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April 29, 2015

RD-G-15-04-322

MINES & GEOSCIENCES BUREAU
REGIONAL OFFICE No. XIII
SURIGAO CITY
RELEASED
DATE: APR 29 2015 TIME: 9:20 AM
BY:

**Honorable Julie C. Chua**
Municipal Mayor
Municipality of Rosario
Province of Agusan del Sur

Dear Mayor Chua:

Respectfully furnishing your end the document entitled "Report on the 1:10,000 Scale Geohazards (Landslide and Flooding) Assessment and Mapping of the Municipality of Rosario, Agusan del Sur submitted by Philsaga Mining Corporation to Mines and Geosciences Bureau as one of the municipalities under Memorandum of Agreement for CY 2014. The assessment is in line with the government's effort aimed at reducing, if not totally mitigating the destructive effects and impacts of natural hazards to the populace.

The Office expresses its deep gratitude for the support and assistance rendered to the Geohazard Mapping and Assessment Team of Philsaga Mining Corporation during the conduct of the field survey.

We look forward to a continuing partnership and collaboration with the LGU of Rosario, Agusan del Sur in the nation's overall disaster risk reduction program.

Very truly yours,

By the Authority of the Regional Director:

**ENGR. DANIEL S. BELDEROL**
OIC, Mine Management Division

Department of Environment and Natural Resources
MINES AND GEOSCIENCES BUREAU
Regional Office No. 13, Surigao City
Municipality of Rosario, ADS
41-15050200077

GSD-15-04-Ghz-259

Cc: **DIRECTOR**, MGB CO
**HON. GOVERNOR**, Agusan del Sur
**HON.REPRESENTATIVE**, 2nd District, ADS
**Office of Civil Defense**, RDRRMC Caraga
**REGIONAL EXECUTIVE DIRECTOR, DENR, R-XIII**
**PENRO**, Agusan del Sur
**CENRO**, San Francisco, ADS
**REGIONAL DIRECTOR**, DILG-Caraga

"MINING SHALL BE PRO-PEOPLE AND PRO-ENVIRONMENT
IN SUSTAINING WEALTH CREATION AND IMPROVED QUALITY OF LIFE."

# RESULTS OF THE MGB LANDSLIDE AND FLOOD ASSESSMENT AND MAPPING (1:10,000 SCALE) OF THE MUNICIPALITY OF ROSARIO, PROVINCE OF AGUSAN DEL SUR

Philsaga Mining Corporation thru a Memorandum of Agreement with the Mines and Geosciences Bureau-R-XIII conducted landslide and flood assessment and mapping (1:10,000 scale) of areas within the Municipality of Rosario on March 5-7, 13-14, 17-19 and 21, 2014, and April 14, 23, 2014. The assessment is in line with the government's efforts aimed at reducing, if not, totally mitigating the destructive effects and impacts of natural hazards on the populace. Comprising the geohazard assessment team are Kent Jan S. Albiso, Jr. Geologist; Crisanto P. Palad and Dioscoro Apas, field mappers.

The MGB-DENR particularly covered the following areas:

- Puroks 1 to 19 in Barangay Bayugan 3
- Puroks 1 to 7 in Barangay Cabantao
- Puroks 1 to 7 in Barangay Cabawan
- Puroks 1 to 5 in Barangay Libuac
- Puroks 1 to 7 in Barangay Maligaya
- Puroks 1 to 8 in Barangay Marfil
- Puroks 1 to 7 in Barangay Novele
- Puroks 1 to 7 in Barangay Poblacion
- Puroks 1 to 17 in Barangay Santa Cruz
- Puroks 1 to 8 in Barangay Tagbayabagan
- Puroks 1 to 8 in Barangay Wasi-an

The assessed areas were rated as having low, moderate, high or very high (critical) susceptibility to landslide. The landslide susceptibility rating parameters are as follows:

**Very High :** Areas usually with steep to very steep slopes and underlain by weak materials. Recent landslides, escarpments and tension cracks are present. Human initiated effects could be an aggravating factor.

**High :** Areas usually with steep to very steep slopes and underlain by weak materials. Areas with numerous old/inactive landslides.

**Moderate :** Areas with moderately steep slopes. Soil creep and other indications for possible landslide occurrence are present.

**Low :** Gently sloping areas with no identified landslides.

Likewise, the assessed areas were also rated as having low, moderate or high susceptibility to flooding. The flood susceptibility parameters are as follows:

**High** : Areas likely to experience flood heights of greater than 1.0 meter and.or flood duration of more than 3 days. These areas are immediately flooded during heavy rains of several hours; include landforms of topographic lows such as active river channels, abandoned river channels and areas along river banks; also areas prone to flashfloods

**Moderate** : Areas likely to experience flood heights of 0.5 to 1.0 meter and flood duration of 1 to 3 days. These areas are subject to widespread inundation during periods of prolonged and extensive heavy rainfall or extreme weather condition. Fluvial terraces, alluvial fans, and infilled valleys are areas subjected to moderate flooding

**Low** : Areas likely to experience flood heights of less than 0.5 meter and/or flood duration of less than one day. These areas include low hills and gentle slopes. They also have sparse to moderate drainage density

The barangay officials were presented with a *Landslide and Flood Threat Advisory* when appropriate*.* This advisory informs them of their area's susceptibility to landslides and floods and contains the corresponding recommendations.

Summarized below are the results of the assessment of the covered areas:

**Table 1. Results of Landslide and Flood Assessment at Barangay Bayugan 3**

| Purok | Landslide Susceptibility Rating | Flood Susceptibility Rating | Recommendations |
|---|---|---|---|
| **1** | **Moderate to high** | **Low** | The community is located along a small lake and steep slopes. Some houses were slowly damaged by the creeping activity and seen also tension cracks. It is advisable to relocate the houses away from the slopes. Observe presence other presence of mass movement, saturated grounds, and sunken/displaced surfaces. The community is also advised to observe rapid increase of water level at the lake and communicate with the barangay/municipal authorities for immediate response. Geographic location of P-1 Bayugan 3 base on GPS reading is $08^0$ 18' 30.3''N and $126^0$ 00' 17.8''E. |
| **1A** | **Low to moderate** | **None to low** | The area covers from the national highway road, crossing Banahaw going to the PMC Millsite. Presence |

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| | | | of mass movement activities were sited at the area, houses and buildings near the slopes must be relocated or stabilized the slopes to avoid relocation of infrastructures. Install proper drainage system to facilitate surface runoff. The community is advised to observe other presence of mass movement at the area and communicate with the MGB/municipal authorities for immediate response. Relocate houses away from the tailings dam of the millsite to avoid contaminations/exposure of hazardous chemicals. Avoid drinking of water from the wells near the tailings dam because of the possible contamination to the wells.<br>Community beside the small lake must observe for rapid increase of water level at the lake and communicate with barangay/municpalauthorities.<br>GPS reading at the purok proper is $08^0$ 18' 47.1''N and $126^0$ 00' 33.6''E. |
| **2** | **Low** | **Low** | The area is situated in a convex morphology with low tosteep slopes. Proper drainage system is needed in the area to avoid low floods. Implement regular cleaning and proper waste disposal and prohibit dumping of waste from the piggery to the creeks or any other kind of water ways at the area. Houses near the slopes must be relocated away from the slopes and observe for any presence of mass movement activities and saturated grounds and report it to the MGB/municipal authorities.<br>Geographic location of P-2 area base on GPs reading is $08^0$ 18' 17.1''N and $126^0$ 00' 20.2''E. |
| **3** | **Generally low with localized high** | **Low to moderate** | The area is situated beside the national highway road having low to localized steep slopes. Areas near the steep slopes must observe presence of mass movement and saturated grounds and report it immediately to the MGB/municipal authorities.<br>No proper drainage system to hold the flood water is lacking at the area, installation of drainage system is recommended to help facilitate flood |

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| | | | waters. Observe rapid increase of water level at the area and communicate with barangay authorities for immediate response.<br>Geographic location of P-3 area base on GPS reading is $08^0$ 18' 09.4''N and $126^0$ 00' 10.9''E. |
| **4** | **Low with localized critical area** | **Low to very high** | The community proper is located around the barangay hall site beside the national highway road. The lack of good drainage system is one of the reasons why the area suffers high floods during heavy rains/rainy season. Develop proper drainage system and maintain regular cleaning of water ways to help facilitate the flood waters. The community is also advised to observe rapid increase of water level at the area, develop early warning device/system and communicate with the barangay/municipal authorities for immediate response.<br>Geographic location of P-4 area base on GPS reading is $08^0$ 18' 03.4''N and $126^0$ 00' 17.1''E. |
| **5** | **Moderate** | **Moderate to very high** | The area is situated near the Bayugan 3 creek and mini dam which overflows during heavy rains/rainy season and bringing flood to the area. Installation of flood control dikes is recommended to prevent the creek not to overflow and implement proper solid waste management to avoid trashes clogged at culverts and creeks. For the meantime the community is advised to observe rapid increase of water level at the creek, develop early warning device/system and communicate with the barangay/municipal authorities for immediate response.<br>Geographic location of P-5 area base on GPS reading $08^0$ 17' 55.9''N and $126^0$ 00' 16.6''E. |
| **6** | **Low to moderate** | **Low to high** | The area is underlain by recent alluvium, carbonaceous mudstone and white limestone. The slopes at the area ranges from flat to very steep slopes. Houses near/beside the slopes must be relocated away from the roads or stabilized the slopes when relocation is impossible to prevent landslides. The community is also advised to observe presence |

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| | | | of mass movement, saturated grounds and sunken or displaced road surfaces at the area and report to the MGB/municipal authorities for immediate response.<br>The center community of the purok is situated in concave morphology making the area a catchment basin for the rain water from the highland. Improvement of the drainage system is recommended to help facilitate the flood water. The community is also advised to observe rapid increase of water level at the area during heavy rains and develop early warning device/system and communicate to the barangay authorities for the immediate response.<br>Geographic location of P-6 area base on GPS reading is $08^0$ 17' 44.1''N and $126^0$ 00' 14.1''E. |
| **7 Kalinagyan** | **Low** | **Low** | The area is situated in a planar surface beside the national highway road and adjacent from the foot slopes of the limestone area. Presences of springs were sited at the area and were used as drinking and other daily water needs of the community. The area is warned for the rockfalls and sinkholes brought by the limestone.<br>Geographic location P-7 Kalingayan base on GPS reading is $08^0$ 16' 43.4''N and $125^0$ 59' 32.6''E. |
| **7A Kalingayan** | **Moderate to high** | **Low** | The area is situated beside the national highway road and Klingayan creek. The gabbions and flood control dikes were already been damaged by the water action; it is recommended to repair/reinstall gabbions and dikes to stop scourings along the banks. The community is advised to observe rapid increase of water level at the creek and develop early device/system and communicate with the barangay authorities for immediate response.<br>Houses near the foot slopes should be relocated and be observant for other presence of mass movements and saturated grounds and report it to the MGB/municipal authorities.<br>Geographic location of P-7A Kalingayan base on GPS reading is $08^0$ 16' 09.9''N and $125^0$ 59' 14.1''E. |
| **8 Ladimora** | **High** | **Low to high** | The area is situated in the highland |

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| | | | part of the barangay underlain by chloritic to argillic diorite. Intense presences of landslides were seen at the area, the community beside the slopes is advised to relocate their houses away from the slopes and put-up slope stabilization measures to prevent another mass movement. Observe other presence of mass movements and saturated grounds and report it to the MGB/municipal authorities.<br>Residents near the Kimaybay creek must observe rapid increase of water level and communicate with barangay authorities.<br>Geographic location of P-8 Lademora base on GPS reading is $08^0$ 16' 29.1''N and $126^0$ 01' 35.3''E. |
| **9** | **High to very high** | **None** | The area is located at the highland part of the barangay area underlain by porphyritic andesite and andesite porphyry. Intense presence of mass movement activities were sited at the area damaging some part of the road. It is recommended to relocate the houses near the slopes to avoid future losses.<br>Geographic location of P-9 is adjacent from sitio Lademora and the GPS reading is $08^0$ 17' 36.6''N and $126^0$ 01' 44.3''E. |
| **10 Sinayugan** | **Very high** | **None** | The area/community is located at the top ridge with very steep slopes; intense presences of landslides were sited at the area and the road so community is advised to relocate their houses rom the slopes or cliffs to avoid future loss. The community is also advised to be very vigilant and observant to their surroundings about the presences of mass movements, saturated grounds and report it to the MGB/municipal authorities for immediate response for the problem.<br>Geographic location of P-10 Sinayugan base on GPS reading is $08^0$ 17' 42.4''N and $126^0$ 03' 04.7''E. |
| **10A Junction Masabong** | **Low to very high** | **None** | The area is located beside the junction of PMC road going to the mine site and road going to Sinayugan area. The community is situated beside the slopes where landslide activities were prominent. The community is advised to relocate their houses away from the slopes |

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| | | | and observe for other presence of mass movement, saturated grounds and communicate with the MGB/Municipal authorities.<br>Geographic location of P-10A Junction Masabong base on GPS reading is $08^0$ 18' 03.4''N and $126^0$ 02' 5.0''E. |
| **11** | **High to very high** | **None** | The area is situated along the top ridge where presence of landslide is prominent at the area. The community is advised to relocate their houses away from the slopes/cliffs and observe for other presence of mass movement, saturated grounds and communicate with the MGB/Municipal authorities.<br>Geographic location of P-11 base on GPS reading is $08^0$ 11' 02.1''N and $126^0$ 04' 39.8''E. |
| **11A** | **High to very high** | **None** | The area is underlain by mudstone, sandstone, porphyritic andesite, volcaniclastic andesite and dacite porphyry. The slopes at the area are ranging from steep to very steep making the area very critical to landslides. Houses at the cliffs/near the slopes must be relocated to prevent future loss; the community must be observant and vigilant in their area about the presence of mass movements, saturated grounds and report it immediately to MGB/municipal authorities.<br>Geographic location of P-11A base on GPS reading is $08^0$ 17' 43.4''N and $126^0$ 04' 30.7''E. |
| **11B Mahunok** | **Very high** | **None** | The area is situated at the ridge beside a pilot road, intense presence of landslide is sited at the area making the community critical to landslide activity. The residents must be relocate their houses away from the cliffs/slopes, observe for other presence of mass movements, saturated grounds and report it to the barangay/municipal authorities for immediate response.<br>Geographic location of P-11B Mahunok area is 1.0km S$70^0$E from GPS reading of $08^0$ 17' 05.1''N and $126^0$ 04' 21.5''E. |
| **12 Blue tent** | **Moderate to very high** | **None** | The area is situated beside the PMC road going to mine site. Houses were built along cliffs/slopes ranging from steep to very steep. Relocation of |

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| | | | some buildings near the slopes is recommended to avoid future loss. Observe for other presence of mass movement, saturated grounds and report it to the barangay/municipal authorities for immediate response. Geographic location of P-12 Blue tent base on GPS reading is $08^0$ 16' 36.6''N and $126^0$ 02' 16.2''E. |
| **13 Bagong Silang** | **Low to moderate** | **None** | The area is located in concave morphology surrounded by moderate slopes; no presence of mass movement near the area was observed. Still the community is advised to observe for other presence of mass movements, saturated grounds, sunken/displaced road surfaces and communicate with barangay/municipal authorities. Geographic location of P-13 Bagong Silang base on GPS reading is $08^0$ 16' 27.0''N and $126^0$ 04' 18.4''E. |
| **Durian** | **Low to high** | **None** | The area is situated beside the PMC road gong to mine site, with moderate to steep slopes. Repair damaged wooden bridge and monitor for other presence of mass movement s, saturated grounds, sunken/displaced road surfaces and communicate with barangay/municipal authorities. Geographic location of P-Durian base on GPS reading is $08^0$ 16' 10.5''N and $126^0$ 02' 54.8''E. |

**Table 2 . Results of Landslide and Flood Assessment at Barangay Cabantao**

| Purok | Landslide Susceptibility Rating | Flood Susceptibility Rating | Recommendations |
|---|---|---|---|
| **1** | **Low to moderate** | **Low to moderate** | The area is located beside the barangay area and Solibao river causing flood during rainy season and heavy rain, houses beside the river must be relocated away from the river to avoid future damages due to intense presence of river scouring, install canals to facilitate surface runoff or flood water. Observe rapid increase of water level at river and communicate with the barangay/municipal authorities for immediate action during flood. |

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| | | | There are some areas of the purok situated in higher ground having moderate slopes, observe presence of mass movements, saturated grounds, and sunken or displaced road surfaces and report it to the authorities.<br>Geographic location of P-1 Cabantao base on GPS reading is $08^0$ 23' 33.9''N and $126^0$ 02' 05.4''E. |
| **2** | **Moderate** | **Moderate** | The area is situated along the Solibao river, some of the houses were built along the river embankments, it is advisable to relocate the houses near the river and prohibit future settlements, put-up large drainage system to help facilitate the flood water particularly at the school premises. Observe rapid increase of water level at the river, develop early warning system/device and communicate with the barangay/ municipal authorities for immediate response.<br>Observe mass movement activities at the highland part of P-2 area, also observe for saturated grounds and sunken or displaced surfaces and report it to the municipal authorities.<br>Geographic location of P-2 Cabantao base on GPS reading is $08^0$ 23' 31.2''N and $126^0$ 02' 03.2''E. |
| **3** | **None** | **Moderate** | The area is situated in a low ground part of the barangay and beside this purok is the Tag-os creek which causing flood at the area during heavy rains. Increase sizes of culverts at the area and maintain regular cleaning of water ways. Re-channeling of Tag-os creek is recommendable to minimize the flooding activity at the area.<br>Geographic location of P-3 Cabantao base on GPS reading is $08^0$ 23' 40.3''N and $126^0$ 01' 51.5''E. |
| **4** | **None** | **High to very high** | The P-4 community is located near the Solibao river causing flood at the area. Re-channeling of Solibao river is advisable to prevent the water to off-course with its channel during heavy rain/rainy season. The community is advised to observe rapid increase of water level at the river, develop early warning device/system and communicate with the barangay/municipal authorities |

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| | | | for quick action.<br>Geographic location of P-4 Cabantao base on GPS reading is $08^0$ 23' 35.8''N and $126^0$ 01' 24.3''E. |
| **5** | **Moderate to low** | **None** | The area is situated in the middle of rolling terrains of the barangay area underlain by mudstone and supergene argillic porphyritic andesite. Presence of mass movements is sited in the area like the terracettes and tension cracks along the barangay road. The community is advised to relocate their houses away from the slopes and prohibit future settlements near the slopes, observe for other mass movement activities and report it immediately to the barangay/municipal authorities for immediate response/action.<br>Geographic location of P-5 Cabantao base on GPS reading is $08^0$ 24' 38.6''N and $126^0$ 02' 05.7''E. |
| **6 Matanog** | **Moderate to very high** | **None** | The area is situated at the highland part of the barangay, along the way going to the purok area, landslides and collapsed road were sited. The community is advised to observe for other presence of mass movement, saturated grounds, and sunken or displaced road surfaces and report it to the barangay/municipal authorities for immediate response.<br>Geographic location of P-6 Cabantao base on GPS reading is $08^0$ 25' 03.9''N and $126^0$ 03' 42.3''E. |
| **7** | **Low** | **Low to high** | The area is situated near the Solibao river causing flood at the area. Houses near the river must be relocated and prohibit future settlement near the river. Re-channeling of Solibao river is recommended to prevent the water to off-course in its channel during heavy rains. Observe rapid increase of water level at the river and develop early warning system/device and communicate with barangay/municipal risk reduction management for immediate response.<br>Geographic location of P-7 Cabantao base on GPS reading is $08^0$ 23' 34.2''N and $126^0$ 01' 57.5''E. |

**Table 3. Results of Landslide and Flood Assessment at Barangay Cabawan**

| Purok | Landslide Susceptibility Rating | Flood Susceptibility Rating | Recommendations |
|---|---|---|---|
| **Durian** | **None** | **Moderate** | The area is situated planar area near Hubang and Solibao river which causes flood to area when they overflow during rainy season/ heavy rains. Install drainage system to facilitate the flood water, observe rapid increase of water levels at the creeks/rivers at the area, develop early warning device /system, and always communicate with barangay/ municipal risk reduction office for immediate response during flood. Repair damaged farm to market roads and relocate houses near the lakes at the area. Geographic location of P- Durian area base on GPS reading is $08^0$ 21' 31.2''N and $126^0$ 00' 01.9''E. |
| **Guava** | **None** | **Moderate** | The area is situated in a planar area beside the Solibao river which causes flood at the area when it overflows during rainy season. It is advisable to relocate the houses near the river embankments and prohibit future settlements near the river. Observe rapid increase of water levels at the creeks/rivers at the area, develop early warning device /system, and always communicate with the barangay/ municipal risk reduction office for immediate response during flood. Geographic location of P-Guava base on GPS reading is $08^0$ 21' 27.2''N and $125^0$ 59' 51.3''E |
| **Kaimito** | **None** | **Moderate** | The area is located beside the Solibao river causing flood during heavy rains and rainy season. Intense presence of river scouring was sited at the area so houses near the river embankments must be relocated away from the river. Observe rapid increase of water levels at the creeks/rivers at the area, develop early warning device /system, and always communicate with the barangay/ municipal risk reduction office for immediate |

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| | | | response during flood.<br>Geographic location of P-Kaimito area base on GPS reading is $08^0$ 21' 31.6''N and $125^0$ 59' 30.0''E. |
| **Lanzones** | **None** | **Moderate** | The area is located not far away from Solibao river which its flood influence is present. The area experiences 0.50m to 0.90m flood height during heavy rains/ rainy season due to the waters that overflow from Solibao river. The community is advised to observe rapid increase of water levels at the creeks/rivers at the area, develop early warning device /system, and always communicate with the barangay/ municipal risk reduction office for immediate response during flood. Repair damaged road from barangay Cabawan site to P-Lanzones area.<br>Geographic location of P-Lanzones area base on GPS reading is $08^0$ 21' 04.0''N and $125^0$ 59' 49.2''E. |
| **Manga** | **None** | **Moderate** | The P-Manga is situated at the flood plain area, the area is situated distant from Solibao river but still under the flood influence of the river when it overflows. In respond to the flood, the community is advised to install a flood control canals to help facilitate or help drain easily the flood waters, observe rapid increase of water levels at the creeks/rivers at the area, develop early warning device /system, and always communicate with the barangay/ municipal risk reduction office for immediate response during flood.<br>Geographic location of P-Manga base on GPS reading is $08^0$ 21' 13.9''N and $125^0$ 59' 55.3''E. |
| **Nangka** | **None** | **Low to high** | P-Nangka is situated distant from Solibao river causing flood at the area during rainy season. River scouring was sited at some parts of the river and some houses were built at the river embankments, it is advisable to relocate the houses away from the river embankments and prohibit future settlements. Gravelling of roads is recommended and increase sizes of culverts to avoid easily be clogged and to contain more water. Observe rapid increase of water levels at the |

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| | | | creeks/rivers at the area, develop early warning device /system, and always communicate with the barangay/ municipal risk reduction office for immediate response during flood.<br>Geographic location of P-Nangka base on GPS reading is $08^0$ 21' 41.7''N and $125^0$ 59' 42.8''E. |
| **Santol** | **None** | **Low to moderate** | The area is situated in the barangay site (GPS reading at the area is $08^0$ 21' 28.5''N and $125^0$ 59' 55.6''E), some parts of the purok are situated near the Solibao creek, they experience moderate flooding while at the barangay site they only have low flooding event. The community is advised to observe rapid increase of water levels at the creeks/rivers at the area, develop early warning device /system, and always communicate with the barangay/ municipal risk reduction office for immediate response during flood.<br>Geographic location of P-Santol base on GPS reading is $08^0$ 21' 27.7''N and $125^0$ 59' 53.1''E. |

**Table 4. Results of Landslide and Flood Assessment at Barangay Libuac**

| Purok | Landslide Susceptibility Rating | Flood Susceptibility Rating | Recommendations |
|---|---|---|---|
| **1** | **None** | **High with localized low portions** | The area is located near Solibao and Limbatangan river bringing flood into the area during heavy rains and rainy season. Relocate the houses along river embankments away from the river,prohibit future settlements near the river, re-channel the Solibao river or install flood control dikes to prevent water to overflow and slow down the rate of river scouring. Observe rapid increase of water level at Solibao and Limbatangan river, develop early warning system/device, communicate with the barangay and municipal authorities for immediate response during flood, put-up highly elevated evacuation centers and acquire rescue boats / dump trucks for quick evacuation.<br>Geographic location of P-1 Libuac base on GPS reading is $08^0$ 23' |

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| | | | 41.7''N and 126$^0$ 00' 43.9''E. |
| **'2** | **None** | **Low to moderate** | The area is located around the barangay site and along the barangay road. The area experiences low to moderate flood when Limbatangan river overflows during heavy rain / rainy season. Observe rapid increase of water level at Limbatangan river, develop early warning system/device, and communicate with the barangay/ municipal authorities for immediate action during flood. Increase/ change sizes of culverts enough to contain flood water and maintain regular cleaning of the water ways.<br>Geographic location of P-2 Libuac base on GPS reading is 08$^0$ 23' 23.9''N and 126$^0$ 00' 37.0''E. |
| **3** | **None** | **Low** | The area is situated near the Solibao river making the area experience a low flood during heavy rain/ rainy season. Observe rapid increase of water level at Solibao river, develop early warning system/device, and communicate with the barangay/ municipal authorities for immediate action during flood.<br>Geographic location of P-3 Libuac base on GPS reading is 08$^0$ 23' 20.1''N and 126$^0$ 00' 39.8''E. |
| **4** | **Low** | **Low to moderate** | The area is situated in a higher elevation than the other puroks but some of the parts of the purok are in the lower grounds making it prone to flood when Limbatangan and Solibao river overflow during heavy rains/rainy season. Observe rapid increase of water level at the area and install early warning device and communicate with the barangay/municipal authorities, and change sizes of culverts to prevent easily clogged. High ground part of P-4 area is a good relocation/evacuation for the flooded residences of Brgy. Libuac.<br>Geographic location of P-4 Libuac base on GPS reading is 08$^0$ 23' 44.7''N and 126$^0$ 00' 49.0''E. |
| **5** | **None** | **Low** | The area is situated along the barangay road in adjacent from Solibao river. The area experiences low food during heavy rains and rainy days. Improve drainage system and |

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| | | | observe sunken road surfaces.<br>Geographic location of P-5 Libuac base on GPS reading is $08^0$ 23' 30.8''N and $126^0$ 00' 42.0''E. |

**Table 5. Results of Landslide and Flood Assessment at Barangay Maligaya**

| Purok | Landslide Susceptibility Rating | Flood Susceptibility Rating | Recommendations |
|---|---|---|---|
| **1** | **None** | **Low** | The area is located in a planar surface near Limbatangan creek. The area experiences only sheet flood so it is recommended to install small canals to facilitate surface runoff. Even if Limbatangan creek doesn't have flood influence still the community is advised to observe for rapid increase of water level at the creek and communicate with the barangay authorities.<br>Geographic location of P-1 Maligaya base on GPS reading is $08^0$ 25' 34.9''N and $126^0$ 01' 59.5''E. |
| **2** | **None** | **Low** | The area is situated in a higher ground having planar surface, it has already drainage system that help facilitate surface runoff. The community is advised to have a regular cleaning of the canals.<br>Geographic location of P-2 Maligaya base on GPS reading is $08^0$ 25' 36.9''N and $126^0$ 01' 58.6''E. |
| **3** | **None** | **Moderate** | The area is situated in a lower ground of the barangay area, experiencing moderate flooding when Limbatangan creek overflows during heavy rains. The community is advised to observe rapid increase of water level at the creek and develop early warning system/device and communicate with the barangay authorities in case of flood. Install flood control dikes at the creek to prevent the creek to overflow into the area.<br>Geographic location of P-3 Maligaya base on GPS reading is $08^0$ 25' 29.7''N and $126^0$ 01' 57.4''E. |
| **4** | **None** | **Moderate** | The area is situated in a lower ground of barangay area and also located beside the Limbatangan creek where flow of flood water |

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| | | | comes into this area. The community is advised to observe rapid increase of water level at the area, develop early warning system/device, communicate with barangay/municipal authorities during flood and evacuate to higher grounds immediately in worst case. The installation of flood control dikes or re-channeling of the creek are the best option to prevent flooding at the area.<br>Geographic location of P-4 Maligaya base on GPS reading is $08^0$ 25' 29.3''N and $126^0$ 01' 58.7''E. |
| **5** | **Moderate to low** | **Low** | The area is located at the higher grounds with convex to planar morphology having steep to low angled slopes making the area prone to mass movement activities. It is advisable to prohibit future settlements near the cliff or slopes, observe other presence of mass movements, saturated grounds and sunken or displaced road surfaces and report it to the barangay/municipal authorities.<br>Geographic location of P-5 Maligaya area base on GPS reading is $08^0$ 25' 12.7''N and $126^0$ 01' 56.8''E. |
| **6** | **Low to moderate** | **Low to very high** | The community of P-6 is located beside the Limbatangan creek which overflows during heavy rains and rainy season. It is recommended to relocate the houses at the creek embankments away from the creek to prevent future losses brought by the flood, re-channel the creek or put-up flood control dikes to prevent the creek to overflow are the best ways to stop the flooding activity at the area. The community is advised to observe rapid increase of water level at the creek, insatl early warning device/system and communicate with the barangay/municipal authorities during flood for immediate response.<br>At the higher grounds of P-6 area, presence of mass movements were sited making the area prone also to landslides, the community is advised also to observe other presence of mass movements and report it immediately to the barangay/municipal authorities for |

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| | | | quick action.<br>Geographic location of P-6 Maligaya community base on GPS reading is $08^0$ 25' 29.6''N and $126^0$ 01' 59.3''E. |
| **7** | **Low** | **Low to high** | The area is situated near Manangahon creek which is causing flood at the area during heavy rains/ rainy season. Houses near the creek must be relocated away from the creek to avoid future loss due to the flood and river scouring. The community is advised to observe rapid increase of water level at the creek and report it immediately to the barangay/municipal authorities for quick action.<br>Geographic location of P-7 Maligaya base on GPS reading is $08^0$ 25' 40.4''N and $126^0$ 01' 59.3''E. |

**Table 6. Results of Landslide and Flood Assessment at Barangay Marfil**

| Purok | Landslide Susceptibility Rating | Flood Susceptibility Rating | Recommendations |
|---|---|---|---|
| **1** | **Low** | **Low to moderate** | Purok area is located at the barangay site. Some areas of the purok like the elementary school is located in lower ground than the road making it prone to moderate flooding but at the other part were generally low; install small canals to facilitate surface run-off and for any other geohazards at the area like sunken/displaced road surfaces and report it to MGB/ municipal authorities.<br>Geographic location of P-1 Marfil base on GPS reading is $08^0$ 23' 53.4''N and $126^0$ 05' 28.3''E. |
| **1A Nursery** | **Moderate to high** | **Low to very high** | The area is situated at a convex to planar morphology having low to very steep slopes. No flood event was recorded at the area where the community is situated; the flood records were only near the river. Still the community is advised to observe rapid increase of water level at the river and communicate with barangay/municipal authorities.<br>The community is situated is situated in planar surface safe for the landslide activities; mass movement activities were sited along the |

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| | | | mountains and creeks at the purok which no houses were built. In addition, the community is still advised to observe other presence of mass movements at the area and report it to the MGB/municipal authorities.<br>Geographic location of P-1A Nursery base on GPS reading is $08^0$ 23' 38.8''N and $126^0$ 05' 03.2''E. |
| **2** | **Low** | **None** | The area is situated along the road with a planar to convex surface having low angle slopes; install cnals on both sides of the road to facilitate the surface runoff.<br>Geographic location of P-2 Marfil base on GPS reading is $08^0$ 23' 50.6''N and $126^0$ 06' 17.6''E. |
| **3** | **None to low** | **None** | The area is situated in a planar surface along the municipal road. Installation of small canals may help facilitate surface runoff;' maintain the good condition of the farm to market road and observe sunken or displaced road surface.<br>Geographic location of P-3 Marfil base on GPS reading is $08^0$ 23' 44.3''N and $126^0$ 06' 23.9''E. |
| **4 Caguban** | **Low** | **Moderate at areas near creeks** | The area is situated in gentle slopes along the road. The area is generally low in fooding activity except for the areas near creeks. Still the community is advised to observe rapid increase of water level at creeks and communicate with the barangay authorities; also observe sunken road surfaces and saturated grounds.<br>Geographic location of P-4 Uguban Marfil base on GPS reading is $08^0$ 23' 02.7''N and $126^0$ 07' 11.2''E. |
| **5 Pamintigan** | **Low** | **None** | The area is situated in flat surfaces with no geohazard activities sited except for the damaged road; repair damaged farm to market road for safety travel of the motorists.<br>Geographic location of P-5 Pamintigan Marfil base on GPS reading is $08^0$ 24' 16.4''N and $126^0$ 04' 36.6''E. |
| **6 Latay** | **Low to high with localized very high areas** | **Moderate to high** | The area is underlain by white limestone with gentle to very steep slopes; the community is located near Latay creek and Niholm falls. Intense creek scouring was present at the creek slowly damaging the |

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| | | | brigdes along the way. Put-up flood control dikes at the creek to slow down the scouring activity; houses near the creek must be relocated away from the creek and prohibit future settlements. Observe rapid increase of water level at the creeks and develop early warning device/system and communicate with the barangay/municipal authorities.<br>Houses near the steep slopes must be relocated away from the slopes, the community must be observant in their area about the presence of mass movements, saturated grounds, sunken surfaces especially those residents whose houses were at the limestone area and report immediately to the MGB/municipal authorities for immediate action.<br>Geographic location of P-6 Latay Marfil base on GPS reading is $08^0$ 21' 54.9''N and $126^0$ 06' 38.5''E. |
| **7 Oguban** | **Low** | **None** | The area is situated at limestone area with gentle to steep slopes. a small sunken part of the road was sited at the area; residents should be observant about sinkholes at the area, any mass movement activities and report it immediately to MGB/Municipal authorities for immediate response to the problem.<br>Geographic location of P-7 Oguban Marfil base on GPS reading is $08^0$ 22' 17.5''N and $126^0$ 08' 15.6''E. |

**Table 7. Results of Landslide and Flood Assessment at Barangay Novele**

| Purok | Landslide Susceptibility Rating | Flood Susceptibility Rating | Recommendations |
|---|---|---|---|
| **1** | **None** | **Moderate** | The area is located beside the Solibao river causing flood at the area. Prohibit future settlements near the river, observe rapid increase of water level at the river and creeks, develop early warning device/system and always communicate with the barangay/municipal risk reduction office for immediate response during calamities. Install drainage system to help facilitate the flood waters.<br>Geographic location of P-1 Novele base on GPS reading is $08^0$ 21' |

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| | | | 07.2''N and 125$^0$ 58' 36.0''E. |
| **2** | **None** | **Low to high** | The area is situated beside the river embankments of Solibao river, the community is advised to relocate their houses away from the river because of the presence of river scouring at the river and to avoid the future damaged brought by the flood when the river overflows. Observe rapid increase of water level at the river and creeks, develop early warning device/system and always communicate with the barangay/municipal risk reduction office for immediate response during calamities. Install drainage system to help facilitate the flood waters.<br>Geographic location of P-2 Novele base on GPS reading is 08$^0$ 21' 05.3''N and 125$^0$ 58' 48.3''E. |
| **3 Banaba** | **None** | **Low to high** | The area is located situated beside the river embankments of Solibao river, the community is advised to relocate their houses away from the river because of the presence of river scouring at the river and to avoid the future damaged brought by the flood when the river overflows. Observe rapid increase of water level at the river and creeks, develop early warning device/system and always communicate with the barangay/municipal risk reduction office for immediate response during calamities. Install drainage system to help facilitate the flood waters.<br>Geographic location of P-3 Novele is adjacent from the Agusan marsh, GPS reading is 08$^0$ 21' 14.8''N and 125$^0$ 59' 11.1''E. |
| **4** | **None** | **Low to moderate** | The area is situated in flat surface surrounded by rice fields and adjacent from Solibao river which causes flood during heavy rains and rainy season. The community is advised to observe rapid increase of water level at the river and creeks, develop early warning device/system and always communicate with the barangay/municipal risk reduction office for immediate response during calamities. Maintain the cleanliness of the water ways to avoid clogging of canals resulting to flood.<br>Geographic location of P-4 Novele base on GPS reading is 08$^0$ 20' |

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| | | | 15.8''N and 125$^0$ 58' 30.2''E. |
| **5 Halwan Sittio Palibo** | **None** | **Very high** | The area is situated along the Solibao river embankments, making the area very prone to flood when the river overflows during heavy rains and rainy season. Relocate houses beside the river to prevent future losses brought by the flood and river scouring. Put-up highly elevated evacuation centers far away from the river, observe rapid increase of water level at the river and develop early warning device/system and always communicate with the barangay and municipal authorities for immediate response/action when flood strikes. Develop proper drainage systems to facilitate surface run-off.<br>Geographic location of P-5 Halwan base on GPS reading is 08$^0$ 20' 32.9''N and 125$^0$ 57' 07.3''E. |
| **6** | **None** | **Moderate to high** | The area is located beside the Solibao river causing 1-2 weeks of flood when it overflows during the rainy season or heavy rains. The community is advised to relocate their houses away from the river to prevent future losses brought by the flood and river scouring. Put-up highly elevated evacuation centers far away from the river, observe rapid increase of water level at the river and develop early warning device/system and always communicate with the barangay and municipal authorities for immediate response/action when flood strikes.<br>Geographic location of P-6 Novele base on GPS reading is 08$^0$ 21' 02.2''N and 125$^0$ 57' 52.4''E. |
| **7** | **None** | **High** | The area is located near the Agusan marsh and adjacent from Solibao river river which causing the area prone to flood. The community is advised to observe rapid increase of water level at the river and develop early warning device/system and always communicate with the barangay and municipal authorities for immediate response/action when flood strikes. Develop proper drainage systems to facilitate surface run-off.<br>Geographic location of the P-7 Novele base on GPS reading is 08$^0$ 20' 52.8''N and 125$^0$ 57' 16.5''E. |

**Table 8. Results of Landslide and Flood Assessment at Barangay Poblacion**

| Purok | Landslide Susceptibility Rating | Flood Susceptibility Rating | Recommendations |
|---|---|---|---|
| **1** | **Low** | **Low to moderate** | The area is situated from national highway road and along the municipal road going to barangay Libuac. The community is located near the Solibao river causing flood during rainy season. Houses beside the river must be relocated and re-channeling of the river is recommended to prevent the water to off-course from its channel during heavy rains. Observe rapid increase of water level at the river, develop early warning device/system and communicate with the barangay/municipal authorities for quick response.<br>Geographic location of P-1 Poblacion base on GPS reading is $08^0$ 23' 00.2''N and $126^0$ 00' 06.3''E. |
| **2** | **None** | **High to very high** | The the area is situated along the municipal road and beside the Solibao river causing flood at the area during rainy season. Houses beside the river (GPS reading is $08^0$23'16.5''N/$126^0$00'31.4''E) must be relocated and re-channeling of the river is recommended to prevent the water to off-course from its channel during heavy rains and improve drainage system to help facilitate the flood water. Observe rapid increase of water level at the river, develop early warning device/system and communicate with the barangay/municipal authorities for quick response.<br>Geographic location of P-2 Poblacion base on GPS reading is $08^0$ 23' 16.1''N and $126^0$ 00' 28.3''E. |
| **3** | **None** | **High to very high** | The area situated beside the Tagbayagan creek and Limbatangan river causing high floods during rainy season. Improve and maintain regular cleaning of the water ways at the area to help facilitate the flood water, observe rapid increase of water level at the river, develop early warning device/system and communicate with the barangay/municipal authorities for |

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| | | | quick response. Acquisition of dump trucks and additional motor boats to the barangay authorities is recommended to be used in quick evacuation during flood.<br>Geographic location of P-3 Poblacion base on GPS reading is $08^0$ 23' 07.5''N and $126^0$ 00' 07.9''E. |
| **4** | **Low to moderate** | **Low to high** | The area covers from the public market area going to NIA building area. Some houses at the purok is located beside the Tagbayagan creek making them highly prone to scouring and flood, it is advisable to relocate the houses away from the creek or put-up flood control dikes at the creek. The community is advised to observe rapid increase of water level at the creek, develop early warning device/system and communicate with the barangay/municipal authorities for quick response. At public market implement proper waste disposal and regular cleaning of canals at the area.<br>Geographic location of P-4 Poblacion base on GPS reading is $08^0$ 23' 00.6''N and $125^0$ 59' 58.1''E. |
| **5** | **Low** | **Low to moderate** | The area is located beside the national highway road; the flow of flood water went beside this purok area making the area moderately prone to flood; the rice field beside the purok is highly prone to flood when Tagbayagan and Limbatangan river overflows during rainy season. The community is advised to observe rapid increase of water level at the creek, develop early warning device/system and communicate with the barangay/municipal authorities for quick response.<br>Geographic location of P-5 Poblacion base on GPS reading is $08^0$ 23' 39.9''N and $125^0$ 59' 53.2''E. |
| **6** | **None** | **Moderate to very high** | The purok area is situated beside Solibao River covering form national highway going to Cabawan; prohibit any other future settlements near the river, repair road and culverts bound to Cabawan area, and install flood control dikes at Solibao river to prevent the river scouring. The community is advised to observe rapid increase of water level at the |

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| | | | creek, develop early warning device/system and communicate with the barangay/municipal authorities for quick response. Geographic location of '$08^0$ 22' 25.4''N and $126^0$ 00' 22.0''E. |
| **7** | **Moderate to high** | **Moderate** | The area is situated in convex to planar surface having moderate slopes; the area has creeks that causes flood during rainy season, it is advisable to install flood control dikes at the creek and implement regular cleaning of the creek; houses beside the creek must be relocated away from the creek. The community must observe rapid increase of water level at the creek, develop early warning device/system and communicate with the barangay/municipal authorities for quick response. Also near the slopes the residents must observe presence of mass movements and saturated grounds and report it to the barangay/ municipal authorities. Geographic location of P-7 Poblacion base on GPS reading is $08^0$ 22' 39.4''N and $126^0$ 01' 05.4''E. |

**Table 9. Results of Landslide and Flood Assessment at Barangay Santa Cruz**

| Purok | Landslide Susceptibility Rating | Flood Susceptibility Rating | Recommendations |
|---|---|---|---|
| **1/Marasigan** | **Low** | **Low** | The area is situated in gentle slopes beside the national highway road. The area experiences low flooding due to sheet floods when Solibao river overflows. It is advisable to add more canals at the area to help facilitate the surface runoff. Geographic location of P-1/ Marasigan Sta. Cruz area base on GPS reading is $08^0$ 22' 06.0''N and $126^0$ 00' 38.3''E. |
| **2/Ocite** | **Low** | **Low** | The area is situated in along the national highway with flat to moderate slopes. The area experiences sheet floods during heavy rains and because of clogged canals; improve drainage system like widen and deepen the canals and implement regular cleaning of any |

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| | | | kinds of water ways. Promote proper solid waste management at the area.<br>Geographic location of P-2/Ocite Sta. Cruz base on GPS reading is $08^0$ 21' 42.9''N and $126^0$ 00' 57.1''E. |
| **4/Gumamela** | **Low to Moderate** | **Low** | The community is situated in a flat to moderate slopes along the national highway. Installation of additional canals may help facilitate surface runoff and improve condition of current drainage system. Implement proper solid waste management at the area to avoid blockage of water ways. Observe any presence of mass movement, saturated grounds and sunken or displaced surfaces and report it to the MGB/municipal authorities.<br>Geographic location of P-4/Gumamela Sta. cruz base on GPS reading is $08^0$ 21' 25.7''N and $126^0$ 00' 58.5''E. |
| **9/Perez** | **None** | **Moderate to high** | The area is in a planar surface beside a rice field going to Agusan marsh. A meandering creek is passing along the area which causes flood when it overflows during the rainy season/ heavy rain. Re-channeling or deepen the creek is recommended to prevent/lessen the flood at the area. Houses must give distant allowance from the creek to prevent future damages brought by the flood or scouring. Houses at the high flooding area must observe rapid increase of water level, develop early warning system/ device and communicate with the barangay/ municipal risk reduction management office for immediate response during flood.<br>Geographic location of P-9/P-Perez Sta. Cruz and its high flooding area base on GPS readings are $08^0$ 21' 38.6''N/$126^0$ 00' 49.2''E and $08^0$ 21' 43.7''N/$126^0$ 00' 31.0E respectively. |
| **10/Talisay** | **None** | **Low** | The area is situated beside the national highway road and experiences sheet floods when canals overflow during heavy rains and rainy season. Regular de-clogging and de-silting of canals is recommended to prevent blockage of water ways and to contain more volume of water and implement proper solid waste disposal. |

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| | | | Geographic location of P-10/ P-Talisay Sta. Cruz base on GPS reading is $08^0$ 21' 39.9''N and $126^0$ 00' 57.1''E. |
| **11/Doldol** | **Low to moderate** | **Low to high** | The area is situated in convex morphology having gentle slopes. Some areas experience high floods because of the canal/creeks that overflow during heavy rains/rainy season. It is recommended to deepen and widen the creeks to contain more water and put-up dikes along with it, to control the scouring and improve the drainage system. Observe rapid increase of water level at the area and communicate with barangay/municipal authorities for immediate response.<br>Areas at the elevated part of the purok should observe presence of mass movement at the area, saturated grounds and sunken or displaced surfaces and report it immediately to MGB/municipal authorities for immediate action to the problem.<br>Geogarphic location of P-Doldol Sta. Cruz base on GPS reading is $08^0$ 21' 47.8''N and $126^0$ 00' 54.2''E. |
| **15 Padigusan** | **Low to high** | **Low to very high** | The community is located beside the national highway road in a flat surface. The area suffers from flood during heavy rains/rainy season because of the clogged creeks and canals. It is recommended to implement regular cleaning and de-silting of the any kind of water ways at the area to prevent blockage of water flow during rain. The community is also advised to observe rapid increase of water level at the area and develop early warning device/system and communicate with the barangay/ municipal authorities for immediate response.<br>At highland part of the area, prohibit future settlements near steep slopes and repair collapsed road surfaces. Observe other presence of mass movement, saturated grounds, and sunken/displaced road surfaces.<br>Geographic location of P-15 Padigusan Sta. Cruz community base on GPS reading is $08^0$ 20' 11.0''N and $126^0$ 00' 40.6''E. |

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| **Bahi** | **High to very high** | **None** | The area is located at the highland part of the purok underlain by andesitic volcaniclastics. Slopes are ranging from moderate to very steep and there are presences of landslides making the critically prone to landslide activities. The community is advised to relocate their houses away from the slopes and river embankments, observe other presence of mass movements, saturated grounds, sunken/displaced road surfaces and report immediately to MGB/municipal authorities for immediate action of the problem.<br>Geographic location of P-Bahi Sta. Cruz base on GPS reading is $08^0$ 21' 09.5''N and $126^0$ 02' 39.5''E. |
| **Guava** | **Low to high** | **None** | The area is underlain by porphyritic andesite and basalt(?) making low to steep slopes. Some areas were underlain by soil making the area prone to landslides. Stabilized the slopes to slow down the rate of mass movement and relocate those houses which are located along steep slopes. Observe other presence of mass movement, saturated grounds and sunken surfaces and report it to the MGB/ municipal/barangay authorities for immediate action of the problem.<br>Geographic location of P-Guava is located along the national highway, GPS reading at the purok area is $08^0$ 21' 39.5''N and $126^0$ 01' 00.5''E. |
| **Hillside** | **Low to moderate** | **None** | The area is situated in a convex morphology having low to moderate slopes and underlain by basalts. Houses and buildings must be relocated away from the slopes particularly at the Sta. Cruz National High School, other buildings must be relocated away from the slope which is starting to erode or establish safety measures like stabilization of slopes. Put-up small canals on both side of the road to facilitate surface runoff.<br>Geographic location of P-Hillside Sta. Cruz base on GPS reading is $08^0$ 21' 31.4''N and $126^0$ 01' 04.9''E. |
| **Kaimito** | **Low** | **None** | The area is located beside the national highway road having low to moderate slopes and no presence of mass movement was sited. Still, the community is advised to observe for |

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| | | | presence of mass movements, saturated grounds, and sunken/displaced surfaces at the area and report it to the barangay/municipal authorities for immediate action.<br>Geographic location of P-Kaimito Sta. Cruz base on GPS reading is $08^0$ 20' 51.1''N and $126^0$ 00' 45.0''E. |
| **Kawayan** | **Low** | **None** | The area is located beside the national highway road with flat to moderate slopes .of 10-13m high. No landslide activity was sited at the area but still, the community is advised to to observe for presence of mass movements, saturated grounds, and sunken/displaced surfaces at the area and report it barangay/municipal authorities for immediate action.<br>Geographic location of P-Kawayan Sta. Cruz base on GPS reading is $08^0$ 21' 11.2''N and $126^0$ 00' 52.3''E. |
| **Loring** | **High to very high** | **Moderate** | The area is underlain by intercalating porphyritic andesite and andesitic volcaniclastics in the highland part of the barangay area. Slopes are ranging from steep to very steep and there are intense presences of landslide activities at the area. Illegal small scale mining add-up the cause of the poor rock mass strength at the area. Stabilization of slopes and repair damaged road surfaces is recommended. Houses beside the slopes must be relocated away from the slopes to avoid future loss. Increase sizes of culverts at the road crossing the creek and deepen the creek to contain more water. Observe for presence of mass movements, saturated grounds, and sunken/displaced surfaces at the area and report it barangay/municipal authorities for immediate action. The community beside the creek is advised to observe rapid increase of water level at the area, develop early warning device/system and communicate with barangay/municipal risk reduction management office for quick response.<br>Geographic location of P-Loring base on GPS reading is $08^0$ 20' |

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| | | | 50.0''N and 126$^0$ 02' 41.6''E. |
| **Mahayahay** | **Low to moderate** | **Low to moderate** | The area is located beside the national highway road. Culverts and creek at the area were clogged; implement regular cleaning/ unclogging of water ways to prevent blockage of water flow during rain.<br>Stabilized slopes along the barangay road and observe presence of mass movements, saturated grounds and sunken road surfaces and report immediately to the MGB/municipal authorities.<br>Geographic location of P-Mahayahay Sta.Cruz base on GPS reading 08$^0$ 20' 30.7''N and 126$^0$ 00' 39.2''E. |
| **San Isidro** | **Moderate** | **Moderate** | The area is situated in planar to convex morphology. Some houses are built beside the cliff which is starting to erode; the community is advised to relocate their houses away from the cliff. Observe other presence of mass movement in the area, saturated grounds, sunken surfaces and report immediately to MGB/municipal authorities. Observe also rapid increase of water level at Gawahon creek and communicate with barangay authorities for updates.<br>Geogarphic location of P-San Isidro Sta. Cruz base on GPS reading is 08$^0$ 21' 36.2''N and 126$^0$ 01' 45.5''E. |
| **Santan** | **Low** | **None** | The area is located beside the national highway road in a convex morphology. No landslide activity was sited at the area; still the community is advised to observe for presence of mass movements, saturated grounds, and sunken/displaced surfaces at the area and report it barangay/municipal authorities for immediate action.<br>Geographic location of P-Santan Sta. Cruz base on GPS reading is 08$^0$ 21' 25.3''N and 126$^0$ 00' 56.4''E. |
| **Sto. Niño** | **Low** | **Low** | The area is underlan by basalts in a planar to convex morphology. The community is advised to observe any mass movement activity at the area, saturated grounds and sunken road surfaces and report to the authorities. Observe rapid increase of water level at the areas near the creek/river.<br>Geographic location of P-Sto. Niño |

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| | | | Sta. Cruz base on GPS reading is $08^0$ 21' 21.9''N and $126^0$ 02' 03.5''E. |

**Table 10. Results of Landslide and Flood Assessment at Barangay Tagbayagan**

| Purok | Landslide Susceptibility Rating | Flood Susceptibility Rating | Recommendations |
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| **1 Mahogany** | **None** | **Low** | The area is in a planar surface located adjacent from Agusan marsh. Install small canals on both sides of the road and other parts of the purok area to facilitate the surface runoff. Develop proper solid waste management like the MRF and garbage pit and observe for displaced/ sunken road surfaces. Geographic location of P-1 Mahogany base on GPS reading is $08^0$ 22' 47.2''N and $125^0$ 59' 36.4''E. |
| **2** | **None** | **Low with localized high prone areas** | The area is underlain by recent alluvium, the area experiences low flooding cause by extreme rainfall, some areas like the road going to the area is highly prone to flood due to improper drainage system. Change/increase sizes of culverts and implement regular cleaning of water ways at the area. For those who are near at the flooded area, they should observe for rapid increase of water level at the area and communicate with the barangay authorities for immediate action. Geographic location of P-2 Tagbayagan base on GPS reading is $08^0$ 22' 30.9''N and $125^0$ 59' 16.2''E. |
| **3 Narra** | **None** | **Moderate** | The area situated in a planar surface surrounded by rice fields. The area experienced moderate flooding due to its clogged drainage system. Change and increase sizes of culverts and implement regular cleaning and unclogging of water ways to prevent blockage of water ways during heavy rains. Observe rapid increase of water level at the area and develop early warning system/device and communicate with the barangay authorities for immediate action. Geographic location P-3 Narra Tagbayagan base on GPS reading is |

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| | | | $08^0$ 22' 09.3''N and $125^0$ 58' 09.6''E. |
| **3A** | **None** | **Low** | The area is situated in a planar area surrounded by rice fields. No recorded flood event at the area but still needs small canals to facilitate the surface runoff and maintain the good conditions of the barangay roads.<br>Geographic location of P-3A Tagbayagan base on GPS reading is $08^0$ 22' 21.0''N and $125^0$ 58' 39.4''E. |
| **4** | **Low** | **None** | The area is situated in convex surface with low angled slopes. Install small canals to facilitate surface runoff and repair damaged roads. Even though the area is under low prone to landslides still monitor and observe for any mass movement activities, saturated grounds and displaced road surfaces and communicate with the barangay/municipal authorities.<br>Geographic location of P-4 Tagbayagan base on GPS reading is $08^0$ 23' 36.2''N and $125^0$ 59' 02.2''E. |
| **5 Manga** | **None** | **Low** | The area is situated in a planar surface, implement regular cleaning of the canals to prevent blockage of water ways. Repair damaged roads, observe rapid increase of water level at the area and comminicat with the barangay authorities.<br>Geographic location of P-5 Manga Tagbayagan base on GPS reading is $08^0$ 22' 05.2''N and $125^0$ 57' 40.6''E. |
| **6 Durian** | **None** | **Moderate to very high** | The area is situated in a planar area with small lakes and creeks beside the area. Some areas experiences moderate to high but some areas like near at the lakes and creeks experiences high flood during heavy rains or rainy season. Repair damaged road, increase sizes/change the culverts to hold more water. Observe rapid increase of water level at the flooded areas, develop early warning device/system and communicate with the barangay and municipal authorities for immediate action.<br>Geographic location of P-6 Durian Tagbayagan base on GPS reading is $08^0$ 21' 37.9''N and $125^0$ 57' 19.4''E. |
| **6A** | **None** | **Low** | The area is situated in a planar surface surrounded by rice fields, install drainage system, observe |

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| | | | sunken/ displace road surfaces and refilling of gravels at the damaged parts of the road.<br>Geographic location of P-6A Tagbayagan base on GPS reading is $08^0$ 21' 58.2''N and $125^0$ 57' 33.2''E. |

**Table 11. Results of Landslide and Flood Assessment at Barangay Wasi-an**

| Purok | Landslide Susceptibility Rating | Flood Susceptibility Rating | Recommendations |
|---|---|---|---|
| **1 Boan** | **Low to very high** | **Low to moderate** | The area covers both lowland and highland parts of the barangay but community of P-1 Boan is situated at the lowland part along the Boan river causing flood at the area during rainy season. Installation of flood control dikes is recommended to prevent the river to overflow at the houses and houses beside the river channel must be relocated away from the river. The community is advised to observe rapid increase of water level at the river, develop early warning device/system and communicate with the barangay/municipal authorities for immediate response. Geographic location of P-1 Boan community base on GPS reading is $08^0$ 19' 11.3''N and $126^0$ 00' 36.1''E.<br>There is an intense presence of mass movement activities at the highland part of the purok; relocate houses that were built near from the slopes, motorists must be vigilant and observant to rock fall activity along the roads. In addition, the community is advised also to observe other presence of mass movement activity and saturated grounds at the area and report it to the barangay/ municipal/MGB authorities for immediate action of the problem. One of the GPS readings at the highland part of the purok- $08^0$ 18' 30.0''N and $126^0$ 02' 41.3''E. |
| **2** | **None** | **Moderate** | The community is situated around the barangay site near the Wasian river. Install drainage system to help facilitate the flood water, install flood |

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| | | | control dikes to prevent the river to overflow, and relocate houses beside the river to prevent future damages brought by river scouring and flood. The community is advised to observe rapid increase of water level at the river, develop early warning device/system and communicate with the barangay/municipal authorities for immediate response.<br>Geographic location of P-2 area base on GPS reading is $08^0$ 19' 28.4''N and $126^0$ 00' 32.7''E. |
| **3** | **None** | **Moderate** | The area is situated in a low ground experiencing moderate flood lasting 4 hours before it drains; developing a drainage system may help to facilitate the flood water. The community is advised to observe rapid increase of water level at the river, develop early warning device/system and communicate with the barangay/municipal authorities for immediate response.<br>Geographic location of P-3 Wasian base on GPS reading is $08^0$ 19' 27.3''N and $126^0$ 00' 25.2''E. |
| **4** | **Low to very high** | **Low to high** | The P-4 community is situated at the lowland part of the purok area beside the Wasian river making the area prone to flooding. Installation of flood control dikes along the river is recommended to prevent the water to overflow during rainy season and prevent also the river scouring activity and relocate houses built beside the river to avoid future loss. The community is advised to observe rapid increase of water level at the river, develop early warning device/system and communicate with the barangay/municipal authorities for immediate response. Geographic location of P-4 community at Wasian base on GPS reading is $08^0$ 19' 31.8''N and $126^0$ 00' 35.1''E.<br>The highland part of the purok called Tandawan area is very prone to landslides, it is advisable not to build houses near the slopes/cliffs and observe fot other presence of mass movement activities, saturated grounds and sunken roads and report it immediately to the MGB/ municipal authorities for immediate action. Geographic location of |

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| | | | Tandawan area base on GPS reading is $08^0$ 19' 00.8''N and $126^0$ 02' 35.4''E. |
| **5** | **None** | **Low to moderate** | The area is located beside the national highway road covering the elementary school beside the Wasian river. The area experiences flood when Wasian river overflows during rainy season; install flood control dikes along the river to prevent water to overflow and stop the river scouring. The community is advised to observe rapid increase of water level at the river, develop early warning device /system and communicate with the barangay/ municipal risk reduction management office for immediate response.<br>Geographic location of P-5 Wasian base on GPS reading is $08^0$ 19' 36.0''N and $126^0$ 00' 09.4''E. |
| **6** | **None** | **Low to high** | The area is located going in planar surface experiencing low to high flooding when the canals and creeks overflow during heavy rainfalls. Improve the drainage system at the area, implement regular cleaning and de-silting the canals to contain more water and clear the water ways. The community is advised to observe rapid increase of water level at the river, develop early warning device /system and communicate with the barangay/ municipal risk reduction management office for immediate response.<br>Geographic location of P-6 Wasian base on GPS reading is $08^0$ 19' 10.2''N and $125^0$ 59' 43.1''E. |
| **7** | **None** | **Moderate** | The community is situated beside a large rice field with irrigation canals beside the road causing flood when it overflows during heavy rains. Implement regular cleaning/ de-silting of canals and observe rapid increase of water level at the area and communicate with the barangay authorities.<br>Geographic location of P-7 Wasian base on GPS reading is $08^0$ 19' 52.6''N and $125^0$ 59' 57.3''E. |
| **8 Blocking** | **Low to high** | **Low with localized high** | The area is situated in the highland part of the barangay area; along the way, bridges must be elevated in order not to get reach by the flood water, observe water level at the |

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| | | | rivers and communicate with the barangay authorities.<br>Along the road, landslides and sunken part of the road were sited, residents should be vigilant of their area and observe for other presence of mass movement activities and report it to MGB/barangay/municipal authorities. Prohibit future settlements near the cliffs and slopes and relocate houses beside the cliff.<br>Geographic location of P-8 Blocking base on GPS reading is $08^0$ 16' 30.7''N and $126^0$ 02' 19.2''E |

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