APPENDIX D – Standard Operating Procedures for Coarse-Grained Sampling

Standard Operating Procedures
for
Coarse-Grained Intertidal Monitoring Protocol

Purpose

Sampling at this coarse-grained level has as its purpose the broad-scale sampling of a number of sites that have been selected so as to be representative of a particular habitat type.

Site Selection

The selection of which particular segments to survey under the coarse-grained sampling level involved several steps: (1) the characterization of habitat types of an inferential set of segments within Glacier Bay proper (see aerial survey SOP), (2) selection of the habitat type for examination, and (3) selection of specific segments of the chosen habitat type.

1. Characterization of habitat types with Glacier Bay proper

Within Glacier Bay National Park and Preserve the coastline of Glacier Bay proper (the inner part of Glacier Bay NP&P, from Pt. Carolus and Pt. Gustavus northward) was divided into 200 m segments using ArcInfo software and a digitized coastline (Geiselman, J. et. al., 1997). This resulted in the identification of 5,545 segments representing a coastline of 1,109 km. Based on our assessment that we could aerially survey 250 segments, a random number was used to identify a particular segment, and 250 segments were then systematically chosen relative to that initial randomly chosen start. Two hundred and forty-two of these segments were surveyed by fixed-wing airplane (see SOP for aerial surveys). The aerial surveys provided estimates of the relative abundance of different substrate types (bedrock, cobble/boulder, pebble/gravel, sand/silt/mud, coarse sand) within segments as well as biota (*Fucus*, mussels, barnacles). The survey results provided a characterization of the habitat types within Glacier Bay proper, and a pool of segments of different habitat types that had inference to the surveyed region.

2. Selection of the habitat type and the specific segments for examination

We initially had been asked by the park to study protected rocky (bedrock) habitat. However, only 3 of the 241 (one of the 242 segments surveyed lacked slope data) segments surveyed by air were comprised of 76% or greater bedrock, with a slope of <60 degrees. We decided, on the basis of further discussions with Center staff and the Park staff, to relax the habitat parameters and include unconsolidated substrates (cobble/boulder) as well as bedrock sites as targets of this study. Thus the combined habitat type was defined as any segments having from 1–100% bedrock with slopes <60 degrees and/or 0% bedrock but 76–100% cobble/boulder and also a slope <60 degrees. This resulted in a pool of more than 100 potential coarse-grained sampling sites. Thirty sites were randomly chosen from this pool. Since the substrate percent coverages and slopes were estimates from the aerial surveys, an additional thirty sites were randomly chosen as extras in case closer inspection led to the elimination of many from the initial thirty. Elimination criteria included: inaccessibility because the site was too steep, or was a designated wildlife protection area; the presence of too much mud; lack of emergence during high tides (the site

was not a true beach). Twenty-five of the original thirty selected segments were ultimately sampled (fig. 1).

Within-Site Sampling:

After (1) locating a site with GPS and photos, the within-site sampling involves: (2) establishment of the horizontal segment line at the approximate MHHW line, (3) establishing vertical transects, (4) point sampling of vertical transects, (5) sampling of bands that included each vertical transect, (6) photos, and (7) transect slope determinations.

1. Site Location
Navigate to the 200m beach segment using the PLGR (Y-code data) GPS unit, aided by use of maps and photographs. The GPS coordinates indicate the location of the site's upper left corner (fig. D1).

One permanent marker, a 2-foot length of rebar, was placed on the left-hand side of the segment, above the site. The marker was placed perpendicular to the 200 m segment tape, upbeach enough to be well above the highest high tide and often into the terrestrial vegetation. A stainless steel 1 1/4" washer with "USGS/BRD, 1997 ###" stamped into it (### is the segment number) was attached to the rebar by a cable tie. Orange flagging tape was tied around the rebar to make it visible in the photos and easier to relocate. The rebar stake was z-sparred (Splash Zone, a marine epoxy) in place if the substrate was suitable. Notes on the placement, including distance and compass bearings from the top left of the 200m segment (the beginning of the horizontal segment line), were recorded in the field notes for the site.

At some sites, additional rebar were added above the horizontal segment line at 100m and 200m. Also, for at least some of the six fine-grained sites sampled in 1997 (sites 36, 59, 63, 69, 89, and 217), there were rebar markers placed above each of the vertical transect lines. Under the fine-grained sampling there were 10 vertical transects sampled at each of these sites, each 20 meters apart, but with the first transect location determined randomly within the first 20 meters (e.g., systematic placement with a random start).

2. Establish horizontal segment line
The horizontal segment line is established at the approximate MHHW (mean higher high water) line by laying out 200m of measuring tape, starting at the left upper edge of the segment and running across the beach. The segment line follows the lower *Verrucaria* (black lichen) zone (defined as approximately 20% coverage of *Verrucaria*), at the juncture of the *Verrucaria* and barnacle zones. Lay the tape parallel to the shoreline. If *Verrucaria* is not visible or is not continuous, estimate the highest tide line using cues of beach wrack and/or the beach grass line or above the upper barnacle zone. Follow the contours of the beach/shoreline. If you come to narrow but deep crevices or indentations, do not run the segment line up into the space, rather cut across it maintaining a line parallel with the shoreline. In some cases littorine snails will be found above the horizontal segment line. Note the distance from the site-marking rebar (above the left edge of the segment) to the horizontal segment line (MHHW). If 100 m and 200 m rebar markers are present, also note the distances from those to the horizontal segment line.

3. Establish Vertical Transects
Six line transects ("vertical" transects) are positioned parallel to the elevational gradient of the segment, running from the horizontal segment line down to MLLW (mean lower low water, the 0-m [=0-ft] tide level). The start of the first vertical transect is randomly chosen while the remaining transects are placed systematically every 33m relative to the location of the first. Prior to sampling, establish a list of 25

random numbers between 0 and 33 to be used to establish the location of the first vertical transect for each of the 25 coarse-grained sites. The random number indicates the distance along the horizontal segment tape to the start of the first transect. For example, if the random number for a site is 12, the first vertical transect is located 12m from the left edge of the segment. Succeeding transects are set every 33 m (at 45, 78, 111, 144, and 177 m from the left end of the 200 m segment tape, when the random number is 12). If a vertical transect falls on a section of the segment that is unsampleable due to steep slope or fresh water input, then determine the horizontal distance of the unsampleable area and shift the remaining transects that distance to the right (fig. D2). Vertical transects are run perpendicular to the shoreline. On concave beaches, positioning the transects perpendicular to the shoreline keeps them from overlapping (fig. D3). Natural variation in the complexity of the topography necessitates some decision-making in the layout of the transect lines. For example, when large rocky outcrops too high for sampling intervened, transect lines were interrupted (Site 108), with the rocky outcrop declared unsampleable, and the transect resumed on the shore-side of the rocky outcrop. The standard should be transect lines laid perpendicular to the shoreline. Transect lines are draped so as to generally conform to the substrate as they are laid, rather than being stretched taut. The intention is that all exposed surfaces have an equal probability of being sampled. The lowest extent of the transect, the 0-m tide level, is determined by using the Tides and Currents computer program (Nautical Software, Inc.) for the sampling date and nearest tide station location (Bartlett Cove, Willoughby Island, Composite Island, or Muir Inlet). At the time of the 0-m tide (MLLW), other activities are stopped temporarily and all transect tapes are run to the water line, with the tape looped to indicate the 0-m location.

4. Point sampling of Vertical Transects

Selected points along the vertical transects are sampled to provide estimates of the relative percent coverage of biota along the transects, and across the site, as well as the relative percent coverage of underlying substrates. The sampling of points along these transects also gives a record of zonation of species. The density of sampling is five points sampled per meter, sampled each 20 cm (e.g., 0, 0.2, 0.4m, etc.). Tapes should be laid with the zero meter mark of the tape at the horizontal segment tape.

Points are sampled by noting the species and substrate at each point, using the right edge of the tape and the distance hash marks along the tape as cross hairs to mark the point. Use a pencil, knitting needle or other pointer to follow the point perpendicularly from the tape to the substrate. Sampling is 3-dimensional. Record all species underlying the point, including multiple "hits" or layers of the same species, then the substrate. Dense *Fucus* and mussels can be difficult to assess accurately in three-dimensional sampling (sampling probably tends to under-estimate the layering). Organisms are identified to the lowest taxonomic level possible in field sampling. Some taxa are grouped because they cannot be discriminated in the field readily (appendix D1.1). Use the abbreviations from the species list when recording. Substrates are classified according to a modified Wentworth-scale (appendix D1.2). The format for recording data is as follows: species/substrate (e.g. FU/BR = *Fucus* over Bedrock). If there is more than one species when following the point down to the substrate (e.g. littorine [*Littorina sitkana*] on a piece of *Fucus* which covers a mussel) then use the following format: (species, species, species.....)/substrate (e.g. (LSI,FU,MY)/BR). Multiple sequential layers or hits of the same species can be indicated by superscripts, e.g., FU^3. If there is silt on another substrate, record the underlying substrate. An example of a completed data sheet is included in appendix D2.

5. Band Sampling
The purpose of sampling a wider swath or band around each vertical transect, is to sample the density of larger or more mobile invertebrates that are less likely to be well-sampled by the points. After the points have been sampled on a vertical transect, band swaths are done. Scan the swath 1m to each side of the transect for selected large or mobile species (starfish, sea urchins, or large chitons). Count the number of each band species observed per meter and record the number and location in the appropriate place on the data sheet. If no band species are observed, be sure to note that none were seen.

6. Transect Slope Descriptions
Take the slope of each vertical transect line, using a hand-held clinometer (e.g., Suunto clinometer). If there appears to be more than one distinct slope (e.g., the slope changes significantly along the transect line), take readings for each section, but also get an overall slope for the transect line by taking a measurement from the bottom to the top or vice versa. Also take the compass bearing of each transect line. Note if the compass bearing is from the bottom to the top or vice versa. Also note if magnetic or true north was used (thus far we have only used magnetic north).

7. Photos
The purpose of taking photographs is to record locations of transect lines, and to obtain a visual record of the geomorphology and biology, both along transect lines and across the site from several spots. Both slide and print film originally were used; these will be supplanted by digital photography. Prints provide easily used visual records and aid relocating the site marker and transect locations. Slide film was used for longer term records of transect shots and general site photos and for use in talks. Photos are taken from the bottom of each transect looking towards the top, from the top of each transect looking down, from the top left area looking towards the top right, and top right towards top left, from the bottom left looking towards the bottom right, bottom right to left, and especially from approximately midbeach between transects 3 and 4 looking right and left, from the top left towards the permanent marker or from the bottom left towards the permanent marker, and of anything that is of particular interest. Photos of the vertical transects from the top looking down were often taken, but not routinely. All photos are recorded in the field notes or on transect data sheets and later entered into a photolog.

8. Data entry and the Access database
These topics are discussed in appendix E.

Reference

Geiselman, J., Dunlap, J., Hooge, P., and D. Albert. (Eds). 1997. Glacier Bay Ecosystem GIS CD-ROM set. U.S. Geological Survey and Interrain Pacific. Anchorage and Juneau, Alaska.

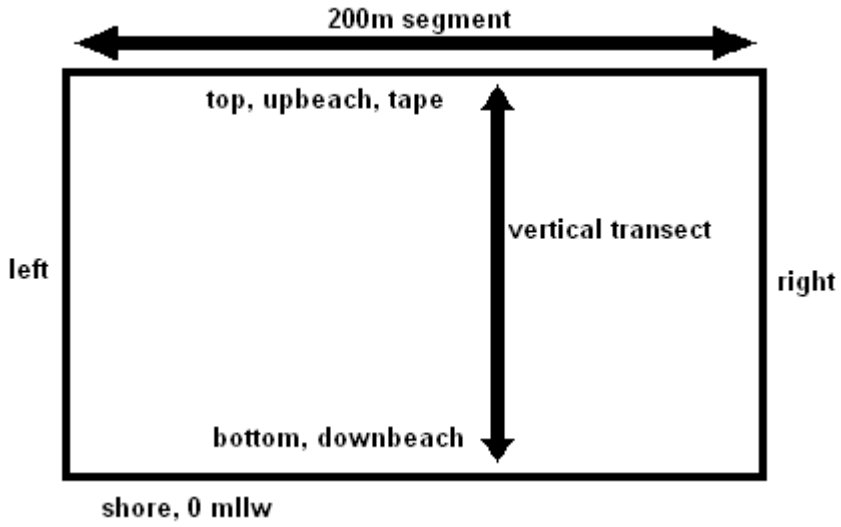

Figure D1. Directional terms used in the coastal monitoring protocol development study.

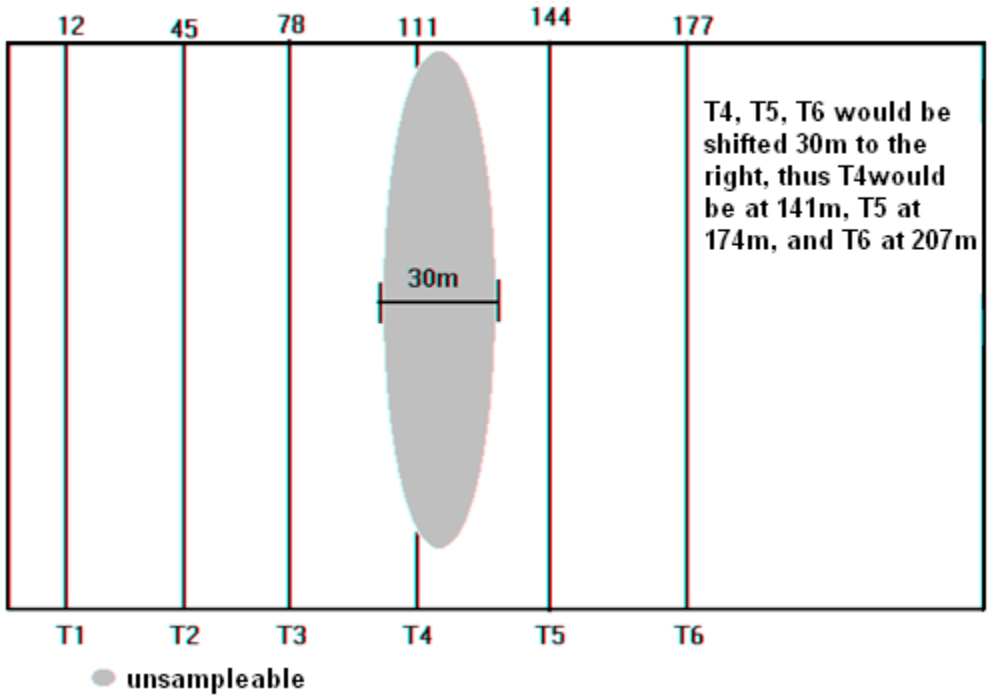

Figure D2. A rough depiction of the arrangement of vertical transects and how to deal with unsampleable areas.

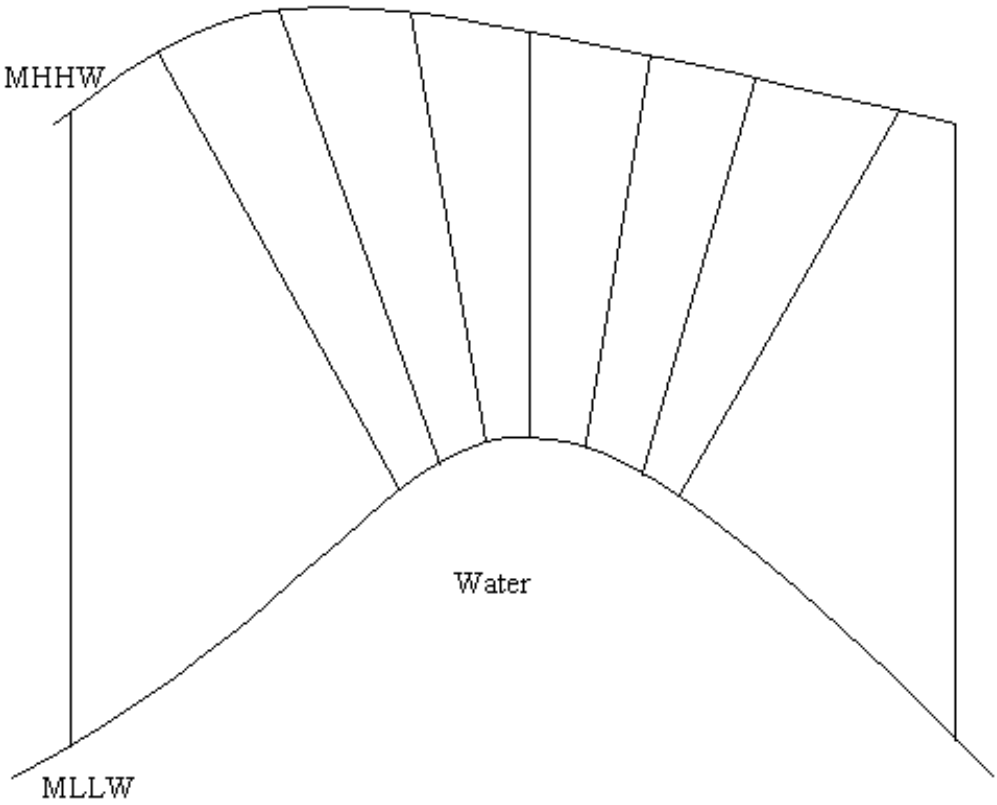

Figure D3. A schematic of vertical transects laid out at a concave beach. Note that the transect lines are laid perpendicular to the shoreline.

Appendix D1

D1.1. List of species, substrates, and abbreviations used in the 1997 coastal monitoring protocol development project. Species noted during band swath searches are marked with an asterisk.

D1.2. The modified Wentworth scale used to classify substrates. This is taken from the sediment surface mapping protocol for Glacier Bay coastal mapping, coastal monitoring, and benthic surveys SOP, sedprot.w51.

D1.1. Species and substrate abbreviations used in the 1997 coarse-grained sampling.

* = BAND SPECIES

MUSSELS		
	Modiolus modiolus	MO
	Musculus spp.	MUS
	Mytilus trossulus	MY
CLAMS		
	Hiatella arctica	HI
BARNACLES		
	Balanomorpha	BA
	Balanus glandula/Semibalanus balanoides	BG
	Chthamalus dalli	CD
	Semibalanus cariosus	SC
	Barnacle spat/cyprids <2mm	BS
LIMPETS		
	Acmaea mitra	ACM
	Diadora spp.	DI
	Lottia digitalis	LD
	Lottia pelta	LP
	Lottidae <8mm or questionable	LO
	Tectura fenestrata	TF
	Tectura persona	TP
	Tectura scutum	TES
SNAILS		
	Buccinum spp.	BU
	Fusitriton oregonensis	FUS
	Lacuna spp.	LA
	Littorina scutulata	LSC
	Littorina sitkana	LSI
	Littorina spp.	LIT
	Margarites spp.	MAR
	Neptunea spp.	NEP
	Nucella canaliculata	NC
	Nucella emarginata	NUE
	Nucella lamellosa	NLA
	Nucella lima	NLI
	Onchidella borealis	ON
	Searlesia dira	SE
	Siphonaria thersites	SI
CHITONS*		
	Cryptochiton stelleri	CR
	Katharina tunicata	KA
	Mopalia spp.	MOP
	Tonicella spp.	TO

RED ALGAE		
	articulated coralline algae	AR
	Cryptosyphonia woodii	CRY
	Encrusting coralline algae	EC
	Endocladia muricata	ED
	Gigartinaceae	GG
	Gloiopeltis furcata	GL
	Halosaccion glandiforme	HA
	Mastocarpus papillatus	MA
	Neorhodamela/Odonthalia spp.	NEO
	Palmaria callophylloides	PC
	Palmaria spp.	PA
	Polysiphonia/Pterosiphonia spp.	PS
	Porphyra spp.	PR
	Red algal crust- fleshy	RE
	Small filamentous red	FIR
	Small foliose red	FOR
BROWN ALGAE		
	Agarum clathratum	AG
	Alaria fistulosa	AF
	Alaria marginata (or ALM)	AL
	Coilodesme spp.	CL
	Costaria costata	COS
	Cymathere triplicata	CY
	Desmarestia spp.	DE
	Fine filamentous brown	FIB
	Fucus gardneri	FU
	Laminaria bongardiana	LB
	Laminaria saccharina	LS
	Leathesia difformis	LEA
	Petalonia fascia	PET
	Scytosiphon/Melanosiphon spp.	SM
	Small foliose brown	FOB
	Soranthera ulvoidea	SOR
	Thick brown crust	TBC
GREEN ALGAE		
	Acrosiphonia spp.	AC
	Enteromorpha intestinalis	EN
	Prasiola meridionalis	PM
	Small filamentous green	FIG
	Ulothrix spp.	UO
	Ulvales	UV
SEAGRASS		
	Phyllospadix serrulatus	PHY
	Zostera marina	ZO

* = BAND SPECIES

ANEMONES		
	Anthopleura artemesia	ANA
	Anthopleura spp.	AN
	Anthopleura xanthogrammica	AX
	Epiactis spp.	EP
	Urticina crassicornis	UR
URCHINS*		
	Strongylocentrotus droebachiensis	SD
	Stronglyocentrotus franciscanus	SF
SEA CUCUMBERS		
	Cucumaria miniata	CU
	Eupentacta quinquesemita	EUP
	Parastichopus spp.	PAR
SEA STARS*		
	Asteroidea - unknown	AS
	Crossaster papposus	CP
	Dermasterias imbricata	DER
	Evasterias troschelli	EV
	Henricia spp.	HE
	Leptasteria hexactis	LE
	Orthasterias koehleri	OR
	Pisaster ochraceus	PI
	Pycnopodia helianthoides	PY
	Solaster spp.	SO
BRITTLE STARS		
	Ophiuroid	OP
NUDIBRANCHS		**NU**
	Archidoris/Anisodoris spp.	AA
NEMERTEANS		
	Amphiporus spp. - fleshy or white	NA
	Emplectonema (or NG)	EM
	Paranemertes (or NP or NB)	PAN
POLYCHAETES		
	Nereid	NE
	Pectinaria granulata	PEC
	Phyllodocidae - scale worm	PH
	Serpulids	SER
	Spirobids	SP

LICHENS		
	Verrucaria spp.	VE
SPONGES		**SG**
	Halichondria spp.	HCH
	Haliclona spp.	HCL
BRYOZOA		**BRY**
HYDROZOA		
	Hydroids	HY
TUNICATES		
	Compound	TC
	Solitary	TS
CRUSTACEANS		**CRU**
AMPHIPODA		**AM**
ISOPODA		**IS**
	Idotea spp.	ID
HERMIT CRABS		**HC**
SMALL CRABS		
	Hemigrapsus spp.	HG
SUBSTRATES		
	Bedrock	BR
	Boulder	BO
	Cobble	CO
	Pebble	PE
	Gravel	GR
	Sand	SA
	Mud	MU
	Shell	SH

D1.2. Substrate categories used in the 1997 coarse-grained sampling.

Substrate	Wentworth Size	Description
bedrock	continuous rock surface	NA
boulder	>256 mm diameter	head size or larger
cobble	64-256 mm diameter	billiard ball size to head size
pebble	4-64 mm diameter	pea size to billiard ball size
gravel	2-4 mm diameter	BB size to pea size
sand	1/16-2 mm diameter	just gritty in fingers to pin head size
mud/silt	NA	floury coating, not gritty, similar to clay
shell	NA	whole shell or identifiable fragments

Appendix D2

D2.1. An example of a completed data sheet from a vertical transect sampled during the 1999 coarse-grained sampling.

Entered

SITE # 200 OBSERVER Jenn / Jeff PAGE# 1 of 1
DATE 14 June 99 TRANSECT LENGTH COMPASS HEAD:
TRANSECT# 5 DIST ALONG HOR TRAN

POINT	SPP/SUBSTRATE	BAND SPP & #	SLOPE	POINT	SPP/SUBSTRATE	BAND SPP & #	SLOPE
0.0	BO BR	0	18°	8.4	MY² / BO	0	10°
0.2	BO			8.6	BO		
0.4	BO			8.8	MY / BO		
0.6	BO			9.0	BO		
0.8	BO			9.2	MY / BO		
1.0	BO			9.4	MY / BO		
1.2	BO			9.6	BO		
1.4	BO			9.8	FU / BO		
1.6	BO			10.0	BO		
1.8	BO BR			10.2	MY / BO		
2.0	FU, BG / BO			10.4	BR² / BO		
2.2	FU² BG / BO			10.6	MY² / BO		
2.4	LSI, BG / BO			10.8	BO		
2.6	BG / BO			11.0	BO		
2.8	FU² BG / BR			11.2	MY / BO		
3.0	FU, LSI / BR			11.4			
3.2	FU⁶ BG / BO			11.6			
3.4	FU³ BG / BO			11.8			
3.6	FU / BO			12.0			
3.8	BG / BO			12.2			
4.0	FU⁵ BG / BO			12.4			
4.2	FU⁵ BG / BO			12.6			
4.4	FU² / BO			12.8			
4.6	FU³ / BO			13.0			
4.8	FU⁴ MY / BO			13.2			
5.0	FU³ MY FU² MY / BO			13.4			
5.2	MY, FIG / BO			13.6			
5.4	FU, MY, FU, FIG, BG / BO			13.8			
5.6	FIG, AC, MY, BG / BO		50°	14.0			
5.8	BG, MY² / BO			14.2			
6.0	BG, MY, BG, MY / BO			14.4			
6.2	MY, LSI², MY, LSI / BO			14.6			
6.4	BG³ MY / BO			14.8			
6.6	MY² / BO			15.0			
6.8	MY / BO			15.2			
7.0	MY, BG / BO			15.4			
7.2	BG / BO			15.6			
7.4	BG / BO			15.8			
7.6	MY / BO			16.0			
7.8	MY, BG / BO			16.2			
8.0	PS / BO			16.4			
8.2	BG / BO		10°	16.6			

NOTES: eg epoxy marks, rebar placement, photos…etc