IMPROVING WASTEWATER TREATMENT LAGOON DESLUDGING THROUGH USE OF HYDROGRAPHIC SURVEYS

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ABSTRACT

Organisations with settlement and treatment lagoons or raw water storages need to periodically carry out de-sludging or de-silting processes, in order to maintain overall storage capacity or minimum water levels above sludge layers. Some sediment or sludge removal methods are highly sensitive to sludge density, reliant on rudimentary measurement techniques or multiple laboratory test samples to estimate when critical sludge or sediment densities and depths have been reached.

Confirming sludge depths, densities and quantities can have many benefits, such as optimised operations, and better forward planning and budgeting. Cost savings can also be achieved through deferring de-sludging or de-silting until needed. This can be achieved by use of modern hydrographic surveys which incorporate traditional survey methods, GPS technology, a hydrographic echosounder and a Portable Suspended Solids Monitor to determine the percentage of solids, sludge blanket interfaces and depths.

These surveys are non-invasive and can normally be done concurrently with lagoon treatment operations, and over time be used to build up deposition history and predictive trends.

KEY WORDS

Settlement lagoons, hydrographic surveys, sludge profile, accurate measurements

1.0 INTRODUCTION

Authorities and commercial businesses operate lagoons for a variety of reasons which include the following:

- Water storages (pre or post chemical treatment, or for emergency/overflow storage)
- Treatment and/or storage of biosolids (wastewater treatment plants, food manufacturing)
- Settlement of stormwater sediment prior to stormwater nutrient treatment
- Settlement of water-borne combustion by-products (power station combustion ash).

Such processes inevitably lead to the ponds or lagoons reaching a point whereby the deposited solids have built up to such a level that the design intent of the lagoon can no longer be achieved – there being too much sediment or sludge and too little available volume for physical treatment or inadequate water depth affecting the biological treatment process balance. The operator of such lagoons or ponds must then intervene to remove sufficient of the sediment or sludge to free up adequate volume again.

Over time, such authorities and businesses have deployed a variety of methods in monitoring the levels of deposited material.

These have included:

- "Do nothing" – i.e. wait until the system clogs up and obviously doesn't work/has no room left, or overtops;
- "Basic" hydrographic (boat mounted) surveys – such as dipping poles with measurement markers to see where different sediment types and depths have been building up, or scooping up samples of deposited matter for visual examination – such methods are by their nature coarse and sufficient for approximate analysis only;
- "Intermediate" hydrographic surveys, which use a GPS mounted on depth sampling poles to map depths of deposits on a grid to more scientifically map volumes and sub-surface profiles, and/or use of laboratory analysis of retrieved samples to ascertain sludge density/density of suspended solids; and
- "Advanced" hydrographic surveys, which use GPS in combination with poles, echo sounders and other scientific measurement devices to more accurately and speedily develop the profile of solids and suspended solids.

The advanced methods are particularly useful and important in lagoons where settlement and separation of deposited matter occurs over time, as suspended solids convert to a more solid sludge with a range of densities, and where the methods used to remove deposits are sensitive to those densities. Removal methods can vary from use of long reach excavators (typically for ash silts, sands, gravels and clays in stormwater settlement ponds) to eduction ("sucker") trucks, to sophisticated mobile dewatering plant with centrifuges to separate water from fine particles, floating dredges and combinations of methods in sequence. These techniques all have their advantages and limitations, and a given pond may have need for one or all of them depending on the nature of the deposits at different locations and depths.

Figure 1: ***WWTP settlement lagoon showing zone of sludge buildup at surface***

2.0 DISCUSSION

2.1 Field Survey Methods and Issues

SMEC Urban's field hydrographic survey techniques have been refined over years of carrying out these specialist surveys for a variety of clients and industries, and in consultation with those clients to account for their changing needs and evolving technologies.

The technique revolves around the following basics:

- Ensuring all OHS issues and Licensing issues are covered, such as site inductions, training in Job Safety Analysis/Safe Work Method Statements etc. It should be noted that only staff with the relevant boat license and using an accredited, registered boat should be allowed to carry out and lead such surveys. In Victoria that means a boat registered with Marine Safety Victoria/Transport Safety Victoria and a survey party leader who has an Inland Waters Coxwain's license. Authorities and Businesses who engage contractors to do hydrographic surveys need to ensure that these legal requirements are in place and that unlicensed staff and boats are not being deployed. Recreational boating licenses and craft may not be appropriate;
- Carrying out an initial surround survey (especially if these are not recent and accurate as-constructed drawings of the facility), in order to establish the profiles and levels of banks, inlet and outlet structures and bottom profile. To this end, it is important to especially establish where is the 'hard bottom', as over removal of sludge or other sediments can result in removal of or damage to specialist clay (or other) liners, without which the lagoons may experience leaching into aquifers, adjacent streams etc;
- Ensuring the site conditions and time of year are appropriate for the survey:
    - Weather conditions must be calm (as windy conditions will stir up sludge reducing the accuracy of measurements and/or make boating hazardous)
    - The time of year/conditions of testing need to suit the intended removal period for de-sludging – remembering that in warm weather sludge biological activity increases.
    - If doing annual surveys to monitor the progressive build up of sediment (as opposed to determining quantities for removal), carrying out at the same time of year will assist with consistency of results.
- Setting up a sampling grid for measurements – e.g. 10m x 10m, 20m x 20m. This is done in consultation with the client, as a higher sampling rate equals a higher survey cost, and the choice of grid must reflect the degree of accuracy of information required by the client. Grids can even be varied, e.g. more dense sampling near entry structures where build up of sediment is more likely;
- Establishing the GPS base station;

Figure 2: ***Establishing Survey Base Station Prior to Survey Commencement***

- Carrying out the survey at each grid point. This can be done during lagoon operations and will generally use a combination of techniques:
  - GPS mounted on a pole to determine 'hard bottom' depths
  - Use of GPS-integrated echosounders to determine and map deposit depths
  - Use of GPS-integrated infra-red suspended solid meters to determine and map depths of sludge at critical particle densities
  - Samples can be gathered at the same time if needed for laboratory analysis at sampling points

Figure 3: ***Deploying GPS-integrated Infra-red sludge particle density detector***

2.2 Hydrographic Survey Outputs

Following the field phase, analysis of the data is done to calculate sludge/deposit volumes, changes to past profiles and develop CAD or other outputs, such as the following:

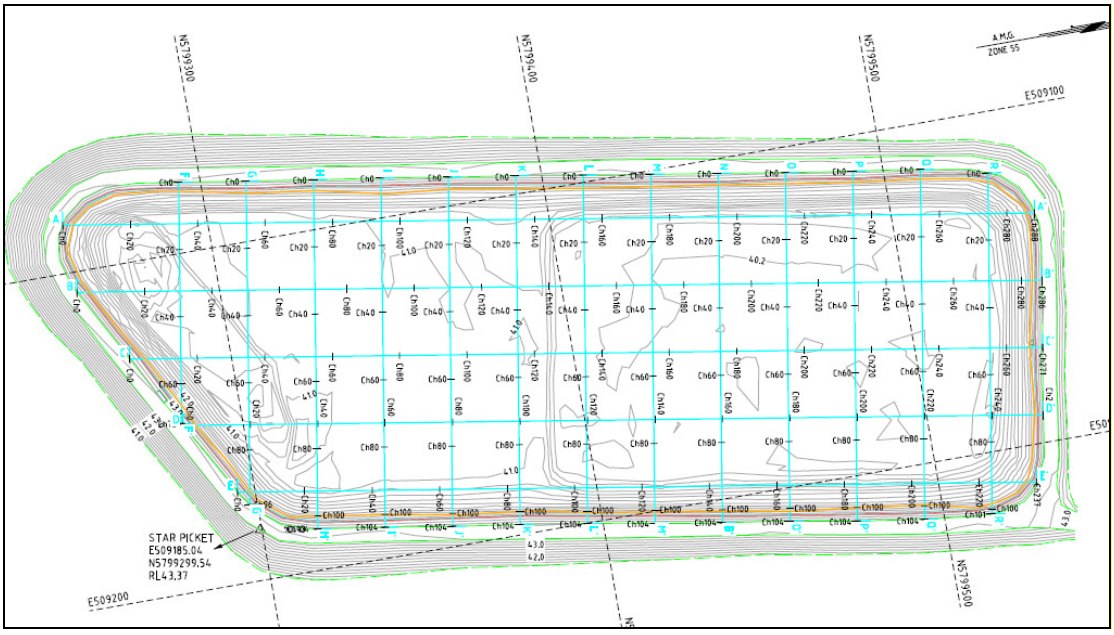

Figure 4: ***Plan view of deposition profiles***

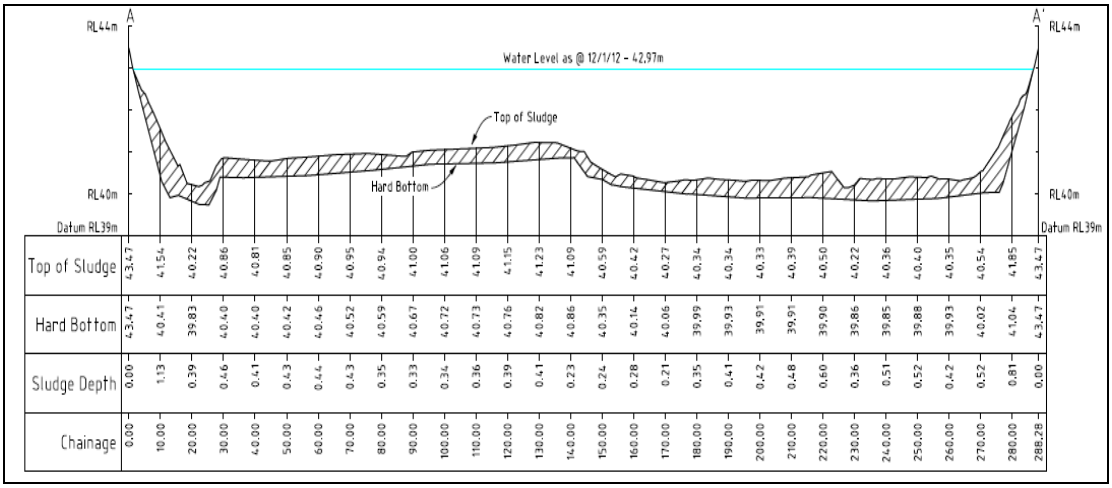

Figure 5: ***Longitudinal section view of deposition profiles***

Eastern Pond			
Date of Survey	**Volume of Deposition**	**Capacity Remaining to Water Level RL89.40m**	**Comments**
Dec 2003		390,150m^3	
Oct 2009	142,000m^3	324,300m^3	
Dec 2009	13,600m^3	312,900m^3	
Sep 2010	143,300m^3	175,300m^3	
17 Dec 2010	54,000m^3	120,660m^3	
7 Dec 2011	81,550m^3	89,420m^3	

Figure 6: ***Table of volumes tracked by survey date***

2.3 Advantages and Issues for Operators of Settlement Lagoons

The methods used by SMEC Urban have provided the following insights:

- Accurate mapping of the preferred sludge density can be provided for centrifugal methods of sludge removal, which are sensitive to the sludge density with regard to use of dosing polymers and balancing tanks;
- Operators can change their procurement method for lagoon deposit removal from contracts based on 'dry weight removed' (as eventually measured over a weighbridge) to simple volumes removed, of various densities. Lagoon operations usually need to free up a volume, not a dried weight;
- Tenders for such contracts can be based on the supplied hydrographic survey profiles plus average deposit density tests. The risk for the removal contractor is that average density sampling results may not be sufficient to capture the true variety in actual density of deposits to be removed. Quantities in removal contracts also need to allow for dynamic inflows if the removal contract period overlaps with continuous lagoon operation;
- 'Before and after' hydrographic surveys can be done to confirm that contractors have removed what was intended under the contract;
- Consecutive surveys can be used over time to validate inflow/settlement rate/sediment removal design models, for lagoon maintenance/operations planning purposes;

3.0 CONCLUSION

Use of modern hydrographic survey techniques can allow operators of settlement and other lagoons or water storages to accurately determine what types, levels and volumes of deposits are occurring in their storage assets. The survey outputs can be used to optimise removal methods and timing of removal works, defer unnecessary removal and validate design models and check the compliance of contractors with removal contracts. Such surveys integrate the use of traditional survey techniques, GPS, echosounders and sludge density testing devices and can provide a range of useful outputs and benefits.

4.0 ACKNOWLEDGEMENTS

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5.0 REFERENCES

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