Annex A - Drainage Impact Assessment (DIA) of Shatin Pass Road

There are two key components in the DIA of a road. First is to investigate whether there are any additional lateral or upstream inflows to the road and to provide interception roadside channels or inlets to prevent them flowing onto the road. Second is to assess the adequacy of the existing drainage facilities of the road and check them with reference to RD/GN/035. Shatin Pass Road is used as a study case and the steps of analysis are shown below.

For the ease of reference of the readers, some remarks and detailed elaboration of the assessment have been added to this DIA. Further information is shown in the Supplementary Guidelines.

Step 1 Realistic delineation of the actual catchment area of the road by making use of the available topographic survey maps.

Using the topographic information on the 1:1,000 survey maps to:

a) delineate the rural catchments along ridges of hills and edges of slopes; and
b) delineate the urban catchments along road boundaries.

Please refer to plan No. SPR-Stage 1.pdf for the preliminary delineation based on the topographical information on the survey maps.

Remarks:

1. Shatin Pass Road has three reaches which are not connected hydraulically. The topography and the road network layout show that most of the stormwater from the upstream reach of Shatin Pass Road will flow into Chuk Yuen Road rather than into the lower reach of Shatin Pass Road. Also, another section of Shatin Pass Road is a flat road separated by Lung Cheung Road and is out of the scope of the present study. In this DIA, only the upper reach of Shatin Pass Road linking with upstream catchments (i.e. road section hatched in yellow in Plan No. SPR-Stage 1.pdf) is studied.
2. Catchments with boundary highlighted in red are potential additional catchments to the concerned section of Shatin Pass Road.

Step 2 Identification of existing drainage provision for interception of stormwater in the catchment area outside the steep road reserve.

Identify the existing drainage provision by reviewing the drainage record plans from DSD and conducting site inspection.

Step 3 Fine tune the actual boundary of the additional catchments outside the road and evaluate the additional stormwater that will eventually flow onto the road pavement.

Based on the identified drainage provision along the boundaries of the adjacent catchments, assess whether they are adequate to intercept the stormwater flow from those catchments and then evaluate additional stormwater runoff will flow

from the adjacent catchments to the road pavement under 1 in 50 years rainstorm event.

Please refer to plan No. SPR-Stage 2.pdf and the Notes for SPR-Stage 2.doc for the fine-tuned catchment boundaries.

Remarks:

1. In the evaluation it is assumed that the existing drainage facilities of other parties(e.g., drainage channels, catch pits, natural watercourses) have adequate intercepting capacities and function properly.
2. Stormwater runoff in the catchments with boundary highlighted in green (i.e. Areas S4, S5 and S11) will unlikely be discharged onto the concerned road section (i.e. road section hatched in yellow in SPR-Stage 1.pdf).
3. Portion of stormwater runoff in the catchments with boundary highlighted in cyan (i.e. upland catchments of Areas S1 – S3 and S8) will likely be discharged onto the concerned road section. However, as there is no road kerb provided along part of the road section adjacent to Area S3, it is anticipated that a majority portion of stormwater runoff on the road section adjacent to Area S3 will run down to the side slope next to the road section.
4. A significant portion of stormwater runoff in the catchment with boundary highlighted in orange (i.e. Area S9) will likely be discharged onto the concerned road section. However, as the catchment is a private area, it is difficult to evaluate the tentative area contributed the concerned road section.
5. A majority portion of stormwater runoff in the catchment with boundary highlighted in red (i.e. Areas S6, S7 and S10) will likely be discharged onto the concerned road section.
6. To sum up, it is considered that the stormwater runoff in the catchments of Areas S1 – S5 and S11 will not be discharged onto the revised concerned road section, which commences from next to the Area S6 (i.e. road section hatched in red in plan No. SPR-Stage 2.pdf); while all of the stormwater runoff in the catchments of Areas S6, S7, S8A, S9 and S10 will be discharged onto the revised concerned road section. (As there is no road kerb provided at the road section adjacent to Area S3, it is assumed that stormwater runoff on that road section will run to the side slope next to the road section instead of running to the downstream road section. Nevertheless, it is recommended to provide adequate interception channels along the edges of those catchments to avoid large amount stormwater runoff in the catchments flowing onto the road section.)

Step 4 Evaluation of the time of concentration for the catchment area and for each critical sub-catchment area.

Using the Brandsby William's Equation, check the time of concentration of Areas S6, S7, S8A, S9 and S10 as below:

For Area S6, L ~ 108m, H ~12% A~1,300 m^2, t_o~ 4.6min (say 5 min);
For Area S7, L ~ 198m, H ~38% A~8,700 m^2, t_o~ 5.6min (say 5 min);
For Area S8A, L ~ 177m, H ~44% A~11,400 m^2, t_o~ 4.7min (say 5 min);
For Area S9, L ~ 128m, H ~16% A~6,700 m^2, t_o~ 4.4min (say 5 min);

For Area S10, L ~ 157m, H ~16% A~9,800 m^2, t_o~ 5.2min (say 5 min)

Therefore using the rainfall intensity of 5-min duration in the design is appropriate.

Steps 5 & 6 Evaluation of the actual stormwater runoff that will flow from the catchments onto the road.

Assuming that Areas S6, S7 and S8A are grass land and Area S9 (temple) and Area S10 (CLP station) are paved areas, therefore using the runoff coefficients for steep grassland (heavy soil) and paved area of C = 0.35 and 1 respectively; and using the rainfall intensity of 1 in 50 year 5-min duration design rainstorm stated in Table 1 of RD/GN/035 (= 270mm/hr); the additional runoff from Areas S6, S7, S8A, S9 and S10 are found to be 0.03m^3/s, 0.23m^3/s, 0.30m^3/s, 0.50m^3/s and 0.74m^3/s respectively.

Step 7 Evaluation of the stormwater interception capacity of the existing drainage provisions at critical locations of the road section.

Based on DSD Drainage Record Plan "Drainage Record-11NE1C.pdf" and using the equation 6 of RD/GN/035, the drainage capacity of the existing drainage facilities are calculated as follow:

Drain 1 (manhole SMH4041898 - manhole SMH4041903)
Length~11m, U/S Invert Level~119.09mPD, DS Invert Level~117.37mPD, Slope~0.16, Diameter = 0.45m, Capacity C~1.3m^3/s

Drain 2 (manhole SMH4041913 - manhole SMH4041914)
Length~58m, U/S Invert Level~97.19mPD, DS Invert Level~87.01mPD, Slope~0.18, Diameter = 0.6m,Capacity C~2.9m^3/s

Drain 3 (manhole SMH4041917 - manhole SMH4041923)
Length~34m, U/S Invert Level~51.85mPD, DS Invert Level~45.91mPD, Slope~0.17, Diameter = 1.425m,Capacity C~27.8m^3/s

Drain 4 (manhole SMH4042075 - manhole SMH4042076)
Length~14m, U/S Invert Level~46.07mPD, DS Invert Level~44.18mPD, Slope~0.14, Diameter = 1.65m,Capacity C ~35.8m^3/s

For tentative locations of Drains 1 – 4, please refer to SPR-Stage 3.pdf. For detailed locations of the drains and manholes, please refer to Drainage Record-11NE1C.pdf.

Besides, with reference to plan No. SPR-Stage 3.pdf, the stormwater runoff collected at the concerned road section is as follow:

Road Area 1, Area ~ 3,600m2, Q=0.278CiA~0.27 m^3/s
Road Area 2, Area ~ 3,900m2, Q=0.278CiA~0.29 m^3/s
Road Area 3, Area ~ 7,100m2, Q=0.278CiA ~0.53 m^3/s

Therefore,

Runoff to be collected by Drain 1 = Runoff from Areas S6, S7, S8A and S9 + Runoff from Road Area 1 ~ 0.03+0.23+0.30+0.50+0.27~1.33 m^3/s > capacity of Drain 1~1.28m^3/s (marginally inadequate). It is suggested to liaise with DSD to further investigate whether the drain is required to be upgraded;

Runoff to be collected by Drain 2 = Runoff from Area S10 + Runoff from Road Area 2 ~ 0.74+0.29~1.03 m^3/s< capacity of Drain 2~2.90m^3/s. Therefore, it is considered that the capacity of Drain 2 is adequate; and

For Drain 3 and Drain 4, it appears that they are not exclusively for the concerned road sections and the upland catchments but may also convey stormwater runoff from some other catchments. Therefore, it is not certain whether they are adequate to convey the stormwater from the concerned road sections and upland catchments (i.e. Road Areas 1, 2 and 3 and Areas S6, S7, S8A, S9 and S10) even though the combined capacity of the two drains are larger than the total stormwater discharge from Road Areas 1, 2 and 3 and Areas S6, S7, S8A, S9 and S10. In such situation, it is recommended to consult DSD to acquire their advice and findings form their relevant drainage studies. For this DIA, DSD has provided a plan showing the catchment plan for the concerned carrier drains and their advice on whether Drains 3 and 4 are adequate to handle the stormwater runoff under a 1 in 50 year rainfall intensity. (please refer to "Drainage Catchment for SPR's Carrier Drains 3 & 4.pdf" and "Adequacy of Drains 3 & 4.pdf"). Based on this information, it is considered that Drains 3 & 4 are capable to handle the stomwater runoff from Road Areas 1, 2 and 3 and Areas S6, S7, S8A, S9 and S10.

Step 8 Review of the history and causes of previous flooding incidents (flooding may be due to reasons other from excess stormwater flow such as debris blockage).

The flooding records received are for locations close to the downstream end of Shatin Pass Road. The incident was due to blockage of gully at the sag and therefore, it was not relevant to the upstream reach of the road.

Step 9 Identification of improvement measures such as providing optimum crossfall, more effective road gully arrangement, transverse drains, on-site road side flood storage, bypass/excess surface runoff diversion/interception plan at upstream, and the use of porous pavement, etc. at suitable locations.

The following measures could be considered for the drainage improvement of the concerned road section:

1) Adequate interception channels should be provided along the slope toe of Area S1 – S8.
2) Adequate interception channels should be provided at the entrances/exit of Areas S9 and S10 as well as the other adjacent sites.
3) Additional drainage facilities should be provided at the junctions with other roads (e.g. multiple gullies).
4) For Shatin Pass Road, the longitudinal slope is around 0.15, while the crossfall is only around 0.02 or less, L is approximately equal to 7.5W which is relatively long. It is considered that provision of more

single/double gullies at downstream and/or sag points of the road as well as provision of transverse drains across the road can improve the runoff intercepting capacity. (Remark: It is noted that the average spacing between adjacent set of gullies is around 32m, which is higher than the upper bound value of 25m specified in Charts 1A and 1B of RD/GN/035. Therefore, flow velocity of the stormwater runoff may be very high and may overshoot the gullies and flow to downstream road section. It is suggested, so far if practical, to provide more gullies to reduce the gully spacing to suit those recommended in Section 3.6 of RD/GN/035 and to reduce the possibility of occurrence of overshooting.)

5) Based on this assessment, it is preliminarily identified that the capacity of Drain 1 is inadequate to convey the stormwater runoff from the concerned road pavement and upland catchments. Further detailed assessment should be conducted to confirm this finding and, if essential, DSD may be consulted to resolve this problem together.

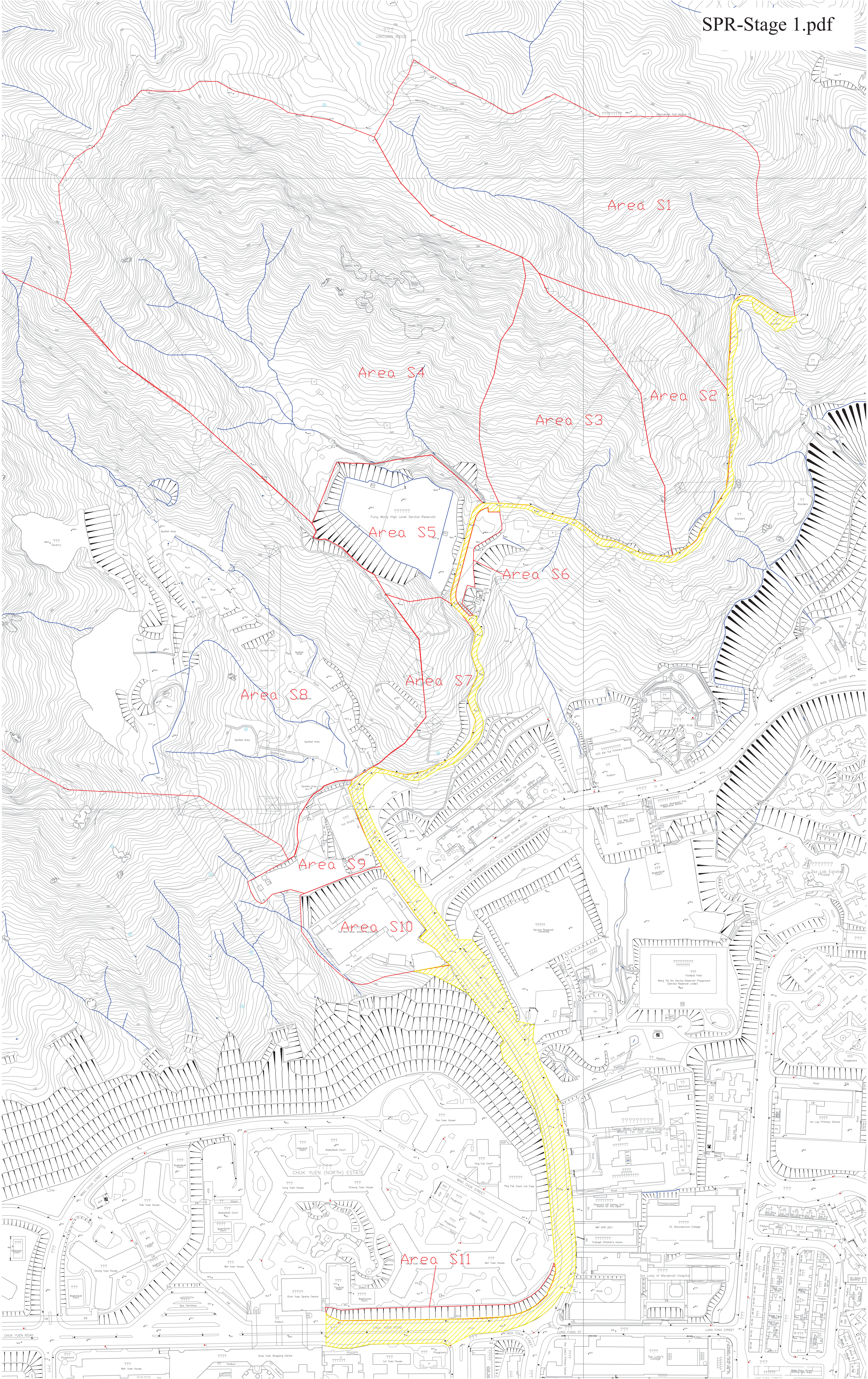
Other Points to Note

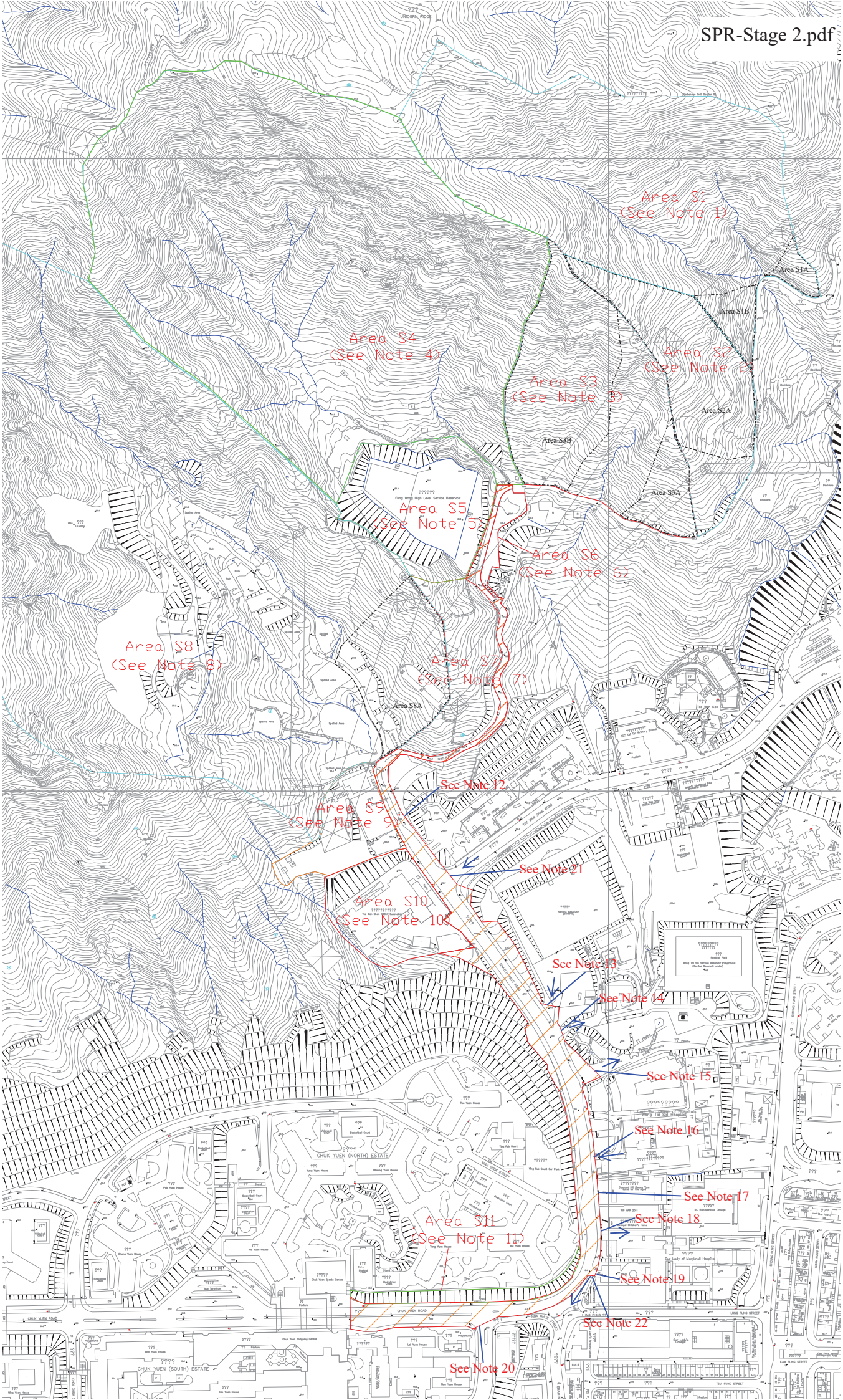
The following additional points are suggested for the consideration of the designers on road pavement drainage works by making reference to the assessment carried out under this DIA:

1) The drainage capacity of exclusive carrier drains should be assessed to ensure that they are adequate to handle the stormwater runoff from the road pavement drainage. For carrier drains which are not exclusively designed to handle the stormwater runoff from road pavements, it is recommended to consult DSD to acquire their information and advice on whether those drains are adequate to convey the stormwater runoff from the concerned catchments and road sections together with that from the other design catchments of the drains.
2) It is usually unlikely that road pavement drainage system alone could handle stormwater runoff from large additional contribution areas; therefore adequate interception drains should be provided at the boundaries of the large additional contribution areas to prevent stormwater runoff from those areas entering onto the road (Remark; For developed private lots, the interception drains may be provided by HyD. For public lots, relevant government departments should be contacted to liaise for their provision of the interception drains.).
3) The drainage pattern at the road junction of Shatin Pass Road/Tse Wan Shan Road have been reviewed and found that the additional inflow from Tse Wan Shan Rd is minimal. For other DIA, similar consideration should be given to the possible additional stormwater runoff from the adjoining road junctions as relevant.

- End -

SPR-Stage 1.pdf




SPR-Stage 2.pdf
Area S1
(See Note 1)
Area S1A
Area S1B
Area S2
(See Note 2)
Area S2A
Area S3
(See Note 3)
Area S3A
Area S3B
Area S4
(See Note 4)
Area S5
(See Note 5)
Area S6
(See Note 6)
Area S7
(See Note 7)
Area S8
(See Note 8)
Area S8A
Area S9
(See Note 9)
Area S10
(See Note 10)
Area S11
(See Note 11)
See Note 12
See Note 13
See Note 14
See Note 15
See Note 16
See Note 17
See Note 18
See Note 19
See Note 20
See Note 21
See Note 22
CHUK YUEN (NORTH) ESTATE
CHUK YUEN (SOUTH) ESTATE
CHUK YUEN ROAD
LUNG FUNG STREET
TSUI FUNG STREET
KWU TUNG STREET

Note 1

The majority of stormwater runoff in Area S1 is expected to be collected by a natural stream and will not run onto the road pavement. However, as there is no interception drain found along the boundary, a portion of runoff in Area S1 (i.e. runoff from Areas S1A and S1B shown in SPR-Stage 2.pdf) will likely run onto the road pavement.

Catchpit at upstream end of cross-road drain

Opening at downstream end of cross-road drain

Note 2

A portion of stormwater runoff in Area S2 is expected to be collected by a natural stream and will not run onto the road pavement. However, as there is no interception drain found along the boundary, a majority portion of runoff in Area S2 (i.e. runoff from Areas S2A shown in SPR-Stage 2.pdf) will likely run onto the road pavement.

Slope drains at upstream end of cross-road drain

Note 3

A portion of stormwater runoff in Area S3 is expected to be collected by a natural stream and will not run onto the road pavement. However, as there is no interception drain found along the boundary, a large portion of runoff in Area S3 (i.e. runoff from Areas S3A and S3B shown in SPR-Stage 2.pdf) will likely run onto the road pavement. Besides, as road kerb is not found along some sections of the road, the majority portion of stormwater runoff on road pavement will likely run to the side slope.

Catchpit at upstream end of cross-road drain

Road section with no side kerb

Note 4

The majority of stormwater runoff in Area S4 is expected to be collected by a natural stream and will not run onto the road pavement.

Slope channel and catchpit at upstream end of cross-road drain

Note 5

The ground level of services reservoir appears lower than the road level, no stormwater runoff will likely run onto the road from the Area S5. However, as there appears no interception drain at the entrance, portion of stormwater runoff on footpath may run into the Area S5.

No interception drain along boundary

Note 6

There is no interception drain found along the boundary, runoff in Area S6 will likely run onto the road pavement.

No interception drain along boundary

Note 7

There is no interception drain found along the boundary, runoff in Area S7 will likely run onto the road pavement.

No interception drain along boundary

Note 8

The majority of stormwater runoff in Area S8 is expected to be collected by a natural stream and will not run onto the road pavement. However, as there is no interception drain found along the boundary, a portion of runoff in Area S8 (i.e. runoff from Area S8A shown in SPR-Stage 2.pdf) will likely run onto the road pavement.

Catchpit at upstream end of cross-road drain

No interception drain along boundary

Note 9

Interception drains are only provided along part of the boundary. A large portion of stormwater runoff in Area S9 will likely run onto the road pavement.

No interception drain along part of boundary

Interception drain provided along part of boundary

Note 10

No interception channel is provided at the main entrance/exit of the catchment. A majority portion of stormwater runoff in Area S10 will likely run onto the road pavement.

No interception drain at main entrance

Note 11
Interception channel is found all along the boundary. It is considered that no stormwater runoff will likely run from Area S11 onto road pavement.

Interception drain provided all along boundary

Note 12
Interception channel is found all along the boundary.

Interception drain provided all along boundary

Note 13
No interception channel is found at main entrance/exit of the site. Additional stormwater runoff will likely run from the site onto road pavement.

No interception drain provided at main entrance/exit

Note 14

No interception channel is found at main entrance/exit of the branch road (except a grated U-channel at road side). Portion of stormwater runoff on road pavement may run into the site.

No interception drain provided at main entrance/exit

Note 15

No interception channel is found at main entrance/exit. Portion of stormwater runoff on road pavement may run into the site.

Note 16

No interception channel is found at entrances/exits of the site. Additional stormwater runoff will likely run from the site onto road pavement.

No interception drain provided at entrances/exits

Note 17

Interception channel is found at main entrance/exit. It is likely that no stormwater runoff will either enter into the road pavement from the site or vice versa.

Interception drain provided at main entrance/exit

Note 18

No interception channel is found at entrances/exits of the site. Portion of stormwater runoff on road pavement may run into the site.

Note 19

Interception channel is found at main entrance/exit. It is likely that no stormwater runoff will either enter into the road pavement from the site or vice versa.

Interception drain provided at main entrance/exit

Note 20

Double gullies are found at road junction. It is likely that no significant quantity of stormwater runoff on the concerned road pavement will run onto the branch road.

Double gullies at road junction

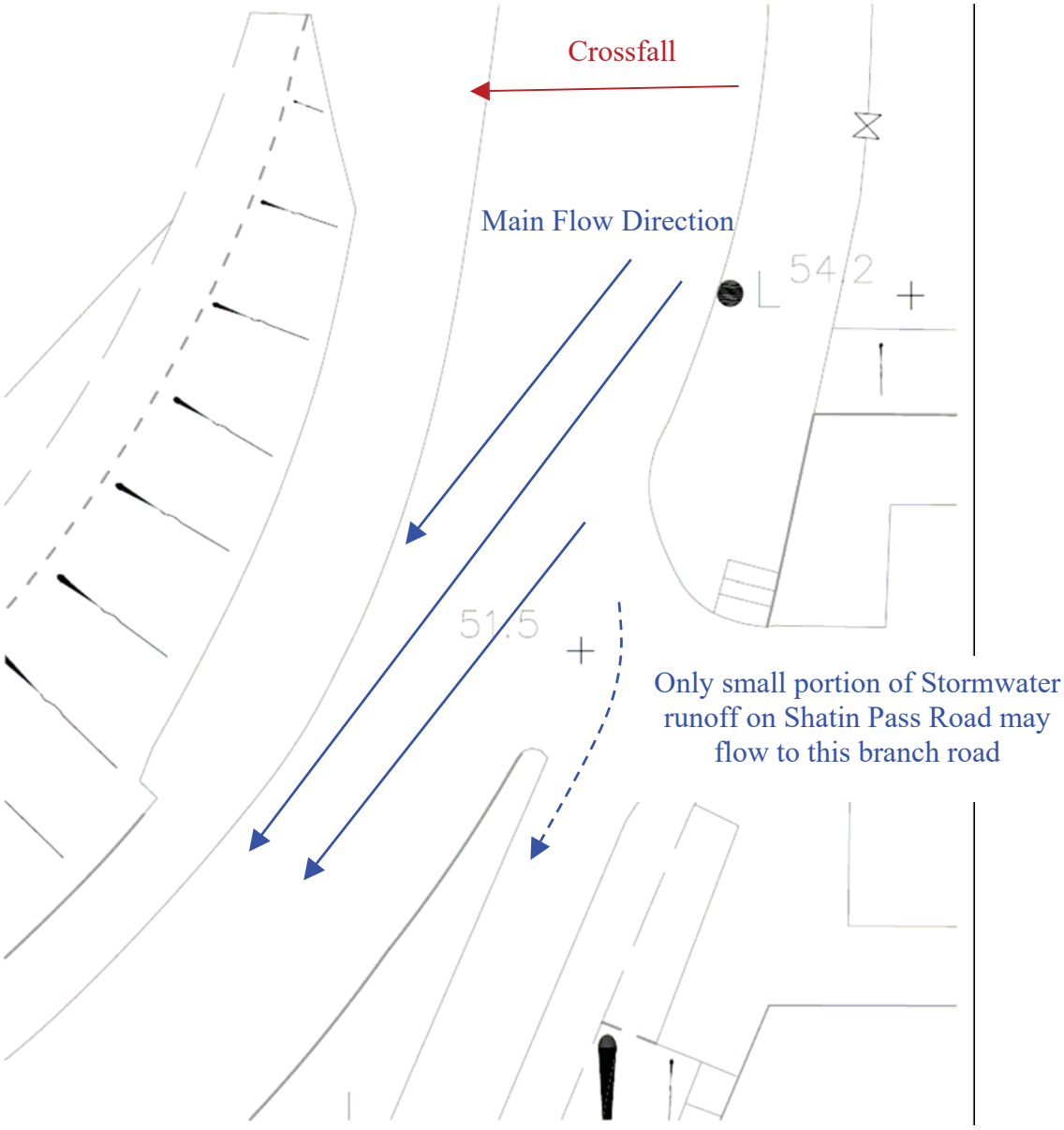
Note 21

Based on the spot level shown in the 1:1,000 survey map and the site inspection, it is found that the section of Tze Wan Shan Road near the junction with Shatin Pass Road is more or less flat (As shown in the figure below, the level of Tze Wan Shan Road near the junction with Shatin Pass Road is more or less constant and equal to 116.7mPD). It is suspected that there may be a sag point and it is hard to predict whether any significant amount of stormwater runoff on Shatin Pass Road will run to Tze Wan Shan Road or vice versa. In this assessment, it is assumed that there is no stormwater runoff flowing form Shatin Pass Road to Tze Wan Shan Road or vice versa for simplicity.

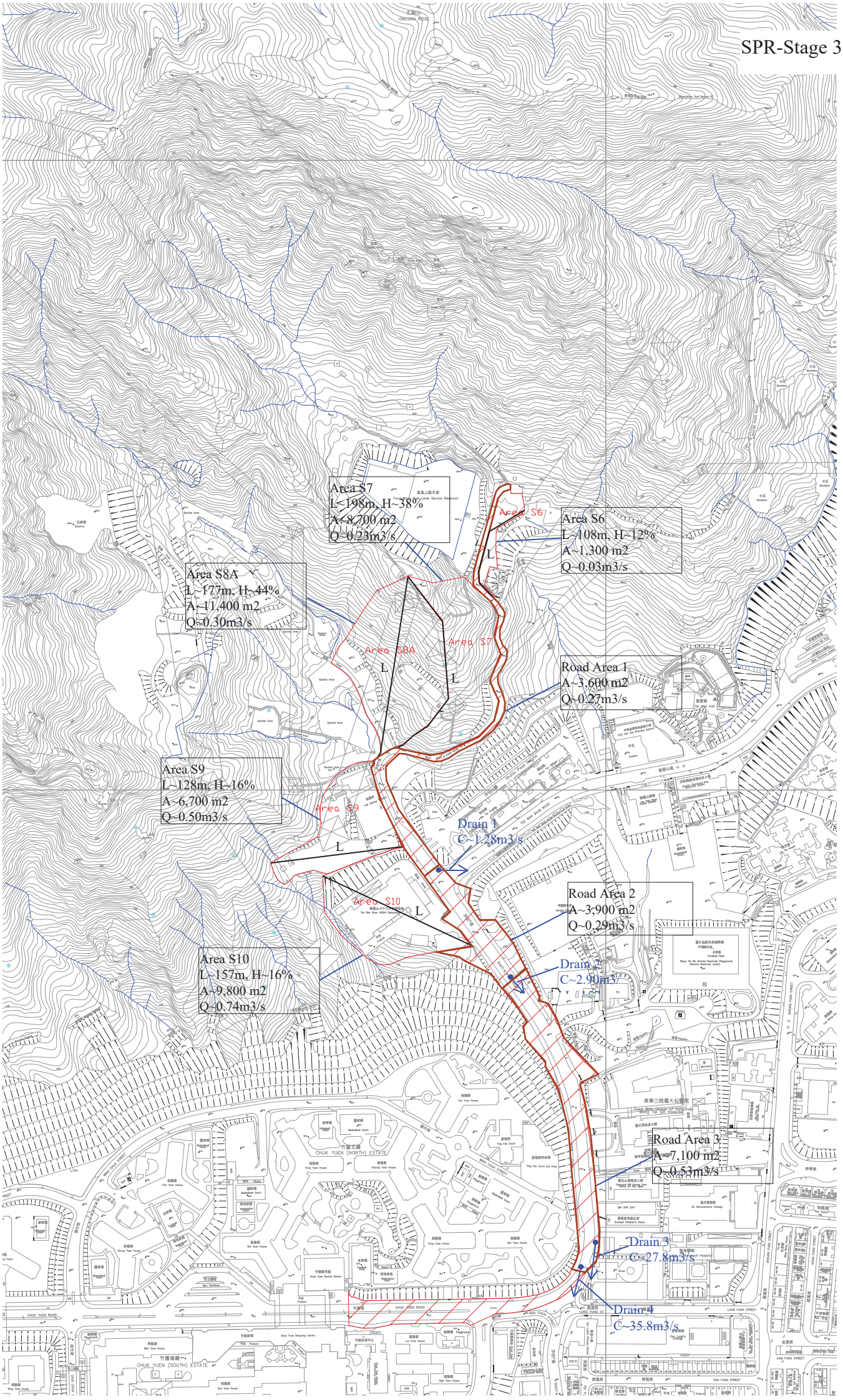
Levels at road junction

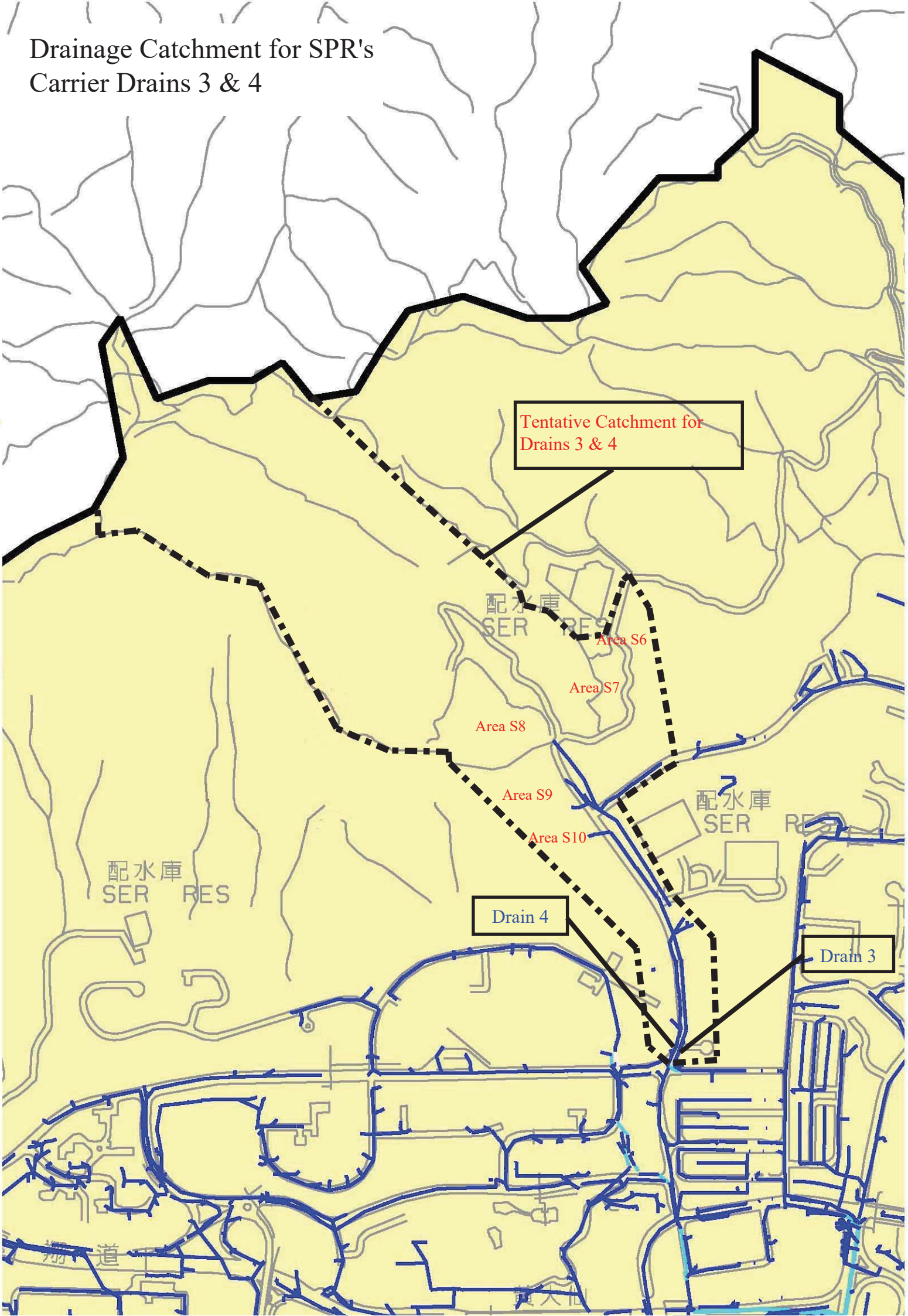
Note 22

Based on the site inspection and the survey map, it is considered that only a small portion of stormwater runoff on Shatin Pass Road may flow to the side branch. For conservative consideration, we have assumed that there is no stormwater runoff flowing form Shatin Pass Road to this branch road in this assessment.



Flow at road junction


Area S7
L~198m, H~38%
A~8,700 m2
Q~0.23m3/s
Area S6
L~108m, H~12%
A~1,300 m2
Q~0.03m3/s
Area S8A
L~177m, H~44%
A~11,400 m2
Q~0.30m3/s
Road Area 1
A~3,600 m2
Q~0.27m3/s
Area S9
L~128m, H~16%
A~6,700 m2
Q~0.50m3/s
Drain 1
C~1.28m3/s
Road Area 2
A~3,900 m2
Q~0.29m3/s
Area S10
L~157m, H~16%
A~9,800 m2
Q~0.74m3/s
Drain 2
C~2.90m3/s
Road Area 3
A~7,100 m2
Q~0.53m3/s
Drain 3
C~27.8m3/s
Drain 4
C~35.8m3/s
CHUK YUEN (NORTH) ESTATE
CHUK YUEN (SOUTH) ESTATE
CHUK YUEN ROAD

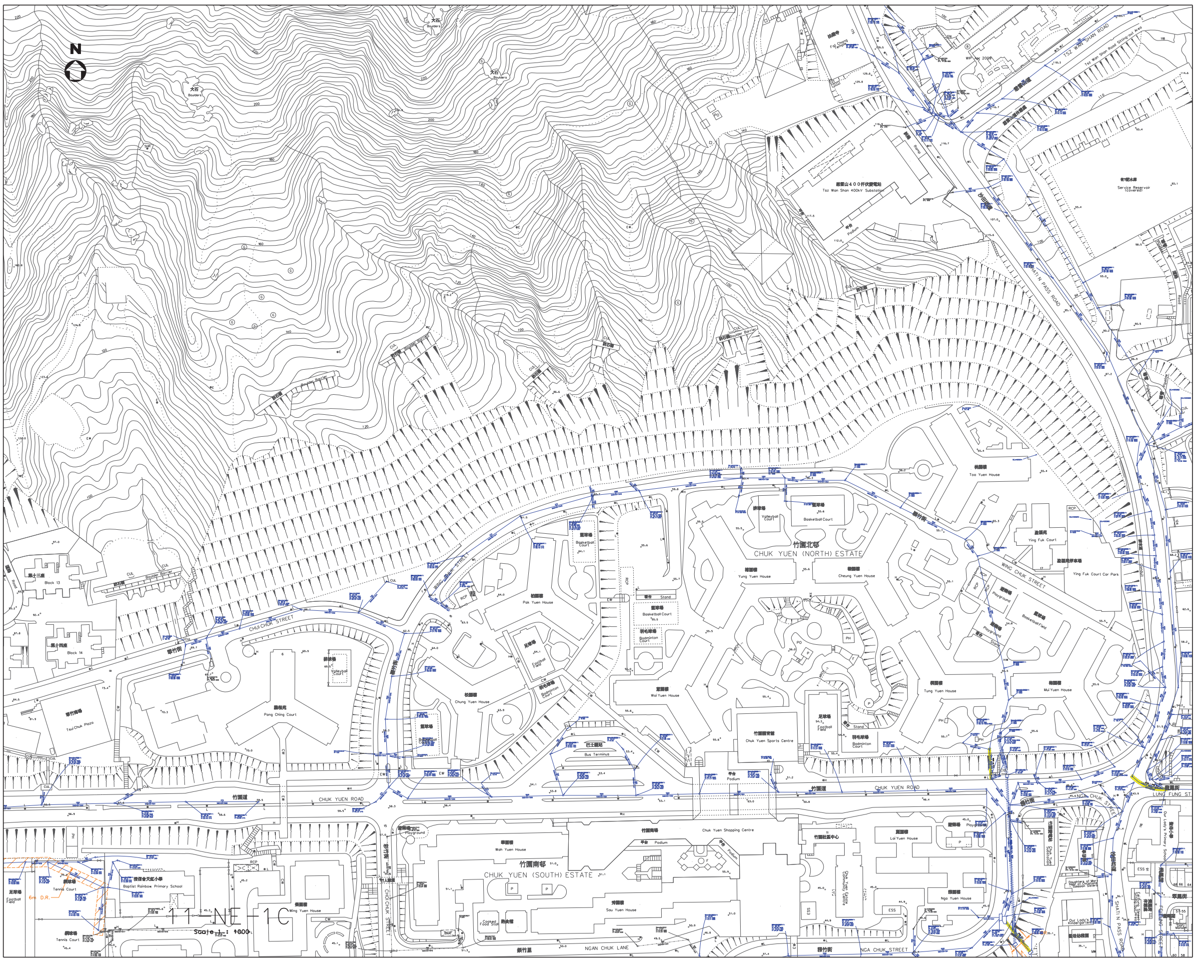

Drainage Catchment for SPR's
Carrier Drains 3 & 4
Tentative Catchment for
Drains 3 & 4
Area S6
Area S7
Area S8
Area S9
Area S10
Drain 4
Drain 3
配水庫
SER RES

Adequacy of Drains 3 & 4

Result of 1 in 50 Yrs Design Period

Location of Pipes

	Node No.	Flood Depth (m)	Node No.	Flood Depth (m)	Pipe Size (mm)	Handle 50 Yrs Design Storm ?
Drain 3	SMH4041917	0	SMH4041923	0	1425	Yes
Drain 4	SMH4042075	0	SMH4042076	0	1650	Yes


N
竹園北邨
CHUK YUEN (NORTH) ESTATE
竹園南邨
CHUK YUEN (SOUTH) ESTATE
竹園道
CHUK YUEN ROAD
浸信會天虹小學
Baptist Rainbow Primary School
Wing Yuen House
11-NE-1C
Scale 1 : 1000