**Supplemental Table**

**Table S1** Summary of matched microbes belong to phyla *Acidobacteria*, *Actinobacteria*, *Armatimonadetes*, *Chlamydiae*, *Chloroflexi*, *Elusimicrobia*, *Ignavibacteriae*, *Nitrospirae*, *Planctomycetes*, *Spirochaetes*, and *Verrucomicrobia* for the three sludges (D, M, and H) based on BLAST.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **The first matched microbes** | | | |  | **D** |  | **M** |  | **H** |
| **phylum** | **Class** | **Genus** | **species** |  |  |  |  |  |  |
| *Acidobacteria* | *Acidobacteria* | *Aridibacter* | *kavangonensis* |  | - |  | - |  | 1 |
|  |  | *Euzebya* | *tangerina* |  | 1 |  | - |  | - |
|  | *Holophagae* | *Geothrix* | *fermentans* |  | 2 |  | 3 |  | - |
|  |  | *Holophaga* | *foetida* |  | 1 |  | - |  | - |
|  | **No classification** | *Thermoanaerobaculum* | *aquaticum* |  | - |  | 1 |  | - |
|  | **Sub-total** |  |  |  | **4** |  | **4** |  | **1** |
| *Actinobacteria* | *Actinobacteria* | *Rubrobacter* | *calidifluminis* |  | - |  | - |  | 1 |
|  | **Sub-total** |  |  |  | **0** |  | **0** |  | **1** |
| *Armatimonadetes* | **No classification** | *Fimbriimonas* | *ginsengisoli* |  | 5 |  | - |  | - |
|  | **Sub-total** |  |  |  | **5** |  | **0** |  | **0** |
| *Chlamydiae* | *Chlamydiia* | *Neochlamydiaa* | *hartmannellae* |  | 1 |  | - |  | - |
|  |  | *Parachlamydiaa* | *acanthamoebae* |  | 1 |  | - |  | - |
|  | **Sub-total** |  |  |  | **2** |  | **0** |  | **0** |
| *Chloroflexi* | *Ardenticatenia* | *Ardenticatena* | *maritima* |  | - |  | - |  | 10 |
|  | *Anaerolineae* | *Bellilinea* | *caldifistulae* |  | 1 |  | - |  | 3 |
|  |  | *Longilinea* | *arvoryzae* |  | 2 |  | - |  | - |
|  |  | *Ornatilinea* | *apprima* |  | - |  | - |  | 14 |
|  |  | *Thermanaerothrix* | *daxensis* |  | 1 |  | - |  | 9 |
|  | *Caldilineae* | *Caldilinea* | *tarbellica* |  | - |  | 3 |  | 2 |
|  |  | *Litorilinea* | *aerophila* |  | - |  | 6 |  | 10 |
|  | **Sub-total** |  |  |  | **4** |  | **9** |  | **48** |
| *Elusimicrobia* | *Elusimicrobia* | *Elusimicrobium* | *minutum* |  | 1 |  | 1 |  | - |
|  | **Sub-total** |  |  |  | **1** |  | **1** |  | **0** |
| *Ignavibacteriae* | *Ignavibacteria* | *Melioribacter* | *roseus* |  | - |  | 1 |  | - |
|  | **Sub-total** |  |  |  | **0** |  | **1** |  | **0** |
| *Nitrospirae* | *Nitrospira* | *Nitrospira* | *moscoviensis* |  | 3 |  | - |  | 3 |
|  |  | *Nitrospirac* | *hydrogeniphilus* |  | 5 |  | - |  | - |
|  |  | *Thermodesulfovibrio* | *defluvii* |  | 1 |  | - |  | - |
|  | **Sub-total** |  |  |  | **9** |  | **0** |  | **3** |
| *Planctomycetes* | *Phycisphaerae* | *Algisphaera* | *agarilytica* |  | 6 |  | - |  | 2 |
|  |  | *Phycisphaera* | *mikurensis* |  | 4 |  | - |  | - |
|  | *Planctomycetia* | *Blastopirellula* | *marina* |  | 7 |  | - |  | 1 |
|  |  | *Phycisphaera* | *mikurensis* |  | - |  | - |  | 1 |
|  |  | *Planctomyces* | *limnophilus* |  | 11 |  | - |  | - |
|  |  |  | *maris* |  | 6 |  | - |  | - |
|  |  | *Rhodopirellula* | *rosea* |  | 4 |  | - |  | - |
|  | **Sub-total** |  |  |  | **38** |  | **0** |  | **4** |
| *Spirochaetes* | *Spirochaetia* | *Spirochaeta* | *asiatica* |  | - |  | 1 |  | - |
|  |  | *Treponema* | *caldaria* |  | - |  | 4 |  | - |
|  |  |  | *stenostrepta* |  | - |  | 1 |  | - |
|  | **Sub-total** |  |  |  | **0** |  | **6** |  | **0** |
| *Verrucomicrobia* | *Opitutae* | *Alterococcus* | *agarolyticus* |  | - |  | 1 |  | - |
|  |  | *Diplosphaera* | *colitermitum* |  | 1 |  | - |  | - |
|  |  | *Opitutus* | *terrae* |  | 6 |  | - |  | - |
|  | *Spartobacteria* | *Candidatus* | *accumulibacter* |  | - |  | 11 |  | 2 |
|  |  |  | *desulforudis* |  | - |  | - |  | 1 |
|  |  |  | *methylomirabilis* |  | - |  | - |  | 3 |
|  |  |  | *nitrospira* |  | - |  | - |  | 1 |
|  |  |  | *solibacter* |  | - |  | - |  | 1 |
|  |  | *Chthoniobacter* | *thiodictyon* |  | - |  | 3 |  | - |
|  | *Verrucomicrobiae* | *Akkermansia* | *flavus* |  | 1 |  | - |  | - |
|  |  | *Brevifollis* | *muciniphila* |  | 1 |  | - |  | - |
|  |  | *Prosthecobacter* | *gellanilyticus* |  | 1 |  | - |  | - |
|  |  |  | *algae* |  | 1 |  | - |  | - |
|  |  |  | *vanneervenii* |  | 5 |  | - |  | - |
|  | **Sub-total** |  |  |  | **16** |  | **15** |  | **8** |

**Table S2** Summary of matched microbes belong to phyla *Bacteroidetes* and *Firmicutes* for the three sludges (D, M, and H) based on BLAST.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **The first matched microbes** | | | |  | **D** |  | **M** |  | **H** |
| **phylum** | **Class** | **Genus** | **species** |  |  |  |  |  |  |
| ***Bacteroidetes*** | *Bacteroidia* | *Acetomicrobium faecale* | *faecale* |  | - |  | - |  | 1 |
|  |  | *Draconibacterium* | *orientale* |  | - |  | 1 |  | - |
|  |  | *Geofilum* | *rubicundum* |  | - |  | 1 |  | - |
|  |  | *Macellibacteroides* | *fermentans* |  | - |  | 1 |  | - |
|  |  | *Marinilabilia* | *nitratireducens* |  | - |  | 3 |  | - |
|  |  | *Mariniphaga* | *anaerophila* |  | - |  | 6 |  | 1 |
|  |  | *Parabacteroides* | *distasonis* |  | - |  | 1 |  | - |
|  | *Cytophagia* | *Cytophaga* | *fermentans* |  | - |  | 3 |  | - |
|  |  |  | *xylanolytica* |  | - |  | 1 |  | - |
|  | *Flavobacteriia* | *Aureivirga* | *marina* |  | 1 |  | - |  | - |
|  |  | *Cloacibacterium* | *rupense* |  | - |  | 2 |  | - |
|  |  | *Gramella* | *jeungdoensis* |  | - |  | 2 |  | - |
|  |  | *Owenweeksia* | *hongkongensis* |  | - |  | 6 |  | - |
|  |  | *Pricia* | *antarctica* |  | - |  | 1 |  | - |
|  | *Sphingobacteriia* | *Ferruginibacter* | *lapsinanis* |  | 1 |  | - |  | - |
|  |  |  | *yonginensis* |  | 1 |  | - |  | - |
|  |  | *Filimonas* | *lacunae* |  | 1 |  | - |  | - |
|  |  | *Hymenobacter* | *ginsengisoli* |  | - |  | - |  | 1 |
|  |  | *Lewinella* | *cohaerens* |  | 2 |  | - |  | - |
|  |  |  | *nigricans* |  | 2 |  | - |  | 1 |
|  |  | *Niabella* | *terrae* |  | - |  | 2 |  | - |
|  |  |  | *zeaxanthinifaciens* |  | 1 |  | - |  | - |
|  |  | *Pedobacter* | *bauzanensis* |  | 1 |  | - |  | - |
|  |  | *Portibacter* | *lacus* |  | 3 |  | - |  | - |
|  |  | *Solitalea* | *canadensis* |  | - |  | 1 |  | - |
|  |  |  | *koreensis* |  | - |  | 1 |  | - |
|  | **No classifcation** | *Prolixibacter* | *bellariivorans* |  | - |  | 5 |  | - |
|  |  | *Rubidimonas* | *crustatorum* |  | 1 |  | - |  | - |
|  |  | *Sunxiuqinia* | *rutila* |  | - |  | 1 |  | - |
|  | **Sub-total** |  |  |  | **14** |  | **38** |  | **4** |
| ***Firmicutes*** | *Bacilli* | *Allobacillus* | *halotolerans* |  | 1 |  | - |  | - |
|  |  | *Ammoniphilus* | *oxalaticus* |  | 2 |  | - |  | - |
|  |  | *Bacillus* | *toyonensis* |  | 1 |  | - |  | 1 |
|  |  | *Enterococcus* | *hirae* |  | - |  | - |  | 1 |
|  |  |  | *italicus* |  | 1 |  | 1 |  | - |
|  |  |  | *moraviensis* |  | 1 |  | - |  | - |
|  |  |  | *thailandicus* |  | 1 |  | - |  | - |
|  |  | *Lactobacillus* | *coryniformis* |  | 1 |  | - |  | - |
|  |  |  | *porcinae* |  | 1 |  | - |  | - |
|  |  | *Leuconostoc* | *mesenteroides* |  | 7 |  | - |  | - |
|  |  | *Thermoflavimicrobium* | *dichotomicum* |  | - |  | - |  | 2 |
|  | *Clostridia* | *Acidaminobacter* | *hydrogenoformans* |  | - |  | - |  | 1 |
|  |  | *Adhaeribacter* | *aerophilus* |  | 3 |  | - |  | - |
|  |  | *Alkaliphilus* | *metalliredigens* |  | - |  | - |  | 4 |
|  |  | *Anaerobacterium* | *chartisolvens* |  | - |  | 1 |  | - |
|  |  | *Anaerovorax* | *odorimutans* |  | - |  | - |  | 1 |
|  |  | *Clostridium* | *aestuarii* |  | - |  | 1 |  | - |
|  |  |  | *Beijerinckii* |  | 2 |  | 2 |  | - |
|  |  |  | *lactatifermentans* |  | 1 |  | - |  | - |
|  |  |  | *sartagoforme* |  | - |  | - |  | 2 |
|  |  |  | *subterminale* |  | - |  | 3 |  | - |
|  |  | *Desulfotomaculum* | *thermosubterraneum* |  | - |  | - |  | 1 |
|  |  | *Desulfovirgula* | *thermocuniculi* |  | - |  | - |  | 1 |
|  |  | *Eubacterium* | *acidaminophilum* |  | - |  | - |  | 1 |
|  |  |  | *coprostanoligenes* |  | - |  | 1 |  | - |
|  |  | *Fervidicola* | *ferrireducens* |  | 2 |  | - |  | - |
|  |  | *Intestinimonas* | *butyriciproducens* |  | - |  | 1 |  | - |
|  |  | *Mahella* | *australiensis* |  | 1 |  | - |  | - |
|  |  | *Massilia* | *namucuonensis* |  | 1 |  | - |  | - |
|  |  | *Moorella* | *humiferrea* |  | - |  | - |  | 4 |
|  |  |  | *perchloratireducens* |  | - |  | - |  | 9 |
|  |  |  | *thermoacetica* |  | 1 |  | - |  | - |
|  |  | *Pelotomaculum* | *thermopropionicum* |  | 1 |  | - |  | - |
|  |  | *Saccharofermentans* | *acetigenes* |  | - |  | 3 |  | - |
|  |  | *Sporotomaculum* | *syntrophicum* |  | - |  | 2 |  | - |
|  |  | *Thermovenabulum* | *ferriorganovorum* |  | - |  | - |  | 1 |
|  | *Negativicutes* | *Megasphaera* | *cerevisiae* |  | - |  | - |  | 4 |
|  | *Thermolithobacteria* | *Veillonella* | *Magna* |  | - |  | - |  | 1 |
|  |  | *Thermolithobacter* | *ferrireducens* |  | 2 |  | - |  | - |
|  | **Sub-total** |  |  |  | **30** |  | **15** |  | **34** |

**Table S3** Summary of matched microbes belong to phylum *Proteobacteria* for the three sludges (D, M, and H) based on BLAST.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **The first matched microbes** | | | |  | **D** |  | **M** |  | **H** |
| **phylum** | **Class** | **Genus** | **species** |  |  |  |  |  |  |
| ***Proteobacteria*** | *Alphaproteobacteria* | *Acidiphilium* | *multivorum* |  | - |  | - |  | 5 |
|  |  | *Afifella* | *marina* |  | - |  | 1 |  | - |
|  |  |  | *pfennigii* |  | 1 |  | - |  | - |
|  |  | *Afifella* | *marina* |  | - |  | 1 |  | - |
|  |  |  | *pfennigii* |  | 1 |  | - |  | - |
|  |  | *Afipia* | *felis* |  | - |  | 6 |  | - |
|  |  |  | *broomeae* |  | 2 |  | - |  | - |
|  |  | *Albidovulum* | *inexpectatum* |  | - |  | 2 |  | - |
|  |  | *Amorphus* | *coralli* |  | - |  | 1 |  | - |
|  |  | *Ancalomicrobium* | *adetum* |  | - |  | 50 |  | - |
|  |  | *Ancylobacter* | *abiegnus* |  | - |  | 27 |  | - |
|  |  | *Azospirillum* | *amazonense* |  | 7 |  | 1 |  | - |
|  |  |  | *brasilense* |  | 1 |  | 1 |  | - |
|  |  |  | *lipoferum* |  | - |  | 2 |  | - |
|  |  | *Aureimonas* | *ferruginea* |  | 1 |  | - |  | - |
|  |  | *Catellibacterium* | *nectariphilum* |  | 1 |  | - |  | - |
|  |  | *Dyella* | *kyungheensis* |  | - |  | 2 |  | - |
|  |  |  | *marensis* |  | - |  | 1 |  | - |
|  |  | *Defluviimonas* | *aestuarii* |  | 1 |  | - |  | - |
|  |  | *Devosia* | *submarina* |  | 1 |  | - |  | - |
|  |  | *Dichotomicrobium* | *thermohalophilum* |  | 1 |  | - |  | - |
|  |  | *Dongia* | *rigul* |  | 2 |  | - |  | - |
|  |  | *Ehrlichia* | *ewingii* |  | 1 |  | - |  | - |
|  |  | *Geminicoccus* | *roseus* |  | - |  | - |  | 3 |
|  |  | *Hartmannibacter* | *diazotrophicus* |  | - |  | 1 |  | - |
|  |  | *Hyphomicrobium* | *aestuarii* |  | 3 |  | - |  | - |
|  |  | *Inquilinus* | *ginsengisoli* |  | - |  | 4 |  | - |
|  |  |  | *limosus* |  | - |  | 3 |  | - |
|  |  | *Magnetospirillum* | *bellicus* |  | 2 |  | 4 |  | - |
|  |  | *Methylocystis* | *echinoides* |  | - |  | 4 |  | - |
|  |  |  | *heyeri* |  | - |  | 1 |  | - |
|  |  |  | *parvus* |  | - |  | 1 |  | - |
|  |  |  | *sp. SC2* |  | - |  | 7 |  | - |
|  |  | *Methylopila* | *musalis* |  | - |  | 3 |  | - |
|  |  |  | *oligotropha* |  | - |  | 2 |  | - |
|  |  | *Mesorhizobium* | *thiogangeticum* |  | 1 |  | - |  | - |
|  |  | *Nitratireductor* | *indicus* |  | - |  | 2 |  | - |
|  |  | *Novosphingobium* | *nitrogenifigens* |  | - |  | 2 |  | - |
|  |  | *Ochrobactrum* | *ciceri* |  | - |  | 1 |  | - |
|  |  |  | *intermedium* |  | - |  | 1 |  | - |
|  |  | *Oligotropha* | *carboxidovorans* |  | - |  | 4 |  | - |
|  |  | *Oceanibacterium* | *hippocampi* |  | 3 |  | - |  | - |
|  |  | *Oceanbaculum* | *pacificum* |  | 6 |  | - |  | - |
|  |  | *Phenylobacterium* | *conjunctum* |  | - |  | 1 |  | - |
|  |  |  | *koreense* |  | - |  | 4 |  | - |
|  |  | *Pseudolabrys* | *taiwanensis* |  | - |  | 1 |  | - |
|  |  | *Paracoccus* | *lutimaris* |  | 1 |  | - |  | - |
|  |  | *Phyllobacterium* | *loti* |  | 1 |  | - |  | - |
|  |  | *Porphyrobacter* | *dokdonensis* |  | 1 |  | - |  | - |
|  |  | *Rhizobium* | *kunmingense* |  | - |  | 1 |  | - |
|  |  |  | *rosettiformans* |  | 2 |  | - |  | - |
|  |  | *Rhodovastum* | *atsumiense* |  | 1 |  | - |  | - |
|  |  | *Rhodoblastus* | *sphagnicola* |  | - |  | 3 |  | - |
|  |  | *Rhodoligotrophos* | *appendicifer* |  | - |  | 1 |  | - |
|  |  |  | *jinshengii* |  | - |  | 1 |  | - |
|  |  | *Rhodoplanes* | *elegans* |  | - |  | 1 |  | - |
|  |  |  | *roseus* |  | - |  | 13 |  | - |
|  |  | *Rhodovulum* | *sulfidophilum* |  | - |  | 1 |  | - |
|  |  | *Rhodobacter* | *blasticus* |  | 1 |  | - |  | - |
|  |  |  | *ovatus* |  | 1 |  | - |  | - |
|  |  | *Roseomonas* | *aerilata* |  | - |  | - |  | 1 |
|  |  |  | *lacus* |  | - |  | 3 |  | - |
|  |  |  | *terrae* |  | - |  | - |  | 2 |
|  |  | *Roseospira* | *thiosulfatophila* |  | - |  | - |  | 1 |
|  |  | *Rubrimonas* | *shengliensis* |  | - |  | - |  | 3 |
|  |  | *Skermanella* | *stibiiresistens* |  | - |  | - |  | 3 |
|  |  | *Starkeya* | *novella* |  | - |  | 1 |  | - |
|  |  | *Thermovum* | *composti* |  | 2 |  | 4 |  | - |
|  |  | *Tistrella* | *mobilis* |  | - |  | 1 |  | - |
|  |  |  | *bauzanensis* |  | 1 |  | - |  | - |
|  | *Betaproteobacteria* | *Acidovorax* | *ebreus* |  | - |  | 4 |  | - |
|  |  | *Aquabacterium* | *commune* |  | 2 |  | - |  | - |
|  |  |  | *fontiphilum* |  | 4 |  | 2 |  | - |
|  |  |  | *limnoticum* |  | 7 |  | - |  | - |
|  |  |  | *parvum* |  | 1 |  | - |  | - |
|  |  | *Aromatoleum* | *aromaticum* |  | - |  | 1 |  | - |
|  |  | *Azoarcus* | *anaerobius* |  | - |  | 1 |  | - |
|  |  |  | *buckelii* |  | 2 |  | - |  | 1 |
|  |  |  | *communis* |  | - |  | 5 |  | - |
|  |  |  | *evansii* |  | - |  | 1 |  | - |
|  |  |  | *indigens* |  | 3 |  | 2 |  | - |
|  |  |  | *sp. BH72* |  | 2 |  | 6 |  | 1 |
|  |  |  | *tolulyticus* |  | 2 |  | 5 |  | - |
|  |  | *Azonexus* | *caeni* |  | 28 |  | 27 |  | 2 |
|  |  |  | *fungiphilus* |  | 9 |  | 9 |  | 1 |
|  |  |  | *hydrophilus* |  | 1 |  | 1 |  | - |
|  |  | *Azospira* | *restricta* |  | 7 |  | 1 |  | - |
|  |  | *Azovibrio* | *restrictus* |  | 3 |  | 17 |  | 1 |
|  |  | *Burkholderia* | *andropogonis* |  | 1 |  | - |  | - |
|  |  |  | *caledonica* |  | - |  | 1 |  | 1 |
|  |  |  | *denitrificans* |  | 1 |  | - |  | - |
|  |  | *Caldimonas* | *manganoxidans* |  | 1 |  | 1 |  | 2 |
|  |  | *Candidatus* | *phosphatis* |  | 19 |  | - |  | - |
|  |  | *Comamonas* | *jiangduensis* |  | - |  | 1 |  | - |
|  |  |  | *serinivorans* |  | - |  | 2 |  | 1 |
|  |  | *Cupriavidus* | *metallidurans* |  | - |  | - |  | 1 |
|  |  |  | *taiwanensis* |  | - |  | - |  | 1 |
|  |  | *Curvibacter* | *gracilis* |  | 1 |  | - |  | - |
|  |  | *Diaphorobacter* | *oryzae* |  | - |  | 3 |  | - |
|  |  | *Dechlorobacter* | *hydrogenophilus* |  | - |  | 7 |  | - |
|  |  | *Dechloromonas* | *agitata* |  | 9 |  | 5 |  | - |
|  |  |  | *aromatica RCB* |  | 30 |  | 22 |  | - |
|  |  |  | *hortensis* |  | 159 |  | 77 |  | 3 |
|  |  | *Ferriphaselus* | *amnicola* |  | 1 |  | - |  | - |
|  |  | *Georgfuchsia* | *toluolica* |  | 1 |  | 22 |  | - |
|  |  |  | *bisanensis* |  | - |  | - |  | 1 |
|  |  | *Hydrogenophaga* | *carboriunda* |  | 2 |  | - |  | - |
|  |  |  | *defluvii* |  | - |  | 1 |  | - |
|  |  |  | *flava* |  | - |  | - |  | 2 |
|  |  |  | *palleronii* |  | - |  | 5 |  | - |
|  |  |  | *pseudoflava* |  | - |  | - |  | 2 |
|  |  |  | *taeniospiralis* |  | - |  | 1 |  | - |
|  |  | *Ideonella* | *dechloratans* |  | 1 |  | - |  | - |
|  |  | *Inhella* | *fonticola* |  | 1 |  | - |  | - |
|  |  | *Kinneretia* | *asaccharophila* |  | 1 |  | - |  | - |
|  |  | *Malikia* | *granosa* |  | - |  | - |  | 2 |
|  |  | *Methylobacillus* | *flagellatus* |  | - |  | 2 |  | - |
|  |  | *Methylophilus* | *leisingeri* |  | - |  | 2 |  | - |
|  |  | *Methyloversatilis* | *thermotolerans* |  | 1 |  | 24 |  | - |
|  |  |  | *universalis* |  | 4 |  | 2 |  | - |
|  |  | *Mitsuaria* | *chitosanitabida* |  | 1 |  | - |  | - |
|  |  | *Nitrosospira* | *multiformis* |  | - |  | 1 |  | - |
|  |  | *Ottowia* | *beijingensis* |  | - |  | 6 |  | - |
|  |  | *Pandoraea* | *thiooxydans* |  | - |  | - |  | 1 |
|  |  |  | *vervacti* |  | 3 |  | - |  | - |
|  |  | *Piscinibacter* | *aquaticus* |  | 8 |  | - |  | - |
|  |  | *Propionivibrio* | *limicola* |  | 1 |  | - |  | - |
|  |  |  | *militaris* |  | 14 |  | - |  | 1 |
|  |  |  | *pelophilus* |  | - |  | - |  | 1 |
|  |  | *Pseudorhodoferax* | *aquiterrae* |  | - |  | 2 |  | - |
|  |  | *Ramlibacter* | *solisilvae* |  | - |  | 1 |  | - |
|  |  | *Rhodocyclus* | *purpureus* |  | 2 |  | - |  | - |
|  |  |  | *tenius* |  | 9 |  | - |  | - |
|  |  | *Rubrivivax* | *gelatinosus* |  | 1 |  | - |  | 1 |
|  |  | *Schlegelella* | *thermodepolymerans* |  | - |  | 1 |  | 1 |
|  |  | *Sideroxydans* | *lithotrophicus* |  | 2 |  | 1 |  | - |
|  |  | *Sphaerotilus* | *montanus* |  | 1 |  | - |  | - |
|  |  | *Sulfurisoma* | *sediminicola* |  | - |  | 1 |  | - |
|  |  | *Sulfuritalea* | *hydrogenivorans* |  | - |  | - |  | 1 |
|  |  | *Tepidimonas* | *taiwanensis* |  | - |  | 2 |  | - |
|  |  | *Tepidiphilus* | *margaritifer* |  | - |  | 4 |  | - |
|  |  |  | *succinatimandens* |  | - |  | 2 |  | - |
|  |  | *Thauera* | *aromatica* |  | 1 |  | 1 |  | 2 |
|  |  |  | *butanivorans* |  | - |  | 1 |  | - |
|  |  |  | *chlorobenzoica* |  | 3 |  | 10 |  | 3 |
|  |  |  | *humireducens* |  | 5 |  | 5 |  | 4 |
|  |  |  | *linaloolentis* |  | - |  | 30 |  | 1 |
|  |  |  | *mechernichensis* |  | - |  | 1 |  | 6 |
|  |  |  | *phenylacetica* |  | - |  | 25 |  | 3 |
|  |  |  | *sp. MZ1T* |  | 6 |  | 47 |  | 5 |
|  |  |  | *terpenica* |  | - |  | 4 |  | - |
|  |  | *Thioalbus* | *denitrificans* |  | - |  | 1 |  | - |
|  |  | *Thiobacillus* | *aquaesulis* |  | - |  | - |  | 1 |
|  |  |  | *denitrificans* |  | - |  | 4 |  | - |
|  |  | *Ulginosibacterium* | *gangwonense* |  | 6 |  | - |  | - |
|  |  | *Undibacterium* | *squillarum* |  | - |  | 1 |  | - |
|  |  | *Vitreoscilla* | *filiformis* |  | 4 |  | - |  | - |
|  |  | *Zoogloea* | *caeni* |  | 16 |  | - |  | 1 |
|  |  |  | *oryzae* |  | 18 |  | 3 |  | - |
|  |  |  | *ramigera* |  | 13 |  | - |  | - |
|  |  |  | *resiniphila* |  | 7 |  | 1 |  | - |
|  | *Deltaproteobacteria* | *Anaeromyxobacter* | *sp. K* |  | 1 |  | - |  | - |
|  |  | *Chondromyces* | *apiculatus* |  | 4 |  | - |  | - |
|  |  |  | *lanuginosus* |  | 1 |  | - |  | - |
|  |  | *Desulfatibacillum* | *alkenivorans* |  | - |  | 5 |  | - |
|  |  | *Desulfatitalea* | *tepidiphila* |  | - |  | 1 |  | - |
|  |  | *Desulfobulbus* | *alkaliphilus* |  | - |  | - |  | 1 |
|  |  |  | *elongatus* |  | - |  | 1 |  | - |
|  |  |  | *rhabdoformis* |  | - |  | 4 |  | 2 |
|  |  | *Desulfocapsa* | *thiozymogenes* |  | 1 |  | - |  | 1 |
|  |  | *Desulfococcus* | *multivorans* |  | 2 |  | - |  | - |
|  |  | *Desulfomonile* | *tiedjei* |  | - |  | 1 |  | - |
|  |  |  | *limimaris* |  | 1 |  | - |  | - |
|  |  | *Desulfonatronovibrio* | *halophilus* |  | - |  | 1 |  | - |
|  |  | *Desulfonauticus* | *autotrophicus* |  | - |  | - |  | 1 |
|  |  | *Desulfonema* | *magnum* |  | - |  | 2 |  | - |
|  |  | *Desulforegula* | *conservatrix* |  | - |  | - |  | 1 |
|  |  | *Desulfotalea* | *psychrophila* |  | - |  | - |  | 1 |
|  |  | *Desulfovibrio* | *alcoholivorans* |  | 1 |  | - |  | - |
|  |  |  | *aminophilus* |  | 1 |  | - |  | 1 |
|  |  |  | *longus* |  | - |  | 4 |  | - |
|  |  | *Desulfonatronum* | *lacustre* |  | 1 |  | - |  | - |
|  |  | *Desulfosalsimonas* | *propionicica* |  | 2 |  | - |  | - |
|  |  | *Desulfuromonas* | *acetoxidans* |  | 3 |  | - |  | - |
|  |  |  | *michiganensis* |  | 1 |  | - |  | - |
|  |  | *Geoalkalibacter* | *ferrihydriticus* |  | - |  | 2 |  | - |
|  |  | *Geobacter* | *anodireducens* |  | 3 |  | - |  | - |
|  |  |  | *bemidjiensis* |  | 1 |  | - |  | - |
|  |  |  | *lovleyi* |  | - |  | 3 |  | - |
|  |  |  | *metallireducens* |  | 1 |  | - |  | - |
|  |  |  | *psychrophilus* |  | - |  | 3 |  | - |
|  |  |  | *uraniireducens* |  | - |  | 1 |  | - |
|  |  | *Haliangium* | *tepidum* |  | 1 |  | - |  | - |
|  |  | *Kofleria* | *flava* |  | 1 |  | - |  | - |
|  |  | *Lawsonia* | *intracellularis* |  | 1 |  | - |  | - |
|  |  | *Myxococcus* | *stipitatus* |  | 1 |  | - |  | - |
|  |  | *Nannocystis* | *exedens* |  | 3 |  | - |  | - |
|  |  |  | *pusilla* |  | 1 |  | - |  | - |
|  |  | *Pelobacter* | *acetylenicus* |  | 1 |  | - |  | - |
|  |  |  | *carbinolicus* |  | 3 |  | - |  | - |
|  |  |  | *seleniigenes* |  | - |  | - |  | 2 |
|  |  | *Sandaracinus* | *amylolyticus* |  | 6 |  | - |  | - |
|  |  | *Smithella* | *propionica* |  | - |  | 35 |  | 9 |
|  |  |  | *koreensis* |  | - |  | 1 |  | - |
|  |  | *Sorangium* | *cellulosum* |  | 1 |  | - |  | - |
|  |  | *Stigmatella* | *aurantiaca* |  | 1 |  | - |  | - |
|  |  | *Syntrophorhabdus* | *aromaticivorans* |  | - |  | - |  | 16 |
|  |  | *Syntrophus* | *aciditrophicus* |  | - |  | 5 |  | 1 |
|  |  |  | *gentianae* |  | - |  | 1 |  | - |
|  |  | *Vampirovibrio* | *chlorellavorus* |  | 3 |  | - |  | - |
|  | *Epsilonproteobacteria* | *Sulfuricurvum* | *kujiense* |  | - |  | - |  | 1 |
|  | *Gammaproteobacteria* | *Acinetobacter* | *guillouiae* |  | 1 |  | - |  | - |
|  |  |  | *johnsonii* |  | 3 |  | - |  | - |
|  |  |  | *seohaensis* |  | 1 |  | - |  | - |
|  |  | *Alkanindiges* | *hongkongensis* |  | 1 |  | - |  | - |
|  |  |  | *illinoisensis* |  | 2 |  | - |  | - |
|  |  | *Allochromatium* | *vinosum* |  | - |  | 2 |  | - |
|  |  | *Aquimonas* | *voraii* |  | 1 |  | - |  | - |
|  |  | *Arenimonas* | *aquatica* |  | - |  | 2 |  | - |
|  |  |  | *daechungensis* |  | 1 |  | - |  | - |
|  |  |  | *maotaiensis* |  | - |  | - |  | 1 |
|  |  | *Arhodomonas* | *recens* |  | - |  | 1 |  | - |
|  |  | *Cronobacter* | *helveticus* |  | 1 |  | - |  | - |
|  |  | *Dokdonella* | *immobilis* |  | - |  | 1 |  | - |
|  |  |  | *soli* |  | 8 |  | - |  | - |
|  |  | *Ectothiorhodospira* | *salini* |  | - |  | 4 |  | - |
|  |  | *Granulosicoccus* | *marinus* |  | 1 |  | - |  | - |
|  |  | *Halochromatium* | *glycolicum* |  | - |  | 7 |  | - |
|  |  |  | *roseum* |  | - |  | 12 |  | - |
|  |  | *Lysobacter* | *cookii* |  | - |  | - |  | 2 |
|  |  |  | *oligotrophilus* |  | 3 |  | - |  | - |
|  |  |  | *thermophilus* |  | 1 |  | - |  | - |
|  |  | *Methylogaea* | *oryzae* |  | - |  | 1 |  | - |
|  |  | *Methylomonas* | *koyamae* |  | - |  | - |  | 2 |
|  |  |  | *paludis* |  | - |  | - |  | 1 |
|  |  | *Methylosarcina* | *lacus* |  | - |  | - |  | 3 |
|  |  | *Microbulbifer* | *yueqingensis* |  | 1 |  | - |  | - |
|  |  | *Moraxella* | *catarrhalis* |  | - |  | 1 |  | - |
|  |  | *Plasticicumulans* | *acidivorans* |  | 9 |  | - |  | - |
|  |  |  | *lactativorans* |  | 6 |  | 7 |  | - |
|  |  | *Povalibacter* | *uvarum* |  | - |  | - |  | 3 |
|  |  | *Pseudomonas* | *azotifigens* |  | 2 |  | - |  | - |
|  |  |  | *carboxydohydrogena* |  | - |  | 1 |  | - |
|  |  |  | *guangdongensis* |  | - |  | - |  | 2 |
|  |  |  | *thermotolerans* |  | 1 |  | - |  | - |
|  |  | *Rehaibacterium* | *terrae* |  | 2 |  | - |  | 2 |
|  |  | *Rhabdochromatium* | *marinum* |  | 1 |  | - |  | - |
|  |  | *Spongiibacter* | *borealis* |  | 1 |  | - |  | - |
|  |  | *Steroidobacter* | *denitrificans* |  | - |  | - |  | 1 |
|  |  | *Thermomonas* | *carbonis* |  | 1 |  | - |  | - |
|  |  | *Thioalbus* | *denitrificans* |  | - |  | 1 |  | - |
|  |  | *Thioalkalivibrio* | *sulfidophilus* |  | 1 |  | - |  | - |
|  |  |  | *thiocyanodenitrificans* |  | 1 |  | 2 |  | - |
|  |  | *Thiobaca* | *trueperi* |  | - |  | 4 |  | - |
|  |  | *Thiocapsa* | *imhoffii* |  | - |  | 14 |  | - |
|  |  |  | *marina* |  | - |  | 1 |  | - |
|  |  |  | *pendens* |  | - |  | 18 |  | - |
|  |  |  | *rosea* |  | - |  | 6 |  | - |
|  |  |  | *roseopersicina* |  | - |  | 6 |  | - |
|  |  | *Thiococcus* | *pfennigii* |  | - |  | 1 |  | - |
|  |  | *Thiodictyon* | *bacillosum* |  | - |  | 47 |  | - |
|  |  |  | *elegans* |  | - |  | 11 |  | - |
|  |  | *Thiohalobacter* | *thiocyanaticus* |  | 4 |  | 10 |  | - |
|  |  | *Thiohalocapsa* | *marina* |  | - |  | - |  | 1 |
|  |  | *Thiolamprovum* | *pedioforme* |  | - |  | 1 |  | - |
|  |  | *Thioprofundum* | *hispidum* |  | 3 |  | - |  | - |
|  |  |  | *lithotrophicum* |  | 1 |  | - |  | - |
|  |  | *Thiorhodococcus* | *drewsii* |  | - |  | 1 |  | - |
|  |  |  | *minor* |  | - |  | 7 |  | - |
|  |  |  | *patagoniensis* |  | - |  | - |  | 1 |
|  |  | *Tolumonas* | *auensis* |  | 1 |  | - |  | - |
|  | **Sub-total** |  |  |  | **576** |  | **824** |  | **128** |

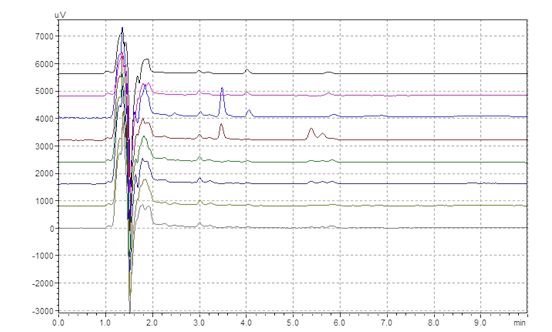
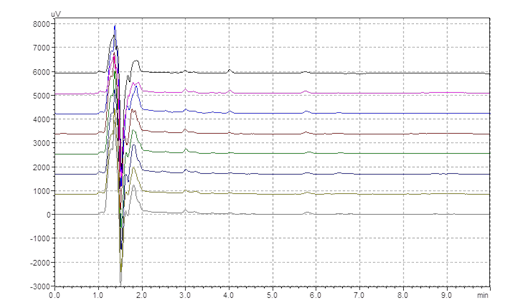
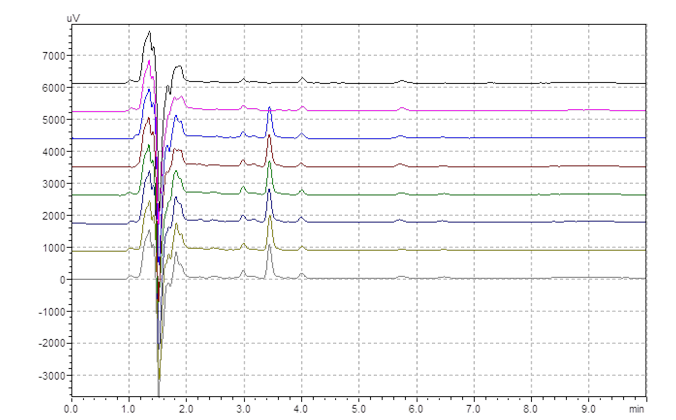
**Table S4** Summary of matched microbes which have not been classified in to certain phylum for the three sludges (D, M, and H) based on BLAST.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **The first matched microbes** | | | |  | **D** |  | **M** |  | **H** |
| **phylum** | **Class** | **Genus** | **species** |  |  |  |  |  |  |
| No classification | No classification | *Aridibacter* | *famidurans* |  | 4 |  | - |  | - |
|  |  |  | *kavangonensis* |  | 20 |  | - |  | - |
|  |  | *Caldithrix* | *palaeochoryensis* |  | - |  | 1 |  | - |
|  |  | *Candidatus* | *oxyfera* |  | 2 |  | - |  | - |
|  |  | *Carboxylicivirga* | *taeanensis* |  | - |  | 6 |  | - |
|  |  | *Dechlorobacter* | *hydrogenophilus* |  | 2 |  | - |  | - |
|  |  | *Falsiporphyromonas* | *endometrii* |  | - |  | 1 |  | - |
|  |  | *Hydrogenispora* | *ethanolica* |  | 1 |  | - |  | - |
|  |  | *Labilithrix* | *luteola* |  | 2 |  | - |  | - |
|  |  | *Lacibacterium* | *aquatile* |  | 6 |  | - |  | - |
|  |  | *Lactivibrio* | *alcoholicus* |  | 1 |  | - |  | - |
|  |  | *Methyloligella* | *halotolerans* |  | 1 |  | - |  | - |
|  |  | *Methyloparacoccus* | *murrellii* |  | 2 |  | 1 |  | - |
|  |  | *Niveispirillum* | *fermenti* |  | 1 |  | 3 |  | - |
|  |  | *Paludibaculum* | *fermentans* |  | 3 |  | - |  | - |
|  |  | *Phaeodactylibacter* | *xiamenensis* |  | 2 |  | - |  | - |
|  |  | *Povalibacter* | *uvarum* |  | 1 |  | - |  | - |
|  |  | *Pyrinomonas* | *methylaliphatogenes* |  | 5 |  | - |  | - |
|  |  | *Salinispirillum* | *marinum* |  | 3 |  | - |  | - |
|  |  | *Solitalea* | *koreensis* |  | 1 |  | - |  | - |
|  |  | *Swingsia* | *samuiensis* |  | 2 |  | - |  | - |
|  |  | *Tangfeifania* | *diversioriginum* |  | - |  | 35 |  | 1 |
|  |  | *Terrimicrobium* | *sacchariphilum* |  | 1 |  | - |  | - |
|  |  | *Thermomarinilinea* | *lacunifontana* |  | 1 |  | - |  | 36 |
|  |  |  | *lacunofontalis* |  | ~~-~~ |  | - |  | 2 |
|  |  | *Zhizhongheella* | *caldifontis* |  | 2 |  | 1 |  | - |
|  | **Sub-total** |  |  |  | **63** |  | **48** |  | **39** |
| **Sum of all sub-total** | **from table 1-4** |  |  |  | **762** |  | **961** |  | **270** |

**Supplemental Figures**



**Fig. S1** Time course of IBU concentrations during 5-day incubation in autoclaved sludges H, M, or D.



Methanol

Medium

0 day

1 day

2 days

3 days

4 days

5 days

Methanol

Medium

0 day

1 day

2 days

3 days

4 days

5 days

Methanol

Medium

0 day

1 day

2 days

3 days

4 days

5 days

0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 min

0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 min

0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 min

uV

7000

6000

5000

4000

3000

2000

1000

0

-1000

-2000

-3000

7000

6000

5000

4000

3000

2000

1000

0

-1000

-2000

-3000

8000

7000

6000

5000

4000

3000

2000

1000

0

-1000

-2000

-3000

Retention time ~3.4 min: IBU

(a)

(b)

(c)

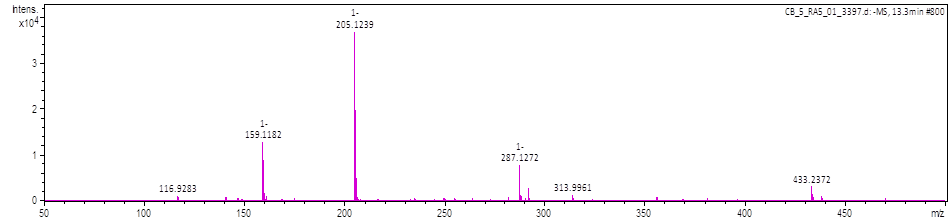
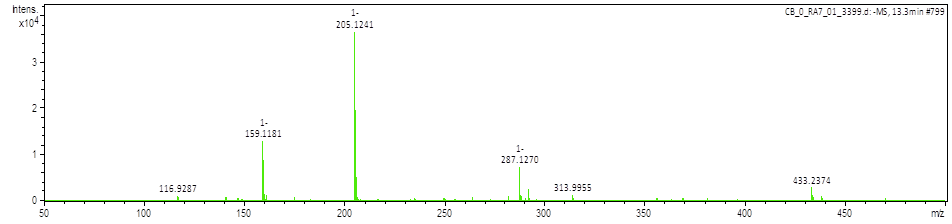
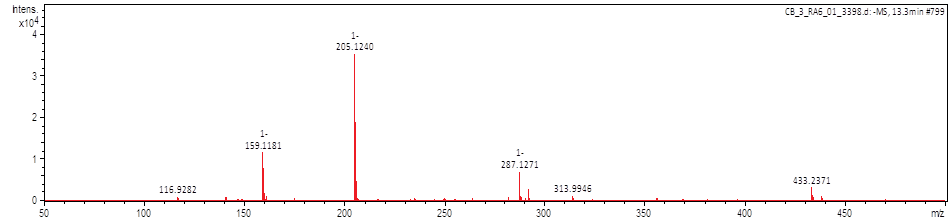
Retention time (min)

Signal intensity (uV)

Retention time ~3.4 min: IBU

Retention time ~3.4 min: IBU

**Fig. S2** Diagrams of HPLC chromatogram analyses for IBU concentrations during 5-day incubation. (a) without seeding sludge; (b) without adding IBU; and (c) with IBU (~5mg/L) and sludge H.



IBU peak (m/z ~205.124)

(a) 0 day

(b) 3rd day

(c) 5th day

**Fig. S3** Diagrams of UPLC/Q-TOF/MS showed IBU remained unchanged during 5-day incubation in medium without seeding sludge.