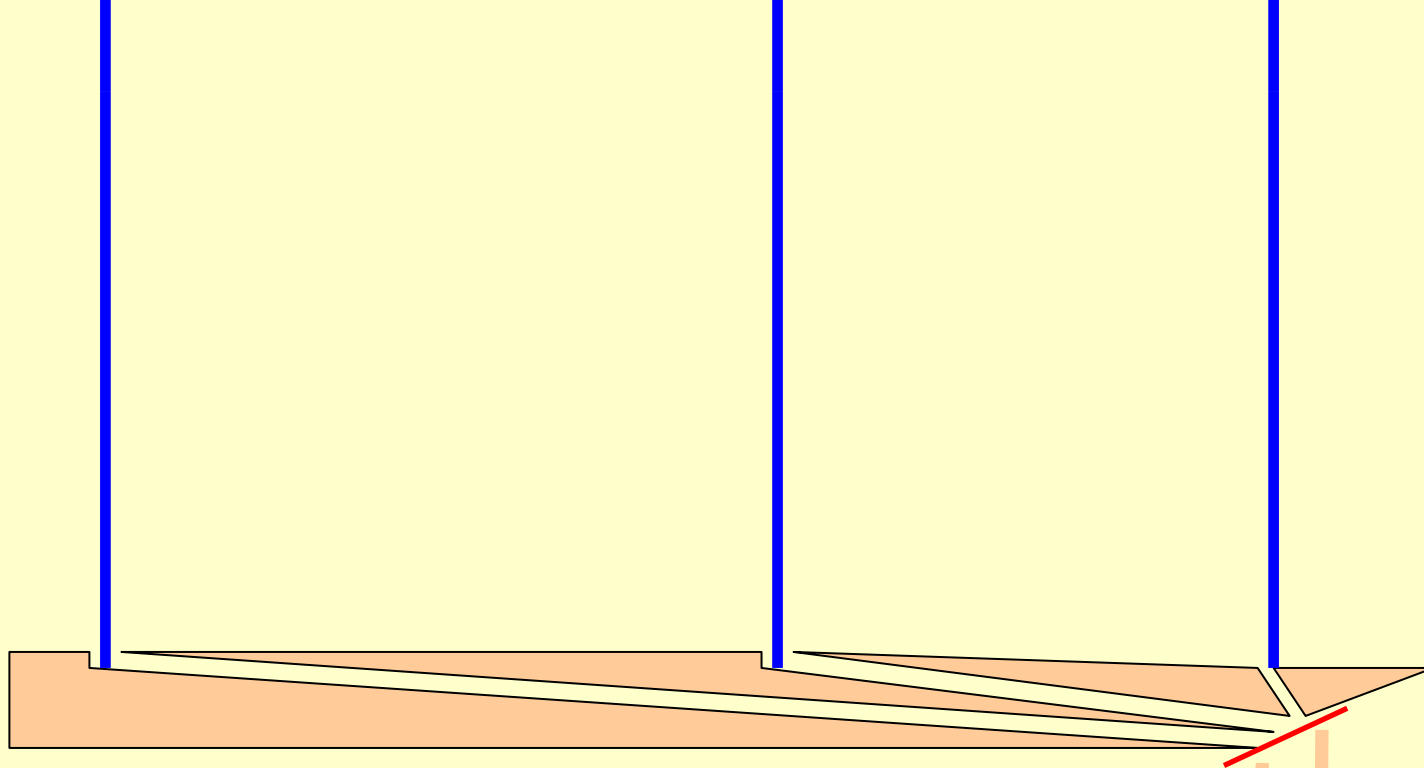


t_c , el mayor tiempo de recorrido de todos los posibles

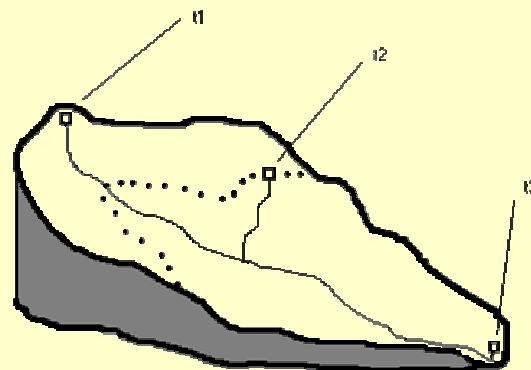


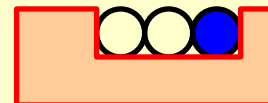
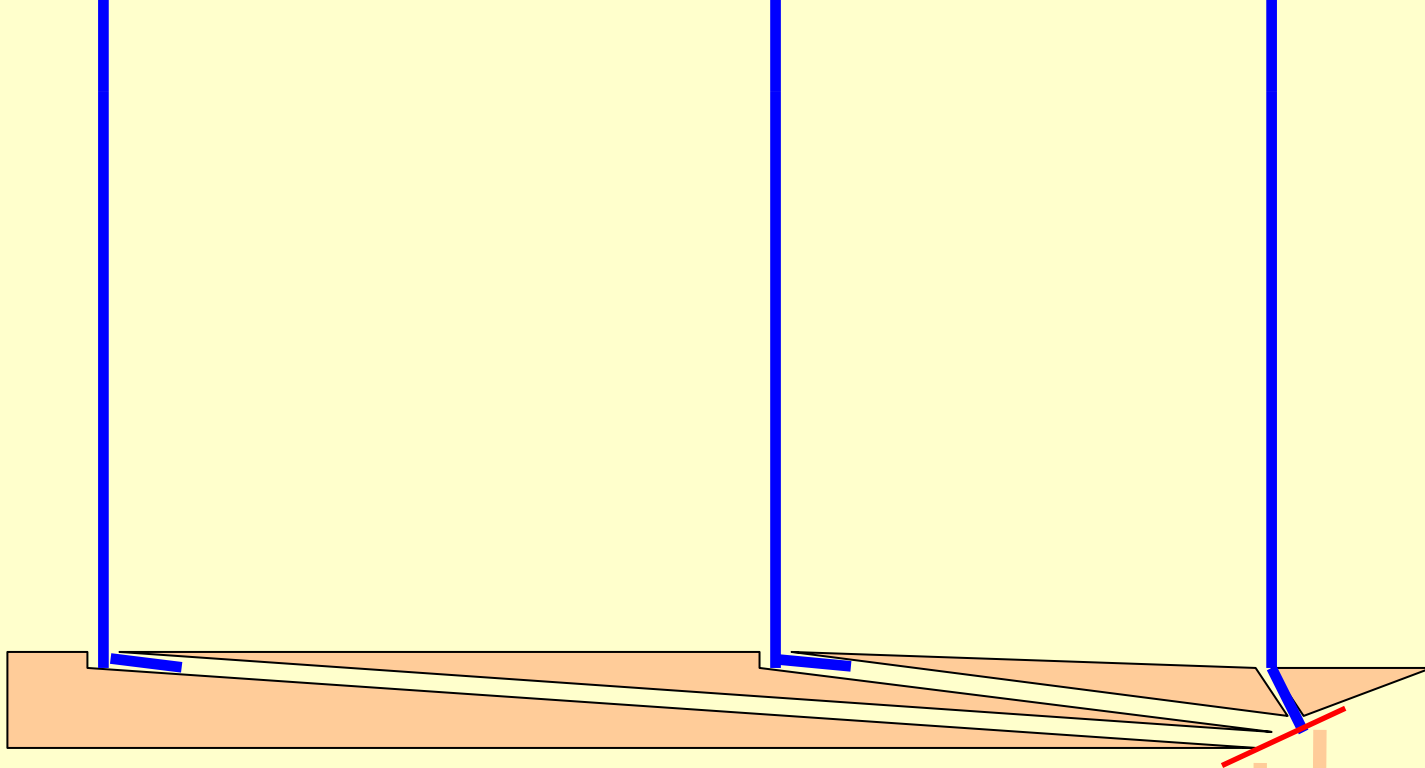
t_c , el mayor tiempo de recorrido de todos los posibles



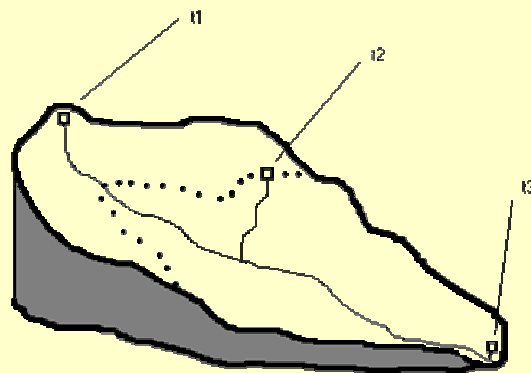


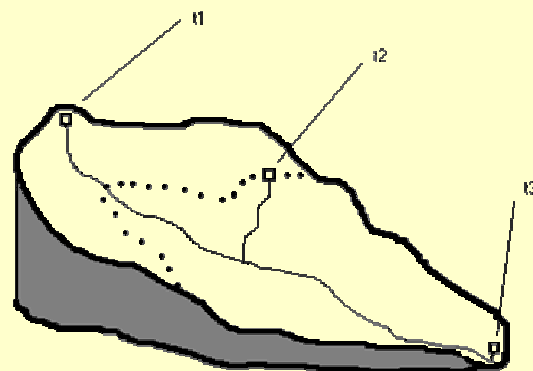
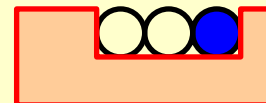
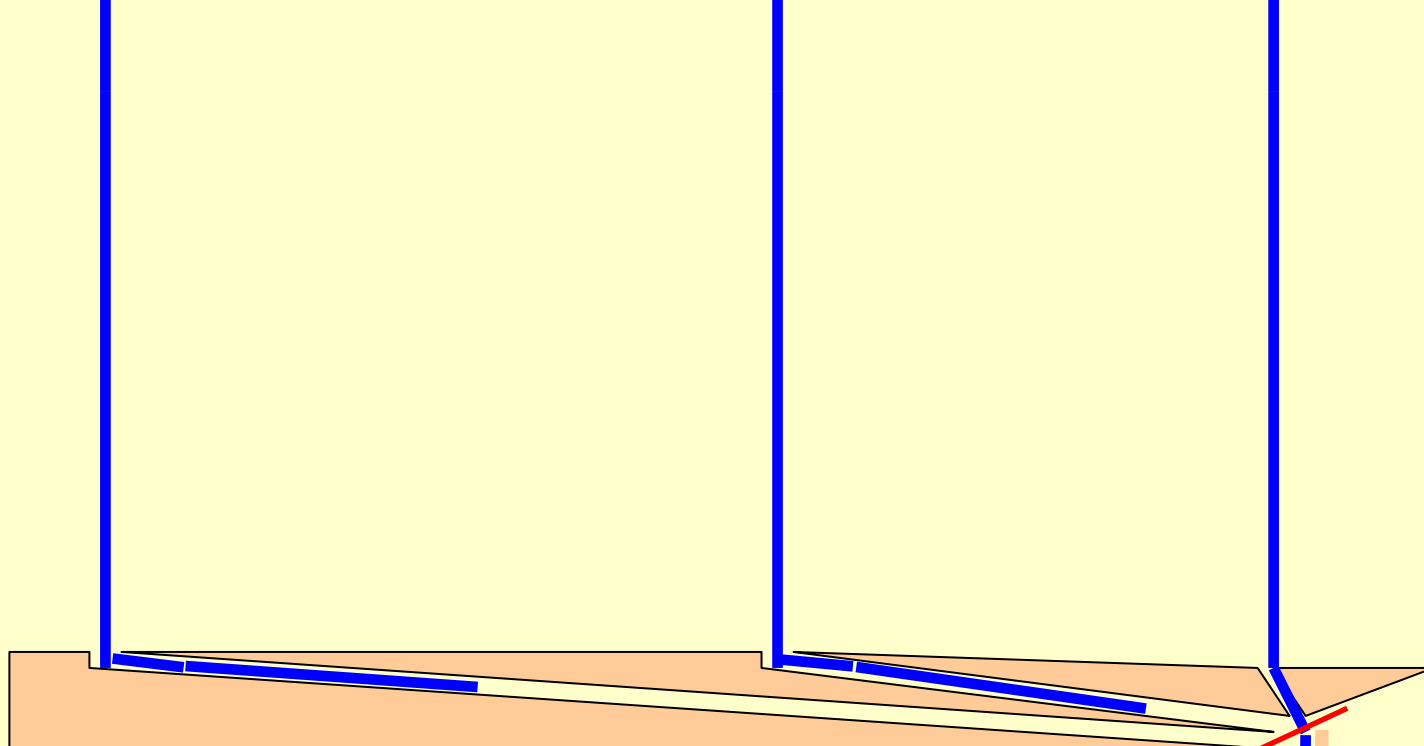
$t = 0$

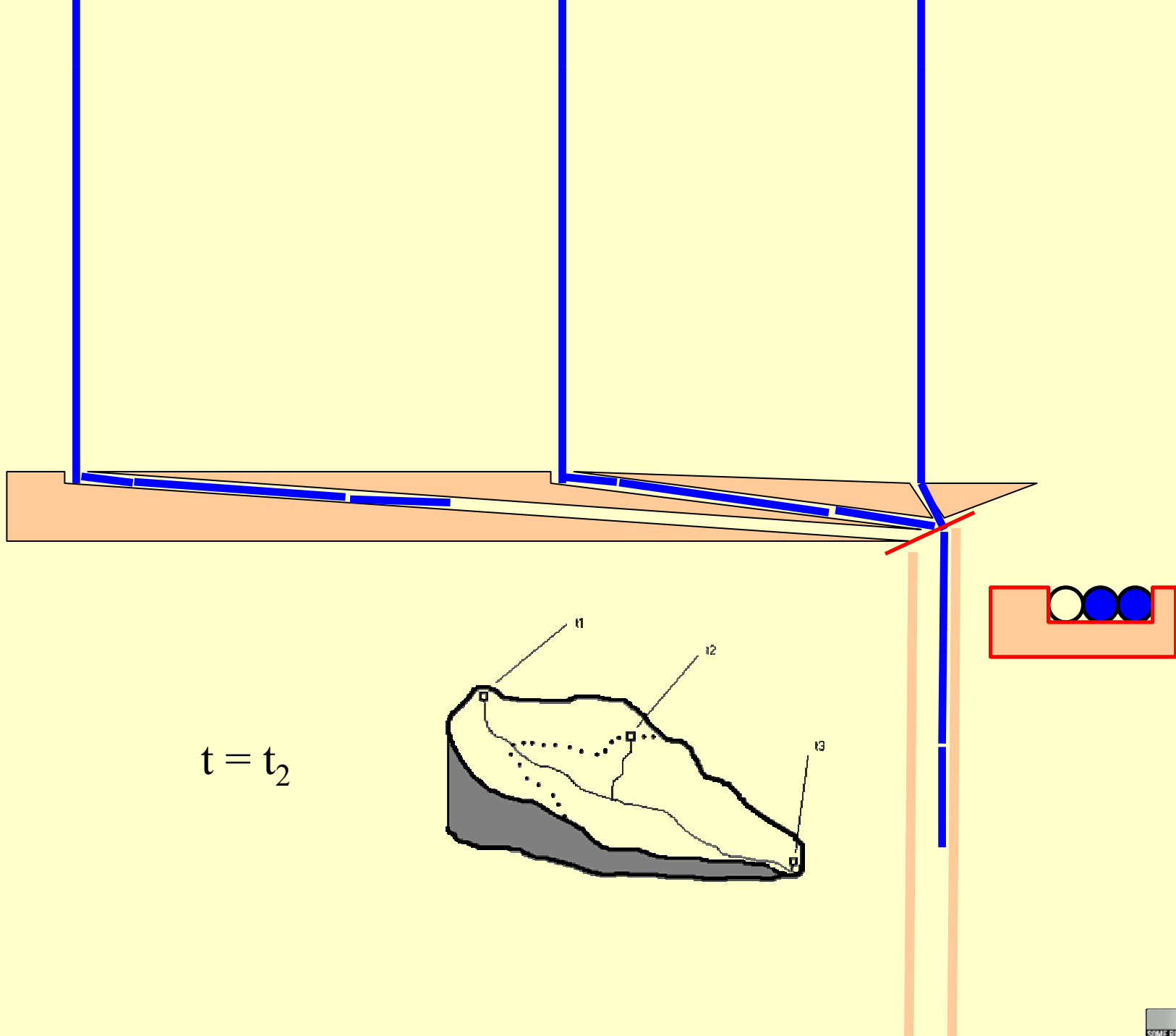




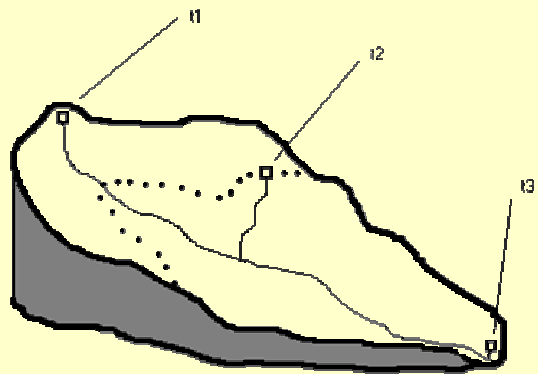
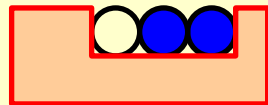
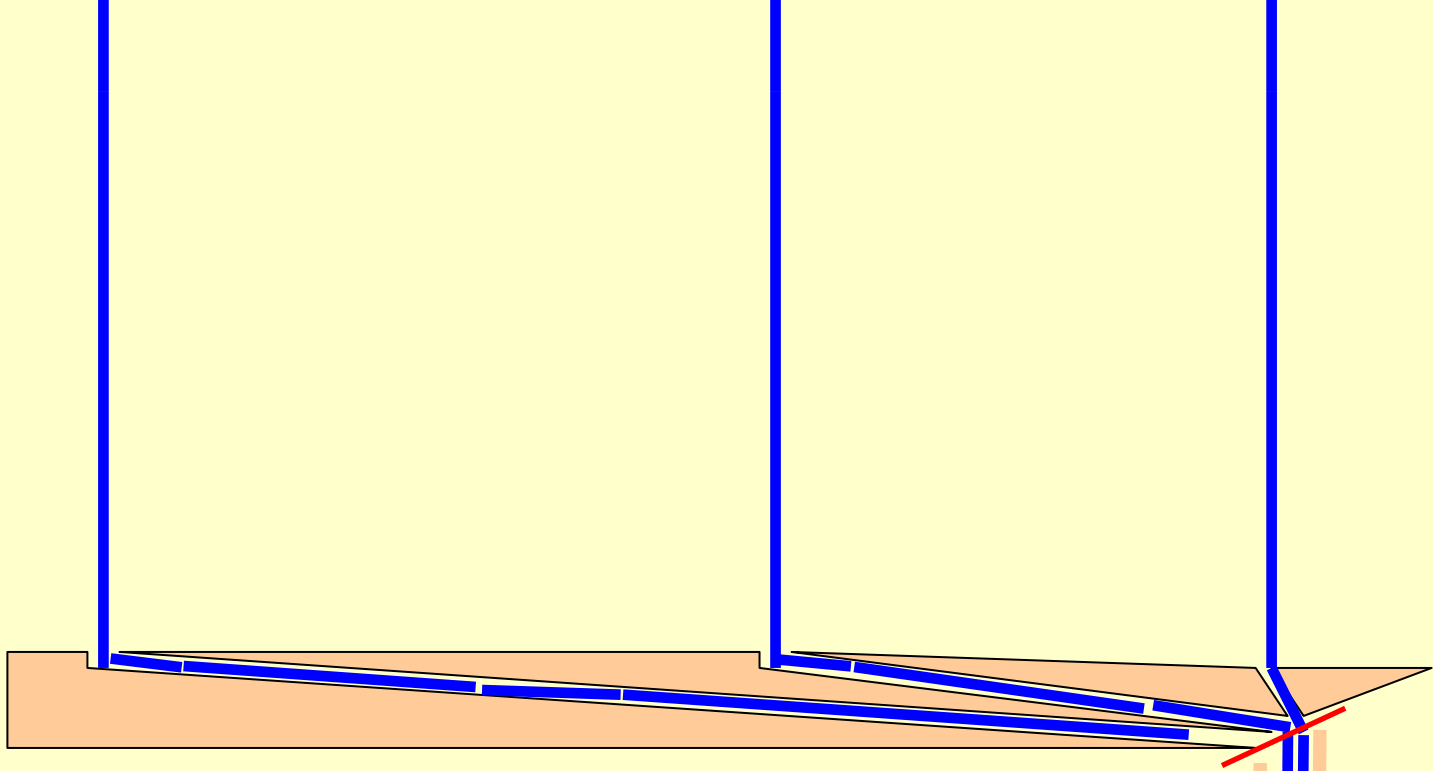
$t = t_3$

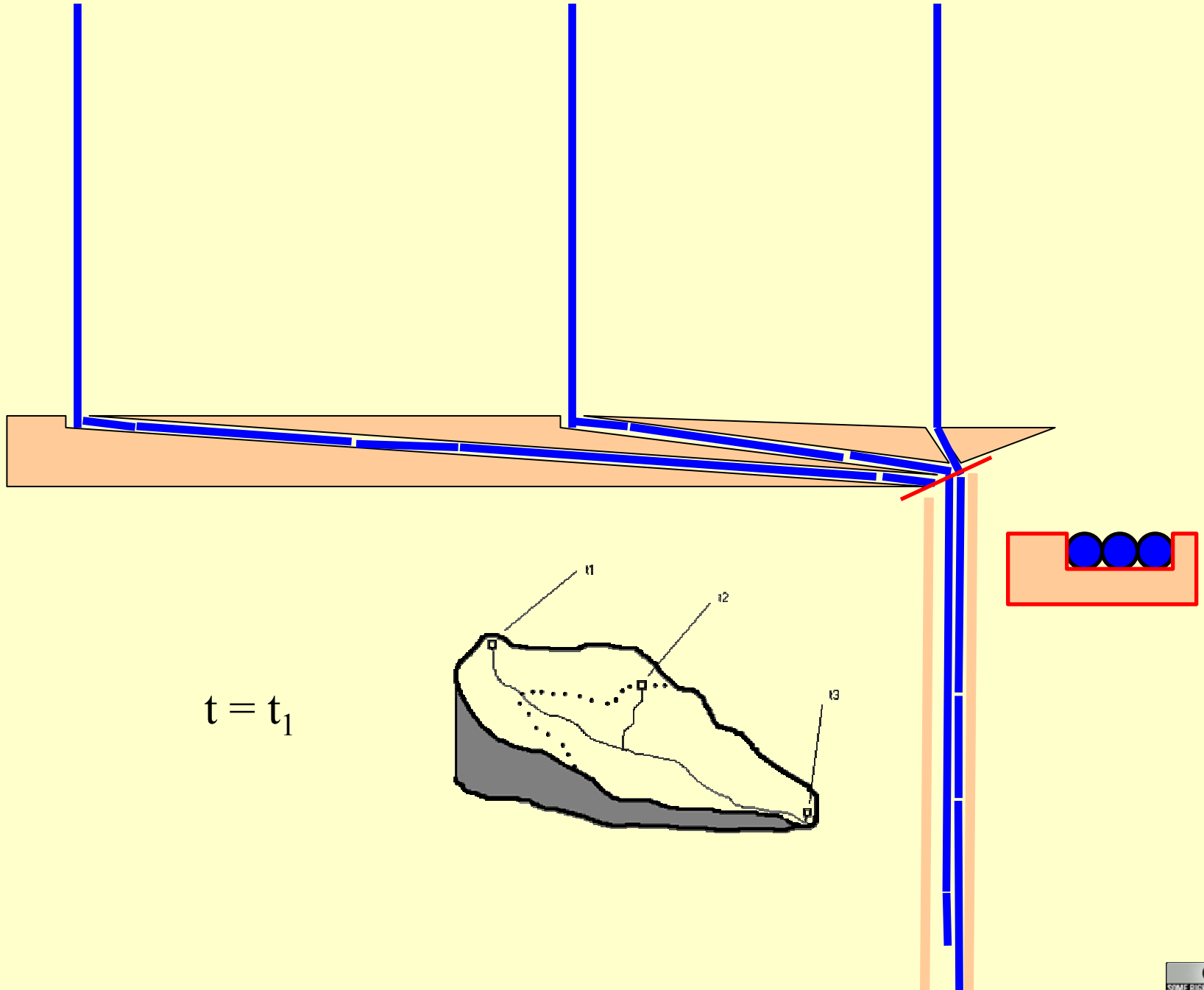




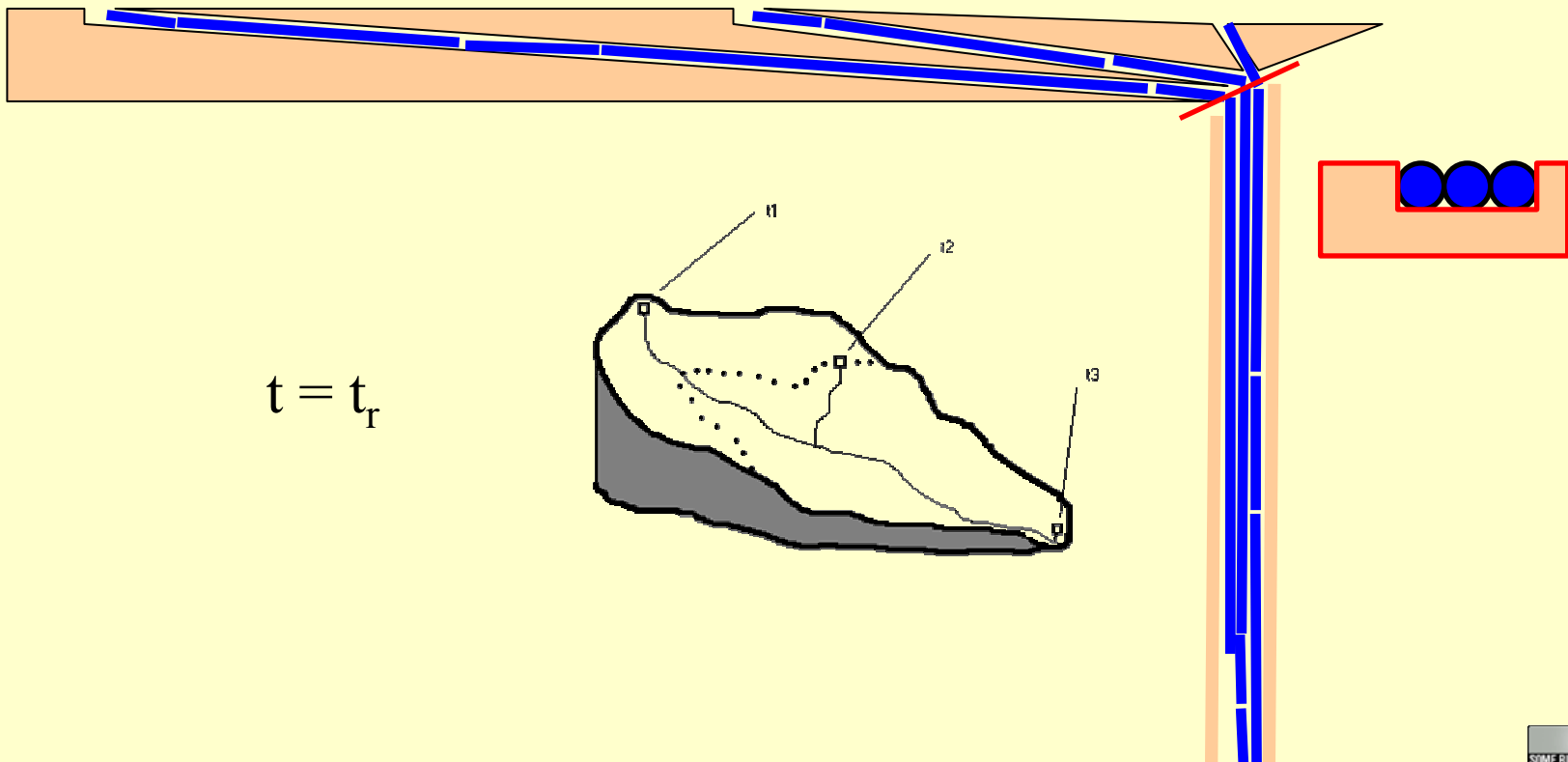


$t = t_2$

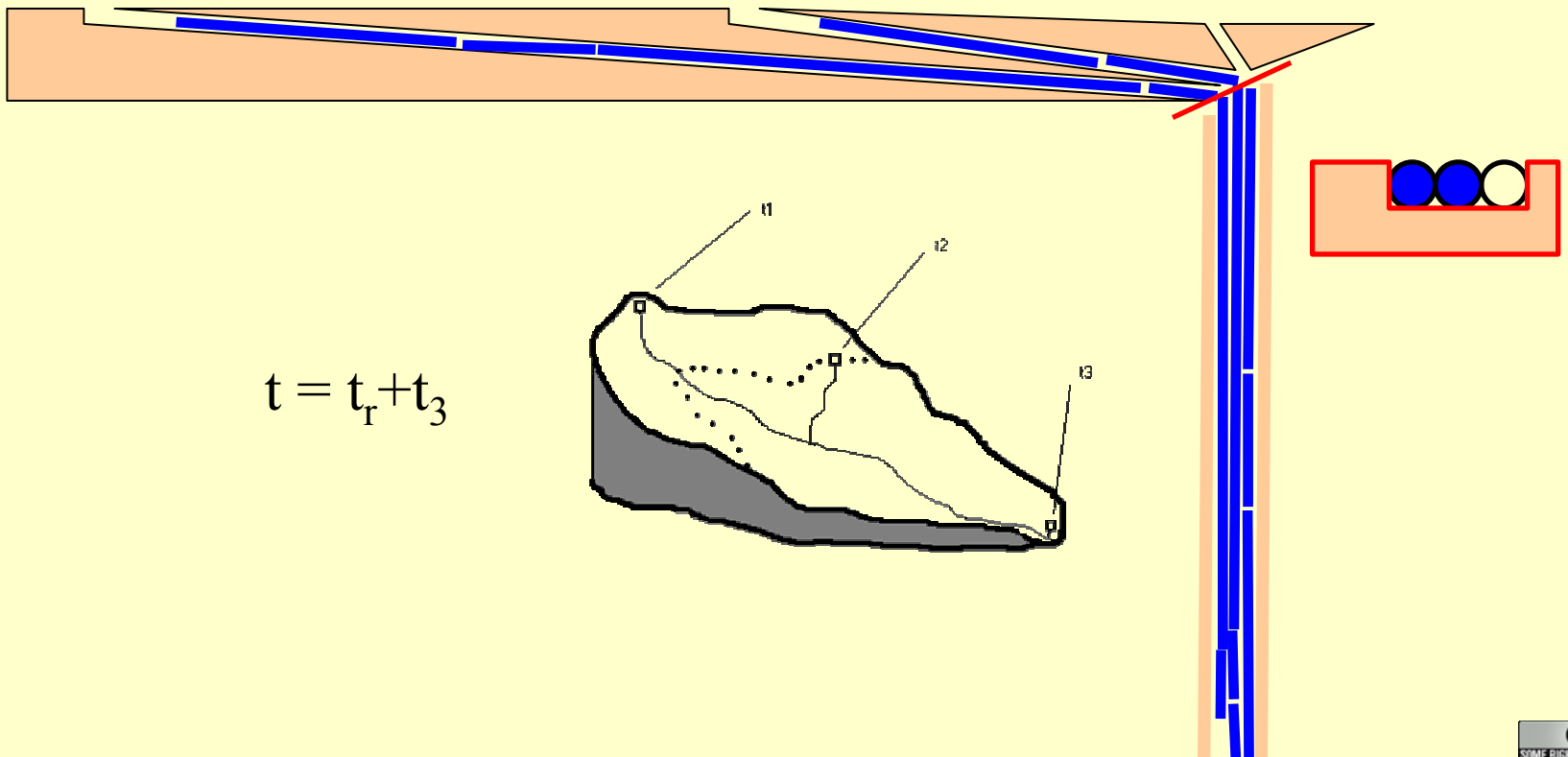




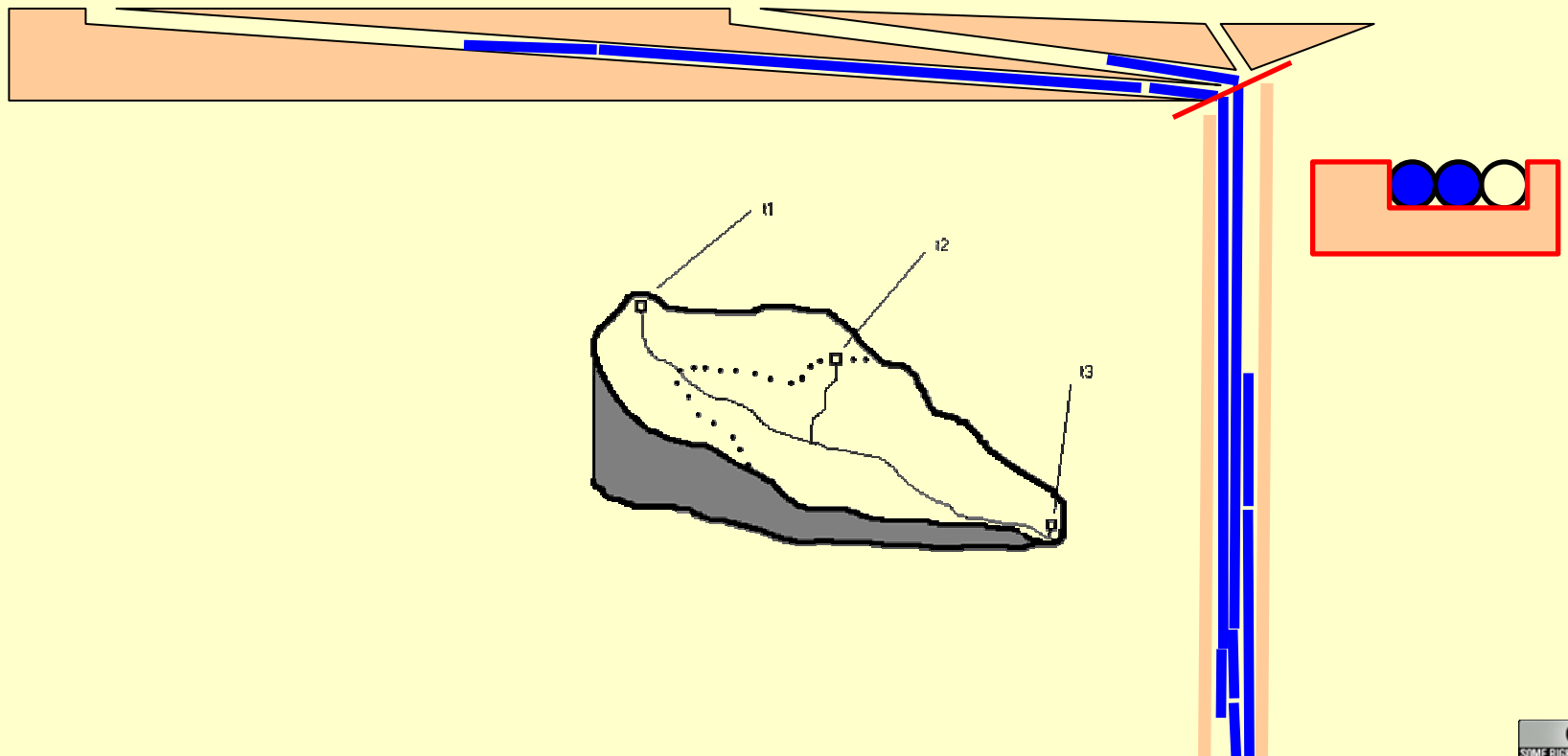
$t = t_1$

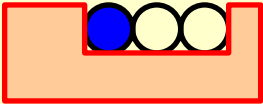
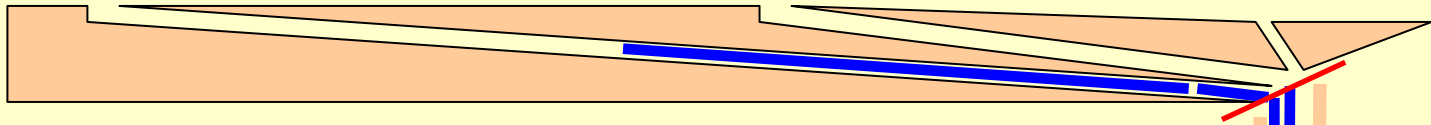


$$t = t_r$$

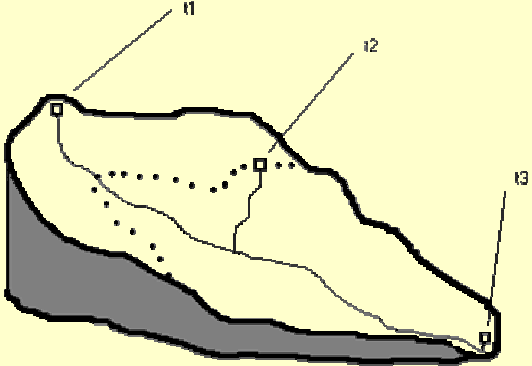


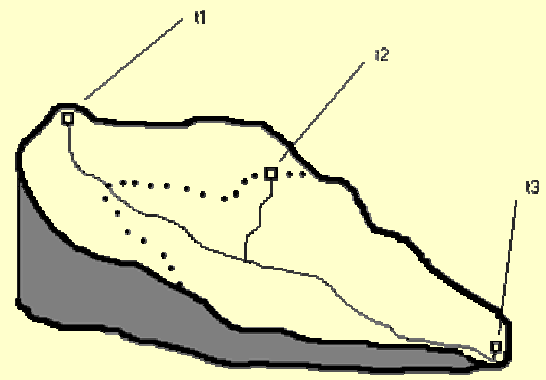
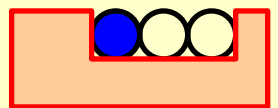
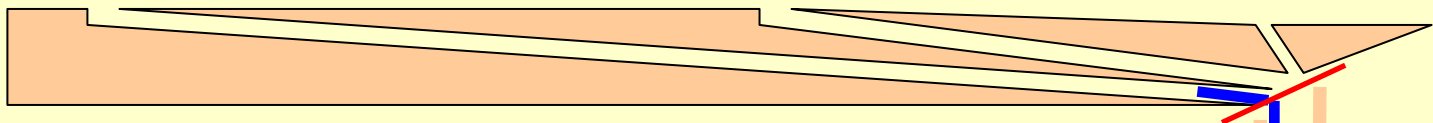
$$t = t_r + t_3$$

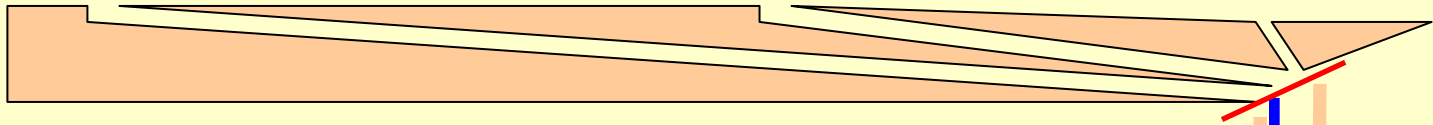




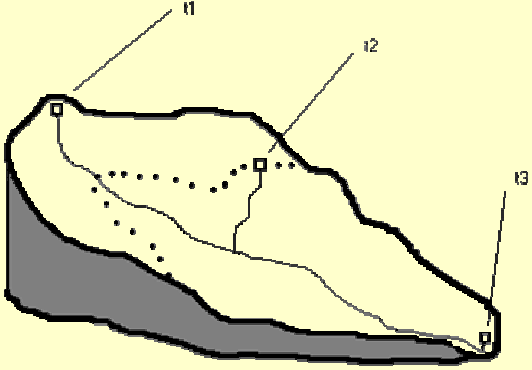
$$t = t_r + t_2$$

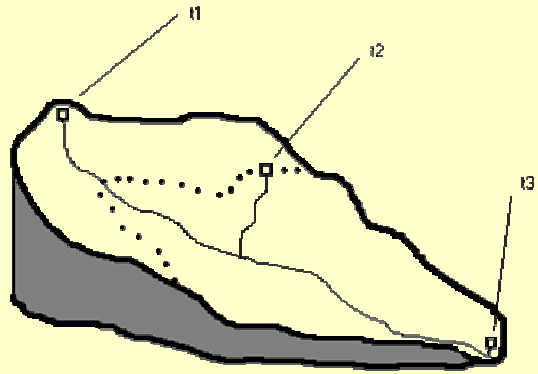
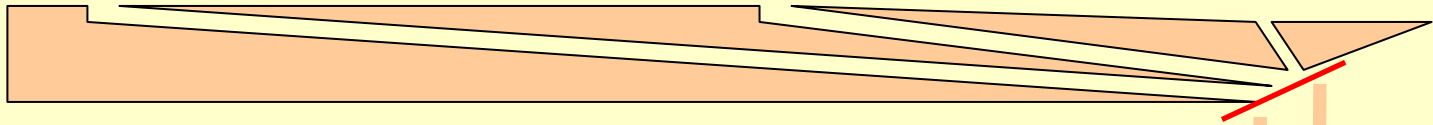


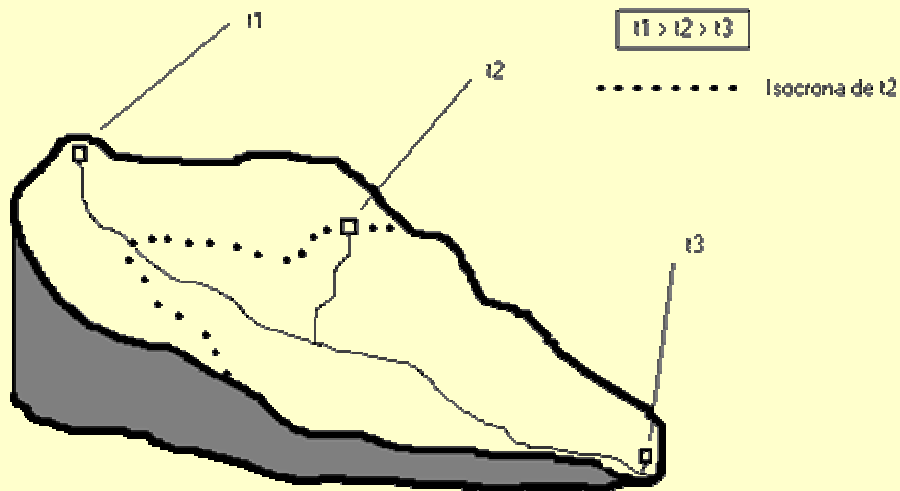




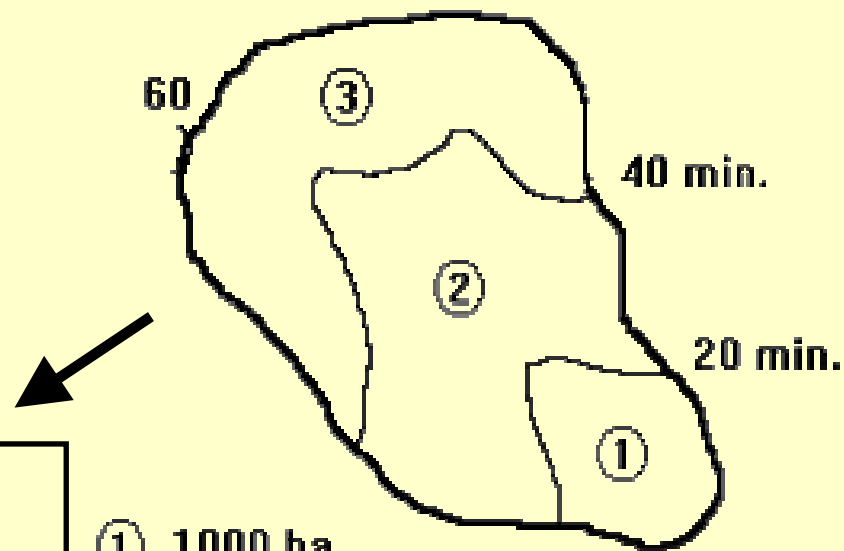
$$t = t_r + t_1$$







t_c , el mayor tiempo de recorrido de todos los posibles

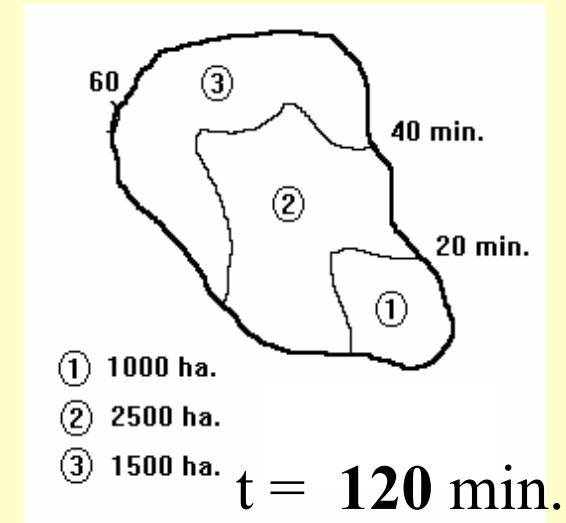
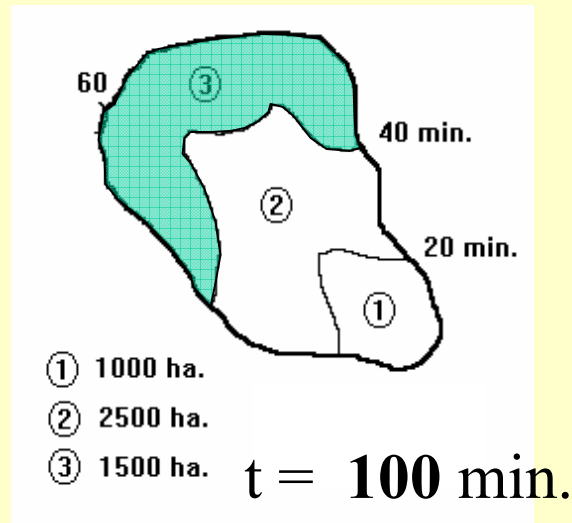
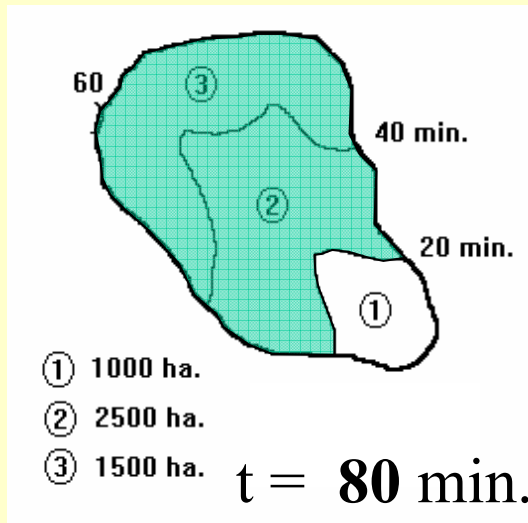
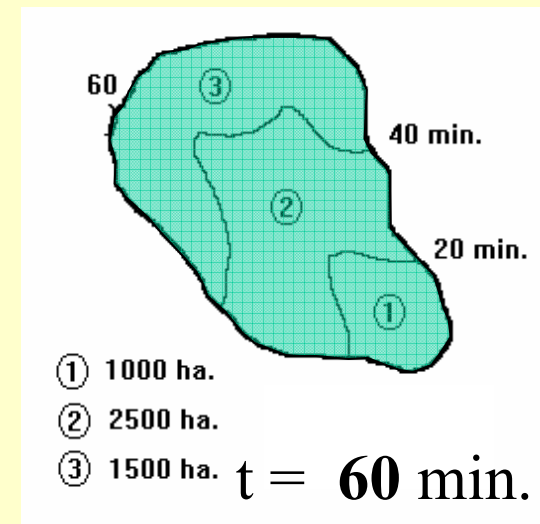
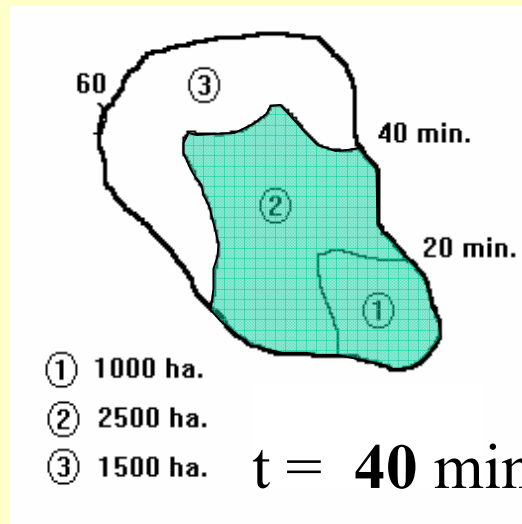
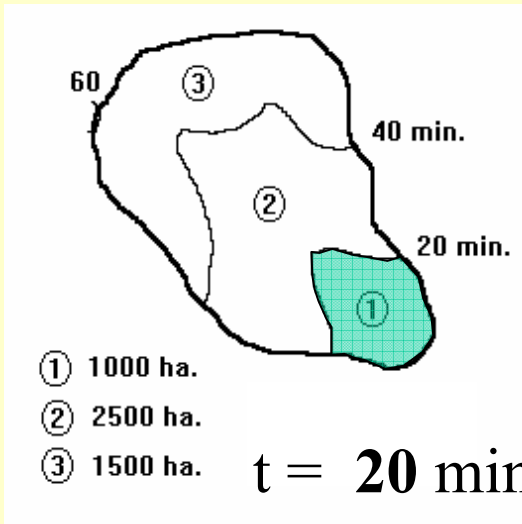


A los 20 min. CAUDAL PROPORCIONAL A 1000 ha.
 A los 40 min CAUDAL PROPORCIONAL A 3500 ha.
 A los 60 min. CAUDAL PROPORCIONAL A 5000 ha.

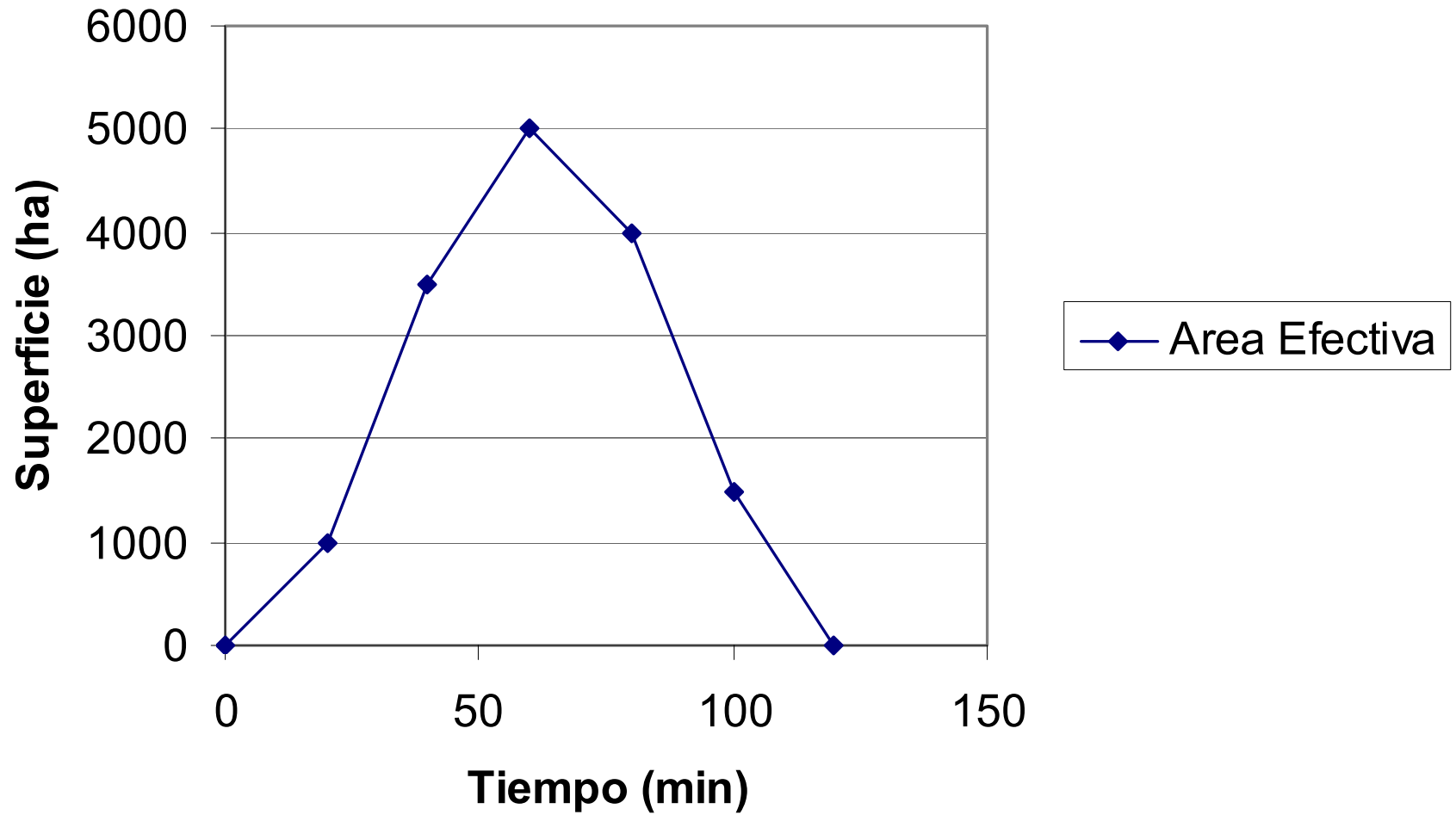
- ① 1000 ha.
- ② 2500 ha.
- ③ 1500 ha.

**Bosque
Suelo grupo C**

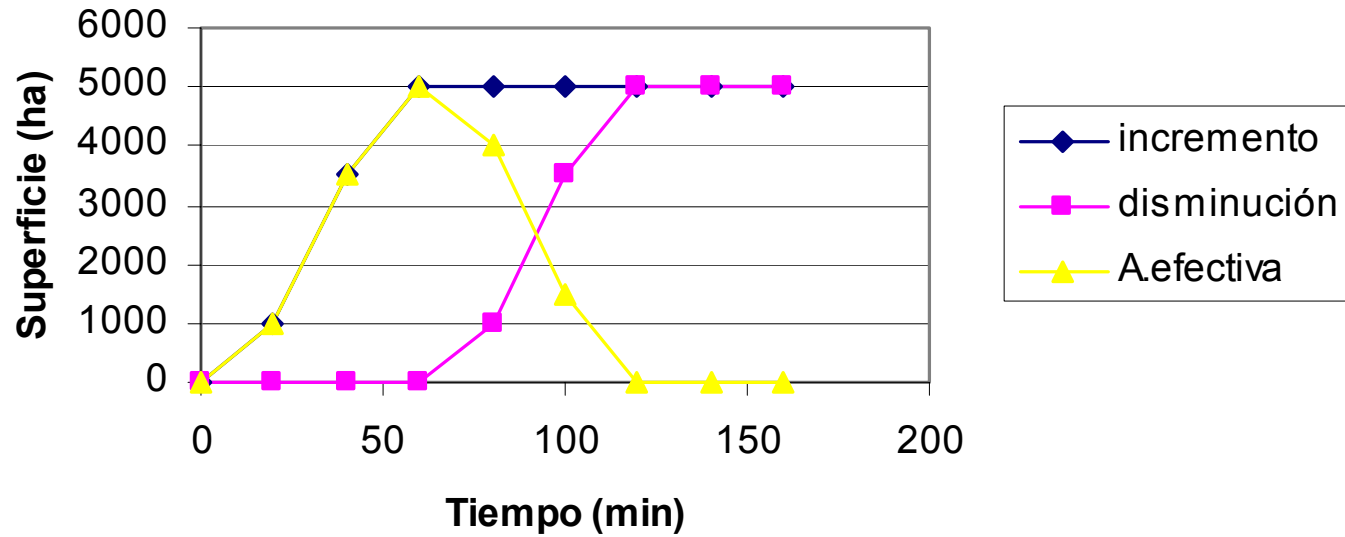
TIEMPO DE LLUVIA DE 60 min.



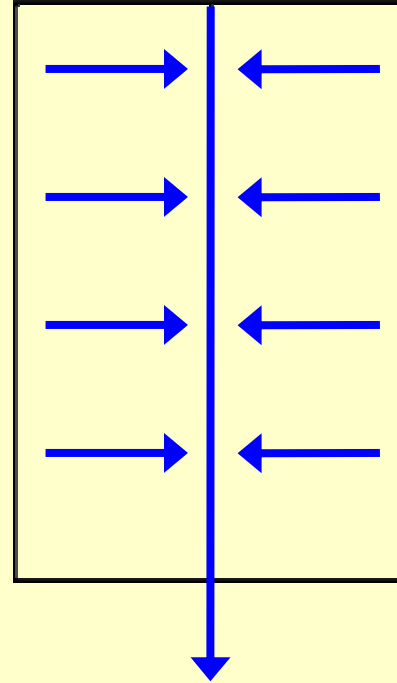
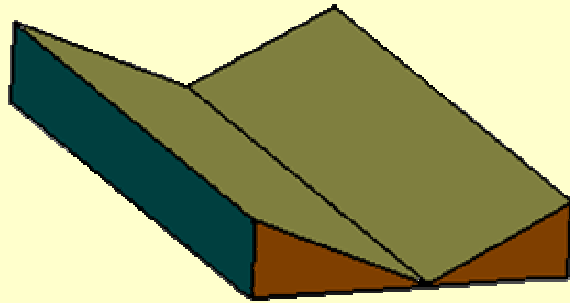
Area Efectiva



Cálculo A efectiva



| min | incremento | disminución | A efectiva |
|-----|------------|-------------|------------|
| 0 | 0 | 0 | 0 |
| 20 | 1000 | 0 | 1000 |
| 40 | 3500 | 0 | 3500 |
| 60 | 5000 | 0 | 5000 |
| 80 | 5000 | 1000 | 4000 |
| 100 | 5000 | 3500 | 1500 |
| 120 | 5000 | 5000 | 0 |
| 140 | 5000 | 5000 | 0 |
| 160 | 5000 | 5000 | 0 |

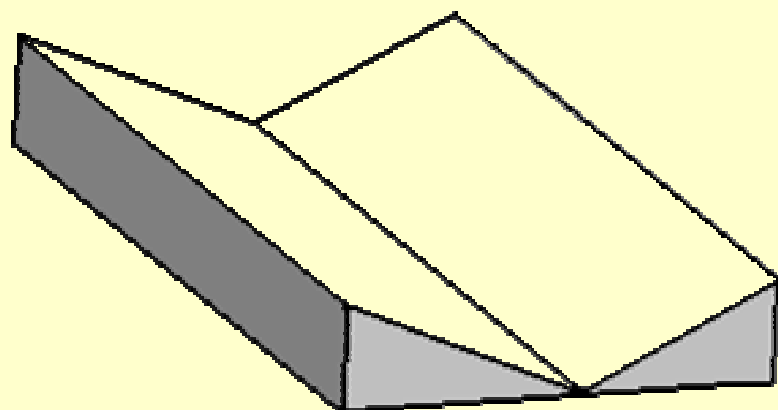
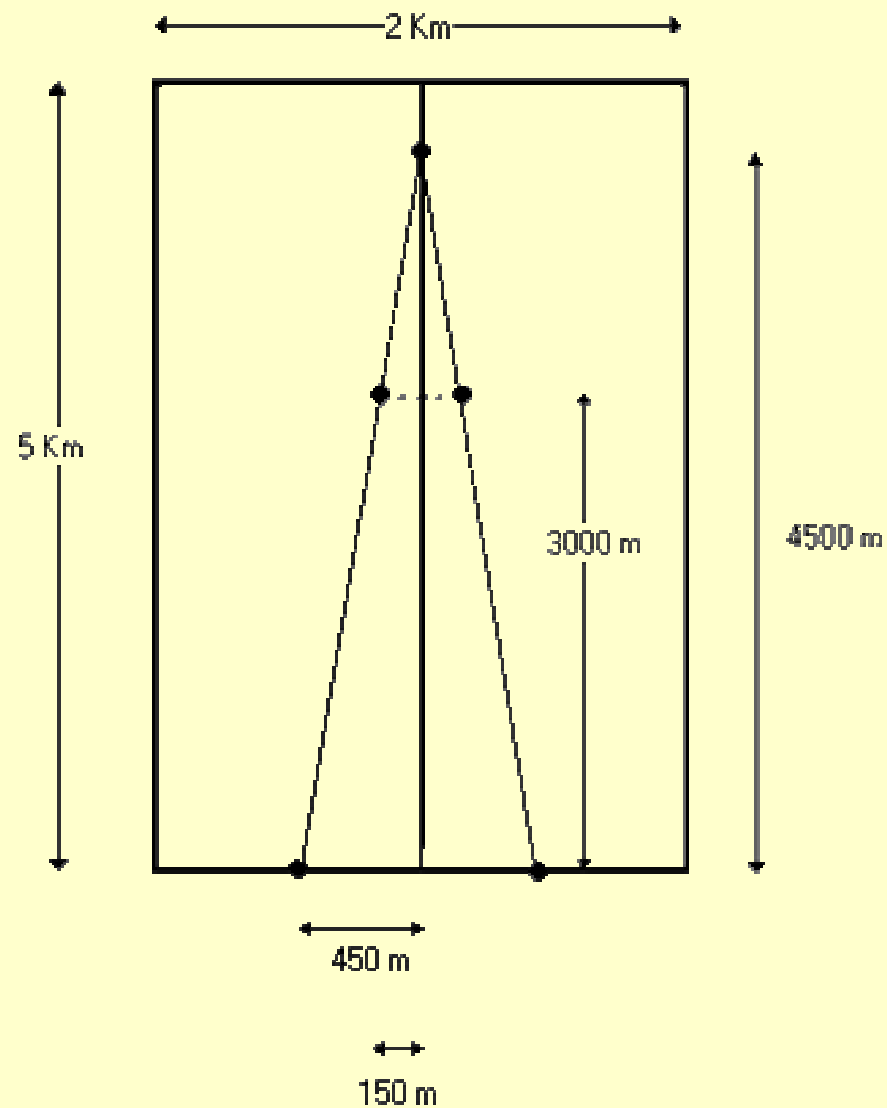


$A = 10 \text{ Km}^2$

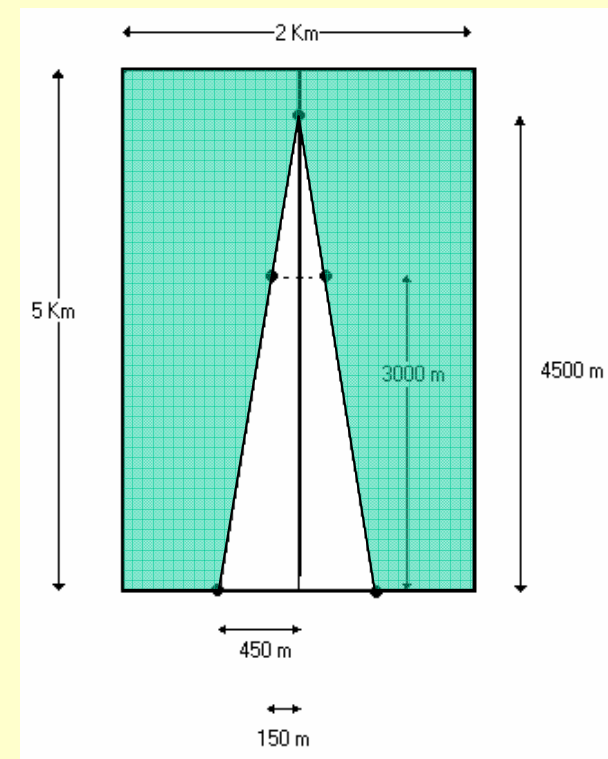
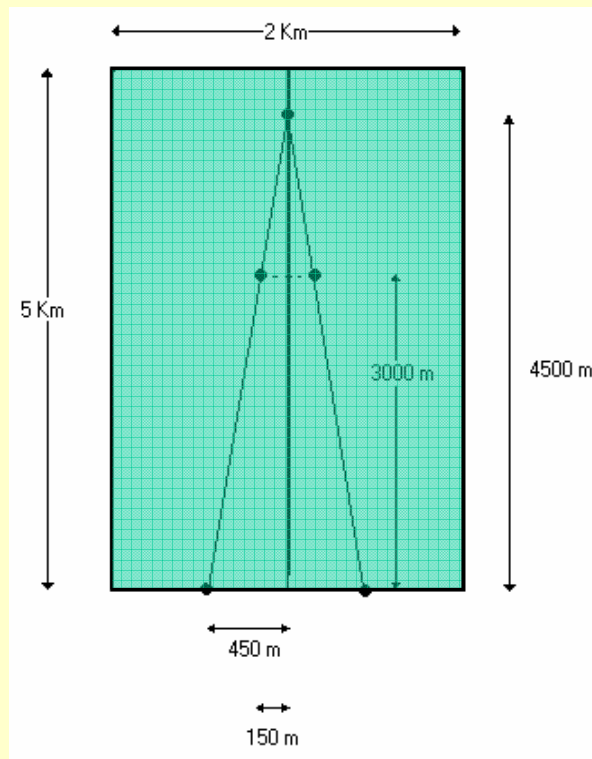
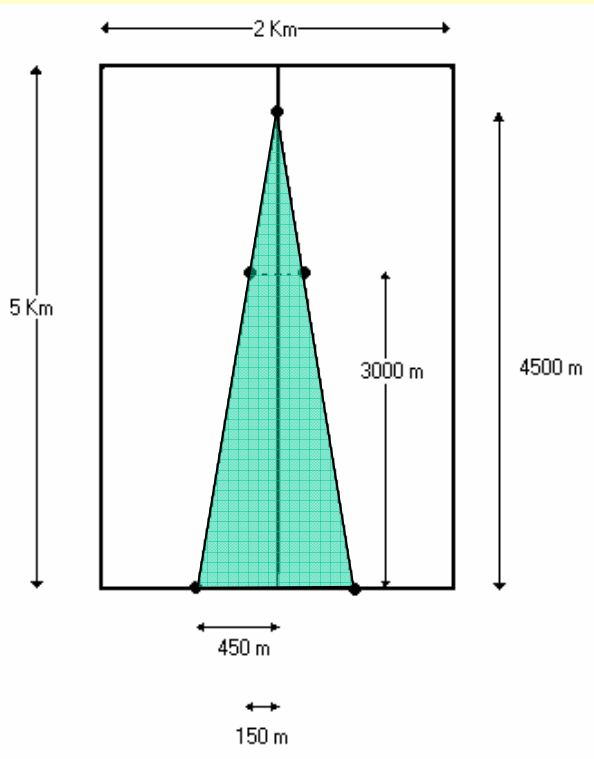
$v_1 \text{ (ladera)} = 0.1 \text{ m/s}$

$v_2 \text{ (cauce)} = 1 \text{ m/s}$

$i = 4 \text{ mm/h}$



TIEMPO DE LLUVIA DE 250 min.



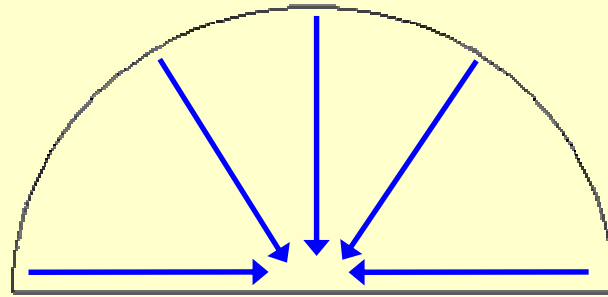
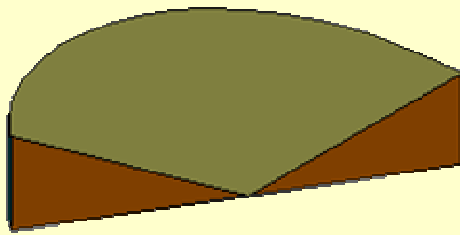
AREA EFECTIVA A LOS:

75 min.

250 min.

325 min.

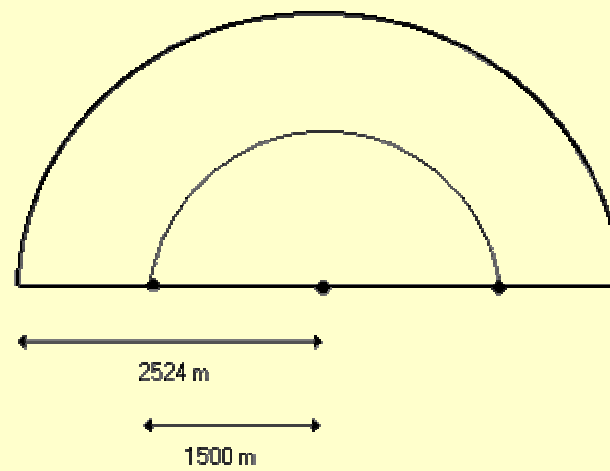
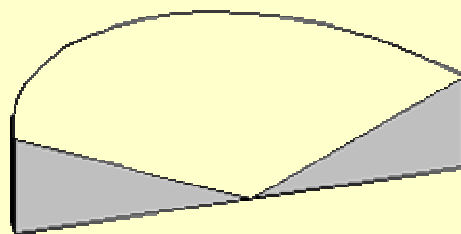
| | | | | |
|-------------------------|-------------|-----------------|--|----------------------|
| Área total | 10 | km ² | | |
| Intensidad | 4 | mm/h | | |
| Vel. Ladera | 0.1 | m/s | | |
| Vel. Cauce | 1 | m/s | | |
| | | | | |
| Tiempo de concentración | | | | caudal |
| | | | | |
| 15000 | segundos | | | Q = I·A / 3.6 |
| 250 | minutos | | | |
| | | | | |
| | tr = 250 | | | |
| tiempo | área | caudal | | |
| 0 | 0.00 | 0.00 | | |
| 75 | 2.03 | 2.25 | | |
| 250 | 10.00 | 11.11 | | |
| 325 | 7.98 | 8.86 | | |
| 500 | 0.00 | 0.00 | | |
| 670 | 0.00 | 0.00 | | |
| 840 | 0.00 | 0.00 | | |
| | | | | |



$A = 10 \text{ Km}^2$

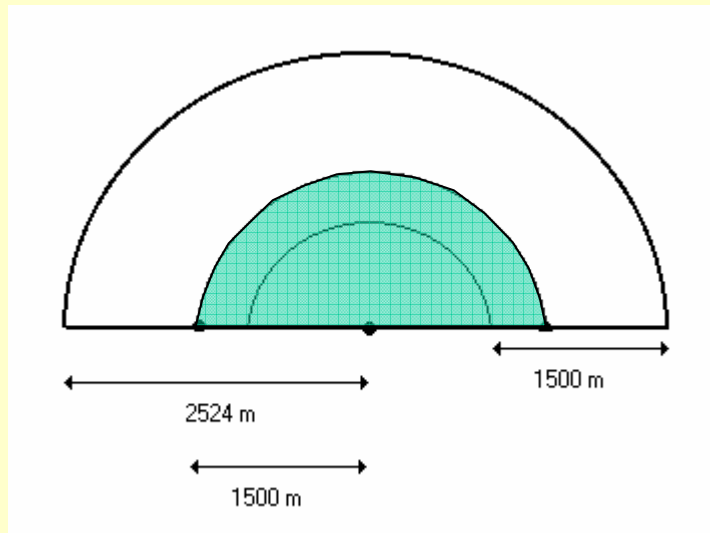
$v_1 \text{ (ladera)} = 0.1 \text{ m/s}$

$i = 4 \text{ mm/h}$

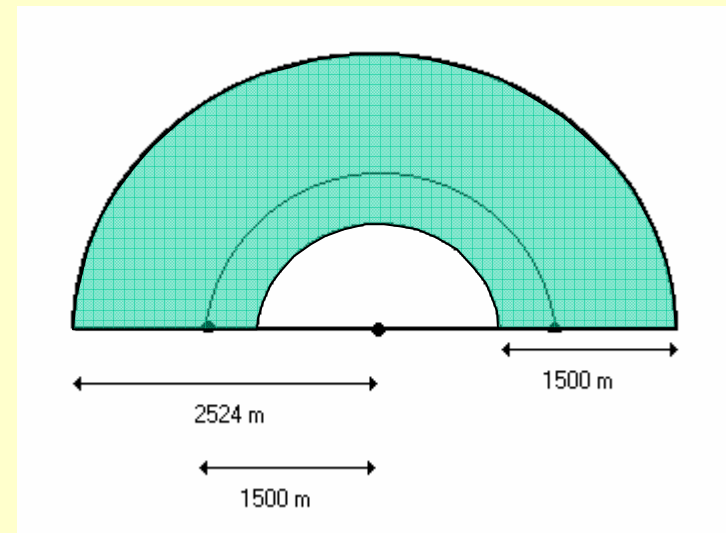


| | | | | | | |
|-------------------------|-------------|-----------------|-------------|----------------------|-----------------|--|
| Área total | 10 | km ² | | | | |
| Intensidad | 4 | mm/h | | | | |
| Vel. Ladera | 0.1 | m/s | | | | |
| | | | | | | |
| Tiempo de concentración | | | | caudal | | |
| | | | | | | |
| 25240 | segundos | | | Q = I·A / 3.6 | | |
| 420 | minutos | | | | | |
| | | | | | | |
| | | | | | | |
| | tr = 420 | | tr = 250 | | | |
| tiempo | área | caudal | área | caudal | | |
| 0 | 0.00 | 0.00 | 0.00 | 0.00 | | |
| 250 | 3.53 | 3.92 | 3.53 | 3.92 | radio de 1500 m | |
| 420 | 10.00 | 11.11 | 8.37 | 9.30 | | |
| 500 | 9.64 | 10.71 | 6.47 | 7.19 | | |
| 670 | 6.47 | 7.18 | 0.00 | 0.00 | | |
| 840 | 0.00 | 0.00 | 0.00 | 0.00 | | |

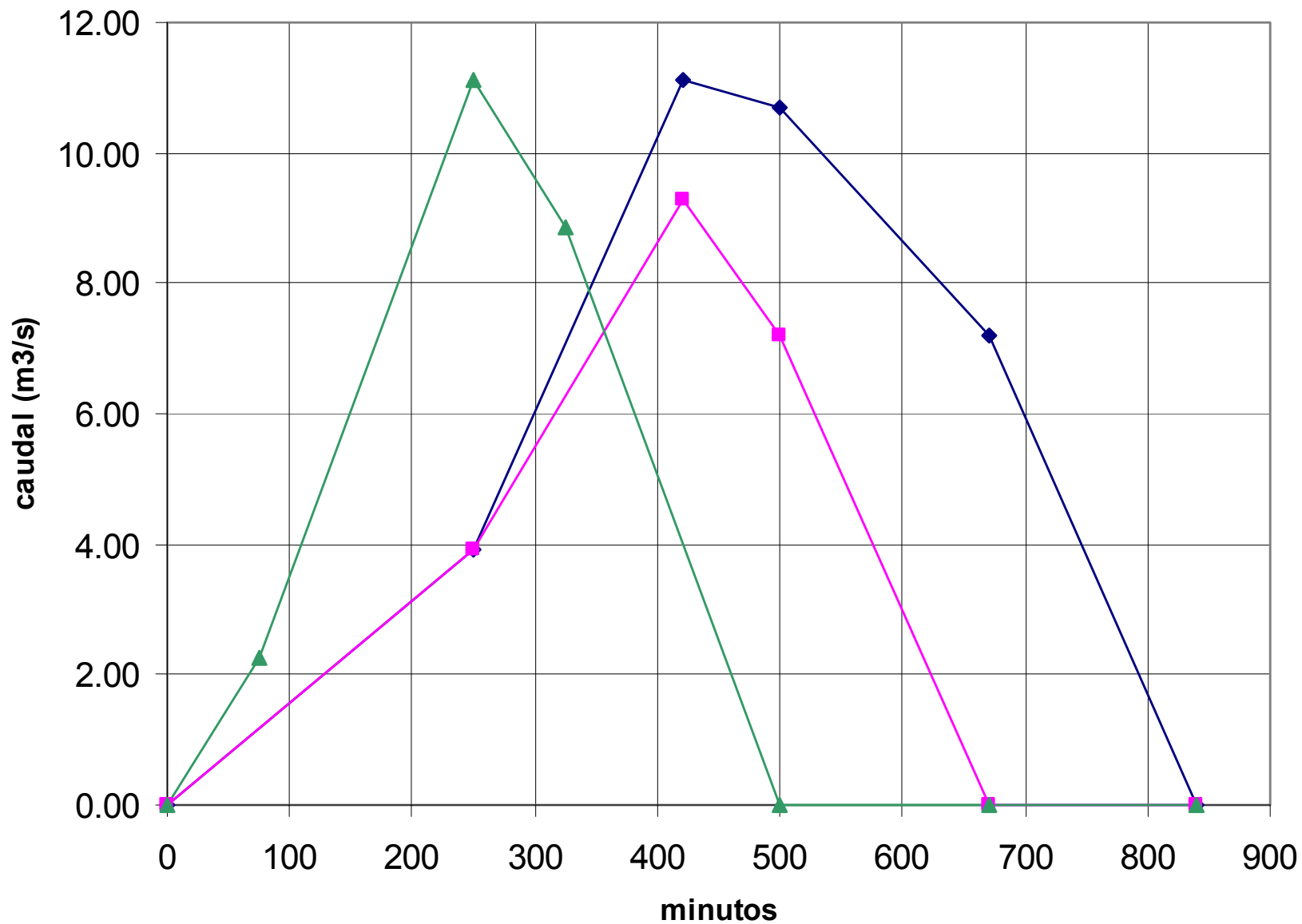
TIEMPO DE LLUVIA DE 250 min.



AREA EFECTIVA A
LOS **250** min.



AREA EFECTIVA A
LOS **420** min.

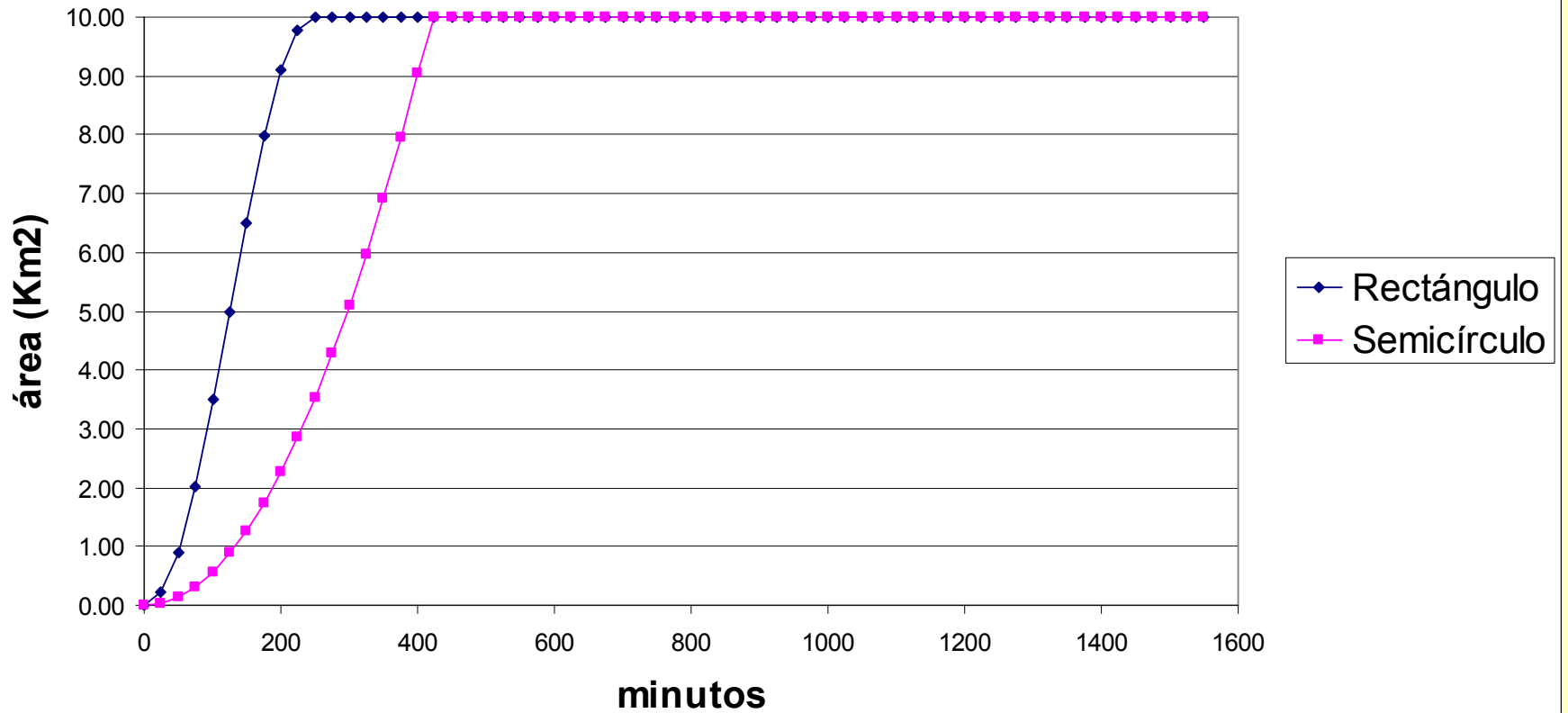


—◆— Circul. Tr=420

—■— Circul. Tr=250

—▲— Rectángulo

Incremento del área efectiva



LLUVIA 100 min.

RECTANGULO

L.máx. 5000 m **INTENSIDAD** 4 mm/h
L.min. 2000 m **VEL. LADERA** 0.1 m/s
Area 10 Km2 **VEL. CAUCE** 1 m/s
 INCREM.TIEM. 25 min.
tc 15000 s
tc 250 min.

SEMICIRCULAR

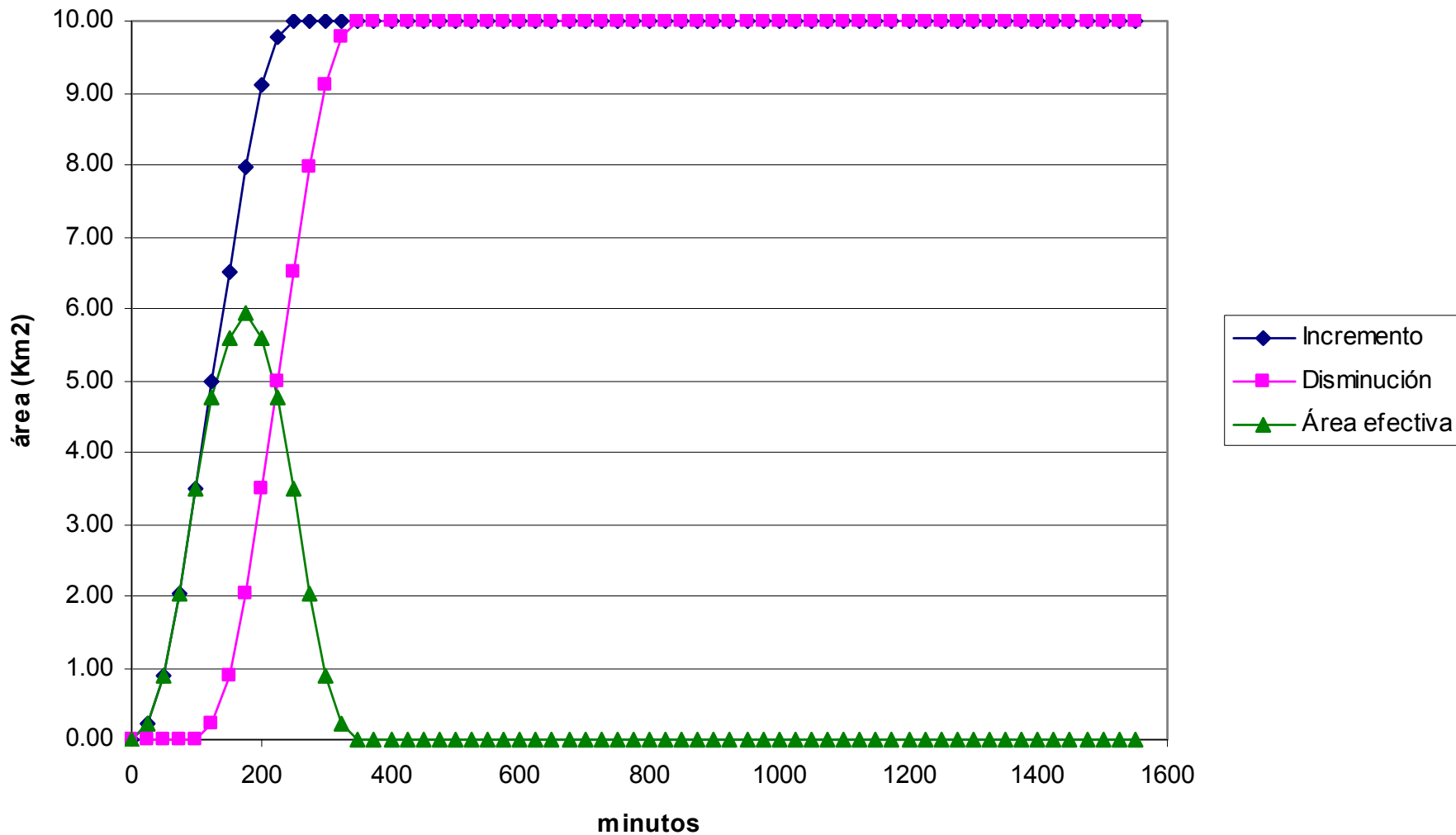
AREA 10 Km2
RADIO 2523.13 m
VEL. LADERA 0.1 m/s
tc 25231.33 s
tc 420.52 min.

TIEMPO

| min. | seg. | lon.cau. | lon.lad. | inc.área | dis.área | área ef. | caudal | lon.lad. | inc.área | dis.área | área ef. | caudal |
|------|-------|----------|----------|----------|----------|----------|--------|----------|----------|----------|----------|--------|
| 0 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| 25 | 1500 | 1500 | 150 | 0.23 | 0.00 | 0.23 | 0.25 | 150 | 0.04 | 0.00 | 0.04 | 0.04 |
| 50 | 3000 | 3000 | 300 | 0.90 | 0.00 | 0.90 | 1.00 | 300 | 0.14 | 0.00 | 0.14 | 0.16 |
| 75 | 4500 | 4500 | 450 | 2.03 | 0.00 | 2.03 | 2.25 | 450 | 0.32 | 0.00 | 0.32 | 0.35 |
| 100 | 6000 | 6000 | 600 | 3.50 | 0.00 | 3.50 | 3.89 | 600 | 0.57 | 0.00 | 0.57 | 0.63 |
| 125 | 7500 | 7500 | 750 | 5.00 | 0.23 | 4.78 | 5.31 | 750 | 0.88 | 0.04 | 0.85 | 0.94 |
| 150 | 9000 | 9000 | 900 | 6.50 | 0.90 | 5.60 | 6.22 | 900 | 1.27 | 0.14 | 1.13 | 1.26 |
| 175 | 10500 | 10500 | 1050 | 7.98 | 2.03 | 5.95 | 6.61 | 1050 | 1.73 | 0.32 | 1.41 | 1.57 |
| 200 | 12000 | 12000 | 1200 | 9.10 | 3.50 | 5.60 | 6.22 | 1200 | 2.26 | 0.57 | 1.70 | 1.88 |
| 225 | 13500 | 13500 | 1350 | 9.78 | 5.00 | 4.78 | 5.31 | 1350 | 2.86 | 0.88 | 1.98 | 2.20 |
| 250 | 15000 | 15000 | 1500 | 10.00 | 6.50 | 3.50 | 3.89 | 1500 | 3.53 | 1.27 | 2.26 | 2.51 |
| 275 | 16500 | 16500 | 1650 | 10.00 | 7.98 | 2.03 | 2.25 | 1650 | 4.28 | 1.73 | 2.54 | 2.83 |
| 300 | 18000 | 18000 | 1800 | 10.00 | 9.10 | 0.90 | 1.00 | 1800 | 5.09 | 2.26 | 2.83 | 3.14 |
| 325 | 19500 | 19500 | 1950 | 10.00 | 9.78 | 0.23 | 0.25 | 1950 | 5.97 | 2.86 | 3.11 | 3.46 |
| 350 | 21000 | 21000 | 2100 | 10.00 | 10.00 | 0.00 | 0.00 | 2100 | 6.93 | 3.53 | 3.39 | 3.77 |
| 375 | 22500 | 22500 | 2250 | 10.00 | 10.00 | 0.00 | 0.00 | 2250 | 7.95 | 4.28 | 3.68 | 4.08 |
| 400 | 24000 | 24000 | 2400 | 10.00 | 10.00 | 0.00 | 0.00 | 2400 | 9.05 | 5.09 | 3.96 | 4.40 |
| 425 | 25500 | 25500 | 2550 | 10.00 | 10.00 | 0.00 | 0.00 | 2550 | 10.00 | 5.97 | 4.03 | 4.47 |
| 450 | 27000 | 27000 | 2700 | 10.00 | 10.00 | 0.00 | 0.00 | 2700 | 10.00 | 6.93 | 3.07 | 3.41 |
| 475 | 28500 | 28500 | 2850 | 10.00 | 10.00 | 0.00 | 0.00 | 2850 | 10.00 | 7.95 | 2.05 | 2.28 |
| 500 | 30000 | 30000 | 3000 | 10.00 | 10.00 | 0.00 | 0.00 | 3000 | 10.00 | 9.05 | 0.95 | 1.06 |
| 525 | 31500 | 31500 | 3150 | 10.00 | 10.00 | 0.00 | 0.00 | 3150 | 10.00 | 10.00 | 0.00 | 0.00 |
| 550 | 33000 | 33000 | 3300 | 10.00 | 10.00 | 0.00 | 0.00 | 3300 | 10.00 | 10.00 | 0.00 | 0.00 |

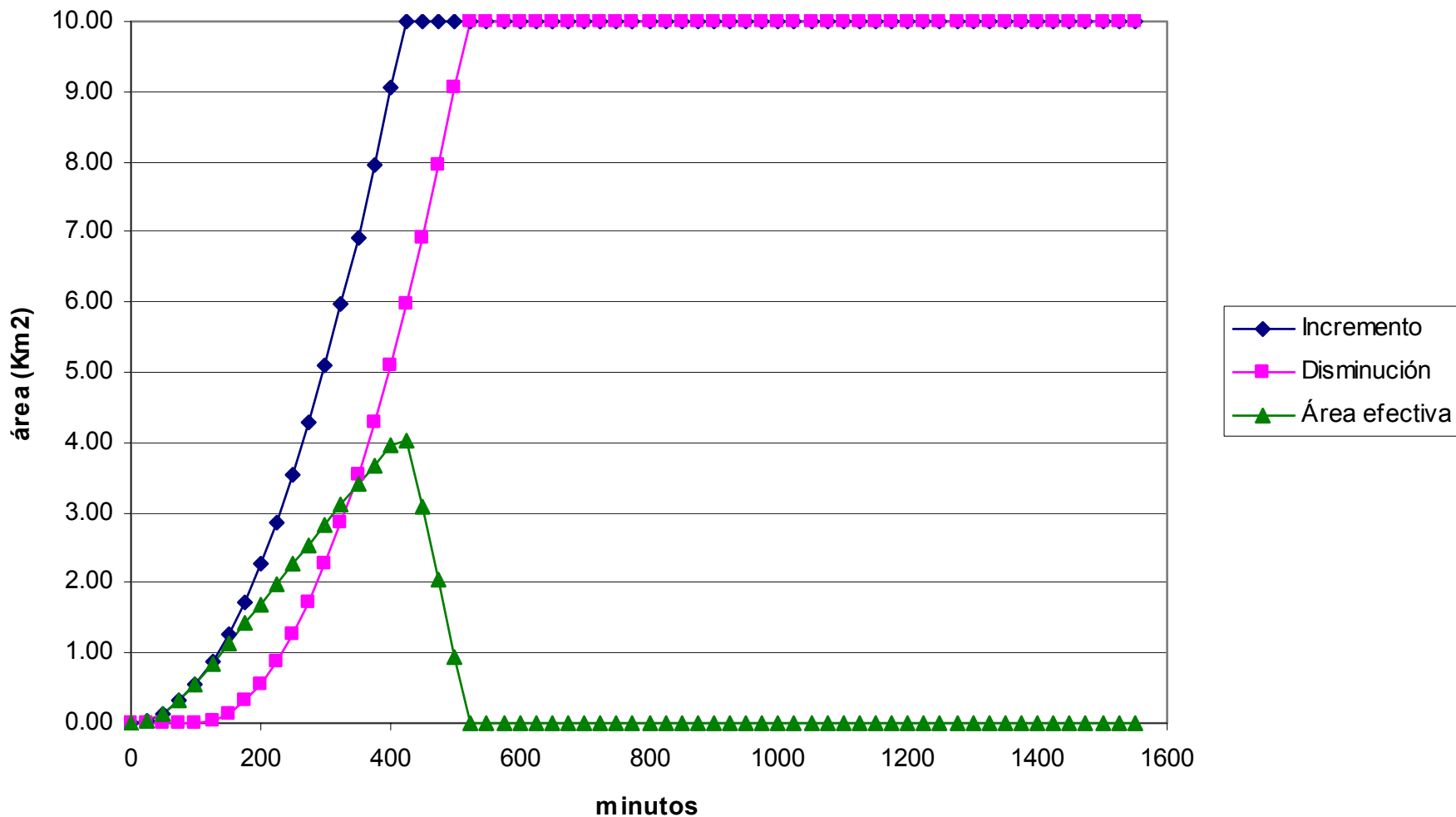
LLUVIA 100 min.

Evolución del área efectiva en el rectángulo



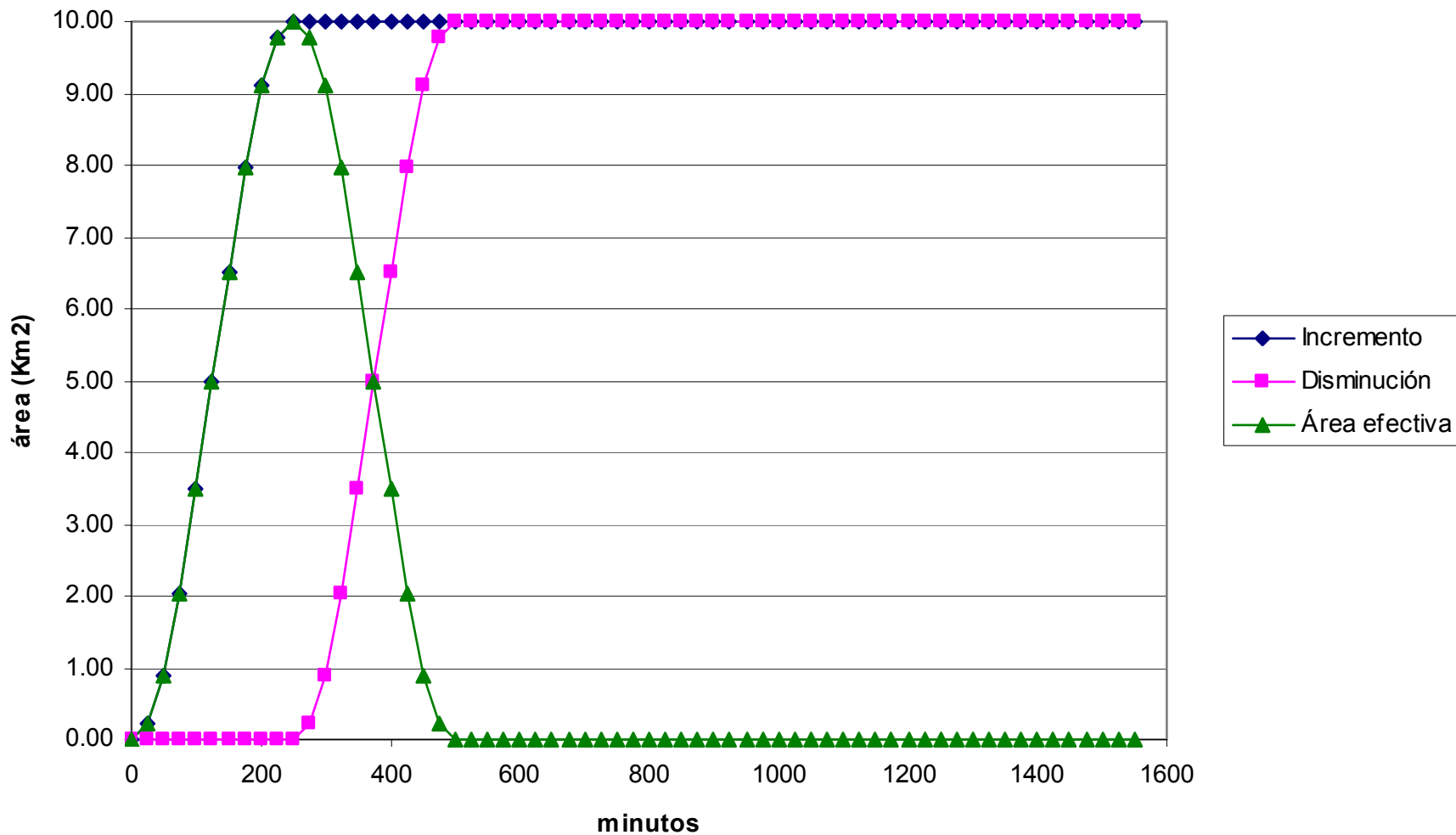
LLUVIA 100 min.

Evolución del área efectiva en el semicírculo



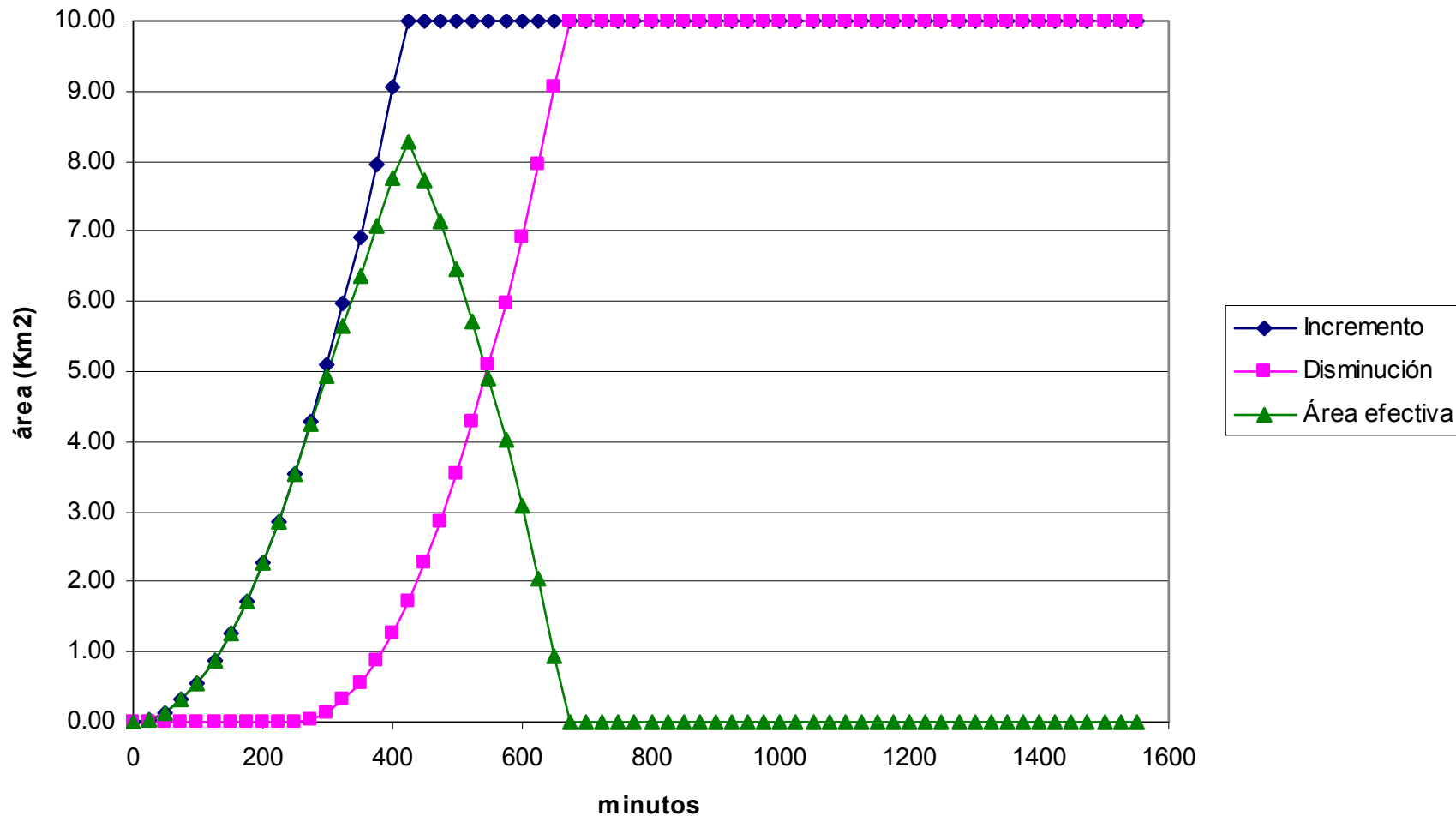
LLUVIA 250 min.

Evolución del área efectiva en el rectángulo



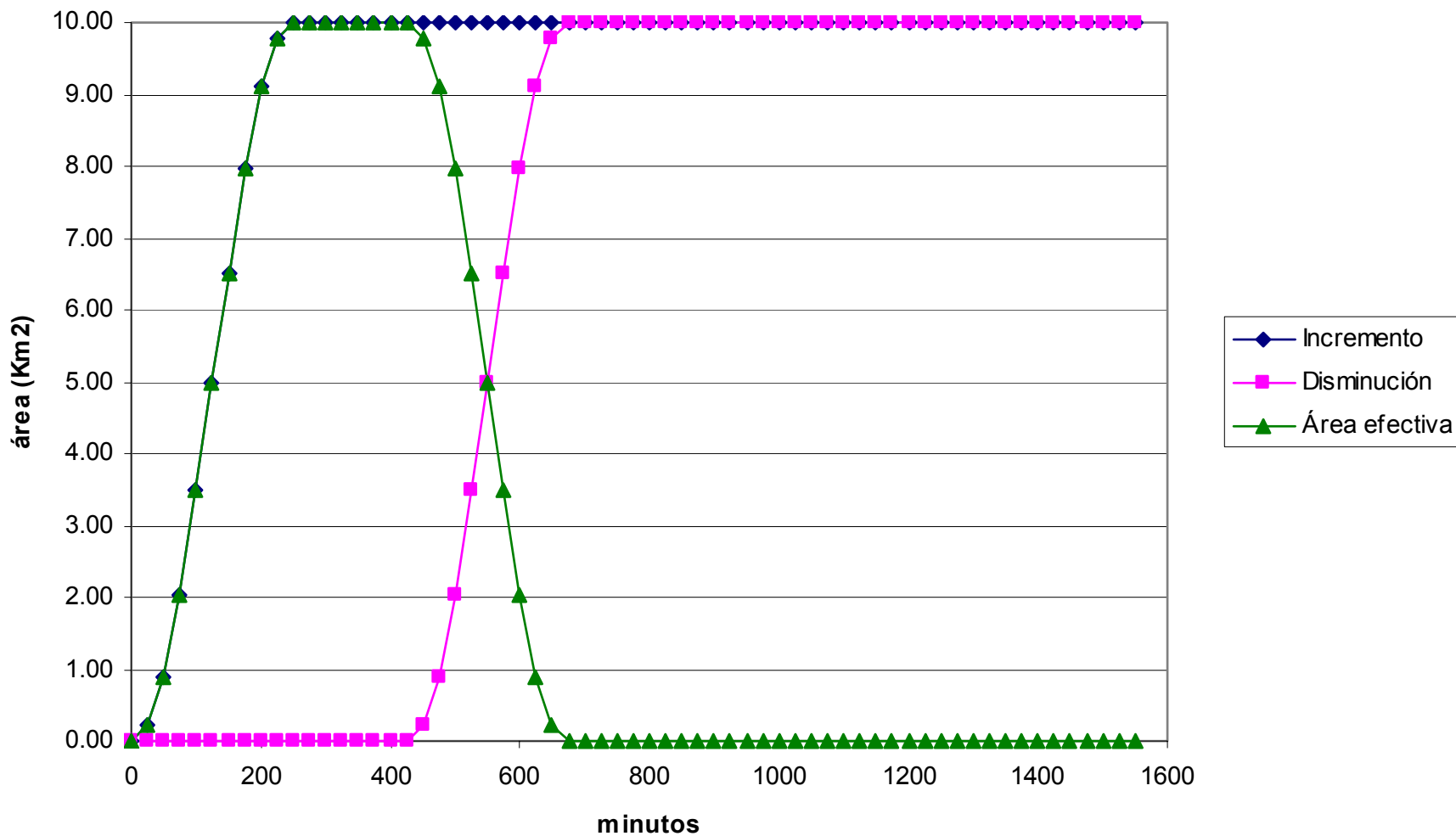
LLUVIA 250 min.

Evolución del área efectiva en el semicírculo



LLUVIA 425 min.

Evolución del área efectiva en el rectángulo



LLUVIA 425 min.

Evolución del área efectiva en el semicírculo

