North Creek Watershed Analysis

for

Las Pilitas Rock Quarry

San Luis Obispo County, California

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Exp 12/2010
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Introduction

North Creek, (as so named in this analysis), is a small tributary creek located within the northern region of the proposed Las Pilitas Rock Quarry sphere of operations. Concerns are raised as to how the associated storm water runoff will be affected as mining operations encroach into the creeks natural watershed area during the later phases of the mine life. Agency requirements include reducing "developed" area runoffs to that of a 2 year "undeveloped" release rate through the use of detention ponds. Environmental concerns arise regarding the creeks natural flow rates and the inability to sustain these flows if all runoff is routed through proposed detention ponds and released at the 2 year undeveloped rate.

Purpose and Scope

The purpose of this analysis is to calculate the North Creek existing peak flow rates using the Rational Method for 2, 5 and 10 year storm events. These values will then be compared to peak flow rates as altered by mining phases 2A, 2B, 3A and 3B which encroach into the watershed. It should be noted phases 1A and 1B do not encroach into the watershed and therefore are not studied. Flow rates into North Creek may be manipulated by allowing more runoff from mined slopes to bypass the proposed ponds and enter the creek via excavated benches established in the Quarry Mining Plan prepared by this office. The results are summarized below in tabular form. Appendix inclusions consist of "Mining Influence" Drainage Maps for each phase, Rational Method runoff calculations and County Hydrology Standards used in the analysis.

North Creek Peak Flows

	Phase 2A			Phase 2B			Phase 3A			Phase 3B		
	Q_2	Q_5	Q_{10}	Q_2	Q_5	Q_{10}	Q_2	Q_5	Q_{10}	Q_2	Q_5	Q_{10}
Existing Peak Flows (cfs) **	30.8	41.7	50.7	30.8	41.7	50.7	30.8	41.7	50.7	30.8	41.7	50.7
Post-mining Peak Flows (cfs)	27.5	37.2	45.3	24.4	33.0	40.2	19.7	26.6	32.4	17.8	24.0	29.2
Percent Change	-11%			-21%			-36%			-42%		

** Flows of the existing, undisturbed Watershed as it occurs today (no change).

Conclusion

Although the calculations show that peak flows taper off as influential mining limits increase in area, these flows may be modified by simply extending or shortening conveyance bench lengths to attain desired runoff rates should adjustments be required. Additionally, not accounted for in the above flow totals are release rates (2 year undeveloped) from the detention ponds. These peak flows will not be realized until well after direct bypass flows (via conveyance benches) have passed due to pond fill time and hydraulic head development.

Transport of sediment into the creek will be addressed prior to discharge by excavating a long, narrow basin in the last two to three hundred feet of conveyance bench length and constructing periodic check weirs (berms) to entrap sediment. It is anticipated yearly maintenance to remove accumulated silts and sediment shall be established and performed as required.

Appendix inclusions

Phased "Mining Influence" Drainage Maps

Rational Method Calculations

San Luis Obispo County Hydrology Standards

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⊙ EXISTING, UNDISTURBED WATERSHED ANALYSIS. CHECK "LOW" FLOWS TO CREEK @ NORTH SIDE OF PROPOSED MINED AREA. WILL LOW FLOWS BE AFFECTED BY PROPOSED MINING OPERATIONS?

- NORTH CREEK WATERSHED AREA

AREA = 29.7 ACRES

- TIME OF CONCENTRATION

ΔH = 1500 - 1155 = 345' & PATH OF TRAVEL = 2,000'
PER CO. STD H-2 T_c = ~ 5½ minutes

USE CHART MIN. T_c = 10 min

- RAINFALL INTENSITY (MINOR EVENTS)

FOR 18" TO 21" ANNUAL RAINFALL: i_2 = 1.70 in/hr
i_5 = 2.30 in/hr
i_{10} = 2.80 in/hr

- RUNOFF COEFFICIENT (PER COUNTY STD H-3A)

RELIEF:	SLOPES > 30% STEEP & RUGGED	= 0.31
SOIL INFIL:	"High" (slow to take up water)	= 0.10
VEG. COVER:	NORMAL to High (Closer to High 75%)	= 0.09
SURF STOR:	"EXTREME"	= 0.11
	total C	= 0.61

- PEAK FLOWS

Q_2 = (.61)(1.7)(29.7) = 30.8 cfs

Q_5 = (.61)(2.3)(29.7) = 41.7 cfs

Q_{10} = (.61)(2.8)(29.7) = 50.7 cfs

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① THE NORTH CREEK WATERSHED IS NOT AFFECTED BY MINING ACTIVITIES DURING PHASE'S 1A & 1B.

- MINING ENCROACHMENT PHASE 1A = < 0.5 AC
- MINING ENCROACHMENT PHASE 1B = 2.1 AC

} Assumed INSignificant

- PHASE 2A EXCAVATION & ITS INFLUENCE ON 2, 5 & 10 YEAR PEAK FLOWS TO THE NORTH CREEK WATERSHED.

① FROM PREVIOUS CALC'S (SEE SHT 1), UNDISTURBED PEAK FLOWS INTO NORTH CREEK:

Q_2 = 30.8 cfs; Q_5 = 41.7 cfs; Q_{10} = 50.7 cfs

① ALTERED FLOWS @ CONCLUSION of PHASE 2A.

(SEE PHASE 2A MINING INFLUENCE MAP)

WATERSHED AREA:

- NATIVE UNDISTURBED AREA = 24.4 AC
- PHASE EXCAVATION AREA (BENCHES) = 1.7 AC.

tot = 26.1 AC.

- Runoff Coefficient (Weighted - C_w)

- "C" NATIVE UNDISTURBED AREA (Per Co STD. H-3A)
  SEE PREVIOUS SHEET CALC'S

  C = 0.61

- "C" EXCAVATED BENCHES
  DETERMINED USING THE HIGHEST VALUES IN THE "EXTREME" COLUMN AS BEST REPRESENTATION FOR WORST CASE.

  C = 0.79

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⊙ WEIGHTED RUNOFF COEFFICIENT (CONTINUE'D)

$$C_w = \frac{(24.4)(.61) + 1.7(.79)}{26.1} = \underline{\underline{0.62}}$$

(NOTE: the remaining 3.6 ACRES of the NORTH CREEK WATER SHED FLOW INTO POND AS A RESULT OF MINING)

· TIME OF CONCENTRATION & INTENSITY

USE CHART MIN DUE RELATIVELY SHORT TRAVEL LENGTHS & STEEP TERRAIN.

T_c = 10 MIN (ALL PHASES)

& $i_2 = 1.7$ in/hr; $i_5 = 2.3$ in/hr; $i_{10} = 2.8$ in/hr

⊙ PEAK BYPASS FLOWS INTO NORTH CREEK

$Q_2 = (.62)(1.7)(26.1) = 27.5$ cfs

$Q_5 = (.62)(2.3)(26.1) = 37.2$ cfs

$Q_{10} = (.62)(2.8)(26.1) = 45.3$ cfs

⊙ NET FLOW DECREASE (%) FOR 2, 5 & 10 YR STORMS = ~11%

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⊙ PHASE 2B BYPASS FLOWS.

(COMPARING TO UNDISTURBED PEAK FLOWS FOR NORTH CREEK)
RECALL. $Q_2 = 30.8$; $Q_5 = 41.7$ & $Q_{10} = 50.7$ cfs

- WATERSHED AREA: (SEE PHASE 2B MINING INFLUENCE MAP)
  - NATIVE UNDISTURBED AREA = 20.8 AC. & C = 0.61
  - PHASE EXC. AREA (CONVIES) = 2.0 AC. & C = 0.79

61. = 22.8 AC.

- WEIGHTED RUNOFF COEFF. (C_w)

$$C_w = \frac{(20.8)(.61) + (2.0)(.79)}{22.8} = \underline{0.63}$$

Intensity @ T_c = 10 min (SAME for all PHASES)
$\langle i_2 = 1.7;\ i_5 = 2.3\ \&\ i_{10} = 2.8 \rangle$

- PEAK BYPASS FLOWS INTO NORTH CREEK

$Q_2 = (.63)(1.7)(22.8) = \underline{24.4 \text{ cfs}}$

$Q_5 = (.63)(2.3)(22.8) = \underline{33.0 \text{ cfs}}$

$Q_{10} = (.63)(2.8)(22.8) = \underline{40.2 \text{ cfs}}$

- NET FLOW DECREASE (%) FOR 2, 5 & 10 yr STORMS $\cong$ **21%**

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- PHASE 3A BYPASS FLOWS

- WATERSHED AREA: (SEE PHASE 3A MINING INFLUENCE MAP)
  - NATIVE UNDISTURBED AREA = 7.2 Ac & C = 0.61
  - PHASE EXC. AREA & BENCHES = 9.1 Ac. & C = 0.79

  total = 16.3 Ac.

- WEIGHTED RUNOFF COEFFICIENT (C_w)

$$C_w = \frac{(7.2)(0.61) + (9.1)(.79)}{16.3} = 0.71$$

- INTENSITIES ARE THE SAME

- PEAK BYPASS FLOWS INTO NORTH CREEK

$$Q_2 = (.71)(1.7)(16.3) = 19.7 \text{ cfs}$$

$$Q_5 = (.71)(2.3)(16.3) = 26.6 \text{ cfs}$$

$$Q_{10} = (.71)(2.8)(16.3) = 32.4 \text{ cfs}$$

- NET FLOW DECREASE (%) FOR 2, 5 & 10 yr STORMS = ~36%

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- PHASE 3B BYPASS FLOWS

- WATERSHED AREA: (SEE PHASE 3B MINING INFLUENCE MAP)
  - NATIVE UNDISTURBED AREA = 4.5 AC & C = 0.61
  - PHASE EXEC. AREA & BENCHES = 9.8 Ac. & C = 0.79

    Tot. = 14.3 Ac.

- WEIGHTED RUNOFF COEFFICIENT (C_w)

$$C_w = \frac{(4.5)(.61) + (9.8)(.79)}{14.3} = \underline{0.73}$$

- INTENSITIES REMAIN THE SAME.

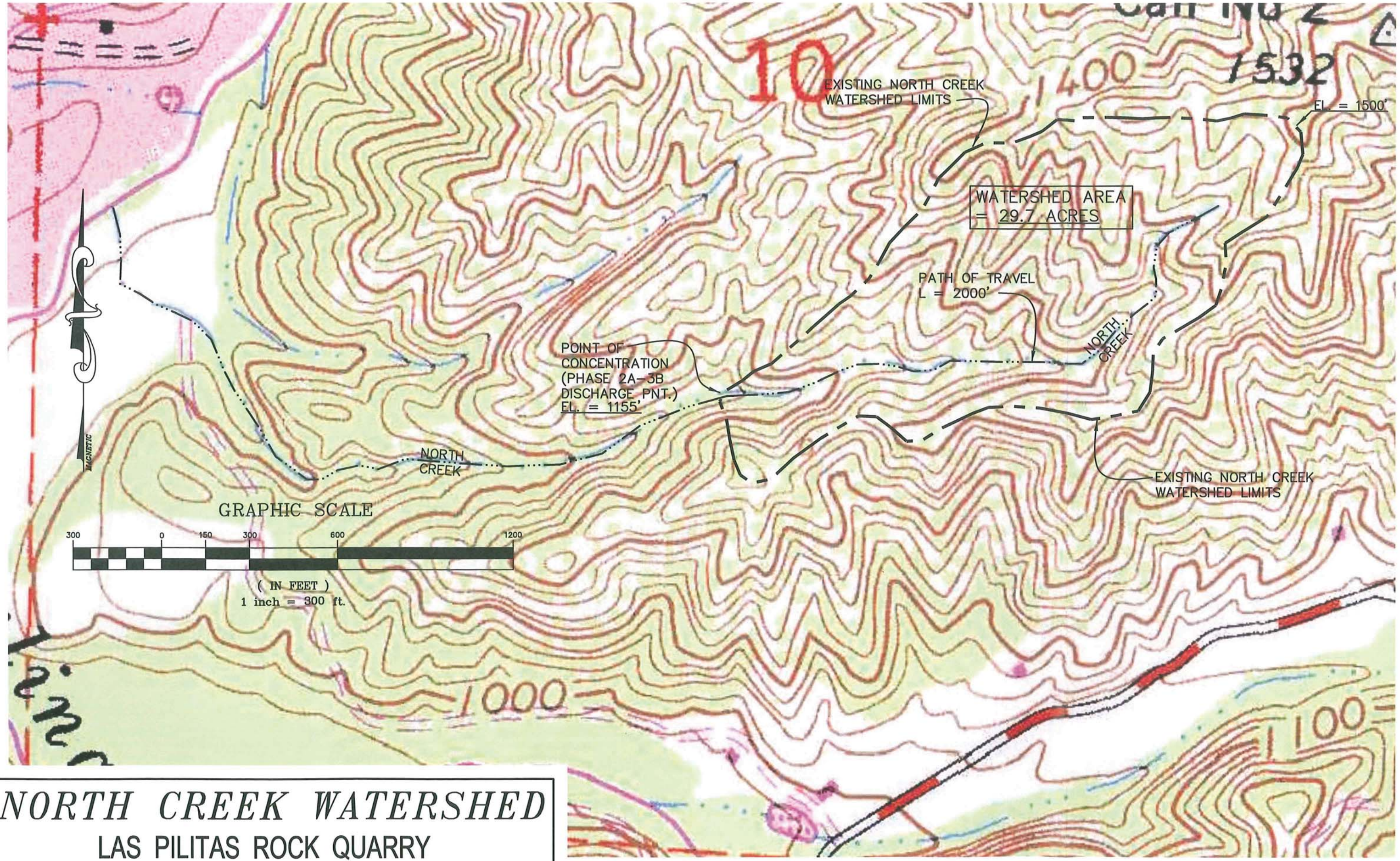
- PEAK BYPASS FLOWS INTO NORTH CREEK

$$Q_2 = (.73)(1.7)(14.3) = \underline{17.8 \text{ cfs}}$$

$$Q_5 = (.73)(2.3)(14.3) = \underline{24.0 \text{ cfs}}$$

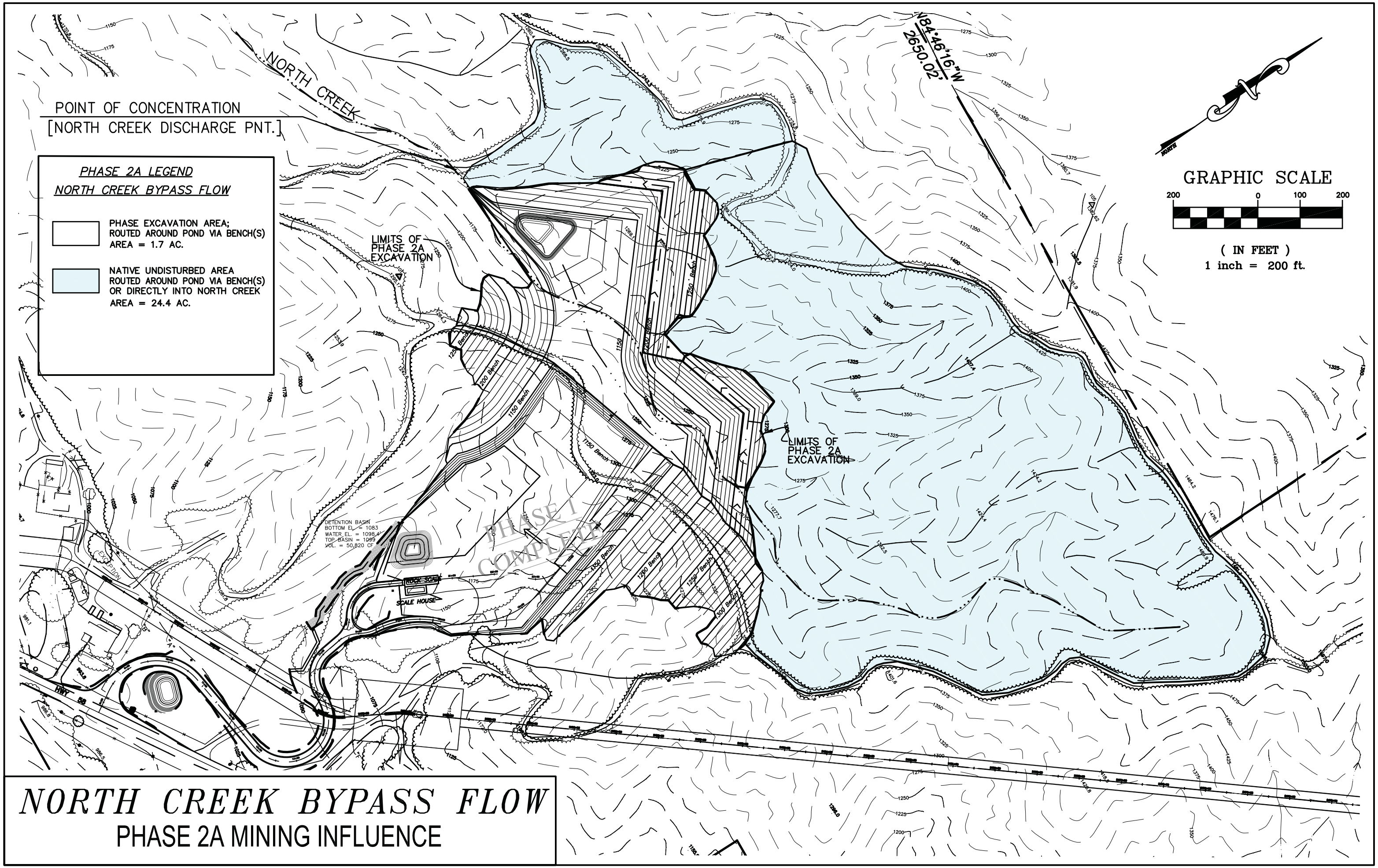
$$Q_{10} = (.73)(2.8)(14.3) = \underline{29.2 \text{ cfs}}$$

- NET FLOW DECREASE (%) FOR 2, 5 & 10 yr STORMS $\cong$ 42% DECREASE



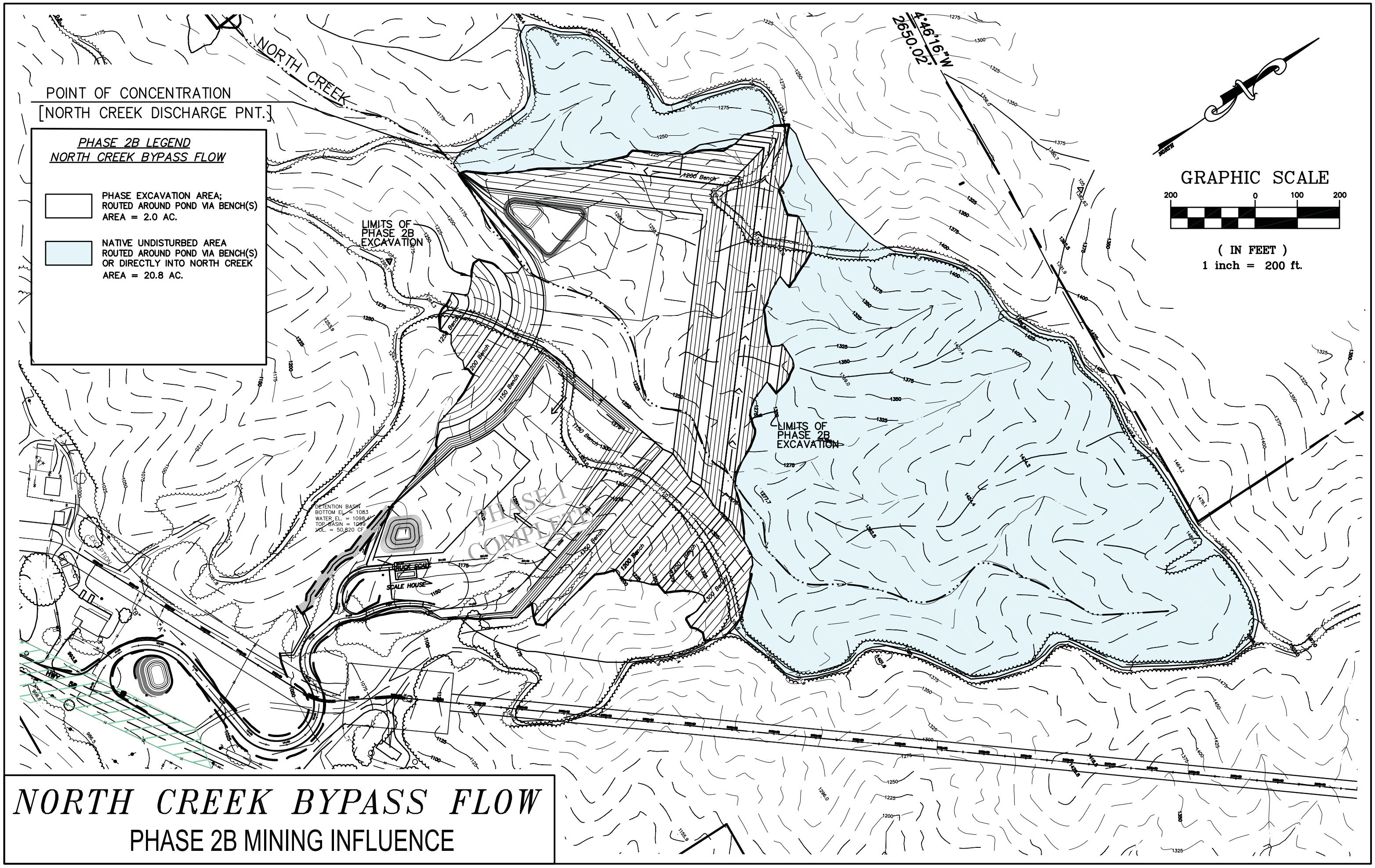
NORTH CREEK WATERSHED

LAS PILITAS ROCK QUARRY



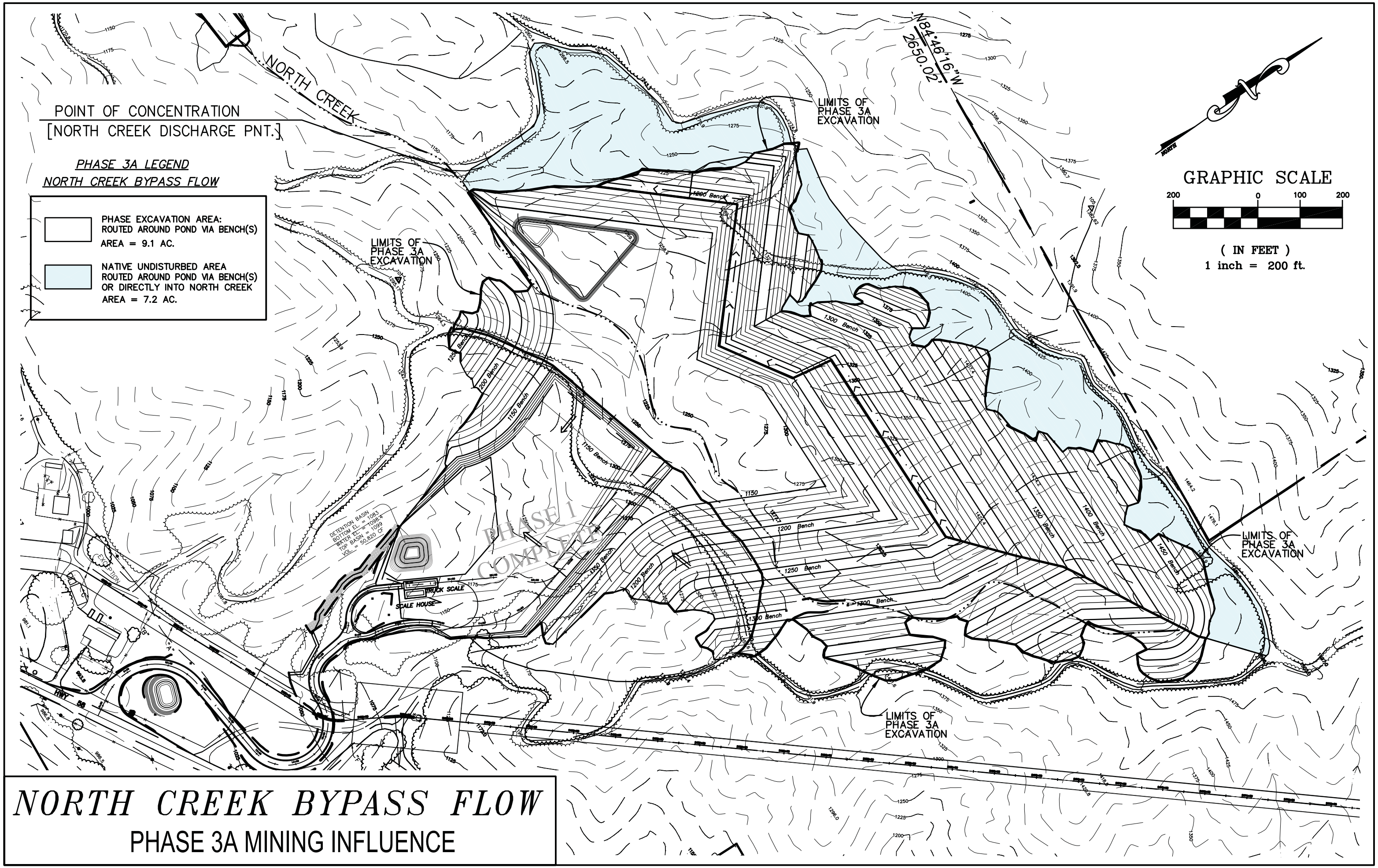
NORTH CREEK BYPASS FLOW

PHASE 2A MINING INFLUENCE



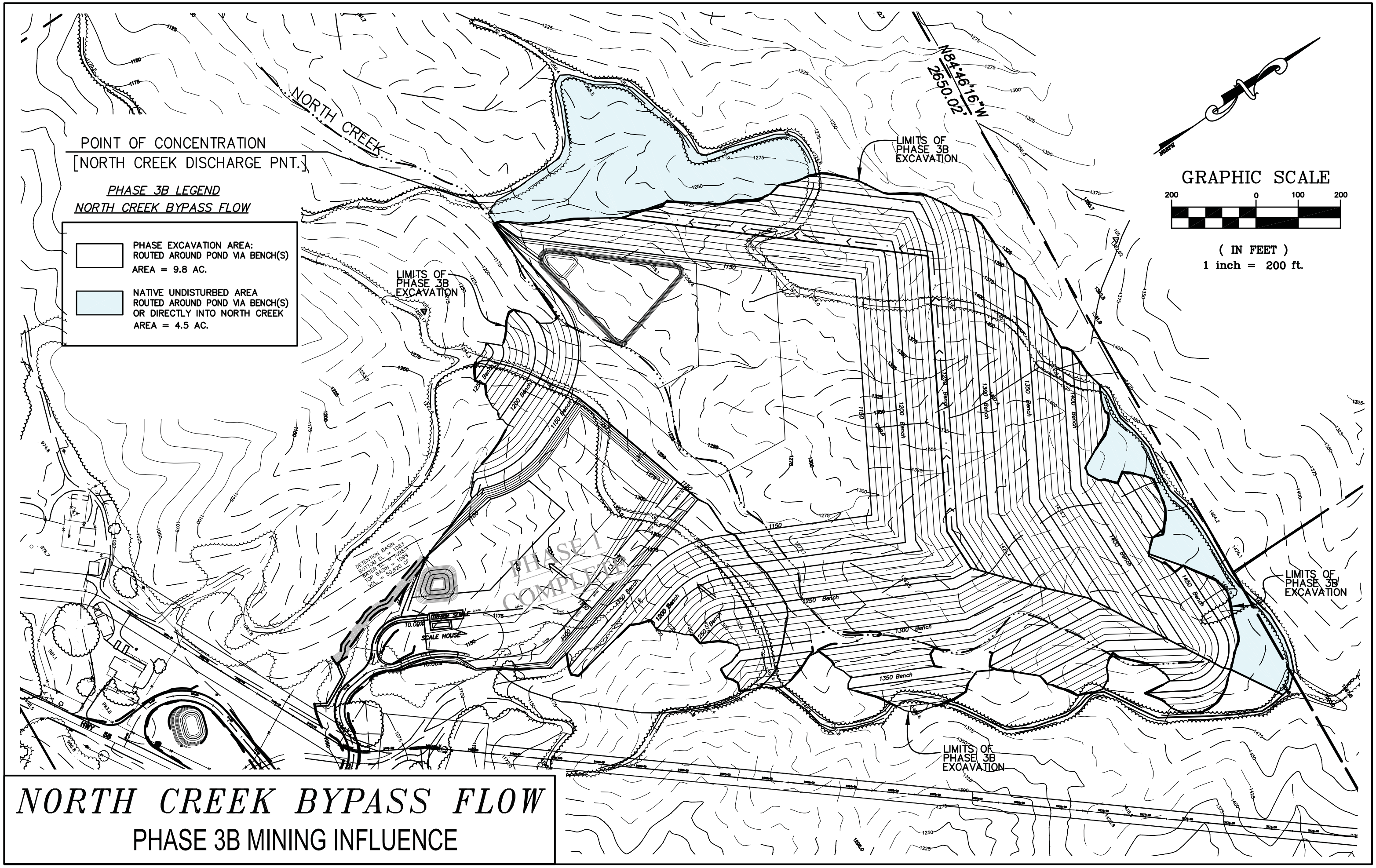
NORTH CREEK BYPASS FLOW

PHASE 2B MINING INFLUENCE



NORTH CREEK BYPASS FLOW

PHASE 3A MINING INFLUENCE



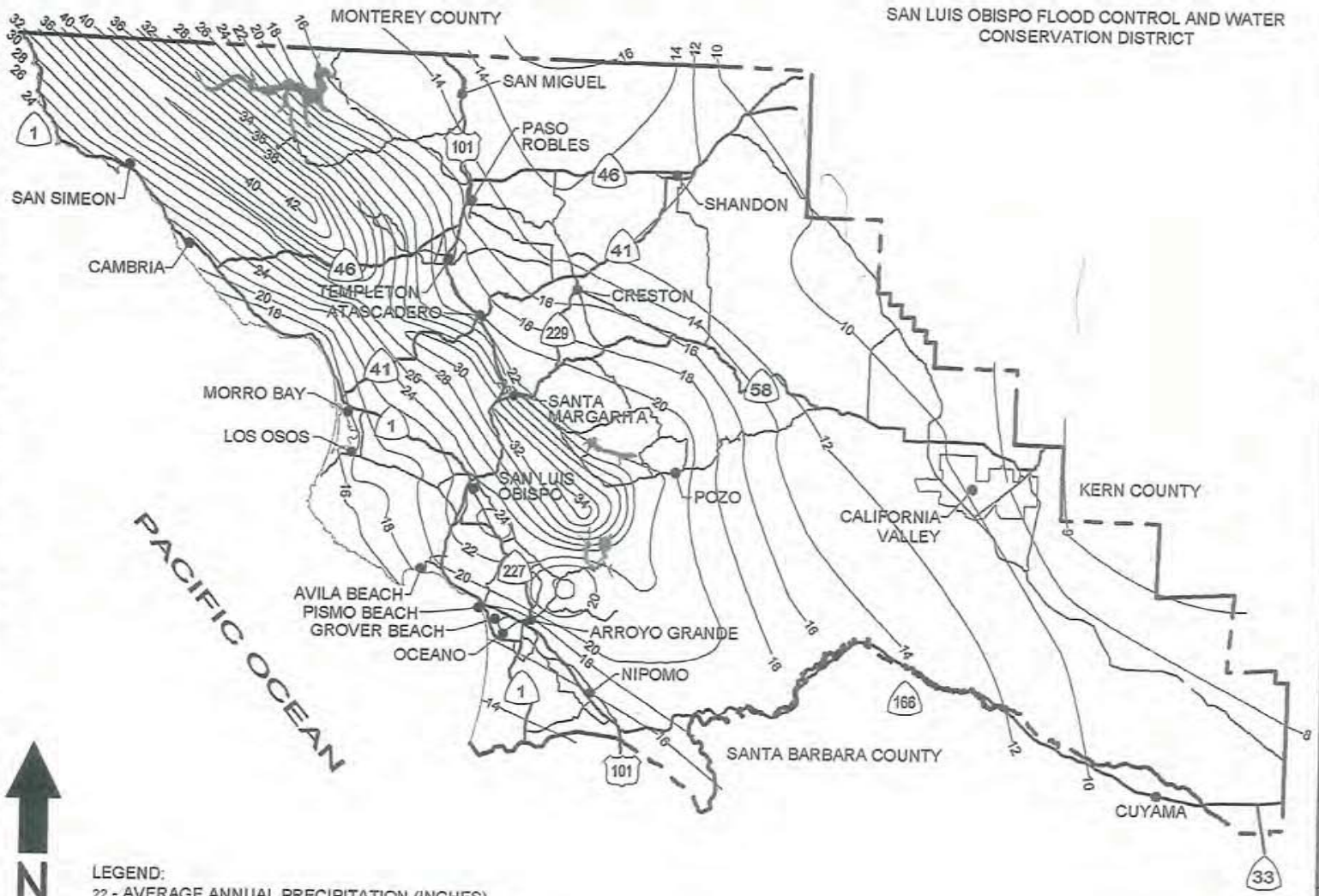
NORTH CREEK BYPASS FLOW

PHASE 3B MINING INFLUENCE

SAN LUIS OBISPO COUNTY
AVERAGE ANNUAL PRECIPITATION

(JULY 1 THROUGH JUNE 30) FOR 42 YEAR PERIOD
FROM 1955-56 THROUGH 1997-98)

SAN LUIS OBISPO FLOOD CONTROL AND WATER
CONSERVATION DISTRICT



LEGEND:
22 - AVERAGE ANNUAL PRECIPITATION (INCHES)

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AVERAGE ANNUAL RAINFALL

Scale: NTS
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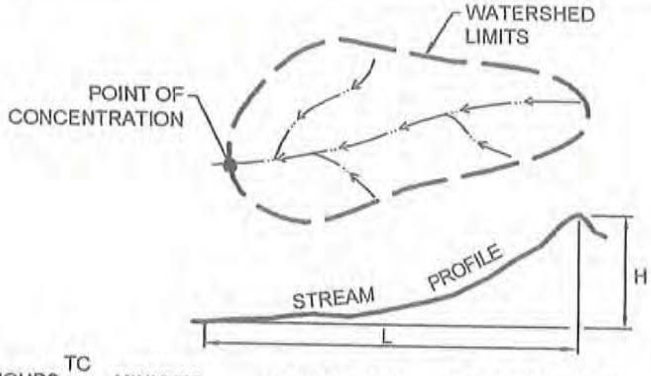
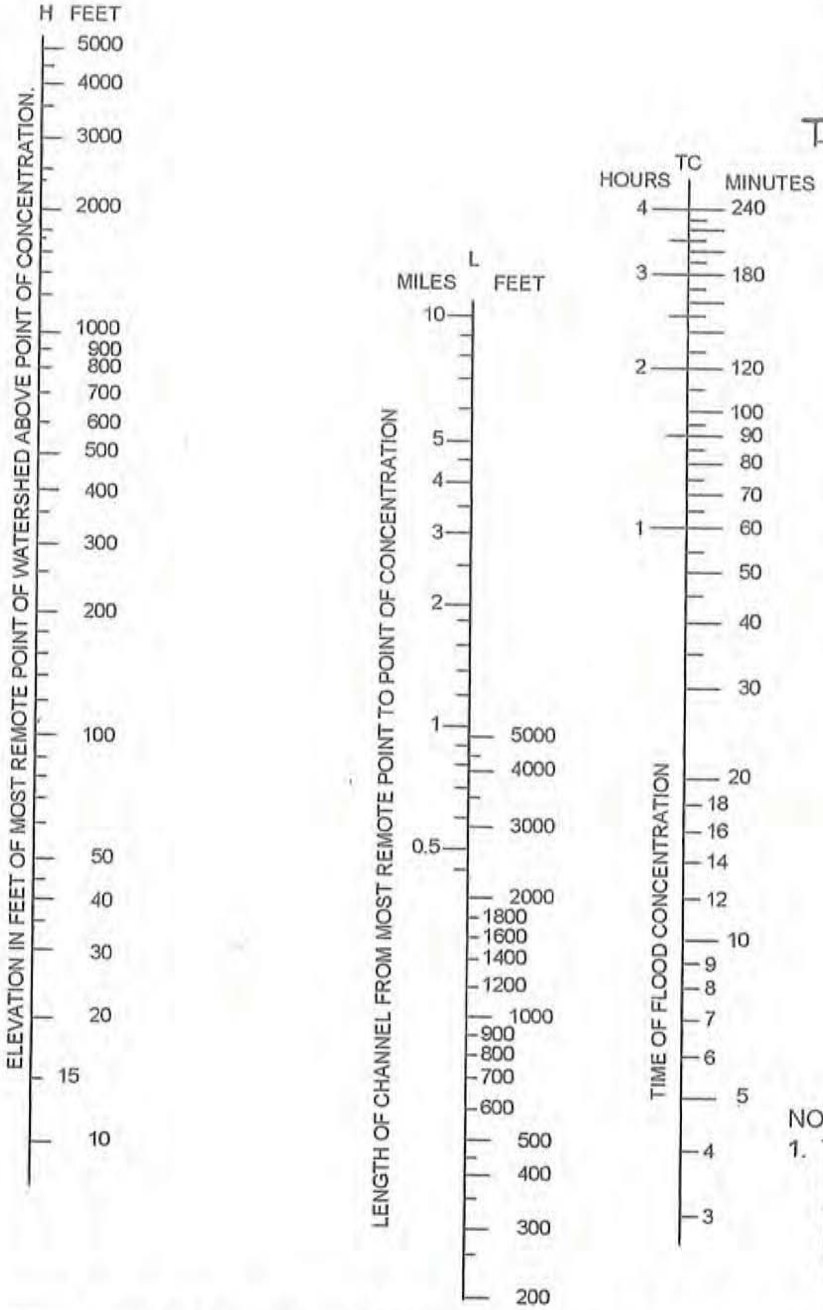
Drawing No: H-1
Sheet No: 1 OF 1

Revisions

Description	Approved	Date	Description	Approved	Date

Revisions					
Description	Approved	Date	Description	Approved	Date





EQUATIONS FOR ESTIMATED "TIME OF CONCENTRATION"

$$Tc = \left(\frac{11.9L^3}{H}\right)^{0.385}$$

LEGEND:

Tc = TIME OF CONCENTRATION IN HOURS.

L = LENGTH OF CHANNEL IN MILES.

H = DIFFERENCE IN ELEVATION BETWEEN MOST REMOTE POINT AND THE POINT OF CONCENTRATION IN FEET.

NOTES:

1. THIS NOMOGRAPH IS TO BE LIMITED TO WATERSHED AREAS OF 200 ACRES OR LESS. FOR LARGER WATERSHEDS REFER TO THE DESIGN STANDARDS.

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TIME OF CONCENTRATION

FOR WATERSHEDS LESS THAN 200 ACRES

Scale:	Issued: Aug. 2006
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Sheet No:	1 OF 1

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TABLE 2: RATIONAL METHOD STANDARD RUNOFF COEFFICIENTS FOR UNDEVELOPED AREAS

	EXTREME	HIGH	NORMAL	LOW
RELIEF	0.28 TO 0.35 STEEP, RUGGED TERRAIN WITH AVERAGE SLOPES ABOVE 30%	0.20 TO 0.28 HILLY, WITH AVERAGE SLOPES OF 10% TO 30%	0.14 TO 0.20 ROLLING, WITH AVERAGE SLOPE OF 5% TO 10%	0.08 TO 0.14 RELATIVELY FLAT LAND, WITH AVERAGE SLOPES OF 0% TO 5%
SOIL INFILTRATION	0.12 TO 0.16 NO EFFECTIVE SOIL COVER, EITHER ROCK OR THIN MANTLE OF NEGLIGIBLE INFILTRATION CAPACITY	0.08 TO 0.12 SLOW TO TAKE UP WATER, CLAY OR SHALLOW LOAM SOILS OF LOW INFILTRATION CAPACITY, IMPERFECTLY OR POORLY DRAINED	0.06 TO 0.08 NORMAL; WELL DRAINED LIGHT OR MEDIUM TEXTURED SOILS, SANDY LOAMS, SILT AND SILT LOAMS	0.04 TO 0.06 HIGH; DEEP SAND OR OTHER SOILS THAT TAKES UP WATER READILY, VERY LIGHT WELL DRAINED SOILS
VEGETAL COVER	0.12 TO 0.16 NO EFFECTIVE PLANT COVER, BARE OR VERY SPARSE COVER	0.08 TO 0.12 POOR TO FAIR; CULTIVATION CROPS, OR POOR NATURAL COVER, LESS THAN 20% OF DRAINAGE AREA OVER GOOD COVER	0.06 TO 0.08 FAIR TO GOOD; ABOUT 50% OF AREA IN GOOD GRASSLAND OR WOODLAND, NOT MORE THAN 50% OF AREA IN CULTIVATED CROPS	0.04 TO 0.06 GOOD TO EXCELLENT; ABOUT 90% OF DRAINAGE AREA IN GOOD GRASSLAND, WOODLAND, OR EQUIVALENT COVER
SURFACE STORAGE	0.10 TO 0.12 NEGLIGIBLE SURFACE DEPRESSIONS FEW AND SHALLOW, DRAINAGE WAYS STEEP AND SMALL, NO MARSHES	0.08 TO 0.10 LOW; WELL DEFINED SYSTEM OF SMALL DRAINAGE WAYS, NO PONDS OR MARSHES	0.06 TO 0.08 NORMAL; CONSIDERABLE SURFACE STORAGE, LAKES AND POND MARSHES	0.04 TO 0.06 HIGH; SURFACE STORAGE, HIGH DRAINAGE SYSTEM NOT SHARPLY DEFINED, LARGE FLOOD PLAIN STORAGE OR LARGE NUMBER OF PONDS OR MARSHES

(REFERENCES FIGURE 819.2A OF HIGHWAY DESIGN MANUAL)

EXAMPLE:

GIVEN: AN UNDEVELOPED WATERSHED CONSISTING OF:

1. ROLLING TERRAIN WITH AVERAGE SLOPES OF 5%
2. CLAY SOILS
3. GOOD GRASSLAND AREA
4. NORMAL SURFACE DEPRESSIONS

FIND: THE RUNOFF COEFFICIENT FOR THE ABOVE WATERSHED

SOLUTION:

1. RELIEF = 0.14
2. SOIL INFILTRATION = 0.08
3. VEGETAL COVER = 0.04
4. SURFACE STORAGE = 0.06

ANSWER: THE RUNOFF COEFFICIENT, C = 0.32

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RUNOFF COEFFICIENTS FOR UNDEVELOPED AREAS

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TABLE 1: ANNUAL RAINFALL < 14":

Recurrence Interval (Years)	Duration							
	10 Min	15 Min	30 Min	1 Hr	2 Hr	3 Hr	6 Hr	10 Hr
2	1.00	0.90	0.60	0.40	0.26	0.22	0.18	0.14
5	1.40	1.20	0.80	0.50	0.37	0.32	0.25	0.20
10	1.70	1.40	1.00	0.60	0.44	0.38	0.30	0.23
25	2.00	1.70	1.10	0.70	0.54	0.47	0.37	0.28
50	2.20	1.90	1.30	0.80	0.60	0.53	0.44	0.34
100	2.40	2.10	1.40	0.90	0.65	0.59	0.48	0.36

TABLE 2: ANNUAL RAINFALL 14" TO 17":

Recurrence Interval (Years)	Duration							
	10 Min	15 Min	30 Min	1 Hr	2 Hr	3 Hr	6 Hr	10 Hr
2	1.30	1.10	0.80	0.50	0.35	0.30	0.23	0.18
5	1.90	1.60	1.10	0.70	0.49	0.42	0.33	0.26
10	2.30	1.90	1.30	0.80	0.60	0.51	0.40	0.30
25	2.60	2.20	1.50	1.00	0.71	0.63	0.50	0.38
50	3.00	2.50	1.70	1.10	0.81	0.74	0.60	0.47
100	3.20	2.70	1.90	1.20	0.90	0.80	0.65	0.49

TABLE 3: ANNUAL RAINFALL 18" TO 21":

Recurrence Interval (Years)	Duration							
	10 Min	15 Min	30 Min	1 Hr	2 Hr	3 Hr	6 Hr	10 Hr
2	1.70	1.40	1.00	0.65	0.44	0.37	0.29	0.22
5	2.30	1.90	1.30	0.85	0.60	0.52	0.41	0.33
10	2.80	2.40	1.60	1.03	0.74	0.64	0.50	0.38
25	3.20	2.70	1.90	1.20	0.92	0.80	0.64	0.50
50	3.70	3.10	2.10	1.40	1.05	0.92	0.74	0.58
100	4.00	3.40	2.30	1.50	1.13	1.00	0.80	0.62

TABLE 4: ANNUAL RAINFALL 22" TO 28":

Recurrence Interval (Years)	Duration							
	10 Min	15 Min	30 Min	1 Hr	2 Hr	3 Hr	6 Hr	10 Hr
2	2.10	1.80	1.20	0.77	0.55	0.47	0.36	0.28
5	2.80	2.50	1.70	1.05	0.76	0.64	0.52	0.42
10	3.60	3.00	2.10	1.30	0.92	0.81	0.64	0.48
25	3.90	3.50	2.40	1.50	1.10	0.98	0.78	0.60
50	4.50	3.90	2.60	1.70	1.28	1.15	0.94	0.72
100	5.00	4.30	2.90	1.85	1.40	1.25	0.98	0.76

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RAINFALL INTENSITY DATA

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Sheet No:	1 OF 1