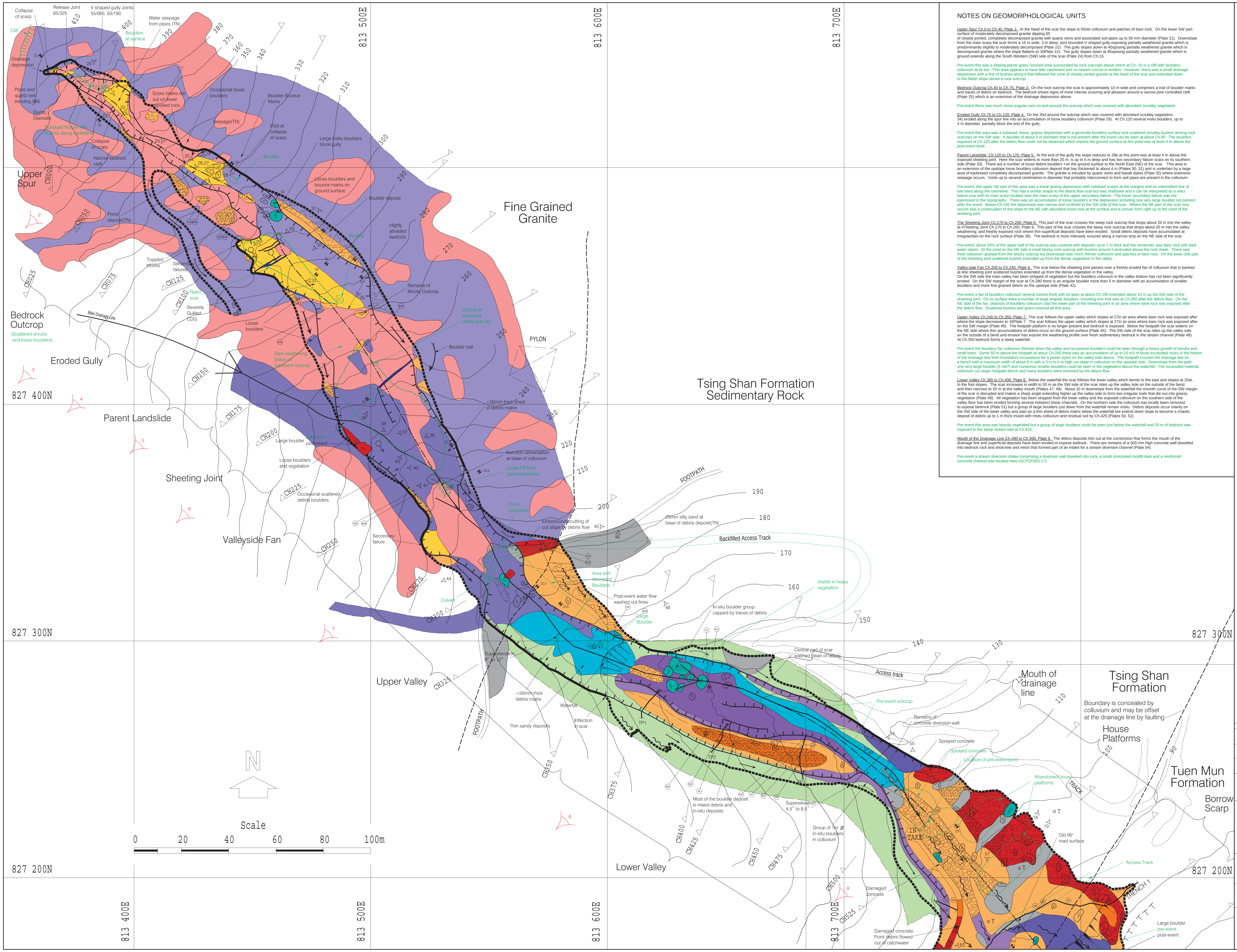

NOTES ON GEOMORPHOLOGICAL UNITS

Upper Spur Ch.0 to Ch.40, Plate 2. At the head of the scar the slope is 50ner colluvium and patches of bare rock. On the lower SW part surface of moderately decomposed granite dipping 65
of closely jointed, completely decomposed granite with quartz veins and associated soil pipes up to 50 mm diameter (Plate 21). Downslope from the main scarp the scar forms a 10 m wide, 3 m deep, joint bounded V-shaped gully exposing partially weathered granite which is predominantly slightly to moderately decomposed (Plate 22). The gully slopes down at 40xposing partially weathered granite which is decomposed granite where the slope flattens to 30Plate 22). The gully slopes down at 40xposing partially weathered granite which is ground extends along the South Western (SW) side of the scar (Plate 24) from Ch.15.

Pre-event this was a sloping planar grass covered area surrounded by rock outcrops above which at Ch.-10 is a cliff with bouldery colluvium at its toe. This area appears to have little catchment and no stream course is evident. However, there was a small drainage depression with a line of bushes along it that followed the zone of closely jointed granite at the head of the scar and extended down to the flatter slope above a rock outcrop.

Bedrock Outcrop Ch.40 to Ch.75, Plate 3. On the rock outcrop the scar is approximately 10 m wide and comprises a trail of boulder marks and traces of debris on bedrock. The bedrock shows signs of more intense scouring and abrasion around a narrow joint controlled cleft (Plate 25) which is an extension of the drainage depression above.

Pre-event there was much loose angular rock on and around the outcrop which was covered with abundant scrubby vegetation.

Eroded Gully Ch.75 to Ch.120, Plate 4. On the 35d around the outcrop which was covered with abundant scrubby vegetation.
34) eroded along the spur line into an accumulation of loose bouldery colluvium (Plate 29). At Ch.120 several insitu boulders, up to 4 m diameter, partially block the end of the gully.

Pre-event this area was a subdued, linear, grassy depression with a generally bouldery surface and scattered scrubby bushes among rock outcrops on the SW side. A boulder of about 3 m diameter that is not present after the event can be seen at about Ch.90. The boulders exposed at Ch.120 after the debris flow could not be observed which implies the ground surface at this point was at least 4 m above the post-event level.

Parent Landslide. Ch.120 to Ch.170, Plate 5. At the end of the gully the slope reduces to 28e at this point was at least 4 m above the exposed sheeting joint. Here the scar widens to more than 20 m, is up to 5 m deep and has two secondary failure scars on its southern side (Plate 33). There are a number of loose debris boulders +on the ground surface to the North East (NE) of the scar. This area is an extension of the upslope loose bouldery colluvium deposit that has thickened to about 4 m (Plates 30, 31) and is underlain by a large area of kaolinised completely decomposed granite. The granite is intruded by quartz veins and basalt dykes (Plate 32) where extensive seepage occurs. Voids up to several centimetres in diameter that probably interconnect to form soil pipes are present in the colluvium.

Pre-event, the upper NE part of this area was a linear grassy depression with subdued scarps at the margins and an intermittent line of low trees along the centreline. This had a similar shape to the debris flow scar but was shallower and it can be interpreted as a relict failure scar with its main scarp located near the main scarp of the upper secondary failure. The lower secondary failure was not expressed in the topography. There was an accumulation of loose boulders in the depression including one very large boulder not present after the event. Below Ch.140 the depression was narrow and confined to the SW side of the scar. Where the NE part of the scar now occurs was a continuation of the slope to the NE with abundant loose rock at the surface and a convex form right up to the crest of the sheeting joint.

The Sheeting Joint Ch.170 to Ch.200, Plate 6. This part of the scar crosses the steep rock outcrop that drops about 20 m into the valley at 47heeting Joint Ch.170 to Ch.200, Plate 6. This part of the scar crosses the steep rock outcrop that drops about 20 m into the valley weathering; and freshly exposed rock where thin superficial deposits have been eroded. Small debris deposits have accumulated at irregularities on the rock surface (Plate 36). The bedrock is more intensely scoured along a narrow strip on the NE side of the scar.

Pre-event, about 30% of the upper half of the outcrop was covered with deposits up to 1 m thick and the remainder was bare rock with dark water stains. At the crest on the NE side a small blocky rock outcrop with bushes around it protruded above the rock sheet. There was thick colluvium upslope from the blocky outcrop but downslope was much thinner colluvium and patches of bare rock. On the lower SW part of the sheeting joint scattered bushes extended up from the dense vegetation in the valley.

Valley-side Fan Ch.200 to Ch.240, Plate 6. The scar below the sheeting joint passes over a freshly eroded fan of colluvium that is banked at 40e sheeting joint scattered bushes extended up from the dense vegetation in the valley.
On the SW side the main valley has been stripped of vegetation but the bouldery colluvium in the valley bottom has not been significantly eroded. On the SW margin of the scar at Ch.280 there is an angular boulder more than 5 m diameter with an accumulation of smaller boulders and more fine grained debris on the upslope side (Plate 42).

Pre-event a fan of bouldery colluvium several metres thick with its apex at about Ch 190 extended about 10 m up the SW side of the sheeting joint. On its surface were a number of large angular boulders, including one that was at Ch.280 after the debris flow. On the NE side of the fan, deposits of bouldery colluvium clad the lower part of the sheeting joint in an area where bare rock was exposed after the debris flow. Scattered bushes and grass covered all this area.

Upper Valley Ch.240 to Ch.350, Plate 7. The scar follows the upper valley which slopes at 27in an area where bare rock was exposed after where the slope decreases to 16Plate 7. The scar follows the upper valley which slopes at 27in an area where bare rock was exposed after on the SW margin (Plate 46). The footpath platform is no longer present and bedrock is exposed. Below the footpath the scar widens on the NE side where thin accumulations of debris occur on the ground surface (Plate 45). The SW side of the scar rides up the valley side on the outside of a bend and erosion has expose the weathering profile over fresh sedimentary bedrock in the stream channel (Plate 48).
At Ch.350 bedrock forms a steep waterfall.

Pre-event the bouldery fan colluvium thinned down the valley and occasional boulders could be seen through a heavy growth of shrubs and small trees. Some 50 m above the footpath at about Ch.250 there was an accumulation of up to 10 m3 of loose excavated rocks in the bottom of the drainage line from foundation excavations for a power pylon on the valley side above. The footpath crossed the drainage line on a bench with a maximum width of about 6 m with a 3 m to 4 m high cut slope in colluvium on the upslope side. Downslope from the path one very large boulder (5 md?) and numerous smaller boulders could be seen in the vegetation above the waterfall. The excavated material, colluvium cur slope, footpath bench and many boulders were removed by the debris flow.

Lower Valley Ch.365 to Ch.490, Plate 8. Below the waterfall the scar follows the lower valley which bends to the east and slopes at 20al, to the foot slopes. The scar increases in width to 50 m as the SW side of the scar rides up the valley side on the outside of the bend and then narrows to 20 m at the valley mouth (Plates 47, 49). About 10 m downslope from the waterfall the smooth curve of the SW margin of the scar is disrupted and makes a sharp angle extending higher up the valley side to form two irregular trails that die out into grassy vegetation (Plate 49). All vegetation has been stripped from the lower valley and the exposed colluvium on the southern side of the valley floor has been eroded forming several indistinct linear channels. On the northern side the colluvium has locally been removed to expose bedrock (Plate 51) but a group of large boulders just down from the waterfall remain insitu. Debris deposits occur mainly on the SW side of the lower valley and start as a thin sheet of debris matrix below the waterfall but extend down slope to become a chaotic deposit of debris up to 1 m thick mixed with insitu colluvium and residual soil by Ch.425 (Plates 50, 52).

Pre-event this area was heavily vegetated but a group of large boulders could be seen just below the waterfall and 20 m of bedrock was exposed in the steep stream bed at Ch.425.

Mouth of the Drainage Line Ch.490 to Ch.500, Plate 9. The debris deposits thin out at the constriction that forms the mouth of the drainage line and superficial deposits have been eroded to expose bedrock. There are remains of a 500 mm high concrete wall dowelled into bedrock rock and shotcrete and mesh that formed part of an intake for a stream diversion channel (Plate 54).

Pre-event a stream diversion intake comprising a diversion wall doweled into rock, a small shotcreted rockfill dam and a reinforced concrete channel was located here (GCP2/D9/3-17).

LEGEND

Debris

Thickness		Composition	
🟧	50mm to 500mm	☐	Matrix rich
🟧	500mm to 1 000mm	▨	Boulder deposition 1m to 3m thick with little matrix.
🟥	Over 1 000mm	▨	Boulder deposition 1m to 2m thick mixed with about 50% matrix.
		▨	Stream channel with cobbles, boulder, washed gravel and sand more than 100mm thick.
		○	Boulder - Part of Debris

Debris is shown by combination of thickness tone and composition overlay.

○ Boulder (same colour as background) no field evidence, most are debris, some may be insitu.

Colluvium (Slope Deposits)

🟪	Spur Colluvium. Clast supported, very loose to medium dense, yellowish brown, angular, slightly decomposed to fresh, granite boulders and cobbles with some gravel, sand and low plasticity finer material.
🟪	Upper Valley Colluvium. Clast supported loose to medium dense, orangeish brown, rounded, slightly decomposed to fresh, granite boulders and cobbles with some gravel and some sand and low plasticity finer material.
🟪	Lower Valley Colluvium. Matrix supported, firm to stiff, orangeish brown, gravelly, sandy clayey silt of low plasticity with some rounded to sub angular, slightly to moderately decomposed, granite boulders.
🟪	Channel Colluvium. Clast supported, loose to medium dense, light brown, subrounded, slightly decomposed to fresh, granite boulders and cobbles with some gravel, some sand and some low plasticity silt.
🟦	Fan Colluvium. Clast-supported, medium dense to dense, orangeish brown-stained, rounded, slightly to highly decomposed, granite boulders and cobbles with much gravel, sand and silt and occasional gravel sized angular clasts of sedimentary rock.

Bedrock

Volcanic rock of the Tuen Mun Formation.

🟫	Andesite, highly to extremely decomposed to form soft to firm light green silt.

Sedimentary rock of the Tsing Shan Formation.

🟩	Residual soil/Slope wash. Weathered profile which may have undergone minor down slope creep.
🟦	Generally fresh to slightly decomposed fine-grained sandstone and siltstone.

Fine-grained granite.

🟨	Highly decomposed and kaolinised, often with associated quartz veins.
🟥	Generally fresh to slightly decomposed.
▬	Basalt Dyke
∼	Quartz Vein
⬜	Construction fill platforms or road.
🟩	Vegetation, undisturbed ground with the underlying material not mapped.

●	Boulder - Insitu, not moved by Debris Flow	○	Location of boulder before event from API.
─	Geological boundary	- -	Edge of mapping
☐	Unmapped Area		
— —	Approximate bedrock geology boundary modified from 1:20 000 Geology sheet 5 Tsing shan		
○	Seepage	→	Water trail
⊤⊤	Scarp at edge of Debris	→	Debris trail
⋯	Edge of Debris Flow Trail	⊤ ⊤ ⊤	Tension cracks and small slump scarps
— · —	Centreline of Debris Flow Trail	▷	Edge of heave lobe
⌒	Borrow scarp	∘T / ∘E	Pre-event location of telephone pole/electricity pole

Highly Abraded Bedrock -- Field Observation, (TN) -- From TN 4/91
Pre-event Outcrop -- Aerial Photograph observation
Green linework is from aerial photograph interpretation

△CH575	Location of cross section used for estimate of qualities and chainage from head of scar.
◁ 2	Approximate viewpoint and plate number of Aerial photograph
◁ 31	Approximate viewpoint and plate number of Terrestrial photograph
} Bedrock Outcrop	Geomorphological Unit used in text

⊕ D14	Insitu Density Pit	■ TP15	Trial Pit
⊔ S1	Sand replacement insitu density test	(M30)	Debris sample location
TP1/ Trench 1	Trial trench	├─┤	Location of superelevation measurement

NOTE

Base map prepared using photogrammetry from post debris flow, September 1990
Aerial Photographs A22763/4

Colluvium less than 0.5m not mapped.

	name	date
drawn	J.King	
traced	Y.L.Lee	

file no. GCP 2/D9/3

project
Tsing Shan Debris Flow Study

drawing title
Geomorphological Map of the 1990
TSING SHAN DEBRIS FLOW
Ch 0 - Ch 500, Erosion Part

drawing no.	scale
GEO/P/PTE/1 Sheet 1	1:630

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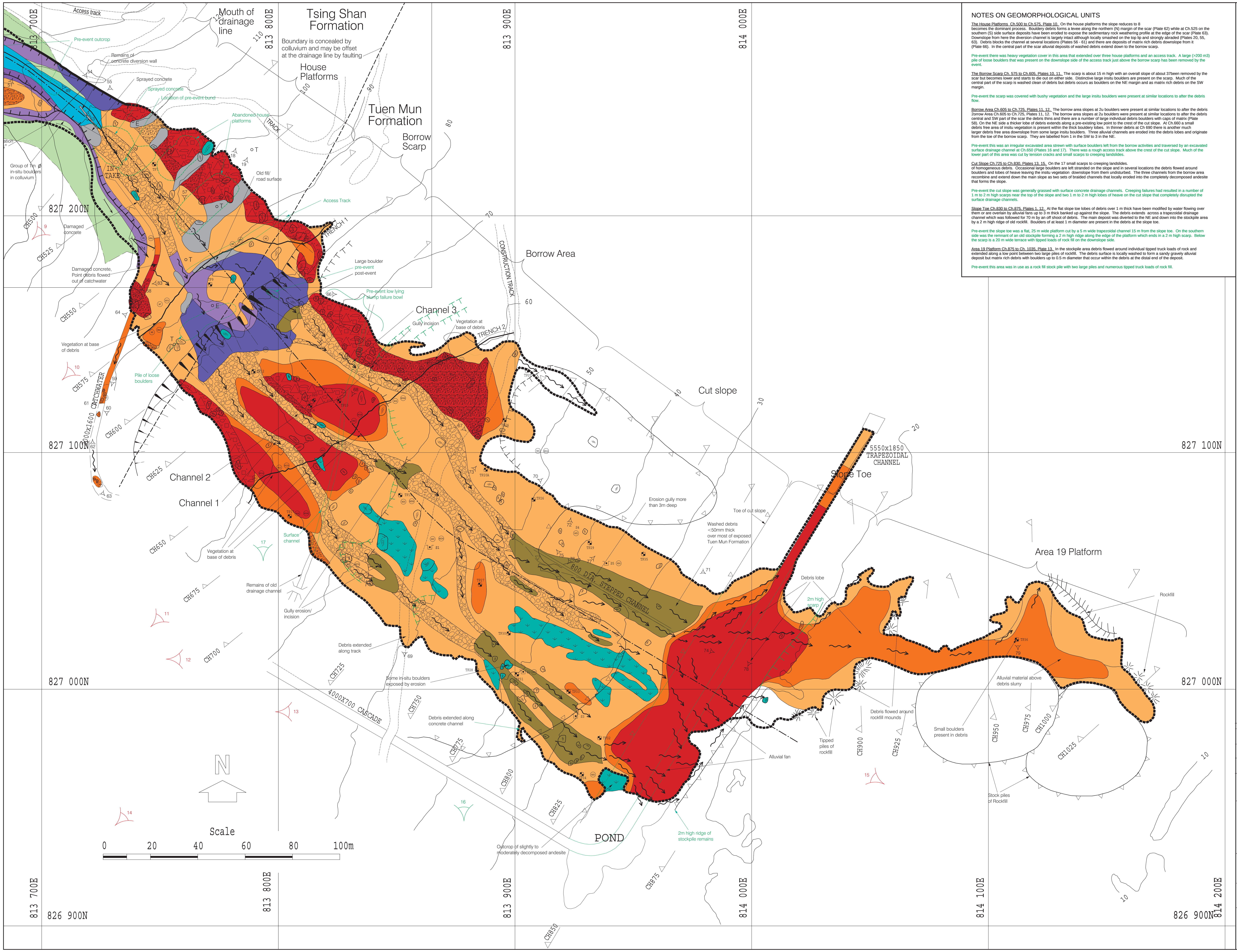

NOTES ON GEOMORPHOLOGICAL UNITS

The House Platforms Ch.500 to Ch.575, Plate 10. On the house platforms the slope reduces to 8 becomes the dominant process. Bouldery debris forms a levee along the northern (N) margin of the scar (Plate 62) while at Ch.525 on the southern (S) side surface deposits have been eroded to expose the sedimentary rock weathering profile at the edge of the scar (Plate 63). Downslope from here the diversion channel is largely intact although locally smashed on the top lip and strongly abraded (Plates 20, 55, 63). Debris blocks the channel at several locations (Plates 56 - 61) and there are deposits of matrix rich debris downslope from it (Plate 66). In the central part of the scar alluvial deposits of washed debris extend down to the borrow scarp.

Pre-event there was heavy vegetation cover in this area that extended over three house platforms and an access track. A large (>200 m3) pile of loose boulders that was present on the downslope side of the access track just above the borrow scarp has been removed by the event.

The Borrow Scarp Ch. 575 to Ch.605, Plates 10, 11. The scarp is about 15 m high with an overall slope of about 37been removed by the scar but becomes lower and starts to die out on either side. Distinctive large insitu boulders are present on the scarp. Much of the central part of the scarp is washed clean of debris but debris occurs as boulders on the NE margin and as matrix rich debris on the SW margin.

Pre-event the scarp was covered with bushy vegetation and the large insitu boulders were present at similar locations to after the debris flow.

Borrow Area Ch.605 to Ch.725, Plates 11, 12. The borrow area slopes at 2u boulders were present at similar locations to after the debris 2orrow Area Ch.605 to Ch.725, Plates 11, 12. The borrow area slopes at 2u boulders were present at similar locations to after the debris central and SW part of the scar the debris thins and there are a number of large individual debris boulders with caps of matrix (Plate 58). On the NE side a thicker lobe of debris extends along a pre-existing low point to the crest of the cut slope. At Ch.660 a small debris free area of insitu vegetation is present within the thick bouldery lobes. In thinner debris at Ch 690 there is another much larger debris free area downslope from some large insitu boulders. Three alluvial channels are eroded into the debris lobes and originate from the toe of the borrow scarp. They are labelled from 1 in the SW to 3 in the NE.

Pre-event this was an irregular excavated area strewn with surface boulders left from the borrow activities and traversed by an excavated surface drainage channel at Ch.650 (Plates 16 and 17). There was a rough access track above the crest of the cut slope. Much of the lower part of this area was cut by tension cracks and small scarps to creeping landslides.

Cut Slope Ch.725 to Ch.830, Plates 13, 15. On the 17 small scarps to creeping landslides. of homogeneous debris. Occasional large boulders are left stranded on the slope and in several locations the debris flowed around boulders and lobes of heave leaving the insitu vegetation downslope from them undisturbed. The three channels from the borrow area recombine and extend down the main slope as two sets of braided channels that locally eroded into the completely decomposed andesite that forms the slope.

Pre-event the cut slope was generally grassed with surface concrete drainage channels. Creeping failures had resulted in a number of 1 m to 2 m high scarps near the top of the slope and two 1 m to 2 m high lobes of heave on the cut slope that completely disrupted the surface drainage channels.

Slope Toe Ch.830 to Ch.875, Plates 1, 12. At the flat slope toe lobes of debris over 1 m thick have been modified by water flowing over them or are overlain by alluvial fans up to 3 m thick banked up against the slope. The debris extends across a trapezoidal drainage channel which was followed for 70 m by an off shoot of debris. The main deposit was diverted to the NE and down into the stockpile area by a 2 m high ridge of old rockfill. Boulders of at least 1 m diameter are present in the debris at the slope toe.

Pre-event the slope toe was a flat, 25 m wide platform cut by a 5 m wide trapezoidal channel 15 m from the slope toe. On the southern side was the remnant of an old stockpile forming a 2 m high ridge along the edge of the platform which ends in a 2 m high scarp. Below the scarp is a 20 m wide terrace with tipped loads of rock fill on the downslope side.

Area 19 Platform Ch.875 to Ch. 1035, Plate 13. In the stockpile area debris flowed around individual tipped truck loads of rock and extended along a low point between two large piles of rockfill. The debris surface is locally washed to form a sandy gravely alluvial deposit but matrix rich debris with boulders up to 0.5 m diameter that occur within the debris at the distal end of the deposit.

Pre-event this area was in use as a rock fill stock pile with two large piles and numerous tipped truck loads of rock fill.

LEGEND

Debris

Thickness		Composition	
🟧	50mm to 500mm	☐	Matrix rich
🟧	500mm to 1 000mm	▨	Boulder deposition 1m to 3m thick with little matrix.
🟥	Over 1 000mm	▨	Boulder deposition 1m to 2m thick mixed with about 50% matrix.
		▨	Stream channel with cobbles, boulder, washed gravel and sand more than 100mm thick.
		○	Boulder - Part of Debris

Debris is shown by combination of thickness tone and composition overlay.

○ Boulder (same colour as background) no field evidence, most are debris, some may be insitu.

Colluvium (Slope Deposits)

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🟪	Upper Valley Colluvium. Clast supported loose to medium dense, orangeish brown, rounded, slightly decomposed to fresh, granite boulders and cobbles with some gravel and some sand and low plasticity finer material.
🟪	Lower Valley Colluvium. Matrix supported, firm to stiff, orangeish brown, gravelly, sandy clayey silt of low plasticity with some rounded to sub angular, slightly to moderately decomposed, granite boulders.
🟪	Channel Colluvium. Clast supported, loose to medium dense, light brown, subrounded, slightly decomposed to fresh, granite boulders and cobbles with some gravel, some sand and some low plasticity silt.
🟦	Fan Colluvium. Clast-supported, medium dense to dense, orangeish brown-stained, rounded, slightly to highly decomposed, granite boulders and cobbles with much gravel, sand and silt and occasional gravel sized angular clasts of sedimentary rock.

Bedrock

Volcanic rock of the Tuen Mun Formation.

🟫	Andesite, highly to extremely decomposed to form soft to firm light green silt.

Sedimentary rock of the Tsing Shan Formation.

🟩	Residual soil/Slope wash. Weathered profile which may have undergone minor down slope creep.
🟦	Generally fresh to slightly decomposed fine-grained sandstone and siltstone.

Fine-grained granite.

🟨	Highly decomposed and kaolinised, often with associated quartz veins.
🟥	Generally fresh to slightly decomposed.
▬	Basalt Dyke
～	Quartz Vein
⬜	Construction fill platforms or road.
🟩	Vegetation, undisturbed ground with the underlying material not mapped.

●	Boulder - Insitu, not moved by Debris Flow	○	Location of boulder before event from API.
—	Geological boundary	- -	Edge of mapping
☐	Unmapped Area		
— —	Approximate bedrock geology boundary modified from 1:20 000 Geology sheet 5 Tsing shan		
⚲	Seepage	～→	Water trail
—	Scarp at edge of Debris	→	Debris trail
⋯	Edge of Debris Flow Trail	T T T	Tension cracks and small slump scarps
— · —	Centreline of Debris Flow Trail	▷ ▷ ▷	Edge of heave lobe
⌒	Borrow scarp	∘T / ∘E	Pre-event location of telephone pole/electricity pole

Highly Abraded Bedrock -- Field Observation, (TN) -- From TN 4/91
Pre-event Outcrop -- Aerial Photograph observation
Green linework is from aerial photograph interpretation

△CH575	Location of cross section used for estimate of qualities and chainage from head of scar.
◁ 2	Approximate viewpoint and plate number of Aerial photograph
◁ 31	Approximate viewpoint and plate number of Terrestrial photograph
} Bedrock Outcrop	Geomorphological Unit used in text

⊕ D14	Insitu Density Pit	▣ TP15	Trial Pit
⊡ S1	Sand replacement insitu density test	(M30)	Debris sample location
⌒ TP1/ Trench 1	Trial trench	├──┤	Location of superelevation measurement

NOTE

Base map prepared using photogrammetry from post debris flow, September 1990
Aerial Photographs A22763/4

Colluvium less than 0.5m not mapped.

	name	date
drawn	J.King	
traced	Y.L.Lee	

file no. GCP 2/D9/3

project
Tsing Shan Debris Flow Study

drawing title
Geomorphological Map of the 1990
TSING SHAN DEBRIS FLOW
Ch 500 - Ch 1035, Erosion Part

drawing no.	scale
GEO/P/PTE/1 Sheet 2	1:630

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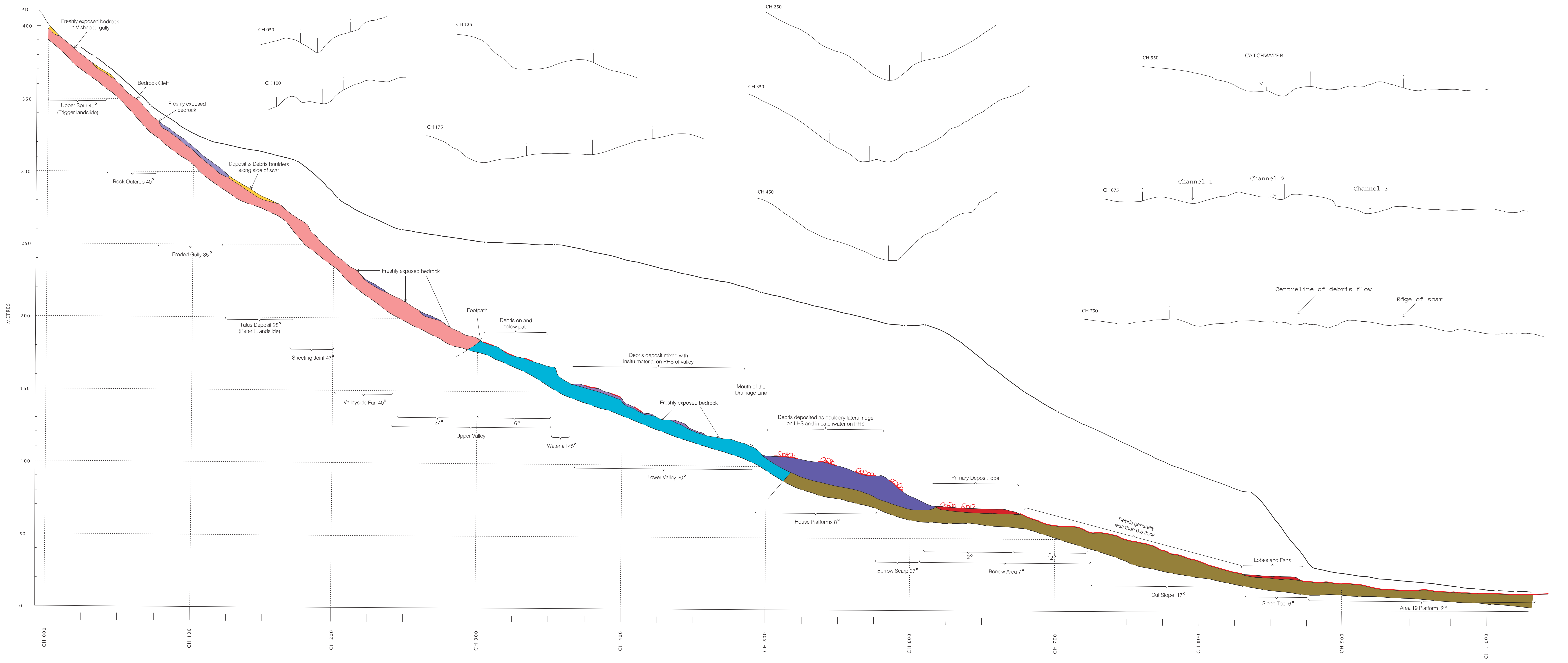

LEGEND

🟥	Debris
▨	Bouldery debris deposits offset from centreline
▨	Spur colluvium
▨	Upper valley colluvium
▨	Lower valley colluvium
▨	Fan colluvium
▨	Volcanic rock
🟦	Sedimentary rock
🟨	Completely decomposed granite
▨	Fine grained granite

2000m^3
1000m^3
0
Volume of active debris in m^3
1mm above ground level=100m^3

no.	date	description	initial
REVISION			

	name	date
surveyed	J.King	
designed	J.King	
drawn	J.King	
traced	P.L.Ho	
checked	J.King	

examined

contract no.

file no. GCP 2/D9/3

job no.

project

Tsing Shan Debris Flow Study

drawing title

Longitudinal Section and Representative Cross Sections of the Debris Flow Scar

drawing no. GEO/P/PTE/2

scale 1:1 800 and 1:900

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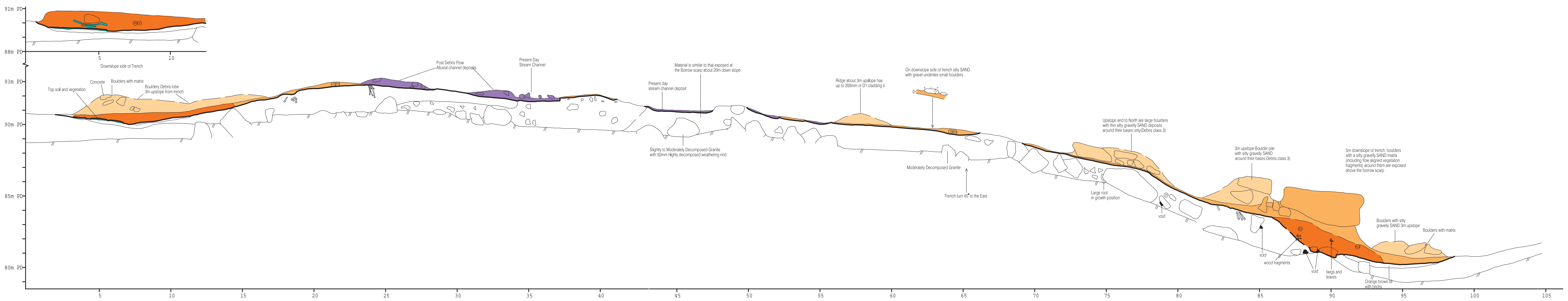
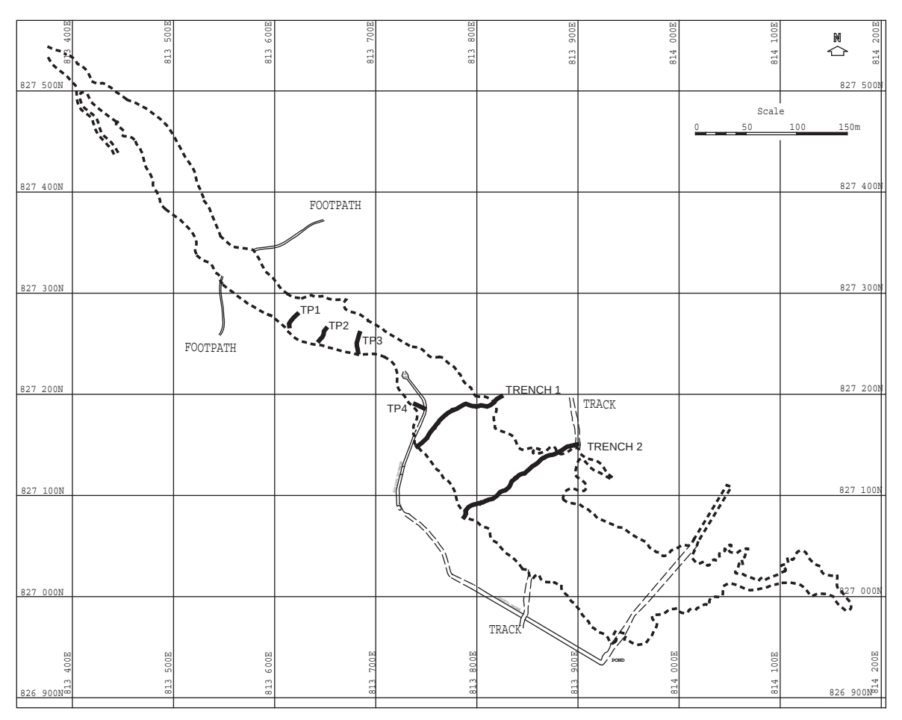
TRENCH 1



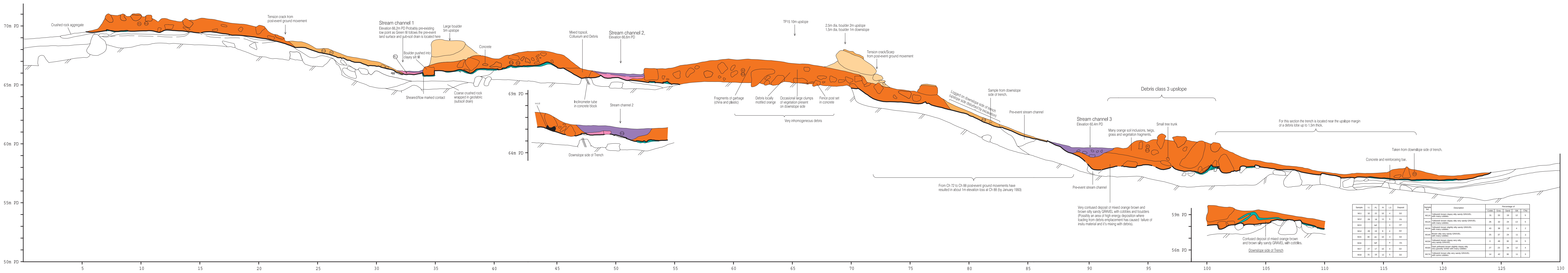
Location Map



Legend

▨	Class 1 Debris - Loose, lightly cemented (dry) grey brown silty gravelly SAND with cobbles. Homogenous texture but locally mottled with dark brown coating on fissures and occasional bubble shaped voids.
▨	Class 2 Debris - Loose, light brown silty gravelly SAND with sub rounded cobbles and boulders of slightly to moderately decomposed granite and sub angular coarse gravel of sedimentary rock. Scattered 10mm to 30mm inclusions of orange brown sandy SILT are present and local areas are mottled dark brown (possibly decomposed remains of organic material).
▨	Sorted Debris (Alluvial Deposits) Very loose, dry light brown sandy GRAVEL with cobbles. (generally post debris flow alluvial channel deposits of washed debris.
▨	Class 4 Debris - Loose(dry) GRAVEL and cobbles with a silty sand coating to the clasts.
▨	Vegetation Mat mainly composed of stems and leaves of sword grass often with roots present at base
▨	Debris off section upslope
☐	Insitu material

TRENCH 2



Sample	LL	PL	PI	LS	Deposit
M11	32	22	10	4	D2
M12	29	18	11	5	D1
M13		NP		3	CF
M14	28	19	9	4	D2
M15	30	20	10	3	D2
M16		NP		4	D1
M17	27	17	10	4	D2
M18	31	19	12	5	D2

Sample No.	Description	Percentage of				
		Cobbl.	Grav.	Sand	Silt	Clay
M11A	Yellowish brown clayey silty sandy GRAVEL with many cobbles	31	33	19	12	5
M12A	Yellowish brown clayey silty very sandy GRAVEL with many cobbles	26	32	24	13	5
M13A	Yellowish brown slightly silty sandy GRAVEL with many cobbles	43	38	13	4	2
M14A	Brown silty very sandy GRAVEL with many cobbles	25	37	24	11	3
M15A	Yellowish brown clayey very silty very sandy GRAVEL	0	49	30	16	5
M16A	Dark yellowish brown slightly clayey silty very gravelly SAND with many cobbles	27	23	34	12	4
M17A	Yellowish brown silty very sandy GRAVEL with some cobbles	14	42	30	11	3

no.	date	description	initial

REVISION

	name	date
surveyed	J.King	
designed	J.King	
drawn	J.King	
traced	Y.L.Lee	
checked	J.King	

examined

contract no.

file no. GCP 2/D9/3

job no.

project

Tsing Shan Debris
Flow Study

drawing title

Cross Section of
the Debris Deposit
(Trenchs 1 and 2)

drawing no. GEO/P/PTE/3

scale
H 1:160
V 1:160
H/V = 1

office

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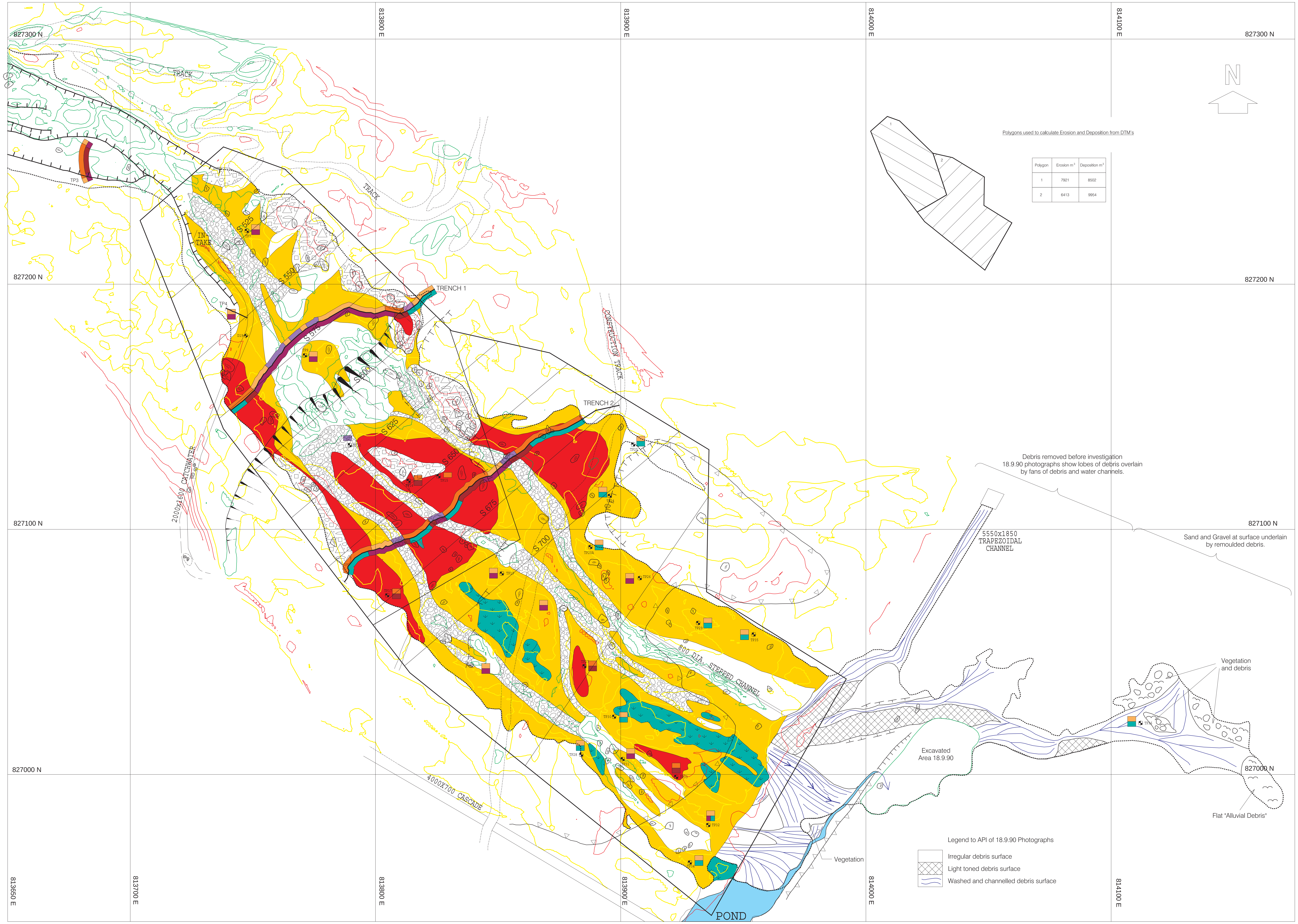

Debris removed before investigation
18.9.90 photographs show lobes of debris overlain
by fans of debris and water channels.

Sand and Gravel at surface underlain
by remoulded debris.

Polygons used to calculate Erosion and Deposition from DTM's

Polygon	Erosion m^3	Deposition m^3
1	7921	8502
2	6413	9954

Legend to API of 18.9.90 Photographs

☐	Irregular debris surface
▨	Light toned debris surface
〰	Washed and channelled debris surface

LEGEND :

Debris and contacts logged at exposures pits and trenches

🟧 🟦	Debris class Contact type

Debris Class

🟧	Class 1 Homogenous matrix debris
🟧	Class 2 Inhomogenous matrix debris
🟪	Class 3 Bouldery debris
🟪	Sorted (alluvial) debris

Contact Type

🟦	Type 1 Low Energy Depositional
🟥	Type 2 High Energy Depositional
🟪	Type 3 High Energy Erosional

Plan

General Debris distribution extrapolated from logged exposure by field observation and A.P.I. Boundaries may be gradational.

🟨	Class 1 Debris
🟥	Class 2 Debris
△	Class 3 Debris
○	Sorted (alluvial) Debris
☐	Insitu Material, with eroded surface and less than 50mm of debris
🟦	Vegetation, Undisturbed Ground
⊕ D19	Insitu density pit
▚ TP9	Test pit
╥	Borrow scarp
⊤⊤⊤	Tension cracks and small slump scarps
▷	Edge of heave lobe

Erosion and Deposition

S 650	Chainage of cross section used for calculation of quantities
—	ZERO CONTOUR
—	DEPOSITION
—	EROSION

1. Erosion and Deposition Data from comparision of pre and post event DTM's
2. All data from 2 m contours.
3. Displayed erosion/deposition contours are 1 m intervals.

no.	date	description	initial
revision			

	name	date
surveyed		
designed	J.P.King	
drawn	J.P.King	
traced	Y.L.Lee	
checked	J.P.King	

examined

contract no.

file no. GCP 2/D9/3

job no.

project

Tsing Shan Debris Flow Study

title

Debris flow Deposits and contacts

drawing no. GEO/P/PTE/4

scale 1 : 600

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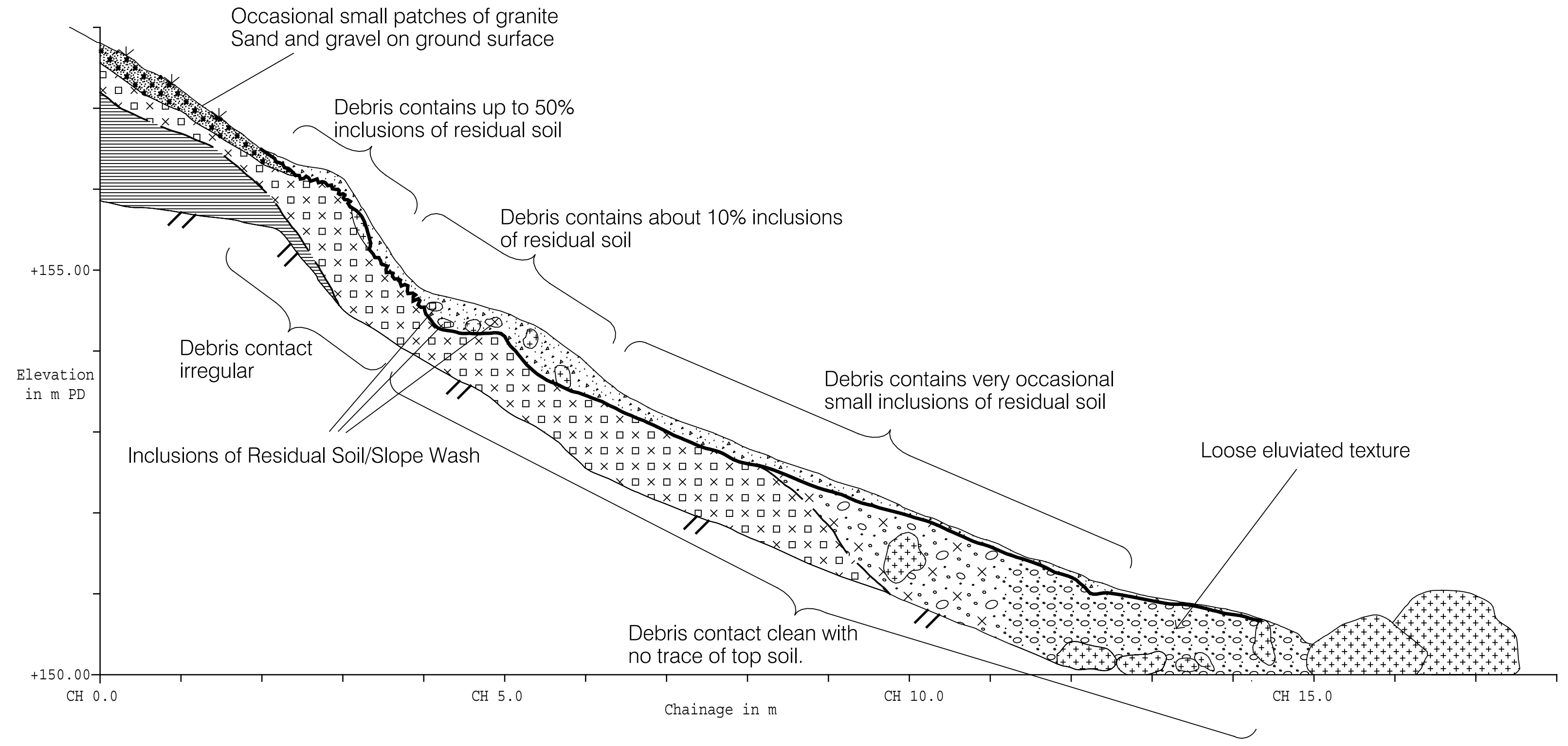
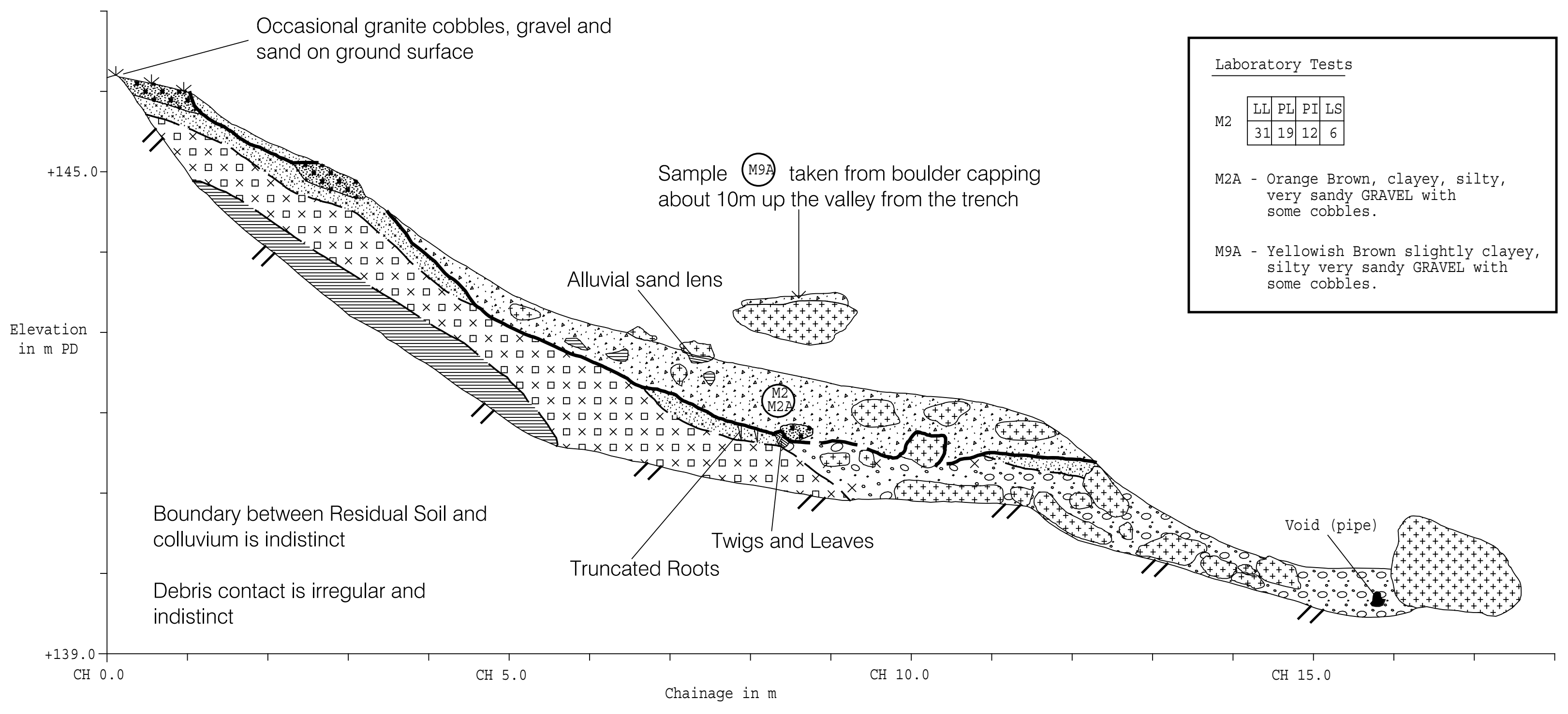
TP1



- ▒ Loose, greyish brown, slightly clayey, silty, very gravelly SAND with rounded to sub angular granite cobbles and very occasional angular gravel and cobbles of sedimentary rock. Locally with 5mm to 30mm inclusions of orange-brown residual soil. (Debris class 1)
- ▩ Firm to stiff, dark brown, clayey sandy SILT with angular gravel of slightly to moderately decomposed sedimentary rock. Many roots are present. (Top soil)
- ⊠ Stiff, orangeish brown, sandy clayey SILT with many angular gravel and cobble sized clasts of slightly to moderately decomposed sedimentary rock. Grades downwards into weathered sedimentary rock. (Residual soil/slope wash)
- ▒ Firm to stiff, orangeish brown, sandy clayey SILT with many angular gravel and cobble sized clasts of slightly to moderately decomposed sedimentary rock and occasional rounded cobbles and small boulders of slightly decomposed to fresh granite. (Lower Valley Colluvium)
  The granite clasts become more numerous towards the valley bottom and the loose eluviated texture implies a high permeability and a region of piping/through flow of groundwater. (Channel deposit)

TP2



Laboratory Tests

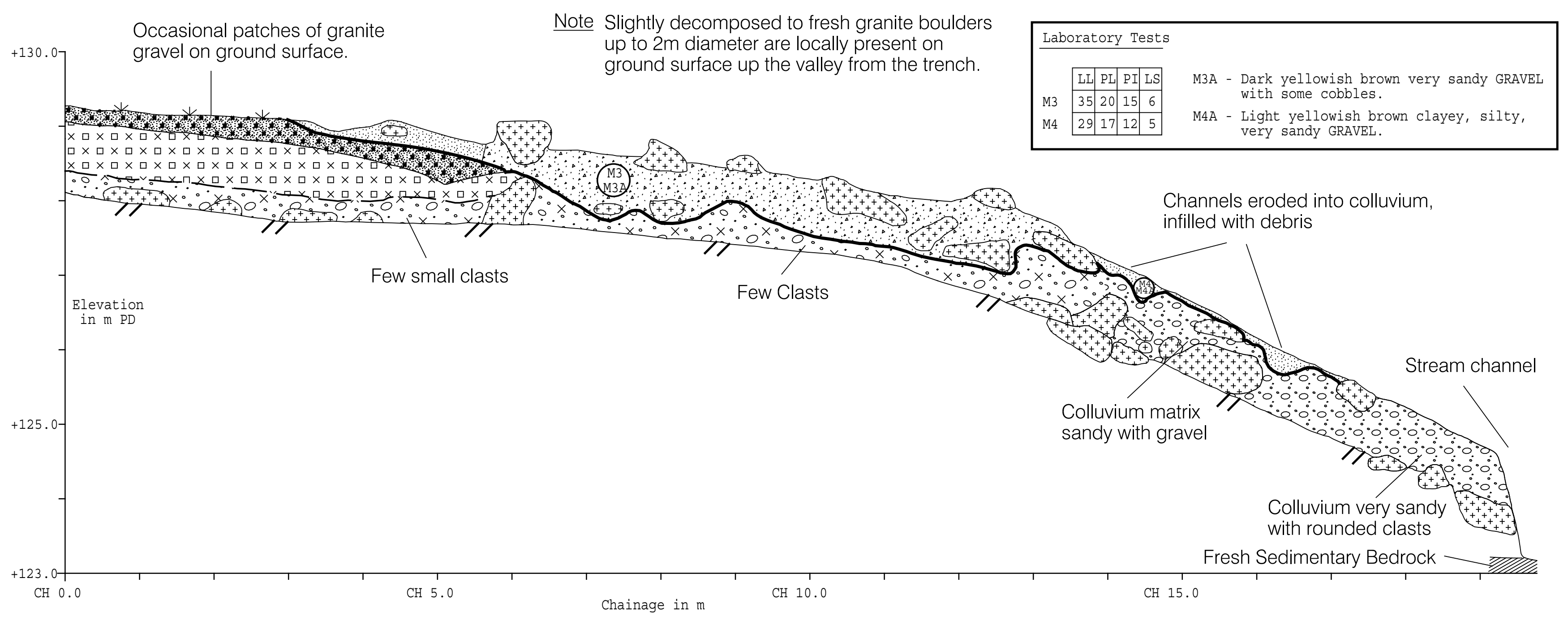
	LL	PL	PI	LS
M2	31	19	12	6

M2A - Orange Brown, clayey, silty, very sandy GRAVEL with some cobbles.

M9A - Yellowish Brown slightly clayey, silty very sandy GRAVEL with some cobbles.

- ▒ Loose, brown, silty SAND with granite gravel. (Debris class 1 debris/trail)
- ▒ Loose, brown, silty gravelly SAND (Debris) with 5mm to 50mm inclusions of orangeish brown clayey sandy SILT (residual soil), sub rounded cobbles and boulders of slightly decomposed to fresh granite and occasional angular gravel of slightly to moderately decomposed sedimentary rock. Twigs roots and leaves are present mixed with the deposit and locally concentrated. (Debris class 2)
- ▩ Firm to stiff, dark brown, clayey sandy SILT with angular gravel of slightly to moderately decomposed sedimentary rock. Many roots are present. (Top soil)
- ▒ Stiff, light yellow-brown, sandy SILT. Locally grades up into topsoil and down into residual soil or colluvium. (Lower topsoil profile)
- ⊠ Stiff, orangeish brown, sandy clayey SILT with many angular gravel and cobble sized clasts of slightly to moderately decomposed sedimentary rock. Grades downwards into weathered sedimentary rock. (Residual soil/slope wash)
- ▒ Firm to stiff, orangeish brown, sandy clayey SILT with many angular gravel and cobble sized clasts of slightly to moderately decomposed sedimentary rock and occasional rounded cobbles and small boulders of slightly decomposed to fresh granite. (Lower Valley Colluvium)
  The granite clasts become more numerous towards the valley bottom. (Channel Deposit)

TP3



Note Slightly decomposed to fresh granite boulders up to 2m diameter are locally present on ground surface up the valley from the trench.

Laboratory Tests

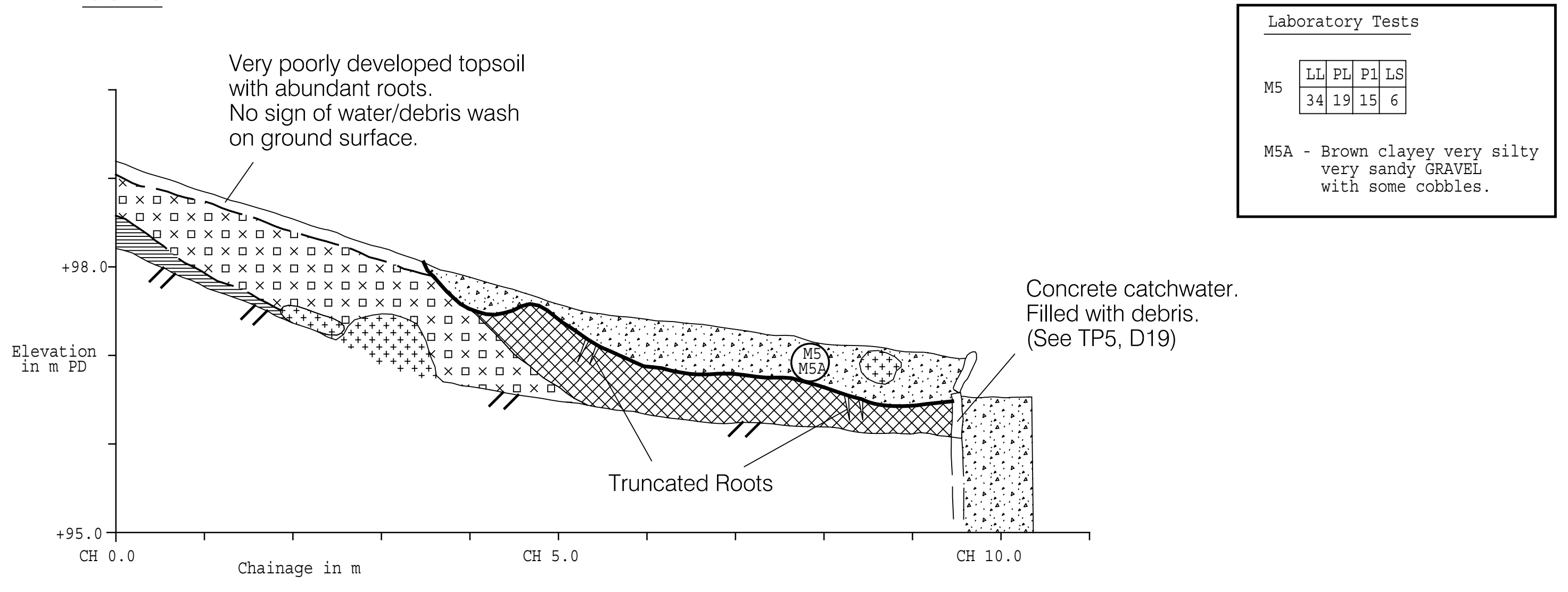
	LL	PL	PI	LS
M3	35	20	15	6
M4	29	17	12	5

M3A - Dark yellowish brown very sandy GRAVEL with some cobbles.

M4A - Light yellowish brown clayey, silty, very sandy GRAVEL.

- ▒ Loose, light-brown, clayey silty very gravelly sand with occasional small inclusion of orangeish brown silt (Debris class 1).
- ▒ Loose, dark brown with orange flecks and streaks, clayey sandy SILT with many sub-rounded cobbles and boulders of slightly decomposed to fresh granite and angular gravel of slightly to moderately decomposed sedimentary rock, and inclusion of orangeish brown silt. (Mixed colluvium, residual soil and debris - [debris class 2])
- ▩ Firm to stiff, light brown, clayey sandy SILT with angular gravel of slightly to moderately decomposed sedimentary rock. Many roots are present. (Top soil)
- ⊠ Firm to stiff, orangeish brown, sandy clayey SILT with many angular gravel and cobble sized clasts of slightly to moderately decomposed sedimentary rock. Grades up into topsoil and down into colluvium. (Slope wash?)
- ▒ Firm to stiff, orangeish brown, sandy SILT with many rounded to sub-angular boulders of slightly decomposed to fresh granite and gravel and cobble sized clasts of slightly to moderately decomposed sedimentary rock and granite. (Lower Valley Colluvium)
  Becomes clast supported and very sandy towards valley bottom. (Channel Deposit)

TP4



Laboratory Tests

	LL	PL	P1	LS
M5	34	19	15	6

M5A - Brown clayey very silty very sandy GRAVEL with some cobbles.

- ▒ Loose, brown very silty SAND with many rounded to sub angular gravel, cobble and small boulder sized clasts of slightly decomposed to fresh granite and some angular gravel and cobble sized clasts of slightly to moderately decomposed sedimentary rock. (Debris class 1)
- ⊠ Firm to stiff, orangeish brown, clayey SILT with some angular gravel and cobble sized clasts of slightly to moderately decomposed sedimentary rock. (Slope wash?)
  Two large slightly decomposed to fresh granite boulders are present at the base? of the deposit. (Lower Valley Colluvium?)
- ▦ Soft to firm greenish-yellow clayey SILT with occasional orange brown clayey SILT inclusions, cobbles of sedimentary rock, steel bars and geofabric fragments. (Fill)

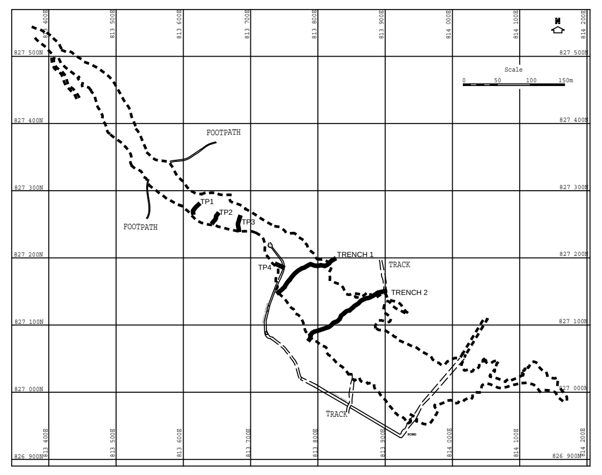
Legend

- ▩ Weak, orangeish brown partially weathered sedimentary rock.
- ▒ Strong, grey brown, slightly decomposed to fresh granite boulder.
- ◯ Sample location and number
- ━ Base of debris
- ⌇ Irregular contact at base of debris
- ─ Indistinct contact
- ⫽ Invert of Trench

Note

Complete logs in Appendix J.

Location Map



no.	date	description	initial
REVISION			

	name	date
surveyed	J.King	
designed	J.King	
drawn	J.King	
traced	Y.L.Lee	
checked	J.King	
examined		

contract no.

file no. GCP 2/D9/3

job no.

project

Tsing Shan Debris Flow Study

drawing title

Cross Sections of the Lower Valley
(Logs of TP1, TP2, TP3, TP4)

drawing no. GEO/P/PTE/5

scale
H = 1:85
V = 1:85
H/V = 1

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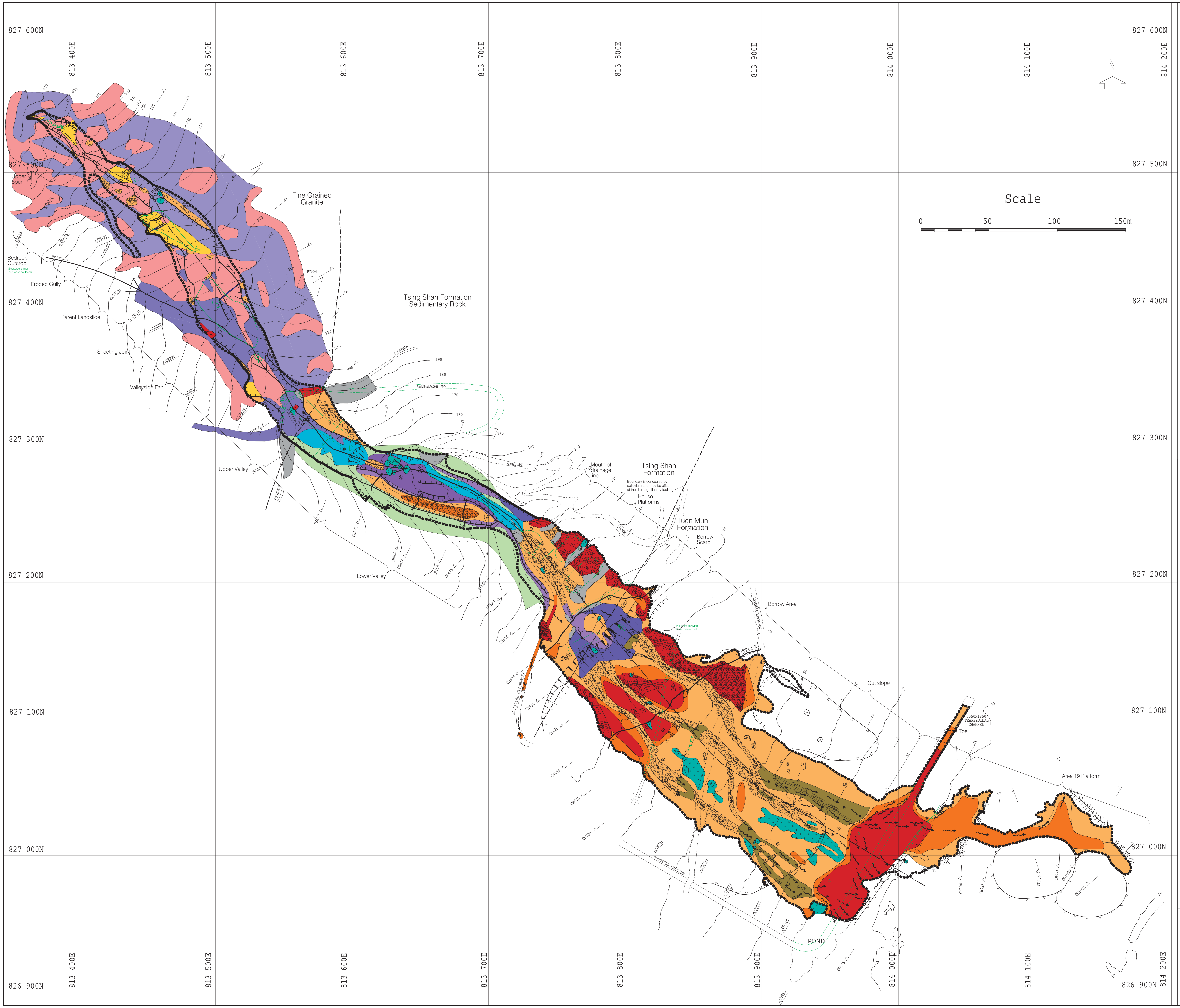

LEGEND

Debris

Thickness		Composition	
🟧	50mm to 500mm	⬜	Matrix rich
🟧	500mm to 1 000mm	▨	Boulder deposition 1m to 3m thick with little matrix.
🟥	Over 1 000mm	▨	Boulder deposition 1m to 2m thick mixed with about 50% matrix.
		▨	Stream channel with cobbles, boulder, washed gravel and sand more than 100mm thick.
			Boulder - Part of Debris

Debris is shown by combination of thickness tone and composition overlay.

Boulder (same colour as background) no field evidence, most are debris, some may be insitu.

Colluvium (Slope Deposits)

- 🟪 Spur Colluvium. Clast supported, very loose to medium dense, yellowish brown, angular, slightly decomposed to fresh, granite boulders and cobbles with some gravel, sand and low plasticity finer material.
- 🟪 Upper Valley Colluvium. Clast supported loose to medium dense, orangeish brown, rounded, slightly decomposed to fresh, granite boulders and cobbles with some gravel and some sand and low plasticity finer material.
- 🟪 Lower Valley Colluvium. Matrix supported, firm to stiff, orangeish brown, gravelly, sandy clayey silt of low plasticity with some rounded to sub angular, slightly to moderately decomposed, granite boulders.
- 🟪 Channel Colluvium. Clast supported, loose to medium dense, light brown, subrounded, slightly decomposed to fresh, granite boulders and cobbles with some gravel, some sand and some low plasticity silt.
- 🟦 Fan Colluvium. Clast-supported, medium dense to dense, orangeish brown-stained, rounded, slightly to highly decomposed, granite boulders and cobbles with much gravel, sand and silt and occasional gravel sized angular clasts of sedimentary rock.

Bedrock

Volcanic rock of the Tuen Mun Formation.

- 🟫 Andesite, highly to extremely decomposed to form soft to firm light green silt.

Sedimentary rock of the Tsing Shan Formation.

- 🟩 Residual soil/Slope wash. Weathered profile which may have undergone minor down slope creep.
- 🟦 Generally fresh to slightly decomposed fine-grained sandstone and siltstone.

Fine-grained granite.

- 🟨 Highly decomposed and kaolinised, often with associated quartz veins.
- 🟥 Generally fresh to slightly decomposed.

Basalt Dyke

Quartz Vein

⬜ Construction fill platforms or road.

🟩 Vegetation, undisturbed ground with the underlying material not mapped.

Boulder - Insitu, not moved by Debris Flow	Location of boulder before event from API.
Geological boundary	Edge of mapping
⬜ Unmapped Area	
Approximate bedrock geology boundary modified from 1:20 000 Geology sheet 5 Tsing shan	
Seepage	Water trail
Scarp at edge of Debris	Debris trail
Edge of Debris Flow Trail	Tension cracks and small slump scarps
Centreline of Debris Flow Trail	Edge of heave lobe
Borrow scarp	°T/°E Pre-event location of telephone pole/electricity pole

△CH5 75 Location of cross section used for estimate of qualities and chainage from head of scar.

} Bedrock Outcrop Geomorphological Unit used in text

TP1/ Trench 1 Trial trench

NOTE

Base map prepared using photogrammetry from post debris flow, September 1990 Aerial Photographs A22763/4

Colluvium less than 0.5m not mapped.

	name	date
drawn	J.King	
traced	Y.L.Lee	
file no.	GCP 2/D9/3	

project
Tsing Shan Debris Flow Study

drawing title
Materials distribution
Tsing Shan Debris Flow

drawing no.	scale
GEO/P/PTE/6	1:1 100

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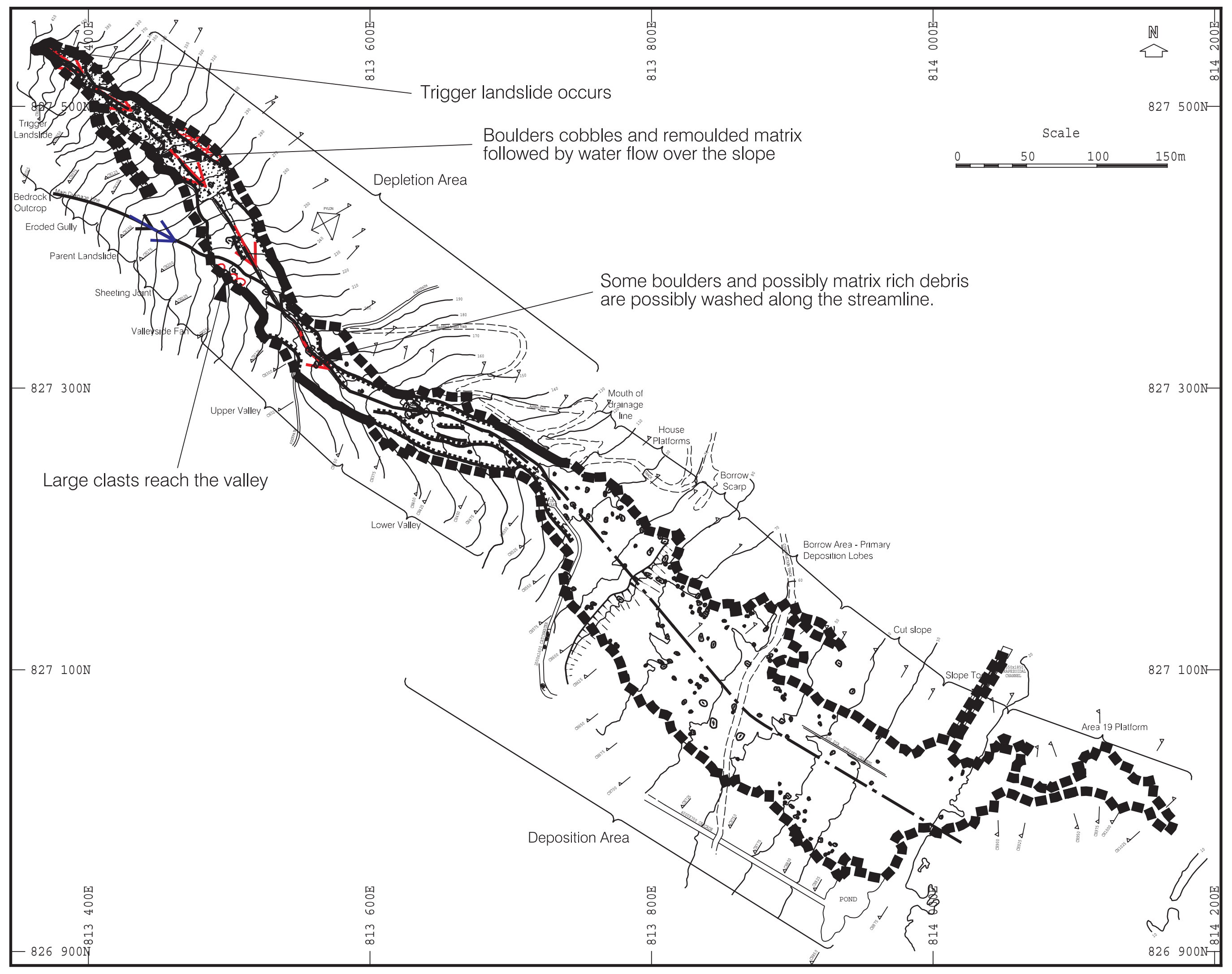
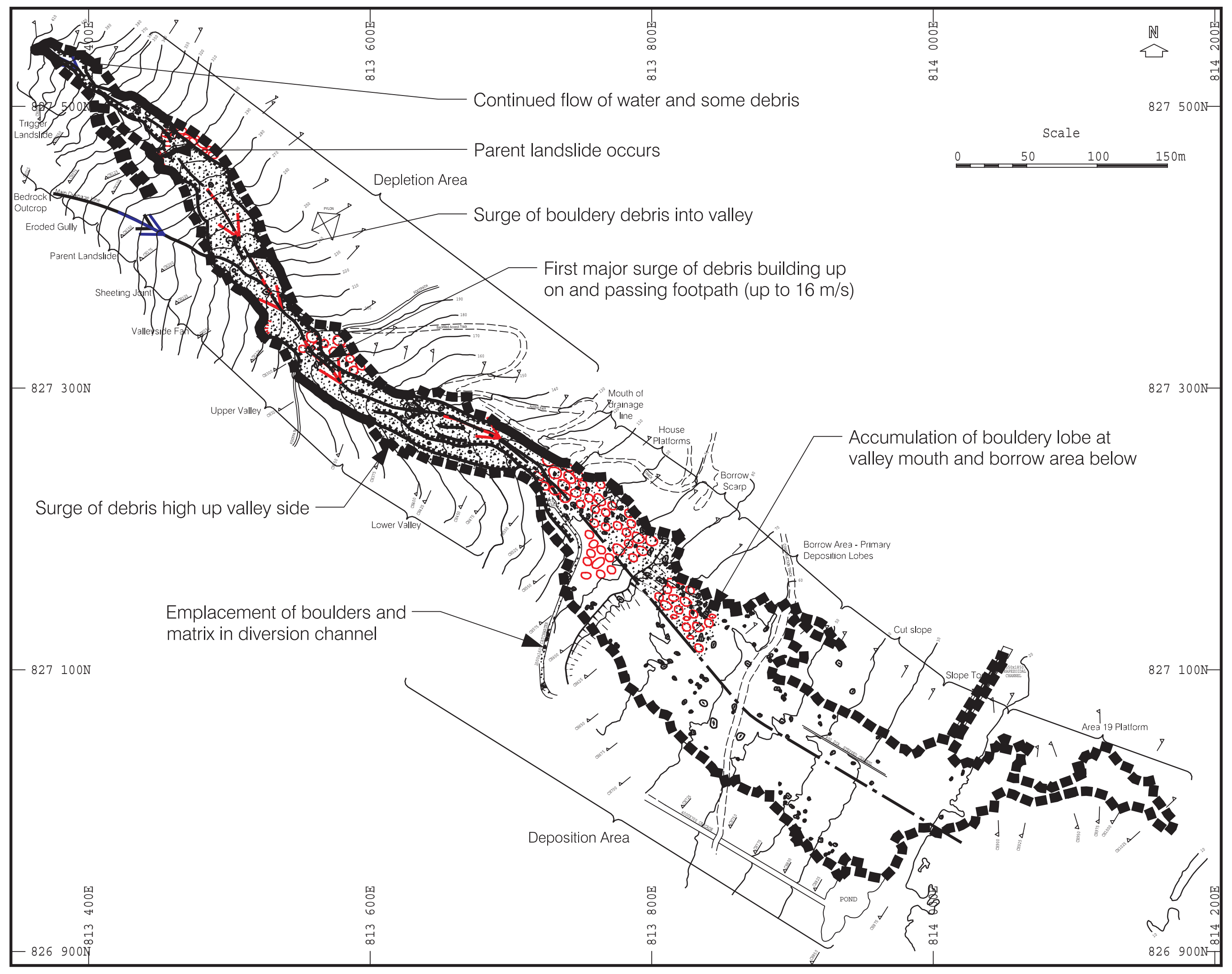


Trigger landslide occurs

Boulders cobbles and remoulded matrix followed by water flow over the slope

Some boulders and possibly matrix rich debris are possibly washed along the streamline.

Large clasts reach the valley



Continued flow of water and some debris

Parent landslide occurs

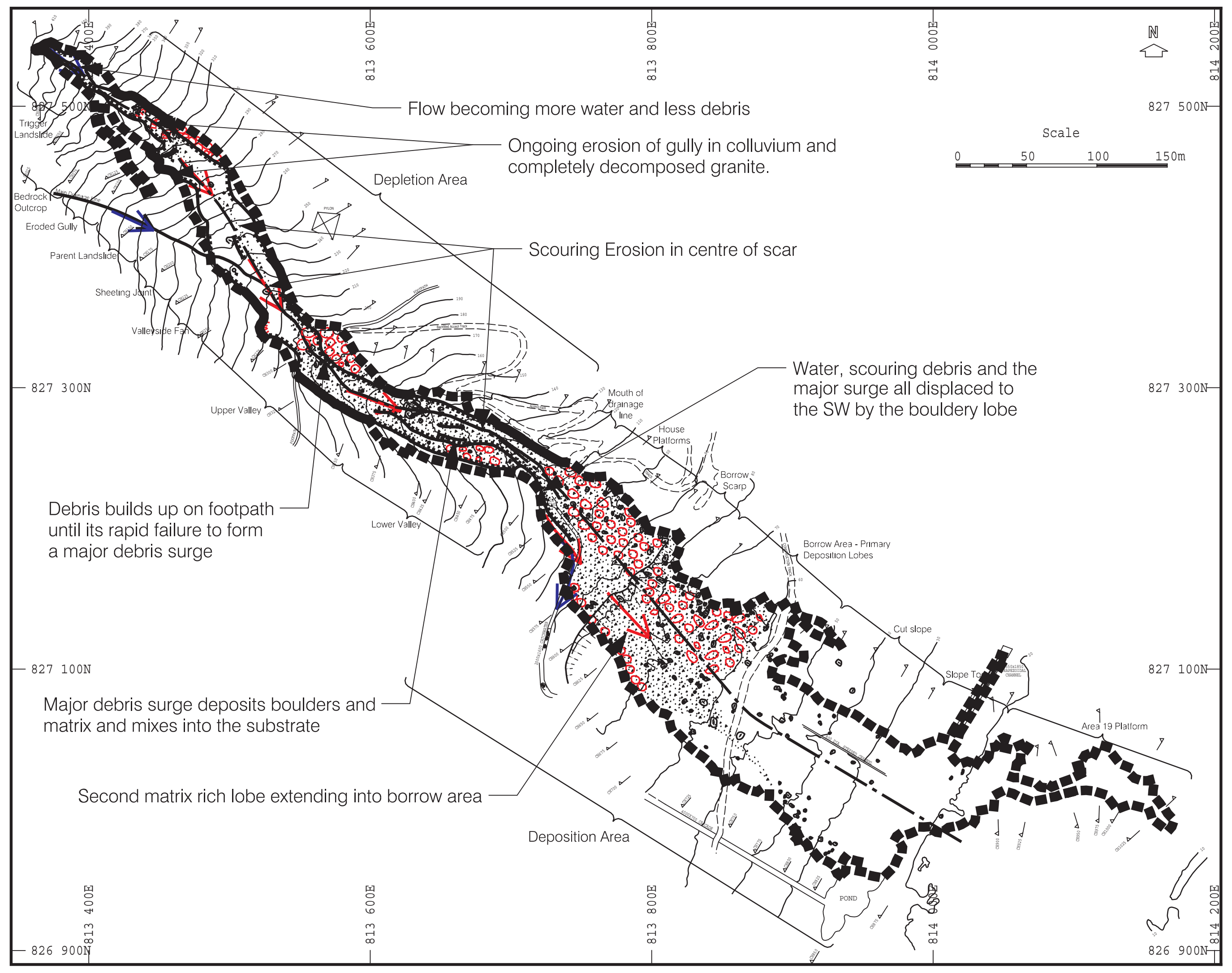
Surge of bouldery debris into valley

First major surge of debris building up on and passing footpath (up to 16 m/s)

Accumulation of bouldery lobe at valley mouth and borrow area below

Surge of debris high up valley side

Emplacement of boulders and matrix in diversion channel



Flow becoming more water and less debris

Ongoing erosion of gully in colluvium and completely decomposed granite.

Scouring Erosion in centre of scar

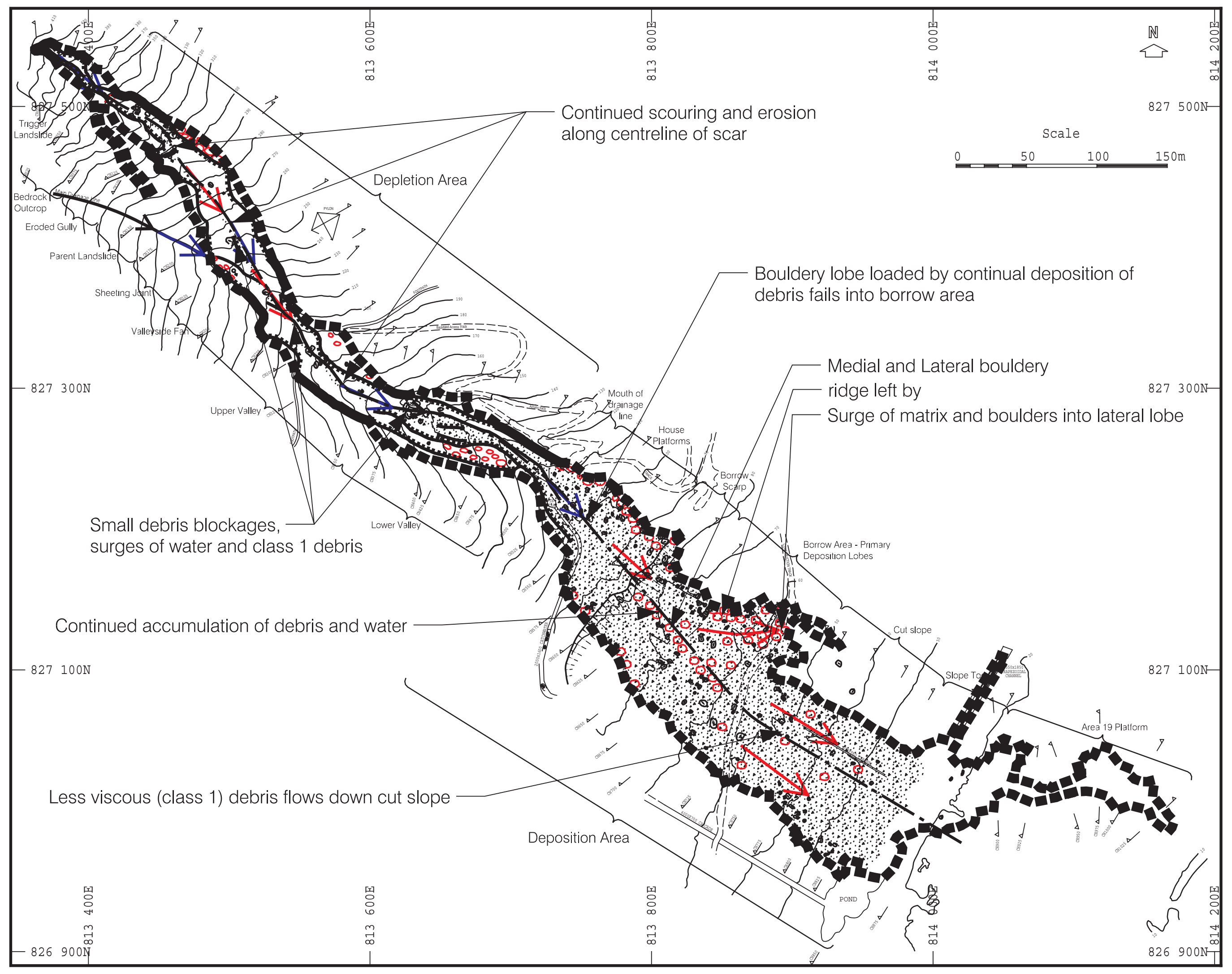
Water, scouring debris and the major surge all displaced to the SW by the bouldery lobe

Debris builds up on footpath until its rapid failure to form a major debris surge

Major debris surge deposits boulders and matrix and mixes into the substrate

Second matrix rich lobe extending into borrow area

About 02.30 hrs



Continued scouring and erosion along centreline of scar

Bouldery lobe loaded by continual deposition of debris fails into borrow area

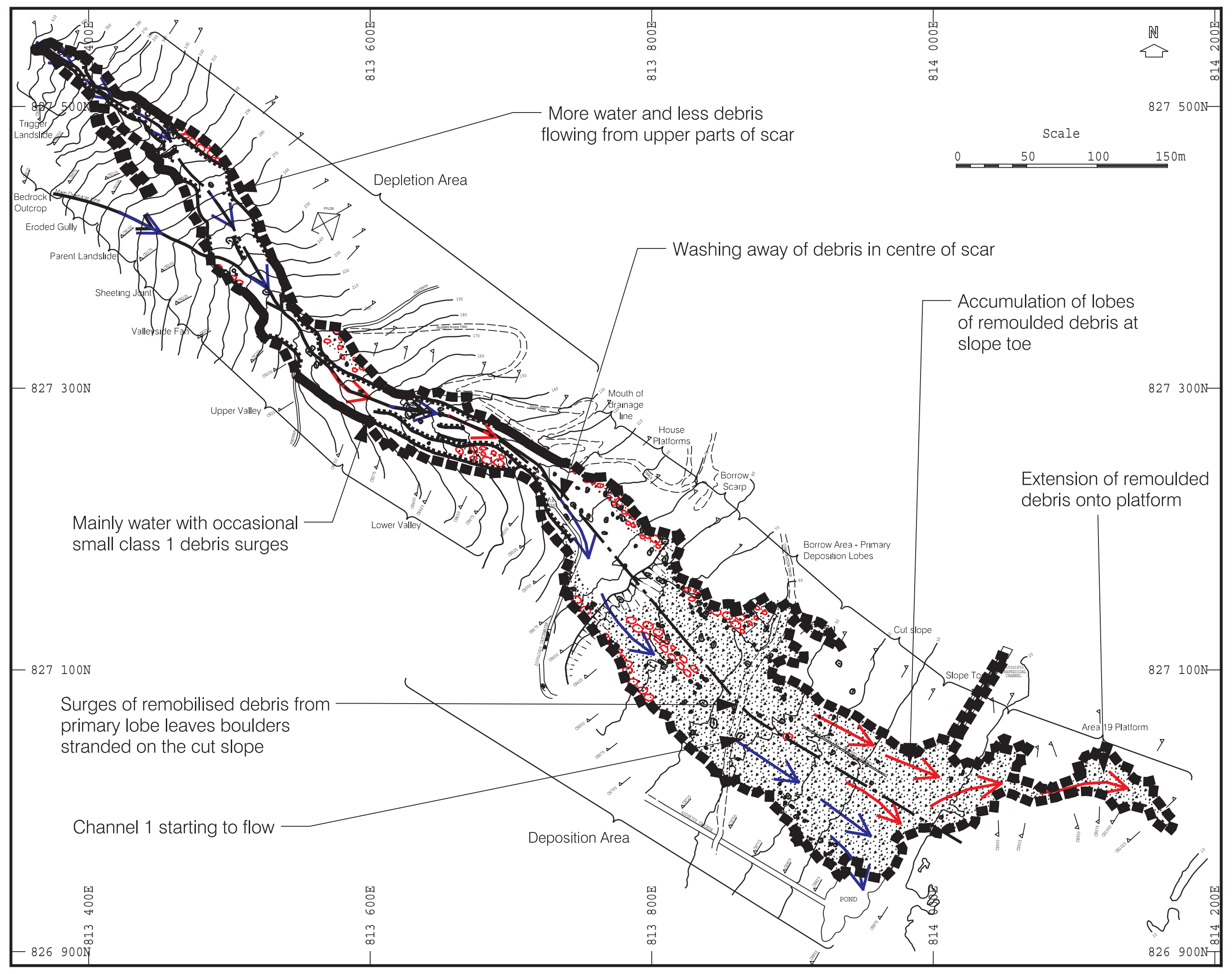
Medial and Lateral bouldery ridge left by

Surge of matrix and boulders into lateral lobe

Small debris blockages, surges of water and class 1 debris

Continued accumulation of debris and water

Less viscous (class 1) debris flows down cut slope



More water and less debris flowing from upper parts of scar

Washing away of debris in centre of scar

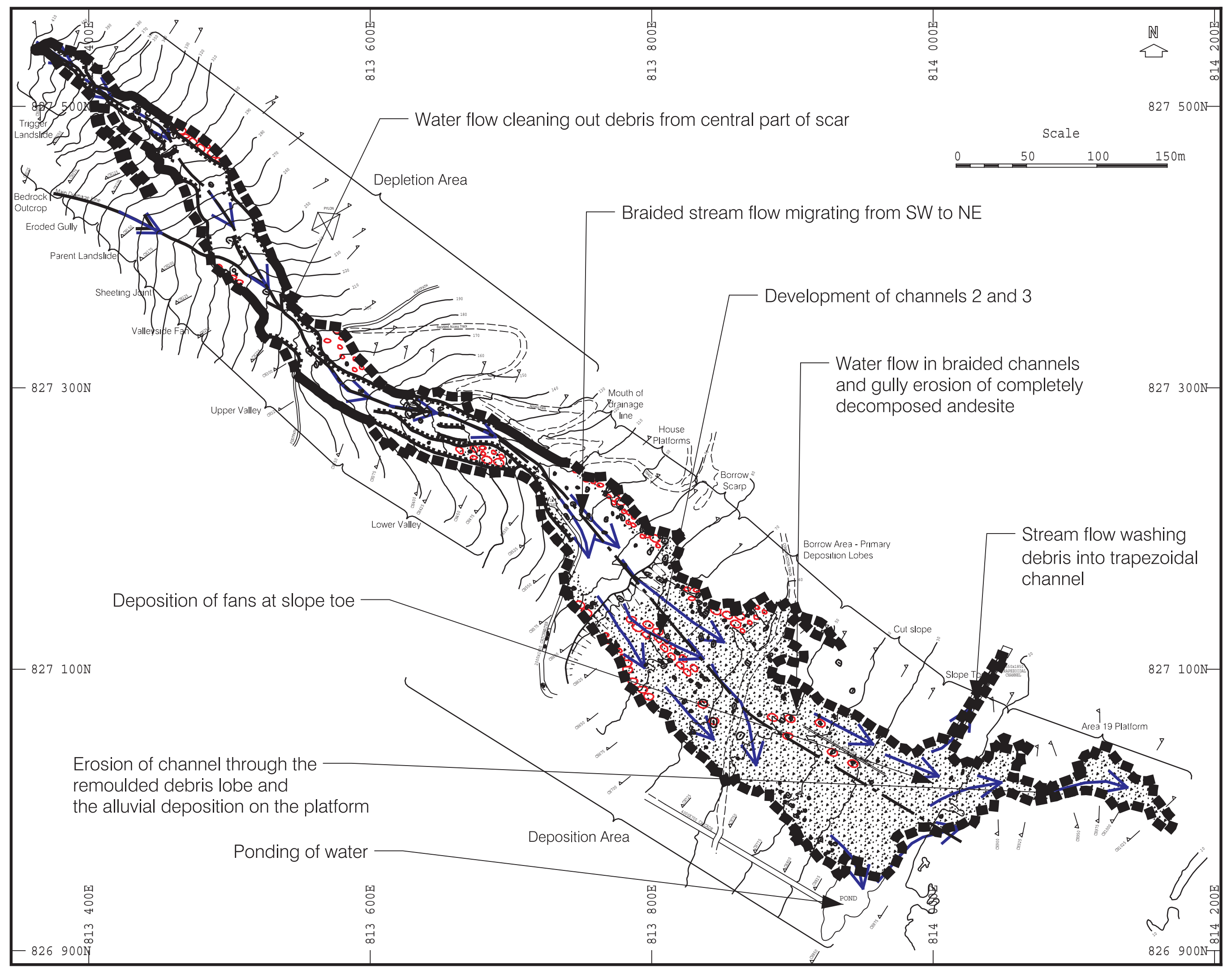
Accumulation of lobes of remoulded debris at slope toe

Extension of remoulded debris onto platform

Mainly water with occasional small class 1 debris surges

Surges of remobilised debris from primary lobe leaves boulders stranded on the cut slope

Channel 1 starting to flow



Water flow cleaning out debris from central part of scar

Braided stream flow migrating from SW to NE

Development of channels 2 and 3

Water flow in braided channels and gully erosion of completely decomposed andesite

Stream flow washing debris into trapezoidal channel

Deposition of fans at slope toe

Erosion of channel through the remoulded debris lobe and the alluvial deposition on the platform

Ponding of water

About 03.30 hrs

Up to about 07.00

LEGEND

→ Water Flow

→ Remoulded Debris Flow

⌒ Active Scarp

▒ Matrix Rich Debris

○ Bouldery Debris

no.	date	description	initial
REVISION			

	name	date
surveyed	J.King	
designed	J.King	
drawn	J.King	
traced	Y.L.Lee	
checked	J.King	

examined

contract no.

file no. GCP 2/D9/3

job no.

project

Tsing Shan Debris Flow Study

drawing title

Interpreted Sequence of
Debris Flow Development

drawing no. GEO/P/PTE/7

scale 1:4 500

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