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Wastewater Treatment and Current Sludge Management Practices in Pogradeci Region

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Abstract

Sludge management strategies need to be developed for each wastewater treatment plant (WWTP) to identify sustainable and cost-effective outlets, and in general, agriculture is likely to be the main beneficiary in Albania, if properly developed. This requires wastewater treatment plant (WWTP) to be designed to produce sludge of an appropriate quality that most readily secures beneficial use on land. Consequently, sludge management strategies should be an integral component of the initial wastewater treatment plant (WWTP) design selection process to ensure an appropriate balance is achieved between affordable wastewater and sludge treatment and securing outlets for the sludge. Sludge is a novel product in Albania as so far, the only experience of using sludge on land is in Kavaja. While the purpose of this study is to develop practicable and sustainable sludge management strategies for Pogradec, Korca and Kavaja, it is inevitable that the study has to address issues and concepts that have not yet been considered in Albania but need to be, urgently, in view of rapid increase in the quantities of sludge expected in the near future.

The coverage of potable water and sanitation services compares unfavorably with othercountries in Europe although the situation is gradually improving through the active support of international donors and the necessary legal and institutions reforms for accession to the EU.

Albania initiated a decentralization process in 2000 in which administrative, political and fiscal tasks, competences and resources were transferred to the municipalities and communes. In the water and sanitation sector, this resulted in the creation of 55 Water and Sewerage Enterprises (UKs) and their progressive conversion into commercial companies,the shareholders of which are the municipalities and communes in the service areas of thecompanies. A key objective of the wastewater project is to reduce the pollution load from the discharge of untreated wastewater to Lake Ohrid.

Keywords: Wastewater, sludge, management strategies, potable water.

1. Introduction

Strategic studies are necessary to determine the best practicable environmental option (BPEO) for the management of sludge (and effluent), i.e. an integrated and holistic approachto planning treatment and reuse or disposal that is adapted to the local conditions. The BPEO takes into account all of the issues relating to the practicability, environmental, social and economic implications of the feasible options of treatment and disposal under the local circumstances. This provides an objective approach to determining the best balance of costs, benefits and impacts, and to provide the most sustainable solution [1].

Identifying the BPEO should be the first step in the wastewater treatment plant (WWTP) design process as this determines the appropriate specifications for sludge (and effluent) quality which can then be designed forby engineers. This 'reverse engineering' approach saves time and money, and avoids thepotential need for supplementary treatment or having to use non-optimal outlets if sludge useand disposal options are identified after design or construction of the wastewater treatment plant (WWTP). This logical approach is not always followed in practice.

In line with the international concept of the waste management hierarchy, the priority for sludge (and effluent) management is reuse, wherever feasible, to maximize the resourcevalue of these products. This approach is generally adopted into national waste managementpolicies by introducing measures which prevent or discourage disposal by prohibition

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(e.g.banning of sludge dumping at sea), setting stringent technical standards, or by economicinstruments (e.g. tax on waste disposal, emissions trading, etc) [2].

Internationally, the preferred and common management option for sludge is beneficial use onland, particularly for agricultural production. This is widely regarded as the most sustainableoption provided sludge quality and its use are controlled, and farmers are willing to use thesludge. Use in this way ensures that nutrients and organic matter are recycled to the soil toenhance crop production, reducing the use of chemical fertilizers while improving soilphysical properties with regard to its cultivability, nutrient retention and moisture holdingcapacity (important where irrigation is necessary).

Co-disposal of sludge with domestic solid waste in landfill has been the most popular optionin many countries due to its low cost, simplicity and relative ease of disposal of difficult orcontaminated sludges. The physical stability of the sludge is usually the only qualityrequirement and a minimum of 35% ds is often specified to minimize site management andenvironmental problems. However, in many countries, landfill disposal of organic wastessuch as sludge, is widely recognized as unsustainable due to the loss of the resource valueof sludge (nutrient, organic matter, energy), limited landfill void that should be preserved fornon-recyclable wastes and concern over environmental emissions, particularly methane (apotent greenhouse gas) [3].

Incineration of sludge is a treatment process for mass minimization, preferentially withenergy recovery, and may be adopted where opportunities for sludge use or disposal arelimited or not available. This process is only practicable on a large-scale and incurs highcapital cost, requires considerable technical ability, may need supplementary fuel ifautothermic combustion cannot be achieved, and often faces planning difficulties due toadverse public perceptions relating to gas emissions and visual intrusion of the plant. Theresidual ash, which comprises about 30-40% of dry solids, is usually disposed of in landfilland may be regarded as a hazardous waste requiring special and expensive disposal. However, some ash components can be used for construction materials (additive to buildingblocks, road base, etc.) [3].

Combustion of sludge as a part-replacement fuel in energy intensive industrial processes,such as power generation and cement production may be practicable where there aresuitable industries within economic transport distance of the wastewater treatment plant (WWTP). This contributes a smallreduction in net CO_2 emissions, which has increasing economic value in European countrieswhere emissions trading takes place under the Kyoto Protocol.

To minimize the potential for harm to the environment and human health from inappropriatesludge quality and its use or disposal, regulations and guidelines have been adopted in mostcountries worldwide. These generally specify the treatment requirements to minimize therisks of disease transmission and provide the maximum acceptable concentrations ofchemical parameters (generally heavy metals) added to soil to prevent possible adverseeffects on the environment and human health. However, the precautionary principle is increasingly applied to sludge, mostrecently due to the prejudices of the global supermarket buyers, resulting in quality standardsand controls being progressively tightened in many countries and sludge managementbecoming increasingly challenging and costly.

This creates a conflict between waste management policies that encourage recycling anddiscriminatory quality standards that impose unnecessarily stringent and costly requirementsthat often direct sludge producers to disposal options rather than use.The acceptance of sludge by farmers and other users is always uncertain as sludge use isvoluntary and is regarded by users as a commodity in the same way as purchasing manureor fertilizer, even if sludge is provided free and there are no adverse perceptions over its use. Consequently, considerable effort may be necessary to develop ‘market’ demand andsustain ‘customer’ loyalty, and this requires an entrepreneurial approach by the sludge producer [3], [4].

In considering sludge management options, the key quality parameters can be categorized as physical, chemical, microbiological and aesthetic (i.e. appearance and odour). Table 1 provides a simple classification of the relative importance of these quality criteria for sludgefor the range of outlets. The specific quality requirements depend critically on localcircumstances and standards. In general, the protection of human health is the mostimportant criterion for sludge use options. Government policy and standards have a decidingeffect on what level of treatment is required at the wastewater treatment plant (WWTP) and the control measures to beadopted to ensure environmental and health protection [4].

Table 1. Sludge Quality Requirements for Use and Disposal Options

Outlet	**General Quality Requirements**			
	Physical	**Chemical**	**Microbiological**	**Aesthetic**
Agriculture	+++	+++	+++	+++
Green areas	+++	++	+++	+++
Forestry	+++	++	++	++
Land reclamation	++	++	++	++
Landfill	++	+	+	++
Combustion (energy)	+++	++	++	++
Incineration (disposal	+++	+	+	+

Quality requirements: + not important; ++ important; +++ very important

2. Material and Methods

Wastewater treatment plants (WWTP) are essentially sludge factories except that unlike a conventional factory, productioncannot be reduced or shut down if no one wants the sludge. Charging customers for sludgeto offset treatment costs only becomes feasible when demand reliably exceeds supply unlessa low-cost and acceptable disposal option is available for unsold sludge; this is rarely thecase. For these reasons, sludge treatment and disposal is a significant component of theoverall costs of wastewater treatment (50-60% in Europe) [3].

The resident population in Pogradec urban area was determined as 35,000 inhabitants in 2015 based on the number of persons registered by the registration office of the municipality in September 2015. In addition, it considers some 20% registered but permanently absent persons and makes an allowance of 6% for non-registered immigrants. The annual rates of population growth assumed were: Pogradec urban area 2%; surrounding villages (Buçimas Commune) 1.22% and seasonal population and tourism 5%. The projections for population growth and the rate of connections to the sewerage system are summarized in Tables 2 and 3 respectively.

Table 2. Population Projections for Pogradec

Population	**2005**	**2007**	**2017**	**2027**
Resident Population Pogradec	33,000	34,195	39,889	47,133
Environs of Pogradec Total	13,039	13,358	15,078	17,025
Resident Population Total	46,039	47,553	54,967	64,158
Seasonal Population/Tourism	720	793	1293	2106
Grand Total	46,759	48,347	56,260	66,264

Table 3. Projected Development in Connection Rates to Pogradec WWTP (%)

City/Village	**2007**	**2017**	**2027**
Centre	50	90	100
West/South	0	80	80
Industrial Area	60	90	100
East/Coastal	17	80	100
East Development Area	0	50	70
Verdove	0	70	90
Starove	0	70	90
Gurras	0	70	90
Tushemisht	80	80	95
Remenj	0	0	70
Geshtenjas	0	0	70

3. Results and Discussions

Minimum and maximum wastewater flow scenarios to the Wastewater treatment plants

(WWTP)were developed according to the rate at which priority sewerage rehabilitation measures can be implemented. These are illustrated in Figure 1 in relation to the planned phasing of the Wastewater treatment plants (WWTP).

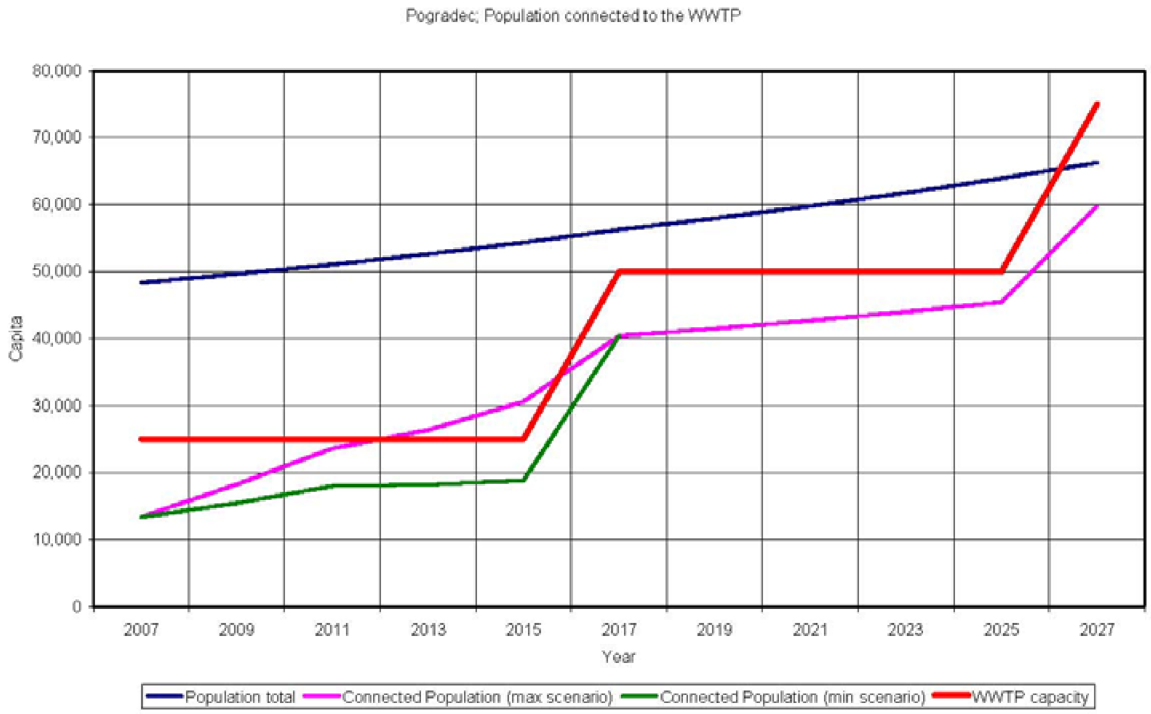

Figure 1. Expected Population Connection to Pogradec WWTP and Proposed Design Capacities

The current Wastewater treatment plants (WWTP)(Phase 1) has a design capacity for 25,000 PE sufficient for the load ofthe minimum scenario plus the industrial load and load from septic tank emptying until 2017.Expansion of the Wastewater treatment plants (WWTP)(Phase 2) was planned to be implemented by 2017 but may berequired sooner depending on the rate of sewerage connection, and this would double thecapacity of the existing Wastewater treatment plants (WWTP) to 50,000 PE. In Phase 3, the Wastewater treatment plants (WWTP)would be expandedfurther to 75,000 PE, if required.

The existing sewerage network acts as a combined system and rather than rehabilitate this,it was recommended in the concept design to pursue in the medium and long-term theconstruction of new separate sewerage systems for all areas. Consequently, allowance ismade for high storm flows during Phase 1 (200%), progressively decreasing 70% by 2027.

Aseasonal summer peaking factor of 1.25 is assumed over the planning period.While most of the flow from the main urban area will be transferred to the Wastewater treatment plants (WWTP) by the MainPumping Station, there are separate connections to the Wastewater treatment plants (WWTP) from the villages, asindicated in Table 4.

Table 4. Design Wastewater Flows to Main Pumping Station and Wastewater treatment plants (WWTP)

Implementation horizon	2007		2017		2027	
Flow (m3/d)	To Main PS	To WWTP	To Main PS	To WWTP	To Main PS	To WWTP
Average total flow	26	26	71	77	81	98
Max total flow (dry weather)	52	52	141	154	174	211
Max total flow (wet weather)	138	138	259	282	283	343

There is no wastewater flow measurement on the Wastewater treatment plants (WWTP), only at the Main PS. Data in the table Nr 4,shows the PS flows over the period June 2014 to August 2015 and indicates that the flow tothe Wastewater treatment plants (WWTP) is continuously in excess of its designed dry weather flow. Flow is particularlyelevated over the winter period due to storm inflow with and a smaller summer peak flow.Allowance for delivery of septage is 6.7 m3/d initially, increasing to 21.6 m3/d by 2027. It wasenvisaged that regular emptying of septic tanks would commence with the operation of theWastewater treatment plants (WWTP) but currently the Wastewater treatment plants (WWTP) receives no septic sludge.

Wastewater Treatment and Sludge Production

The Wastewater treatment plants (WWTP)is located about 1,500 m south of Lake Ohrid between the villages Buçimas andGurras. The total area of the treatment site is about 13 ha. The site was formerly a fish farm and the existing ponds were exploited in the design of the WWTP to minimize excavation.The plant is currently designed to achieve the effluent discharge standards of: 25 mg BOD/l,125 mg COD/l and 1000 MPN faecal coliforms/100 ml. The effluent currently meets thesestandards. It is envisaged that nutrient removal will be progressively introduced to reduce theeutrophication load on Lake Ohrid, as follows: 2 mg P/l from 2017 and 15 mg N/l from 2027.The type and number of treatment units installed and proposed at each phase ofdevelopment of the Wastewater treatment plants (WWTP) are summarized in Table 5.

Table 5. Wastewater and Sludge Treatment Process Units

Unit	Phase 1	Phase 2	Phase 3
Septage station	1	1	1
Screens	1	2	2
Anaerobic ponds	1	2	3
Trickling filters for BOD removal	1	2	3
Phosphate precipitation	0	1	1
Trickling filters for nitrification	0	0	1
Sedimentation/maturation ponds	10	20	30
Sludge storage tanks	1	2	3
Sludge reed beds	14	14+	14+

At the inlet works to the Wastewater treatment plants (WWTP), there is a 6 mm mechanically raked screen and 40 mmmanually raked screen in a by-pass channel. There is no grit removal channel installed.The wastewater flows to the anaerobic pond where there is simultaneous sedimentation andanaerobic digestion of sludge. The settled sewage is aerobically treated by trickling filter anddischarged to two trains of five maturation ponds arranged in series before discharge via achannel to Lake Ohrid. Humus sludge from the trickling filter accumulates in the maturationponds.

Table 6. Sludge Balance of PogradecWastewater treatment plants (WWTP)

Parameter	Units	Phase 1	Phase 2	Phase 3
Anaerobic Ponds				
Specific quantity grit	l/PE.y	4	4	4
Total solids primary sludge	kg/d	1,260	2,520	3,780
Organic content, primary sludge	%	70	70	70
Total solids excess sludge	kg/d	0	0	0
Organic content, excess sludge	%	65	65	65
Degradation of organic content	%	50	50	50
Total solids, digested sludge	kg/d	819	1,638	2,457
Solid content sludge	kg/m³	60	60	60
Total volume, digested sludge	m³/d	13.7	27.3	41.0
Yearly volume, digested sludge				
80% of max load = average load	m³/y	3,986	7,972	11,957
Solid content grit	%	30	30	30
Yearly volume, grit	m³/y	333	667	1,000

Parameter	Units	Phase 1	Phase 2	Phase 3
Yearly volume, digested sludge + grit	m³	4,319	8,638	12,957
Desludging interval y	Y	1.05	1.04	1.04
Trickling Filters				
Specific excess sludge production	g ds/g BOD	0.75	0.75	0.75
Excess sludge production	kg ds/d	607.5	1,215	1,822.5
Sedimentation Maturation Ponds				
Total solids excess sludge	kg/d	608	1,215	1,823
Solid content sludge	kg/m³	60	60	60
Total volume excess sludge	m³/d	10.1	20.3	30.4
Total solids precipitation sludge	kg/d	0	1,299	1,993
Solid content precipitation sludge	kg/m³	0	100	100
Total volume precipitation sludge	m³/d	0 13.0 19.9	13.0	19.9
Yearly volume, sludge				
80% of max load = average load	m³/y	2,957	9,706	14,688
Max. Sludge Volume	%	30	30	30
Sludge Volume Ponds	m³	1,403.5	1,403.5	1,403.5
Desludging interval	y	2.11	6.92	10.47
Sludge Reed Beds				
Total volume of sludge	m3/y	6,942	17,678	26,645
Dry solids	kg ds/y	416,538	833,076	1,010,466
Specific organic load	kg ds/m².y	30	30	30
Area required	m2	13,885	27,769	33,682
Total existing surface	m2	14,002	14,002	14,002

The sludge is removed from the anaerobic pond and the maturations ponds by pump from afloating pontoon. The design desludging interval of the anaerobic pond is once per year, andtwice per year from the maturation ponds; the frequency of desludging the latter will dependon the rate of accumulation of sludge which will be greatest in the first pairs of ponds.The sludge is pumped to a sludge storage tank equipped for mixing the contents and anadjustable boom for decanting supernatant. The sludge may be withdrawn from the tankdirectly to tanker (not supplied) for land application or pumped to 14 sludge reed beds(SRBs) where further mineralization and drying will take place.

4. Conclusions and Recommendations

The Wastewater treatment plants (WWTP), is currently functioning well in so far as it is meeting the required dischargestandards despite receiving wastewater in excess of its design average flow. However, thereare some issue that should be addressed in the design of the subsequent expansion of theWastewater treatment plants (WWTP).

It is noted that the mechanical screen is currently not functioning and consequently floatingdebris has to be skimmed manually from the anaerobic pond. As a consequence, the sand and grit accumulate in theanaerobic pond and is removed during desludging operations. This has no significantdetrimental effect on the quality of sludge except as a diluent reducing both the nutrient andheavy metal contents of the sludge.

However, the lack of sand and grit removal is cause for concern for the operation of theWastewater treatment plants (WWTP), as follows: (i) there will be sedimentation of sand and grit in the sludge storage tank that may not bereadily put into suspension by the mixing equipment provided. Accumulation of sedimentwill reduce progressively the useful volume of the storage tank but there is no access intothe tank for removal of accumulated sand and grit; (ii) Anaerobic pond treatment is robust and will accommodate seasonal variations in loading,both hydraulically and biologically. Since sludge is removed infrequently, the peak populationin the tourist season will not be a significant factor as regards sludge production ormanagement. Nevertheless, the planned timing of annual sludge removal in October isappropriate in view of the summer load on the Wastewater treatment plants (WWTP).

The main concerns are the quantity of floating plants (pond weed) and the development ofislands of reeds (Phragmites). Excessive pond weed growth is creating mats that aredecaying and there is a risk that this will introduce a BOD load on the effluent unlessregularly removed. The growth of reeds will make desludging of the ponds increasinglydifficult and will progressively reduce the retention time of the ponds. With the extent ofcurrent growth, removal of pondweed and reeds will need to be done from a boat. Thealternative would be to take one train of ponds out of service and drain for cleaning but thisshould only be done as a last resort.

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