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# Greening Sludge Management in the Malaysian Water Supply Sector

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*Abstract*

Water supply sector is closely related to the environment. Water is first abstracted from nature and environment for treatment and use, before it is channelled back for future use. Along the value chain of water processes (of abstraction, treatment, distribution, and disposal of used-water), to certain extent, such processes might have affected nature and environment. Harmonious co-existence between economic and environmental considerations is the key for a sustainable water sector in the long run. This paper analyses sustainable sludge management in the Malaysian water sector. In Malaysia Environment Quality Act (EQA) 1974 is the key legal regulation for sludge management and other hazardous substances. This regulation classifies sludge as 'scheduled waste' due to the presence of heavy metals. Sludge, therefore must be properly treated prior to disposal. Based on the data gathered through interviews and a survey, this paper reveals that most of the treatment plants do not have on-site sludge treatment facilities and there is low level of readiness among water utilities to undertake sludge recycling. While most of the water companies show concern about deploying environmental-friendly technologies but what seems to hinder them from doing so is high cost of acquiring these technologies (which eventually will be passed-through to water users in form of tariff). Lastly, this paper recommends

that the government must take a lead role in facilitating effective sludge management in the water sector. Among the feasible recommendations is the establishment of a regional sludge treatment facilities and financial incentives.

*Keywords*
Environment, water, sludge, scheduled waste, government Malaysia

*"We do not inherit water from our grandfathers,*
*but we borrow them from our next generation."*

- Kenyan proverb

*"Only when the last tree has been cut down,*
*only when the last fish has been caught,*
*only when the last river has been poisoned,*
*only then you realize that money cannot be eaten."*

- Cree Indian prophecy (taken from Chan, 2007)

## 1. **Introduction**

The above proverbs are clearly demanding all of us to play our role to value the precious water resources and safeguarding them for the benefit of future generations. In the context of Asian countries, meeting this demand has become a great challenge to comprehend. It is still a challenge for most of the Asian countries to supply water to its citizen. Asian Development Bank (ADB) et. al (2005) estimated one third of Asian populations do not have access to safe and sustainable water supplies. On a global scale, around two thirds of world's populations without or having limited access to water live in Asia. ADB also estimated that countries in Asia (and the Pacific) would need at least USD8 billion to meet the Target 10 of the UN's Millennium Development Goals by 2015 especially on water production. Although WHO and UNICEF (2010) predicted the likeliness of meeting Target 10 in 2015, still there are 672 million world populations lack access to safe drinking water.

The notion of sustainable water supply development has gained great concern among water managers in Asia lately. They started to recognize the potential impacts of water projects on the environment. They urged Asian leaders the need to have harmonious co-existence between economic and environmental considerations for attaining sustainable water sector in the long run. Water policies must aim to strike a balance between environmental and economic interests, and between ecological and economic rationality (Mol, 1995). One of the ecological or environmental challenges is how to ensure that the by-product of the water treatment process, the sludge is treated and disposed in a sustainable manner, in which its negative impacts could be minimised. Little we realise by accelerating water production to meet the demand for drinking water, more sludge is produced from the water purification process. Sludge is the substances removed from raw water, and also agents added to raw water during coagulation and filtration processes (O'Connor & Markis, 2007).

Continuous direct discharge of sludge into rivers, lakes etc., will definitely reduce the availability of water resources for future utilization. The presence of toxic characteristics such as aluminium, arsenic etc. in the sludge could pose serious threat to raw water quality to the extent that they are beyond being treatable (O'Connor & Markis, 2007). Therefore, it is the interest of this paper to investigate sustainable sludge management in the context of the Malaysian water supply sector. The issue of sustainable sludge management is becoming more pressing to handle considering the increasing amounts of sludge produced from water treatment plants throughout the country. For instance, the Langat 2 water treatment plant alone is estimated to generate around 400 – 500

tonnes sludge per day (PAAB, 2009), while another 600 tonnes of sludge is generated daily by 29 water treatment plants managed by PNSB.[1] The increase amount of sludge, to certain extent, is also contributed by increased water production to cater for the high water demand. For instance, water demand rose from 9,666 million litres per day (MLD) in 2000 to 15,285 MLD in 2010. It is anticipating that water demand will reach 20,338 MLD in 2020 and 31,628 MLD in 2050 (EPU, 2000).

Most of the water utilities especially the state water departments are not well equipped to manage sludge in a sustainable manner. Most of the treatment plants do not have on-site sludge treatment facilities, let alone using environmental-friendly treatment technologies. Another area which is still not fully explored yet is sludge recycling and re-utilization especially its potential beneficial use. Moreover, government incentives for sludge recycle and reuse whether by water utilities or universities are not common in Malaysia. First, this paper presents the historical data about the presence of the on-site sludge treatment facilities; and the adoption of the environmental-friendly sludge treatment technologies among the water utilities. Second, it assesses to what extent the beneficial use of sludge has been promoted in the Malaysian water sector. Third and lastly, it examines, to what extent, the water sector reforms could facilitate both the adoption of the environmental-friendly sludge treatment technologies and sludge recycling and re-utilization in the Malaysian water supply sector.

## 2. **Literature review and Methods**

### 2.1 Literature review

2.1.1 Water treatment process generates waste known as residuals. Residuals are also referred to as sludge. Sludge generation could come in several forms: solid, liquid and gaseous (Iacob & Anagabriela, 2010; Awwa Reseach Foundation, 2007). Due to the presence of the toxic contents (aluminium, arsenic etc.), sludge could be harmful to the environment (and human health) especially to the water sources. Conventional disposal methods of untreated sludge include direct discharge into streams, sanitary sewer systems or into municipal landfills (Basta & Dayton, 2001). These methods considered not sustainable because it degrades the environment in long run. As countries experiencing economic growth and accelerating water demands, the call for sustainable sludge management is becoming more prominent (Walsh, Lake and Gagnon, 2008). Many countries enacted environmental laws aiming at regulating sludge – treatment and disposal. In the United States, the Federal Resources and Recovery Act regulates the sludge disposal in the municipal solid waste landfills (Walsh, Lake and Gagnon, 2008). In Canada, sludge came under the control of the Canadian Environmental Protection Agency (INAC, 2008), whereas in Australia, the sludge management requirements varied from state to state (Hamann & McMurrich, 2004).

In Malaysia, sludge has been classified as ‘scheduled waste’ under First Schedule of the Environmental Quality (Scheduled Waste) Regulation 2005 of the Environment Quality Act (EQA) 1974 (Department of Environment (DOE), 2005). Environmental Quality (Scheduled Waste) Regulation 2005 furthers prescribe modes of treatment and disposal of the sludge. At the

[1] PNSB is the treatment operator in the State of Selangor.

moment, all scheduled waste substance are required to be disposed of at *Kualiti Alam Sdn Bhd*,[2] a private scheduled waste facility in Bukit Nenas, Negeri Sembilan, or at sanitary landfill or disposal sites in accordance with the Regulation 7(1), Environmental Quality (Scheduled Waste) Regulations 2005 of the EQA 1974.

2.1.2 Many literatures demonstrated that water treatment sludge has the potential to be turned into some useful materials by way of recycling or re-utilisation. According to O'Connor and Markis (2007), sludge recycling and re-utilization was not only environmental-friendly, but also had the cost reductive advantages. They argued that less sludge contamination into streams would result into cheaper costs associated with drinking water treatment.

Many studies have also pointed out the usage of sludge. The potential beneficial use of sludge include land application (Ippolito, Barbarick and Elliot, 2011; Brinton, O'Connor, and Oladeji, 2008; Agvin-Birikorang et. al, 2009; Novak and Watts, 2005; Walsh, Lake, and Gagnon, 2008), brick manufacturing (Iacob and Farcas, 2010; Huang et. al, 2001; Tay et. al, 2001; Hsieh and Raghu, 2008), land reclamation (Basta and Dayton, 2001; Hsieh and Raghu, 2008), and cement production (Hsieh and Raghu, 2008).

In the USA, the American Water Works Association Research Foundation (AwwaRF) has been very active exploring not only the potentials options for converting sludge to some useful purpose, but also marketing of sludge for reuse (AwwaRF, 2007). Awwa RF proved that sludge, among others, can be used as land application, cement and brick manufacturing, turf farming, composting and top soil and potting soil production.

In the Netherlands, 99.8% of the sludges generated from the drinking water production process were recycled (Vewin, 2010). Water companies in the Netherlands jointly established the Residues Union to spearhead sludge recycling and to explore potential uses of sludge. So far the recycled sludges produced by Dutch water companies are widely used for brick making, materials for road barriers, road foundation, land elevation and ballast material in construction of industrial parks (Vewin, 2010).

In the developing countries including Malaysia, sludge recycling or re-utilization is a new area which is yet to be explored. On the contrary, sludge recycling and beneficial uses of sludge have been extensively promoted as an environment-friendly disposing method in most of the developed countries (O'Connor & Markis, 2007). Nevertheless, there were several studies conducted with regard of the potential use of sludge in Malaysia. For instance, Wahid et. al (2008) revealed that sludge has the plasticity characteristic that can be shaped and moulded into pottery products. Meanwhile, Hassan (2006), Wan Jusoh (2007) and Syed Zin (2007) studied the potential use of sludge in ceramics.

At water utilities level, several water utilities have also collaborated with several institutes of higher learning into turning sludge into pallets for power generation, material for brick making and pottery.[3]

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[2] Futher information about the company can be found at www.kualitialam.com

[3] Personal interview with a representative from Syabas on 23 July 2009 and ABASS on 19 June 2009.

2.2 Methods

Two main data gathering methods were used in this research. They were interviews and survey.

2.2.1 *Interviews*: Face-to-face interviews were conducted with five groups of stakeholders: water utilities (public and private), officials from the Ministry of Energy, Water and Communications[4] (MEWC) and the Economic Planning Unit (EPU) of the Prime Minister's Department (policy maker), the National Water Services Commission (NWSC) (industry regulator); and the Department of Environment (DOE) (guardian of the EQA 1974).

Interviews were used to find answers for 'why' rather than for 'what' questions (Yin, 2009). Meanwhile, survey was used to answer 'what'questions (as explained in section 2.2.2). More specifically, it was used to ascertain qualitative data about government interventions for promoting sustainable sludge management among water utilities such as incentives etc. 31 interviews were held from April to October 2009 (see Table 1).

Table 1: Summary of interviews

| Stakeholders | Number of interviews |
|---|---|
| Water utilities | 26 |
| MEWC | 1 |
| EPU | 1 |
| NWSC | 1 |
| DOE | 2 |
| Total | 31 |

2.2.2 *Survey*: Survey questionnaires were used to obtain quantitative data mainly from the water utilities. These data were meant to complement the qualitative data gathered through interviews. Kind of quantitative data collected through survey were 'what'questions related to the availability and method of on-site sludge treatment facilities, and the time frame for adopting the environmental-friendly sludge treatment technologies among water utilities. 35 open and close ended questionnaires were distributed to water utilities from April to October 2009.

## 3. Results

3.1 Availability of on-site sludge treatment facilities

From the survey[5] conducted among water utilities (both public and private), it was revealed that majority of water treatment plants were not equipped with on-site sludge treatment facilities. From the 96 plants surveyed, 69 plants or 72% did not have such facilities (see Table 2). With the absence of the on-site treatment facilities, most of the water utilities discharged raw sludge directly into rivers.

[4] From Mac 2008, it is know as the Ministry of Energy, Green Technology and Water.

[5] Based on 40% (14/35) of returned questionnaires.

Table 2: Availability of on-site sludge treatment facilities among water utilities

| Water Utilities | Ownerships | No. of WTPs managed | No. of WTPs with on-site sludge treatment facilities | No. of WTPs without on-site sludge treatment facilities |
|---|---|---|---|---|
| MUC | Private | 2 | 0 | 2 |
| GSL Water | Private | 4 | 0 | 4 |
| Air Utara Indah | Private | 4 | 3 | 1 |
| Equiventures | Private | 2 | 2 | 0 |
| Taliworks (Langkawi) | Private | 5 | 1 | 4 |
| Salcon Engineering | Private | 3 | 2 | 1 |
| Gamuda Water | Private | 2 | 2 | 0 |
| Konsortium ABASS | Private | 1 | 1 | 0 |
| Air Kelantan Sdn Bhd | Corporatised Public | 30 | 5 | 25 |
| SADA | Corporatised Public | 33 | 8 | 25 |
| PBAPP | Private | 10 | 3 | 7 |
| Total/Percentage | | 96 | 27 (28%) | 69 (72%) |

Sludge lagoon appeared to be the most preferred treatment method among the 27 plants, which were equipped with on-site treatment facilities. 24 plants or 89% used this method. Other treatment methods used include sludge recovery tank with thickener to make sludge cake, drying bed, and dewatering centrifuge or flat-sheet membrane. However, from the perspective of safeguarding the environment, using these technologies can only mitigate up to certain extent especially avoiding direct discharge to waterways. Heavy metals are still present in the settled sludge, and as such, "some form of control is needed to ensure sludge is properly treated prior to disposal".[6]

Next questions were what does constraint water utilities from not having treatment facilities, and where did they dispose the sludge. It was obvious that, due to non-presence of such facilities, almost all of water utilities discharged (raw) sludge back into the environment that provides source for drinking water. It appeared that direct discharge of sludge into the streams was the cheapest solution for water utilities, but turned out to be costly for consumers. Heavily contaminated rivers were not only affecting the aquatic life, but also increased the treatment costs. Increased treatment cost forced water utilities to demand for higher tariffs, which eventually ended up in the consumers' bills. DOE (2009) reported the number of slighty polluted and polluted rivers have increased from 245 rivers in 2008 to 271 rivers in 2009. Concerted efforts therefore are urgently needed to undertake river conservation. Rivers must be regarded as something valuable and "must be treated as common goods rather than common waste".[7] However, from the regulatory standpoints, a representative from the industry regulator NWSC believed that at the moment "we are politically not ready to include water resources as part of the

[6] Personal interview with a representative from the DOE on 16 Oct. 2009.

[7] Personal interview with a representative from the DOE on 3 Aug. 2009.

(water supply) reform as land is still a state matter".[8] NWSC convinces that Federal government would want to avoid as being seen as encroaching into State (governments) matters such as land, water resources etc. as this will jeopardise the existing cordial Federal-State relationships. Therefore, it is unlikely that under the current political set-ups, jurisdiction over water resources would change hands.

Water utilities cited three main reasons for not having on-site sludge treatment facilities. First, old plants that they acquired from the Public Works Department or state governments in the 50s and 60s (through various modes of acquisitions/asset transfers/private participations) did not have treatment facilities. Furthermore, at that time public water utilities were exempted from having such treatment facilities. Second, building treatment facilities required sizeable land areas, which most of the water utilities did not have huge land banks to accommodate such facilities. Huge piece of land was also needed to dispose of the treated sludge. Third, most water utilities re-iterated that the requirement for having treatment facilities were not part or within the scope of works signed with the state governments. Their main responsibility was to operate and maintain the plants. Moreover, they argued that it was the state governments that obliged to build or provide in the event that treatment facilities are needed. Since building treatment facilities involved land matter, they were convinced that the state government was in the best position to mitigate this risk (of land acquisition), thus preventing tariff hikes if this responsibility were to be given to water utilities.

Water utilities were also duly concerned about the high transportation costs if sludge was to be disposed at private disposal site such as at the Kualiti Alam Sdn Bhd in the state of Negeri Sembilan (some 100 km south of city centre of Kuala Lumpur) especially when it involved large quantities. Hence, water utilities preferred to discharge sludge directly into streams. They were sceptical how the government could expect proper sludge management "where there are no such facilities available in location where they are operated".[9] However, water utilities agreed that permanent solution to this problem must be sought. A representative from one water utility suggested "sludge issues can be managed in a more sustainable way under one single authority. Disposing (sludge) at landfill is only a temporary solution, and among others, sludge re-cycling could be explored as permanent solution".[10]

### 3.2 Adoption of the environmental-friendly sludge treatment facilities

Majority of the water utilities indicated their readiness to build on-site treatment facilities in the future. This is indeed a positive indication of a greater concern among water utilities about the effect of sludge to the environment. However, majority of them did not indicate the specific time frame for converting to environmental-friendly sludge treatment technologies such as decanter, membrane filtration, drying bed etc. The willingness of water utilities to consider deploying 'green options' in sludge management reflects the general awareness among them in ensuring sustainable water sector in the future.

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[8] Personal interview with a representative from NWSC on 23 Sept. 2009.

[9] Personal interview with a representative from Taliworks Corporation Berhad on on 8 May 2009.

[10] Personal interview with a representative from Taliworks Corporation Berhad on on 8 May 2009.

Even though most of the water utilities did not give specific plan for deploying new sludge treatment facilities, Salcon Engineering Berhad[11]had indicated the possibilities of deploying 'green technology' in their plants if their (O&M) contract is renewed. "We would recommend cyclone system or decanter in interest of limited space we have now to dump the sludge. But as private utilities, we concern about dollars and cents".[12]

Other water utilities concerned about the costs for upgrading their existing plants to meet the sludge regulation under EQA 1974, which eventually will burden the consumers. A representative from Gamuda Water said, "having mechanical (sludge treatment) system is costly, unless government is willing to assist. If water utilities were to bear the costs, it will result in the higher bulk supply rate, which eventually will be passed on to the public in terms of higher water tariffs".[13]

Did on-site treatment facilities help to reduce the amount of sludge produced? This was the concern of Syabas, the private water operator in the State of Selangor, Federal Territory of Kuala Lumpur and Putrajaya. For Syabas, by having on-site treatment facilities in place, "we are actually creating another problem, which is where to dispose the treated sludge".[14]

### 3.3 Sludge recycling and re-utilization

Majority of water utilities indicated a low level of readiness to convert sludge into other usable products. Even though few water utilities like Syabas, ABASS[15], PBAPP[16] have initiated some attempts to convert sludge into brick, pottery products, pallets for power generation etc., most of them did not see a 'business sense' for taking such initiative. Such initiative, to them, was not only costly, but also had no economic value. A representative from ABASS revealed that, "it is economically not viable to convert sludge into brick as it shrinks for about 40%, and it has no bonding property. Apart from that, it is incurred additional costs to transport sludge and to acquire clay to mix with sludge".[17] Moreover, water utilities were not legally required to do so, thus they did not see the need to spend money on something unprofitable which had no demand. These pertinent issues need immediate attention if government is seriously considering sludge recycling as one of the means to mitigate the negative effect of sludge on the environment. The issue of sludge management is there to exist as long as water process exists.

Apart from low demand and high cost to undertake sludge recycling, water utilities opinioned that as long as sludge was classified as 'scheduled waste' under EQA 1974, it gave the indication that sludge, when converted into other products, was not safe (for consumption). This, to certain extent had reduced the public's acceptance on products made from recycled sludge. Water utilities urged DOE to consider declassifying sludge as 'scheduled waste'. Several studies

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11 An O&M operator for the SAINS, the water supply provider in the state of Negeri Sembilan.

12 Personal interview with a representative from Salcon Engineering Berhad on 25 May 2009.

13 Personal interview with a representative from Gamuda Water on 27 May 2009.

14 Personal interview with a representative from Syabas on 23 July 2009.

15 ABASS is the treatment operator in the State of Selangor.

16 PBAPP is the sole water operator in the State of Penang.

17 Personal interview with a representative from ABASS on 19 June 2009.

conducted revealed that potable water treatment sludge did not exhibit scheduled waste characteristics, thus did not warrant it to be classified as scheduled waste (Aminudin, 2009; PAAB, 2009). On contrary, they pointed out "the ammonia released by Indah Water Konsortium's sewerage plants has not been classified as 'scheduled waste' even though it clearly contravenes the law".[18] However, from the perspective of regulation, DOE did not see the need to amend the EQA 1974 now to accommodate the request from water utilities. A representative from DOE is convinced that "some forms of controls are needed due to the presence of heavy metal in sludge. We do believe that sludge need proper treatment before proposal. However, water utilities can apply for exclusion from this regulation under the Guideline for Application of Special Management of Scheduled Waste, which allows them to dispose sludge at sanitary landfill".[19]

### 3.4 Government incentives to facilitate sludge recycling and re-utilization

At the present, some water utilities undertook sludge recycling on a voluntary basis. There was no single authority entrusted to promote and coordinate sludge recycling among water utilities and in other industries. Most of the water utilities did not have the capacity to handle sludge management as it involved high capital investment and land issues. It was here that water utilities urged government to consider setting-up a regional sludge treatment facility (RTF) to facilitate and coordinate sludge recycling activities among water utilities. The proposed RTF could be managed like other government-linked companies and run as a business entity. "The other possible option would be for the government and water utilities jointly co-sponsored the establishment of the RTF".[20] Water utilities wanted RTF to focus on the R&D activities of the beneficial uses of sludge during its initial year of establishment, and then into production and commercialization in the later stage. Furthermore, the proposed RTF was indeed nicely fitted into the broad overall policy direction of the sector of facilitating sustainable water supply management in the long run. In this regard, the NWSC wanted the RTF to consider "extending its scope of work to include sewerage (and waste water) sludge as well".[21]

While establishing RTF was rather a long-term solution, water utilities were also keen on having environmental-friendly sludge treatment technologies installed in their plants. However, the cost factor was preventing water utilities from acquiring such technologies or equipment. A study commissioned by the Pengurusan Aset Air Berhad (PAAB), the national water asset management company (2009) has shown that water utilities would need high investment to install, for instance, a mechanical dewatering machine. This option would result in higher treatment cost and water tariffs. It was here that water utilities wanted government to provide financial incentives such as subsidies or grants to promote adoption of 'green technologies' in sludge management.

In one specific case, PBAPP wanted the government to facilitate the R&D activities on sludge recycling. What the government, through NWSC, could consider was to make it mandatory that

[18] Personal interview with a representative from ABASS on 19 June 2009.

[19] Personal interview with a representative from the DOE on 16 Oct. 2009.

[20] Personal interview with a representative from PBAPP on 4 Nov. 2009.

[21] Personal interview with a representative from NWSC on 23 Sept. 2009.

every water utilities must set aside some percentage of their revenues for the R&D activities. PBAPP proposed 2%. Another equally important consideration was for the NWSC to internalize cost for sludge treatment as part of the environmental costs, and therefore allowed for this cost be reflected in the tariff revision".[22]

## 4. Discussion

This paper presents the overview of the availability of the on-site sludge treatment facilities, the adoption of a more environmental-friendly sludge treatment technologies, and sludge recycling initiatives among the water utilities in Malaysia. It also assesses the government interventions in promoting the beneficial use of sludge and adoption of environmental-friendly sludge treatment facilities in the sector.

### 4.1 Sludge disposal

Studies have shown that only a part of sludge disposal method used by water utilities in Malaysia complies with the widely accepted disposal methods practiced in the developed countries such as in the US and UK (PAAB, 2009). In this regard, sludge lagoons or dewatering plants are considered as acceptable method in handling sludge. However, old plants build in the 50s or 60s do not have sludge lagoon and sludge is discharged directly into rivers. Even though sludge is proven chemically not hazardous, direct discharge of sludge into streams must not be encouraged. Building sludge lagoon requires not only large land areas but also involves substantial administration costs to comply with EQA 1974. It is here that both state governments and PAAB have a role to play. PAAB as the government-owned asset management arm could come in to finance sludge lagoon, whereas state governments handle land issue since land matters are under its controls. With this in place, it is envisaged that, to certain extent, the potential water tariff hikes could be cushioned.

The proposal from NWSC that the scope of sustainable sludge management must be widened to include sewerage sludge is in line with the overall policy direction for holistic water management of the sector reform (MEWC, 2008). Water and sewerage services should not be segregated as both are inextricably linked in the water cycle chain. Moreover, the integration between both services will not only facilitate the creation of a holistic water company and single billing system, but also allows for economies of scale. However, the integration can only take place when issues of under investment and tariff rationalization in the sewerage sector are resolved.

Studies from PAAB (2009) and Malaysian Water Association (MWA) (2008) have proven that sludge does not exhibit characteristics of a scheduled waste under EQA 1974, and thus can be declassified as scheduled waste. However, at the moment DOE is not ready to amend EQA 1974 to accommodate the request from water utilities. Not only declassification of sludge from First Schedule involves rigorous and long legal procedures, it also will cause DOE to lose control over hazardous substances management including sludge. It is why DOE is insisting that sludge must be treated prior to disposal. However, the willingness of DOE to allow water utilities to apply for exemption for Special Management of Scheduled Waste Guideline under the Environmental

[22] Personal interview with a representative from PBAPP on 12 Nov. 2009.

Quality (Scheduled Waste) Regulation 2005 is a relief to water utilities. With this approval, water utilities can now dispose sludge at landfills since they comply with this requirement (PAAB, 2009). This option allows water utilities to have some savings as sludge disposal at municipal landfills tend to cost less than to use a private-run facility like Kualiti Alam. As a consequence, water utilities manage to lower its operating costs thus do not see the need to demand for tariffs increase which water users will be the direct beneficiary.

### 4.2 Sludge recycling and re-utilization

The full potentials of beneficial use of sludge in Malaysia have not been fully explored. Despite several attempts by water utilities and universities, no real result was achieved thus far. This could be due to the fact that recycled sludge has no (economic) value as singled out by water utilities. It is here where government-driven intensive R&D on production, new applications and commercialization of the water treatment sludge is vital. In fact, studies by MWA (2008) and PAAB (2009) re-iterated the important of having coordinated R&D activities especially to identify new potential reuse of sludge. In developed countries, many studies have shown the potential use of sludge for land reclamation, soil substitute, brick making, fertilizer etc. A proposed establishment of RTF is indeed a timely move to spearhead the coordinated and organized R&D activities in this area. Perhaps RTF could learn from the experience of the Dutch water utilities in setting up the Residuals Union. It envisages that RTF would have to depend on government financial supports while water sector and universities can provide the expertise.

Forming RTF is a long-term solution. An interim or short-term solution would be to facilitate sustainable sludge management at water utilities level. Among others government can consider introducing economic instruments as recommended in the EPU's handbook for Economic Instruments for Environmental Management (EPU, 2004). For instance, government can use deposit-refund system and revenue neutrality to encourage investment in the environmental-friendly sludge technologies among water utilities and sustainable sludge management in the sector. Water users are expected to favour this option, as they will not be burdened with tariff increase.

Government can also introduce environmental taxes in the form of pollution taxes and product taxes to mitigate the effect of the direct discharge of sludge into the environment (EPU, 2004). Both pollution and product taxes will act as disincentive to deter direct discharging of sludge into water courses. However, government will have to be mindful of the financial implications of such taxes, as they will result in higher operating costs for water utilities. In most cases these extra costs will be passing on to water users in terms of higher water charges. Moreover, imposing such taxes too might have great socio-political implications. Socially, they will generate a lot of resistance from water users, and politically local politicians may regard such move can dilute political supports among their electorates.

## 5. Conclusions

The time has come for all parties (government, water utilities etc.) to take the issue of sustainable sludge management seriously. Sludge possesses both threats and opportunity. On the one hand, direct discharge of raw sludge could harm the environment and threat to raw water. On the other,

sludge has the potential to be turned into beneficial use. Malaysia needs to have a specific policy on sludge management within the framework of water sector reform. At the moment sludge management comes under the broad jurisdiction of EQA 1974. The reform needs to seriously consider pertinent issues raised by water utilities on this matter. This include issues of lack of land for sludge lagoon and dumping ground for treated sludge, high cost for sludge treatment at private facilities, incentives to facilitate adoption of environmental-friendly sludge treatment technologies and sludge recycling, and lastly declassification of sludge as non-scheduled waste under EQA 1974. None other than the MEWC or NWSC will have to spearhead this effort. NWSC could contribute technical inputs and matter on overall sector regulation, while MEWC is in the better position to initiate inter-department discussions (with EPU, DOE and other related agencies) on matters pertaining to policy direction.

Water sector in Malaysia will have to face the reality that sludge will continue to be produced as long as water production exists. Indeed, the quantity of sludge produced is increasing year by year. The concern here is that how sludge could be managed in a more sustainable way especially to reduce the amount being discharged into the environment. Perhaps the proposed RTF could be the answer for a more coordinated R&D activity including in the area of sludge recycling. Again MEWC or NWSC will have to take this matter to a higher level of policy making. In the spirit of holistic water management, there is no reason why this idea must not be supported, but it requires strong political will from the government to make it happens. This idea has not being put forward to the authority yet.

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