

MINING AND MINERALS SECTOR R&D Roadmap for Critical Minerals

Updated as of 29 February 2024

OVERALL STRATEGIES

Human Resource

1. Capacitate researchers on critical minerals extraction and processing
2. Participation in short courses/training abroad on critical minerals extraction and processing
3. Conduct benchmarking activities, visit laboratories, facilities, processing plants abroad related to critical minerals extraction and processing
4. Invite Balik-Scientists with expertise on critical mineral processing

Laboratory Facilities / Services

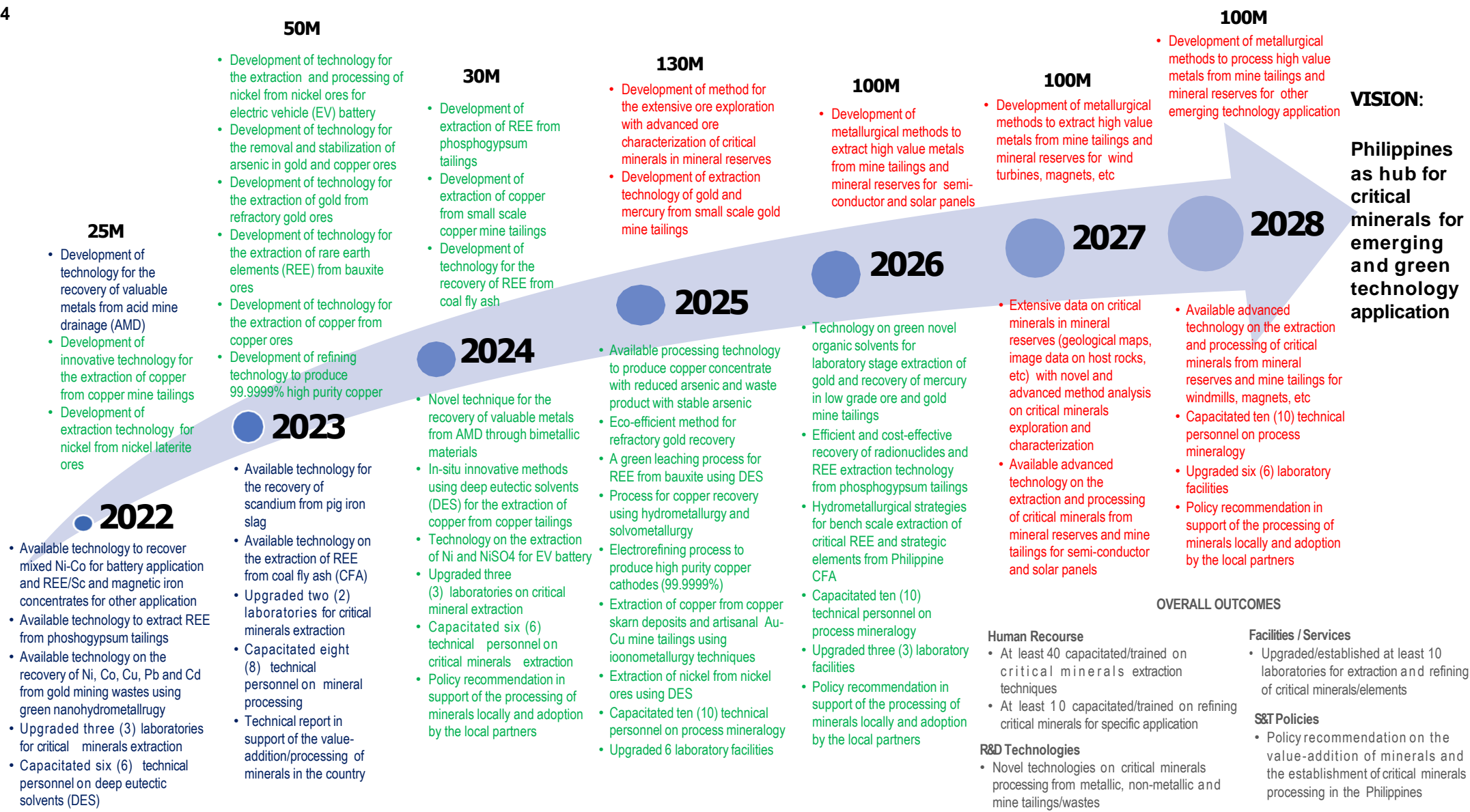
1. Equip SUCs, HEs and RDIs with advanced laboratory equipment
2. Availability of testing facilities needed in the research
3. Availability of facilities to produce target products at pilot scale level

R&D Technologies

1. Extensive ore exploration method with advanced ore characterization in support of critical minerals processing
2. Extraction of high value critical minerals from metallic (gold, copper, nickel, iron, chromite) and other metallic ores
3. Extraction of high value critical minerals from non-metallic minerals
4. Extraction of high value critical minerals from mine tailings/wastes/silts
5. Processing/refining/purification of the extracted critical minerals for industrial application

S&T Policies:

- R&D collaboration with HEIs, RDIs and private sector partners for the above research
- R&D collaboration with foreign funding agencies and foreign research institutions
- Technically and scientifically sound basis research results for policy formulation on the value-addition of metallic and non-metallic minerals and mine tailings and the establishment of processing facilities



R&D Technologies	No	Projects	BUDGET ALLOCATION (PhP)							STATUS
			2022	2023	2024	2025	2026	2027	2028	
Extraction of high value critical minerals from metallic ores	1	Recovery of Nickel, Cobalt, Iron and Rare Earth Elements from Low Grade Philippine Laterite Ores using Atmospheric Leaching with Reduction Pre-treatment	-							Completed
Extraction of high value critical minerals from mine tailings/wastes/silts	2	Extraction of Radionuclides, Rare Earths, and Other Valuable Industrial Elements from Philippine Phosphogypsum Tailings	-							Completed
Extraction of high value critical minerals from mine tailings/wastes/silts	3	Valorization of Mining Wastes by Green Nano-hydrometallurgy: Application of Green-mediated Leaching Process and Innovative Magnetic Nano-separations for the Recovery of (Precious)Metals	4,981,050.00							Completed
Extraction of high value critical minerals from mine tailings/wastes/silts	4	Recovery of Scandium from Laterite-based Pig Iron Slag by Dry Digestion and Precipitation Methods	1,146,250.76							Completed
Extraction of high value critical minerals from mine tailings/wastes/silts	5	Recovery of rare earth elements and strategic elements from coal fly ash by hydrometallurgical technique	2,256,612.00							Completed
Extraction of high value critical minerals from metallic ores	6	Extraction of Ni and NiSO4 from Nickel ores for EV battery application	10,642,043.24	6,473,793.24						On-going
Extraction of high value critical minerals from mine tailings/wastes/silts	7	A novel technique for the recovery of valuable metals from AMD through bimetallic materials	3,986,729.60	2,261,729.60						On-going
Extraction of high value critical minerals from mine tailings/wastes/silts	8	PROMT: Philippine Remediation of Mine Tailings (Large Grant)	6,031,905.60	5,818,057.54	4,774,404.38					On-going
Extraction of high value critical minerals from metallic ores	9	REVIVE PH: Responsible Extraction of Various Valuable Elements in the Philippine Laterite Deposits		6,286,627.20	5,336,627.20					On-going



R&D Technologies	No	Projects	BUDGET ALLOCATION (PhP)						STATUS	
			2022	2023	2024	2025	2026	2027		2028
Extraction of high value critical minerals from metallic ores	10	Removal and stabilization of arsenic in gold and copper ores using aqueous and nonaqueous solvents		4,950,144.00	3,735,545.85					On-going
Extraction of high value critical minerals from metallic ores	11	Innovative technology for refractory gold extraction using deep eutectic solvent (DES) and hypochlorite solution		4,943,127.40	3,492,320.62					On-going
Extraction of high value critical minerals from mine tailings/nonmetallic minerals	12	Rare earth elements in bauxite: characterization and extraction of a potential resource		3,277,692.42	2,750,797342					On-going
Extraction of high value critical minerals from metallic ores	13	Cu-HySolvEr: Copper Hydrometallurgical and Solvometallurgical Extraction from Sulfides and Oxides		3,542,360.00	2,386,512.00					On-going
Extraction of high value critical minerals from metallic ores	14	Electrorefining Process Development for the Production of 6N Copper Cathodes (Cu-Refine)		3,211,274.00	1,746,898.00					On-going
Extraction of high value critical minerals from mine tailings/wastes/silts	15	From Waste to Wealth: Hydrometallurgical Strategies for Bench Scale Extraction of Critical Rare Earth and Strategic Elements from Philippine Coal Fly Ash, and Other Environmental Applications)			8,870,600.00					On-going
Extraction of high value critical minerals from mine tailings/wastes/silts	16	Application of Ionometallurgy for Recovery and Extraction of Copper from Copper Ore and Artisanal Copper-Gold Tailings (I-REACT			4,999,142.40					New
Extraction of high value critical minerals from mine tailings/wastes/silts	17	Extraction of Radionuclides, Rare Earths, and Other Valuable Industrial Elements from Phosphogypsum Tailings			7,797,521.80	4,926,521.80				New
Extraction of high value critical minerals from mine tailings/wastes/silts	18	NEAT-ORE: Novel Extraction of Au and other critical metals in Artisanal Tailings and Low-Grade Ores using organic solvents			7,232,365.10					New



MINING AND MINERALS SECTOR - R&D Roadmap for Technologies in Support of the Remediation of Mined Areas



Updated as of 29 February 2024

OVERALL STRATEGIES

Human Resource

1. Capacitate researchers on (1) circular economy in mine tailings/wastes/silt and rehabilitation/remediation/restoration techniques and (2) ex-ante assessment of offshore and on-shore mined area
2. Participate in short courses/training abroad on mine tailings/wastes/silt circular economy and rehabilitation/remediation/restoration techniques and (2) ex-ante assessment of mined area (legacy, artisanal small-scale mines, offshore mining)
3. Conduct benchmarking activities/visit laboratories, facilities, processing plants abroad
4. Invite Balik-Scientist with expertise on circular economy in mining and rehabilitation techniques

Laboratory Facilities / Services

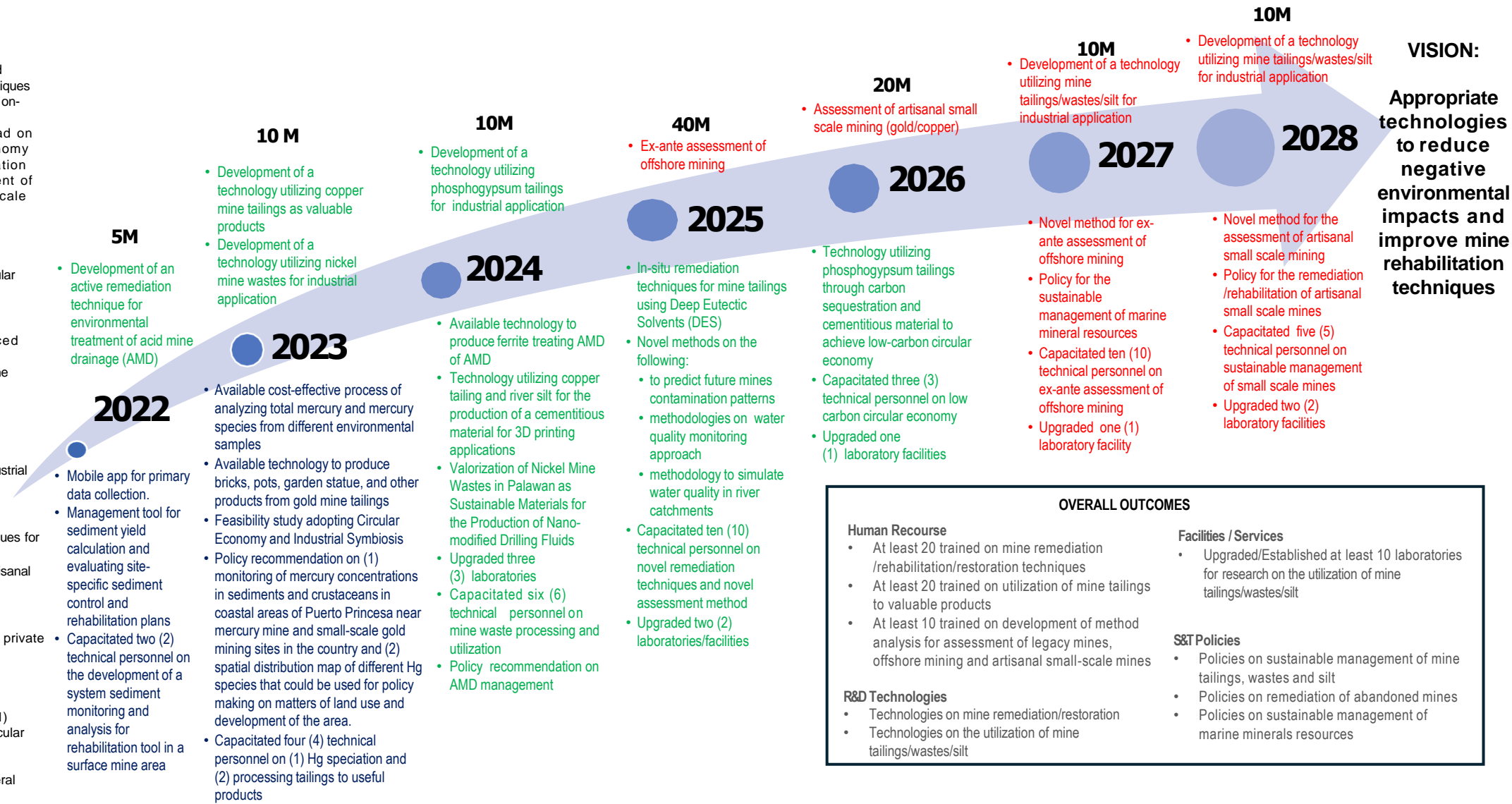
1. Equip SUCs, HESl and RDIs with advanced equipment
2. Availability of testing facilities needed in the research
3. Availability of facilities to produce target products at pilot scale level

R&D Technologies

1. Utilization of mine tailings/wastes/silt for industrial application
2. Application of circular economy
3. Innovative, environment friendly rehabilitation/remediation/restoration techniques for mined-out/abandoned mine areas
4. Assessment of the impact of legacy and artisanal small-scale mines
5. Assessment of offshore mining

S&T Policies:

1. R&D collaboration with HEIs, RDIs and private sector partners for the above research
2. R&D collaboration with foreign funding agencies and foreign research institutions
3. Technically and scientifically sound basis research results for policy formulation on (1) processing mine tailings/wastes/silt, (2) circular economy application for mine tailings/wastes/silt, and (3) sustainable management/ development of marine mineral resources in the country.



OVERALL OUTCOMES	
Human Recourse <ul style="list-style-type: none"> At least 20 trained on mine remediation /rehabilitation/restoration techniques At least 20 trained on utilization of mine tailings to valuable products At least 10 trained on development of method analysis for assessment of legacy mines, offshore mining and artisanal small-scale mines 	Facilities / Services <ul style="list-style-type: none"> Upgraded/Established at least 10 laboratories for research on the utilization of mine tailings/wastes/silt
R&D Technologies <ul style="list-style-type: none"> Technologies on mine remediation/restoration Technologies on the utilization of mine tailings/wastes/silt 	S&T Policies <ul style="list-style-type: none"> Policies on sustainable management of mine tailings, wastes and silt Policies on remediation of abandoned mines Policies on sustainable management of marine minerals resources

R&D Technologies	No	Projects	BUDGET ALLOCATION (PhP)						STATUS	
			2022	2023	2024	2025	2026	2027		2028
Innovative, environment friendly rehabilitation/remediation/restoration techniques for mined-out/abandoned mine areas	1	SMART MINE: Development of Sediment Monitoring and Analysis for Rehabilitation Tool in a surface MINE area	-							Completed
Utilization of mine tailings/wastes/silt for industrial application	2	Gold Mine Tailings Utilization for Waste Reduction and Socioeconomic Benefits	4,853,910.44							Completed
Assessment of the impact of legacy mines	3	Speciation and Isotopic Characterization of Mercury in Honda Bay and Puerto Princesa Bay, Palawan	3,795,786.00							Completed
Utilization of mine tailings/wastes/silt for industrial application	4	A two-step neutralization ferrite process as active remediation technique for environmental treatment of AMD	3,986,729.60	2,261,729.6						Completed
Utilization of mine tailings/wastes/silt for industrial application	5	Valorization of Nickel Mine Wastes in Palawan as Sustainable Materials for the Production of Nano-modified Drilling Fluids		4,997,428.80						Completed
Utilization of mine tailings/wastes/silt for industrial application	6	Marindu-crete 3D: Development of a Cementitious Material from Tailings and Silt for 3D Printing Applications		4,945,934.58						On-going
Assessment of the impact of legacy and artisanal small scale mines	7	Philippine Mining at the National to Catchment Scale: from Legacy Impacts to Sustainable Futures (Project PAMANA)	6,122,011.00	4,652,763.00	4,225,225.60					On-going
Utilization of mine tailings/wastes/silt for industrial application	8	Carbon sequestration and low-carbon cementitious material from Phosphogypsum repurposing (CARBOPHOS)			5,593,244.60	4,355,744.60				New

