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Hospital waste management & environmental assessment in Pakistani selected facilities

Guidelines for Safe and Environmental Management

2006

Hospital waste management & environmental assessment in Pakistani selected facilities

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PRESENTATION

This study is a result of a request of the John Snow Inc. (JSI), through the Pakistan Initiative for Mothers and Newborns Program, known as PAIMAN Project, funded by the United States Agency for International Development (USAID). It was made by a private consultant, Eng. Gladys Monge, technically assisted by PAIMAN Consortium staff. Main objective of this study is assessing hospital waste management situation and environmental conditions in selected health care facilities of Pakistan, in order to improve maternal and newborn health care services. The consultant wants to thank Major Javed Khwaja support and Dr. Shehzad Awan technical assistance. Working team is mentioned below.

Support Team

- Nabeela Ali
- Javade Khwaja
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Field team

- Shehzad Awan
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- Gladys Monge (Team leader)

Executive Summary

The main purpose of this study is to assess technical and sanitary aspects of hospital waste management situation and environmental conditions in selected health care facilities in the designated ten districts of Pakistan, in order to recommend environmentally sound, technically feasible, economically viable, and socially acceptable systems for hospital waste management, drinking water supply and wastewater management; to improve maternal and newborn health care services.

The methodology of the study comprised field work as well as office work. Developed activities included: 1) Literature review, 2) Development and validation of tools, 3) Field visits and interviews, 4) Data processing and reporting.

Regarding hospital waste management in selected facilities, a critical situation is observed at all stages, from generation to final disposal. Lack of awareness about the extent, severity and significance of the problem is identified. Risk waste (infectious, sharps, special) and non-risk waste are mixed, increasing the volume of hazardous waste and the risks to the personnel.

No facility has proper systems of handling, collection, transportation and final disposal of hospital waste. No treatment is provided to risk wastes. Final disposal is carried out in open dumps; mixed wastes are scattered and burned open-air in several places around the health facilities and in municipal open dumps. There are no sanitary landfills for the appropriate disposal of solid wastes at all visited districts. Scavengers have been seen, including children, looking for recyclables in open dumps, stepping over mixed wastes (infectious, sharps, general waste).

With respect to drinking water supply and wastewater management at selected health facilities, both of them are also in a critical situation. Drinking water supply is deficient. Low pressure, hard water, suspended solids, no proper filtration system, bad smell, are some of the problems recognized. Cleaning of overhead reservoir is not a routine practice, 64% of them either have never cleaned it or frequency of cleaning is more than a year. Bacteriological analysis performed in water samples reported values that overcome the maximum permissible limits of the World Health Organization (WHO) for total coliform and fecal coliform, among others.

Concerning wastewater management, in most of the visited facilities septic tanks are damaged and not properly functioning. They are clogged with solid wastes, have broken covers or do not have covers at all. There is no regular maintenance and cleaning; therefore, they are causing environmental pollution and health risks to the population, besides of the understandable nuisance due to bad odors. Not all facilities have a soakaway system after the septic tank. Some health facilities discharge wastewater directly to open drains which poses major environmental and health risks due to the nature of this liquid waste.

Inappropriate hospital wastewater management is a source of environmental pollution and health risks. Hospital wastewater is loaded with pathogenic microorganisms, heavy metals, disinfectants, detergents, solvents, pharmaceuticals, among others. Uncontrolled discharge from hospitals in selected districts enhances the eco-toxicological risk for environment and toxic or infectious risk for humans.

The high incidence of illnesses in some districts could have origin, among others, in the bad environmental conditions related to poor basic sanitation: bad quality drinking

water; open drains for wastewater; solid waste disposed of in the streets, in open drains, and being open-burned.

All visited facilities need intervention to improve the critical situation of solid waste management, drinking water supply and wastewater management; in order to avoid risks to public health (patients, doctors, technicians, sanitary personnel) and the environment.

With reference to hospital waste management, institutional strengthening to develop, implement and enforce regulations on hospital waste management is needed. A hospital waste management plan, policies, and specific procedures for all waste management stages is proposed and recommended to implement. Proper classification and segregation systems should be put in place.

A simplified segregation option is proposed for small facilities (RHC's), along with a low-cost, low-maintenance treatment system (the De Monfort incinerator); as a transitional technology to other more environmentally friendly technologies, such as autoclave disinfection. Design and operational characteristics of the De Montfort incinerator, for small facilities, are included.

The recommended treatment system for medium size and big health facilities (THQH and DHQH's) is the sterilization with autoclave, which presents a low adverse environmental impact and low operating costs compared with a double-chamber incinerator.

Bearing in mind that one of the main components of a solid waste management system is human resources, development of training courses at all levels is strongly recommended. Sensitization, motivation campaigns and technical courses among professionals, technicians and sanitary workers should be carried out; so that they identify themselves with their responsibilities. Suggested strategy to develop training courses should be "Training of trainees". Course content and planning procedures are included.

The implementation of a demonstrative pilot project on appropriate hospital waste management is also recommended. It would allow hospital personnel to observe the system in place and functioning; which is very important since it would serve as a way to 'educate' and build support to the program. Technical visits from other selected facilities to the functioning pilot project are recommended, which would allow facilitating the process of its replication.

Improving situation of drinking water supply in selected facilities is imperative. Detailed assessment of available water characteristics; considering determination of the source of identified pollutants is recommended; followed by the formulation of a technical project, taking into account coagulation and flocculation systems; clarification; filtration processes; disinfection; organics removal and inorganics removal; according to the specific characteristics of water source.

A scheme of a suggested drinking water treatment system is included, which could be locally provided, from a Pakistani company that is an affiliate of an American company called EcoTech International Inc. USA. The system comprises a slow sand bio / multi media filter, a chlorination tank, a granularly activated charcoal filtration, and units for nitrate / arsenic reduction. However, it is necessary to perform a detailed assessment in order to determine the most appropriate system, as it has been mentioned.

Along with the implementation of a drinking water treatment system, training should be provided to the personnel in-charge of managing the system. A good program of maintenance and monitoring is also recommended.

In relation to wastewater management, an adequate wastewater treatment system is required at all facilities. Discharging of hospital wastewater to municipal sewers without pretreatment is not recommended.

An on-site treatment or pre-treatment of hospital wastewater comprises *primary treatment* (screening, grit chamber, sedimentation tank), *secondary treatment* (biological treatment processes, such as activated sludge, trickling filters, lagoons), *tertiary treatment* (physical, biological, or chemical processes to remove nutrients such as nitrogen and phosphorus, and carbon adsorption to remove chemicals); *chlorine disinfection*; *sludge treatment* (anaerobic digestion, natural drying beds and incineration).

Minimal requirements for small facilities would be installation of proper septic tanks and soakaway systems. It is fundamental to ensure a good design, construction, functioning, and monitoring of septic tank and soakaway system, otherwise odor nuisance, flooding and pollution problems could be generated. A proper and on-time maintenance to the system, including a periodic monitoring are also obligatory activities.

Finally, the renovation and up-gradation of selected health facilities aroused concerns for any potential environmental hazards resulting from the civil works. According to the assessment, no big negative environmental impacts have been identified, since only existing building is being renovated, and there are no interventions in new areas. However, they might cause some minor impacts that need to be addressed. Mitigation measures are recommended to minimize environmental and health impacts of civil works.

PAIMAN civil works are designed to protect public health and environment. Taking into consideration the recommended mitigation measures, and the extent and duration of projects, environmental and health impacts are considered insignificant, as it has been mentioned. PAIMAN civil works will improve hygienic conditions, working environment, facilities for patients, enhance staff availability and facility utilization.

In conclusion, it is recommended to implement the suggested measures on hospital waste management, drinking water supply and wastewater management in selected facilities; which are going to help achieving PAIMAN Project's objectives**:** improving maternal and newborn health.

Chapter I – Introduction

1.1 Background

The Pakistan Initiative for Mothers and Newborns (PMNH) Program, known as PAIMAN Project, is a five-year project funded by the United States Agency for International Development (USAID). The PAIMAN consortium is led by John Snow Inc. (JSI), a U.S.-based public health organization, who signed a cooperative agreement with USAID in October 2004. Partners include the Aga Khan University (AKU), Contech Int., Greenstar, Johns Hopkins University Center for Communication Program (JHU/CCP), PAVHNA, the Population Council, and Save the Children/US.

PAIMAN's vision of success fully endorses the vision proposed in the National Maternal and Neonatal Health Strategic Framework: "The Government of Pakistan recognizes and acknowledges that access to essential health care is a basic human right. The Government's vision in MNH is of a society where women and children enjoy the highest attainable levels of health and no family suffers the loss of a mother or child due to preventable or treatable causes. The Government of Pakistan henceforth pledges to ensure availability of high quality MNH services to all, especially for the poor and the disadvantaged."

Recently, interest in the issue of mothers and newborns has increased substantially within the Government of Pakistan, as well among a number of international donors, who are tackling the issue of maternal and newborn health in a more systematic, and high profile manner. In the last few years, the Government of Pakistan's Ministry of Health has worked closely with national and international experts to develop a National MNH Strategic Framework that clearly outlines a road map for improving maternal and newborn health for the coming years in Pakistan as a whole. The PAIMAN projects fits squarely into this overall national strategic framework, and works in close cooperation with the government and other key partner within the country.

PAIMAN is working to reduce maternal, newborn, and child mortality in Pakistan, through viable and demonstrable initiatives and capacity-building of existing programs and structures within health systems and communities, to ensure improvements and strengthen links in the continuum of health care for women from the home to the hospital.

One of the major areas of implementation is the renovation and up-gradation of selected health facilities in the designated ten (10) districts of Pakistan. In this regard, JSI carried out detailed assessment of the prospective facilities in close collaboration with the respective district health officials and prepared civil works assessment. After completing this first preliminary round of assessment, a subsequent detailed assessment for the selected facilities was carried out to arrive at detailed costing and specifications, so that exact civil works costing is finalized for moving to the next steps of implementation of this major initiative.

Further, since the proposed renovation and up-gradation involves civil works in areas such as, but not limited to, washrooms, water supply, operation theatre, labor room, waiting areas, floors, drainage/disposal, etc. the concerns for any potential environmental hazard emerge. Accordingly, the USAID Mission advised Negative Determination with conditions pursuant to 22CFR216.3 (a) (2)(iii), recommending that an environmental assessment be carried out for this component of the PAIMAN project.

Hospital waste management in selected facilities represents a big environmental health issue, as well as other basic sanitation aspects like drinking water supply and wastewater management. Efforts are being developed by PAIMAN in this sector, to solve the serious problems and avoid the deterioration of public health and environmental pollution.

1.2 Objectives

1.2.1 General Objective

To assess hospital waste management situation and environmental conditions in selected health care facilities of Pakistan, and recommend an environmentally sound, technically feasible, economically viable, and socially acceptable systems for hospital waste management, drinking water supply and wastewater management in selected facilities, in order to improve maternal and newborn health care services.

1.2.2 Specific objectives

- Evaluate technical and sanitary aspects of hospital waste management situation in selected facilities, regarding to handling, storage, treatment, collection and final disposal.
- Assess the existing legal and regulatory framework of hospital waste management in Pakistan.
- Carry out an environmental assessment of the facility-wise civil work plans on drinking water supply and wastewater management, to identify areas of potential environmental concerns that will need to be addressed in light of the Negative Determination with conditions pursuant to 22CFR216.3 (a) (2)(iii).
- Develop medical waste management policies and procedures and health staff training guidelines on these procedures.
- Recommends/advise purchase and installation of necessary and workable equipment for safe waste disposal
- Help decisions makers to adopt better alternatives to solve the mismanagement of the hospital wastes

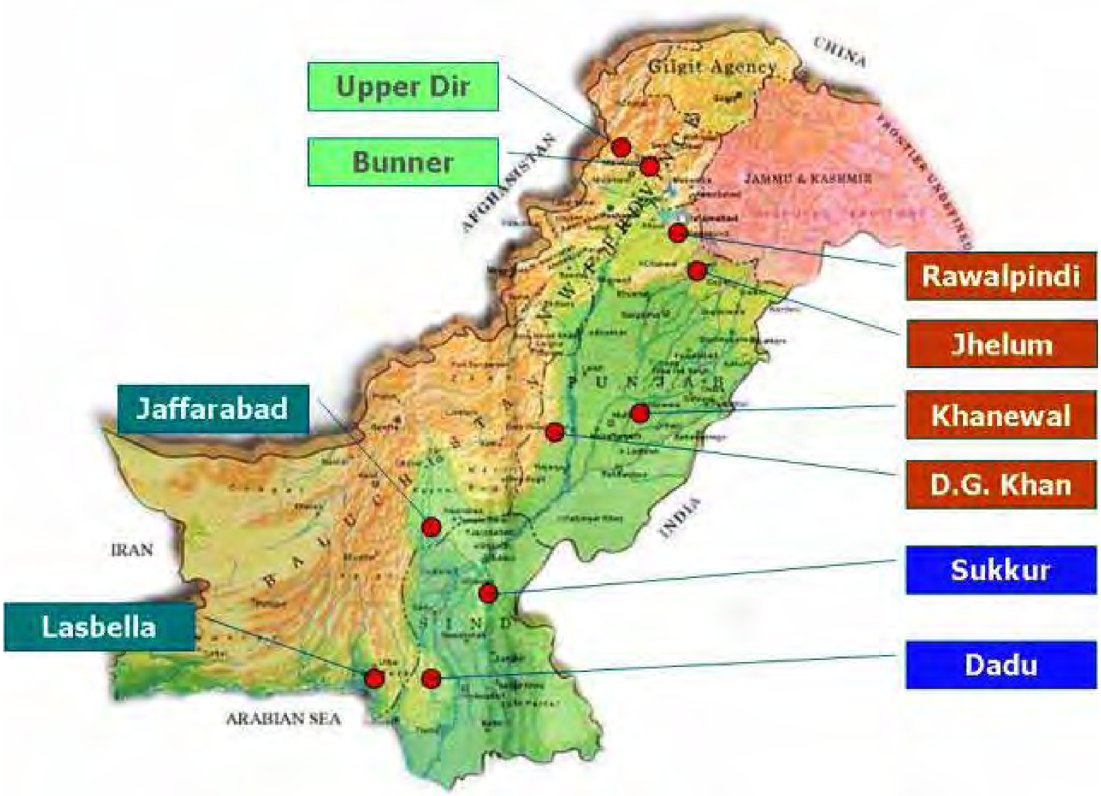
1.3 Methodology of the study

The study has been performed in two parts: a) field work, visiting selected facilities and carrying out interviews with local counterparts, in ten districts of Pakistan; and b) office work (literature review, data processing and formulation of proposals). During this work special advisors were provided by PAIMAN Project.

1.3.1 Literature review

The existing information and documents were reviewed and analyzed, such as the Districts Health Profile, prepared by CONTECH International Health Consultants (a partner of JSI, PAIMAN Project); the legal and regulatory framework on hospital waste management; the Manual for Infection Control in Hospitals, Infections Control Society of Pakistan; the USAID Negative Determination document [22CFR216.3 (a) (2)(iii)]; several documents of the World Health Organization (WHO) on health-care waste management and infection control in health-care facilities; among other relevant documents.

Districts health profile of Buner, Dadu, DG Khan, Jaffarabad, Jhelum, Khanewal, Lasbella, Rawalpindi, Sukkur and Upper Dir were reviewed. Map 1 shows location of selected districts.



Map 1. Location of selected districts

1.3.2 Development and validation of tools

A questionnaire on hospital waste management was prepared, to collect the necessary information during the field visits to selected health facilities. The questionnaire was validated during the first field visit, which allowed some modifications to better adjust this tool to the particular characteristics of selected facilities. Annex 1 shows the mentioned questionnaire.

A detailed working plan was also prepared, based on the tentative schedule that JSI staff planned. Questionnaire and detailed working plan were presented at a meeting in JSI Office. Final schedule is presented in Annex 2.

1.3.3 Field visits and interviews

Field visits and interviews have been carried out, in order to gather relevant information, assess hospital waste management situation and evaluate the facility-wise civil work plans on drinking water supply and wastewater management in selected health facilities of Pakistan. A list of persons contacted at selected health facilities is presented in Annex 3.

JSI Office, through PAIMAN project, established the necessary mechanisms to perform the visits, to obtain documents and data, providing the necessary support to facilitate these activities. Table 1 shows the health care establishments where the necessary information was collected.

Table 1. Selected facilities

Nº	District	Health facility
1	Rawalpindi	THQH Gujjar Khan
		RHC Mandara
		THQH Murree
2	Jhelum	DHQH Jhelum
		THQH Sohawa
		RHC Domeli
3	Khanewal	DHQH Khanewal
		THQH Mian Channu
		RHC Kacha Khuh
4	DG Khan	DHQH DG Khan
		THQH Tounsa
		RHC Choti Zerin
5	Sukkur	DHQH Sukkur
		THQH Rohri
		RHC Kandara
6	Dadu	DHQH Dadu
		THQH Khairpur Nathan Shan
		RHC Seta Road
7	Buner	DHQH Daggar
		THQH Chamla
		RHC Jowar
8	Upper Dir	DHQH Dir
		THQH Warri
		RHC Barawal
9	Jaffarabad	DHQH Dera Allah Yar
		THQH Usta Muhammad
		RHC Rojhan Jamali
10	Lasbela	DHQH Uthal
		THQH Hub
		RHC Bela

Some pictures of the performed visits are shown below.

Photo 1. Office of Executive District Officer Health – Sukkur

Photo 2. In-charge of teaching hospital Sukkur

Photo 3. EDO Health Buner

Photo 4. RHC Jowar. In-charge

Photo 5. DHQ DG Khan. In-charge and medical staff

Photo 6. EDO Health Khanewal

1.3.4 Data processing and reporting

Collected field work data and information was initially assessed, validated and processed. First results, main findings and preliminary proposals were presented in a debriefing session with counterparts at JSI Office. Preliminary proposals were discussed; feedback from the participants of the meeting was received and next steps were agreed.

Chapter II – Hospital waste management and environmental assessment in selected facilities

2.1 Analysis of the Pakistani legislation on hospital waste management

Hospital waste in Pakistan is regulated by the Hospital Waste Management Rules, 2005, enacted in Islamabad, the 3rd of August, 2005. An assessment of these regulations identifies the following comments:

- In clause 2 “Definitions”, it is written: "hospital waste" includes both risk waste and non-risk waste. It would be convenient to analyze the possibility of specifying “…risk waste and non-risk waste generated by a hospital”, given that a definition of “hospital” is included.

- In the same clause 2 “Definitions”: "waste management" includes waste segregation, waste collection, waste transportation, waste storage, waste disposal and waste minimization and reuse. It would be convenient to analyze the possibility of including also ***waste treatment***.

- In clause 14, “Duties and responsibilities of the Waste Management Officer”, waste treatment is not included specifically. It could be “waste treatment and disposal”:
  c) for waste ***treatment and*** disposal
  (ii) “ensure that the correct methods of transportation of waste are used on-site to the central storage facility or ***treatment facility (***incinerator***, autoclave or other)*** if installed, and off-site by the local council; and…”

- The legislation does not cope with waste treatment options. In some paragraphs incineration is mentioned, and in others autoclave is mentioned as a special treatment, although much less than incineration.

- In clause 16, “Waste segregation”, there is paragraph describing characteristics of plastic bags for risk waste: “All risk waste shall be placed in a suitable container made of metal or tough plastic, with a pedal type or swing lid, lined with a strong yellow plastic bag”. “Strong” is a qualitative word. It would be better to specify the thickness of the yellow plastic bag.

- In the same clause 16, it is written: “Sharps including the cut or broken syringes and needles shall be placed in metal or high-density plastic containers resistant to penetration and leakage, designed so that items can be dropped in using one hand, and no item can be removed”. It is recommended to write “…and needles shall be placed in rigid, puncture proof containers (cardboard or high-density plastic containers) resistant to penetration and leakage…” Most of rigid containers for sharps are made of cardboard or plastic materials. If plastic material is chosen, it should be other than PVC.

- Another paragraph in clause 16 specify: “Large quantities of chemical waste, and waste with a high content of mercury or cadmium shall not be incinerated, but shall be placed in chemical resistant containers and sent to specialized treatment facilities.” It does not say anything related to places where there are no specialized treatment facilities.

- For non-risk waste Pakistani legislation specifies the use of a white plastic bag: “Non-risk waste shall be placed in a suitable container lined with a white plastic bag”. WHO guidelines recommend black plastic bags (they are easer to find and cheaper).

- Regarding clause 19, “Waste storage”, it addresses only risk waste storage: “No materials other than yellow-bagged waste shall be stored in the central storage facility”. It does not say anything regarding non-risk waste storage. Non-risk waste also needs to be stored with similar precautions, but in a separated environment from hazardous waste. Furthermore, concerning distance from waste storage facility and other facilities:
  (2) The designated central storage facility shall -
  (a) be located within the hospital premises close to the incinerator, if installed, but ***away*** from food storage or food preparation areas.
  “Away” is a qualitative word. The statement does not specify the appropriate distance from waste storage facility and food storage, food preparation area or internal facilities. Distances could be 30 m from food storage or preparation area and 15 m from internal hospital facilities.

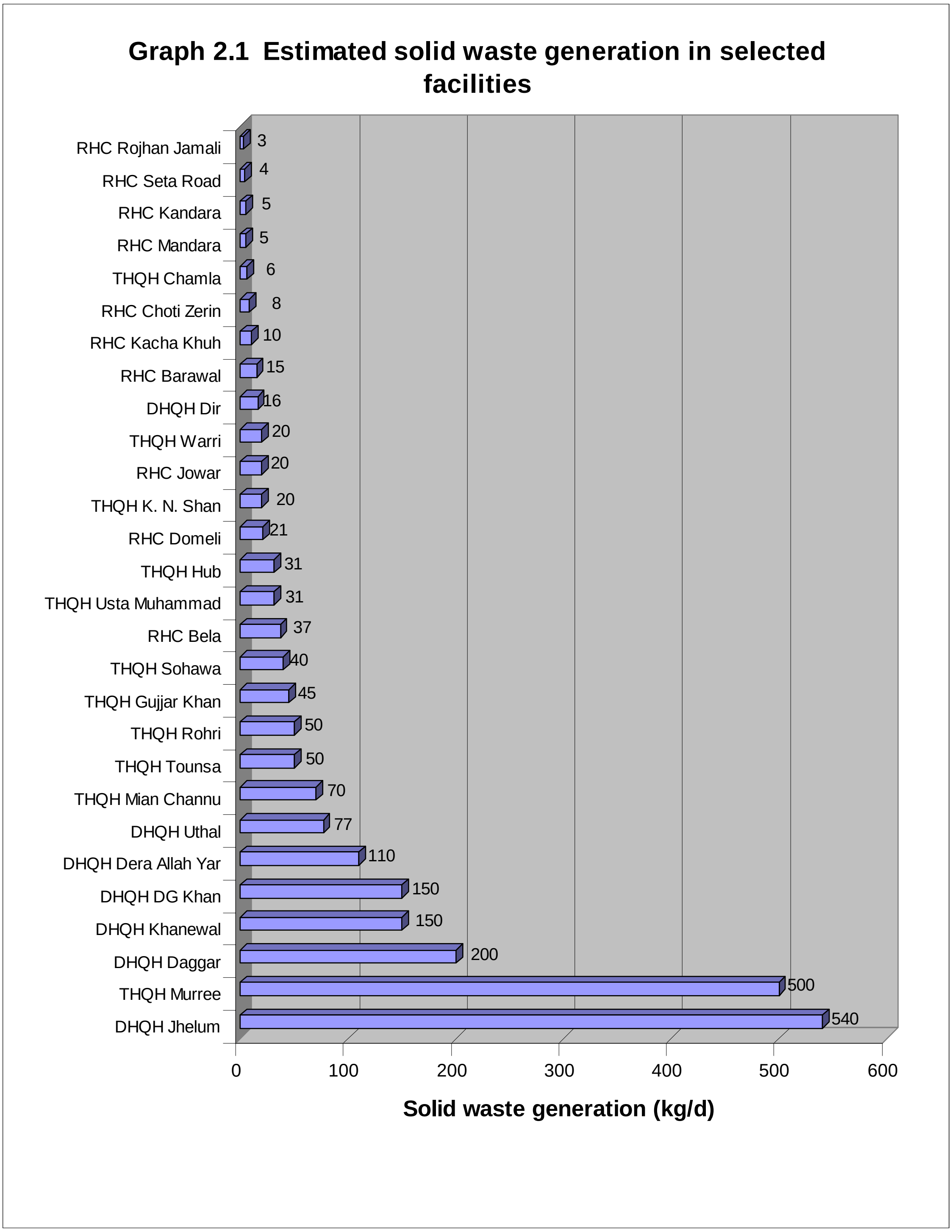
- Regarding waste disposal (clause 20):
  - It is written: “Yellow-bagged waste shall be disposed of by **burning in an incinerator** or by burial in a landfill or by any other method of disposal approved by the Federal Agency or Provincial Agency concerned”. Incineration is a treatment method; it is not a final disposal method since incineration generates also some residues to deal with (ashes, gases, particulate matter, among others).
  - Another paragraph is: “Landfills shall be located at sites with **minimal risk** of **pollution of groundwater and rivers**. Access to the site shall be restricted to authorized personnel only. Risk waste shall be buried in a separate area of the landfill under a layer of earth or non-risk waste of at least one meter depth which shall then be compacted”. Nothing is written about the meaning of “minimal risk”. More specific parameters are needed, unless there is another Pakistani regulation about criteria for a sanitary landfill location.

2.2 Hospital waste management situation in selected facilities

A detailed description of the hospital waste management situation in all selected facilities is presented in Annex 4, together with pictures of the visited facilities, showing the critical situation observed with respect to the hospital waste management at all stages, from generation, handling and primary storage, internal collection, central storage and final disposal. Main findings that summarize the situation at all visited facilities are:

- Lack of awareness at all levels (medical, paramedical, sanitary workers) about the extent, severity and significance of the problem (the initial question asked for a hospital staff in one of the visited facilities was: “What do you mean by hospital waste?”). General population does not clearly identify the inadequate management of solid wastes as a health and environmental problem.

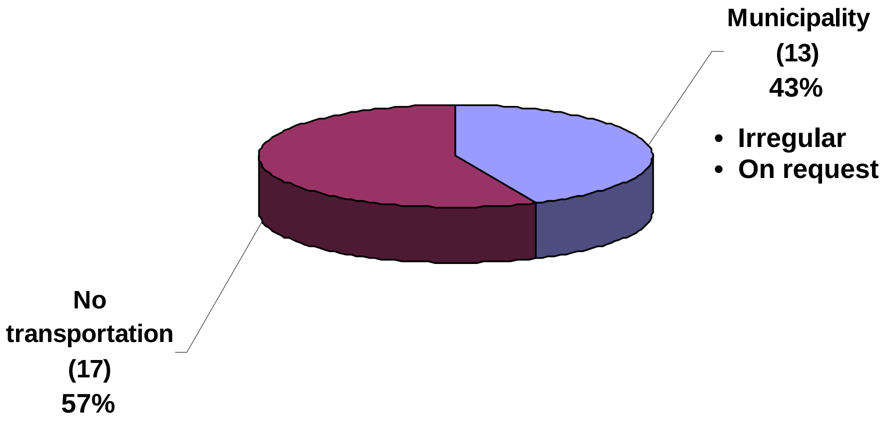
- No health facility has any data about solid waste generation. Keeping records of waste management (generation, collection, treatment, final disposal, among others) is not an established practice at any facility. Estimated amounts reported during the field visits are shown in graph 2.1.



- No segregation by type of solid waste (infectious waste, sharps, common or general waste). All wastes are mixed, increasing both the volume of hazardous waste and the risks to the personnel in–charge of managing them, from generation to final disposal.
- Some facilities are implementing measures for sharps segregation in cardboard boxes, but afterwards these boxes are emptied in bigger boxes or bags in order to reuse the cardboard box, which annuls the whole purpose of confining the needles and increases risks of puncture accidents during all solid waste management steps (handling, collection, transportation and final disposal).

- Not all medical, paramedical, and sanitary workers know about the risk of re-capping needles after injections. Needles re-capped or not re-capped were observed, without distinction.
- No proper handling and internal collection system. Internal collection is performed in several ways: cardboard boxes, plastic containers, and plastic bags. Most of the time these containers are damaged, broken, or dirty (dust, blood, patients' secretions, among others). In many cases waste bins themselves are carried to the central storage place or final disposal place by sanitary workers or nurses.
- No proper interim storage, when needed. Wastes are stored in the corridors or below ladders.
- Central storage is performed open-air, and in most of the cases without any boundary wall. Wastes are scattered and burned open-air in several places around the health facilities.
- Few facilities have service of external collection and transportation of hospital waste by the municipality. However, collection and transportation of hospital waste is carried out together with domestic waste. According to what was informed during the field visits, 57% of the visited facilities do not have the service of collection and transportation (see graph 2.2). The remaining 43%, even when having access to this service, it is not appropriately performed. Service is completely irregular and in some cases just on request and after several requests. In 85% of cases collection is performed once a week or fortnightly.

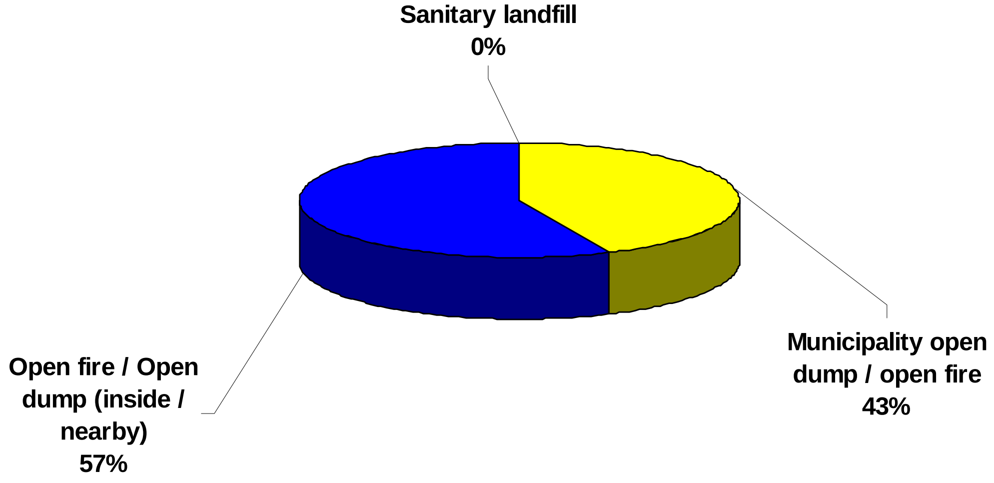
Graph 2.2 External transportation of solid waste



- No facility has a treatment system for hospital waste. Infectious and especial wastes do not receive a proper treatment, being mixed with general waste.
- No facility has separate department for solid waste management. Some facilities have asked for more sanitary workers without any response.
- Management of solid waste is performed by hospital employees. There are no private companies offering this service.
- There are no sanitary landfills for final disposal of solid wastes in selected districts (see graph 2.3). Final disposal is performed in open dumps within the

facility or by Municipality. Wastes are scattered and burnt. In some places wastes are disposed near or in open sewerage drains, which becomes clogged. Wastes are also disposed at the streets.

Graph 2.3 Final disposal of solid waste



- Scavengers have been seen, including children, looking for recyclables at open dumps, both at the health facilities or municipal disposal sites. They carry out this job without any personal protection equipment.
- Medical and paramedical staff and sanitary workers in general, have not received training in hospital waste management. There are no protocols or written procedures on this topic in selected facilities.
- Weaknesses of environmental policies and lack of guidelines on hospital waste management at selected facilities have been identified.
- Hospital staff showed great interest in receiving training in hospital waste management. The need of having standard procedures and written protocols is recognized.
- Most of the visited facilities carry out on-site hospital waste open burning. There is a potential nuisance for patients, medical staff and neighborhood. Major environmental and health impacts occur in open dumps, and nearby areas where waste is burned open air, without any environmental or sanitary consideration.
- Visited districts do not have sanitary landfills for solid waste final disposal. Municipal and hospital wastes are disposed of together in open dumps, which pose severe risks for the population's health and the environment.
- All visited facilities need intervention to improve the critical situation of solid waste management and avoid risks to public health (patients, doctors, technicians, sanitary personnel) and the environment.
- Institutional strengthening to develop, implement and enforce regulations on hospital waste management is needed.

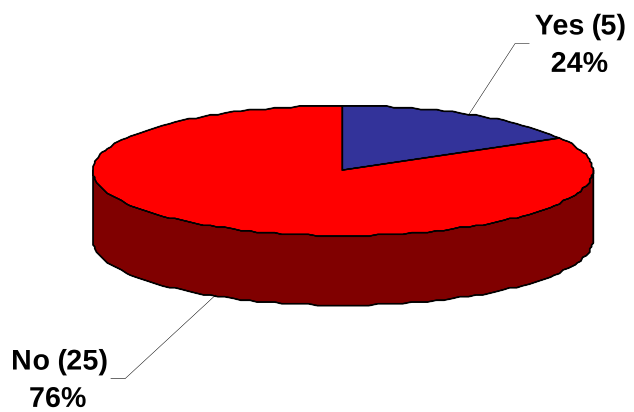
2.3 Drinking water supply and wastewater management in selected facilities

All selected facilities that have been assessed need PAIMAN interventions on drinking water supply and wastewater management. Annex 5 shows a detailed description of the critical situation of drinking water supply and wastewater management at selected facilities. Pictures of the visited facilities, related to drinking water supply and wastewater management are also included.

Main findings related to this subject are:

- Drinking water supply in most of the selected facilities is deficient. In some facilities drinking water has strong sewerage smell, visible suspended solids and different colors.
- In many districts the high incidence of illnesses could have origin in the bad environmental conditions related to poor basic sanitation: bad quality drinking water, open drains for wastewater, solid waste disposed of in the streets.
- During field visits to selected facilities, most of the facility's in-charges expressed to be concerned about water quality, however, less than 25% of them (only five facilities out of 30) have ever requested for water testing (see graph 3.1).

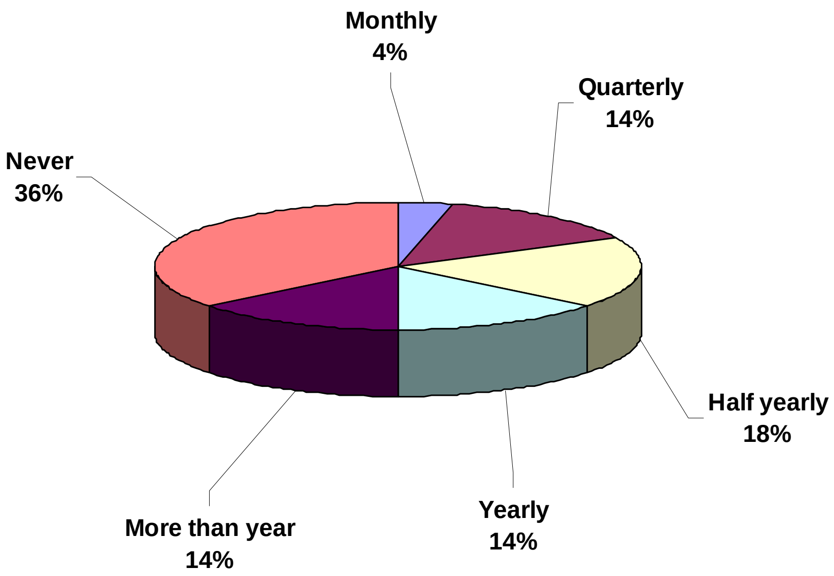
Graph 3.1 Ever requested for water testing?



- Reasons for requesting water testing was epidemic (2) change in water appearance and bad odor (2), and orders from senior officer (1).
- Low pressure, hard water, suspended solids, no proper filtration system, bad smell, are some of the problems reported by the hospital staff during interviews in selected facilities.
- Most of the selected facilities do not carry out cleaning of overhead reservoir as a routine practice. 36% of them have never cleaned it. Frequency of cleaning in 28% of them is yearly or more than a year, half yearly in 18%, quarterly in 14% and only 4% clean the overhead reservoir monthly (see graph 3.2). Suggested frequency would be half yearly. Therefore, according to what was informed

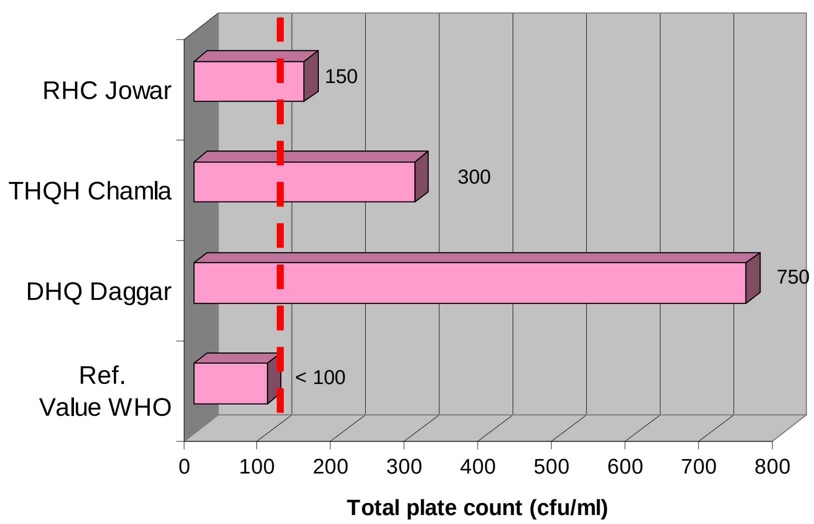
during the field visits, only 36 % of the selected health facilities would be cleaning the over head reservoir within the necessary frequency.

Graph 3.2 Frequency of cleaning of Overhead Reservoir



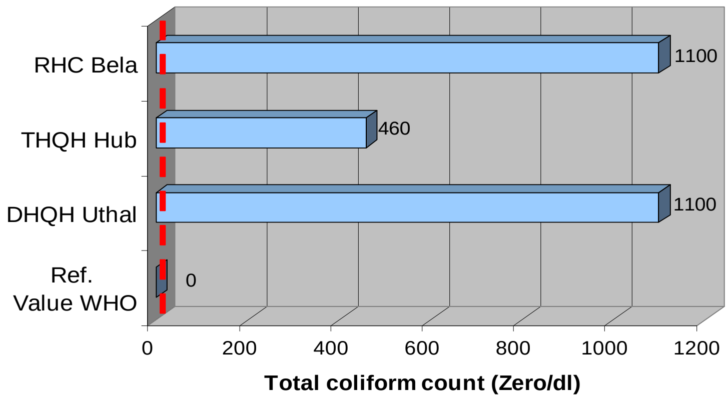
- As regards to bacteriological analysis, some visited facilities overcome the World Health Organization (WHO) reference value for the total plate count (maximum permissible limit is 100 cfu/ml), as it can be seen in Graph 3.3.

Graph 3.3 Total Plate Count values comparison

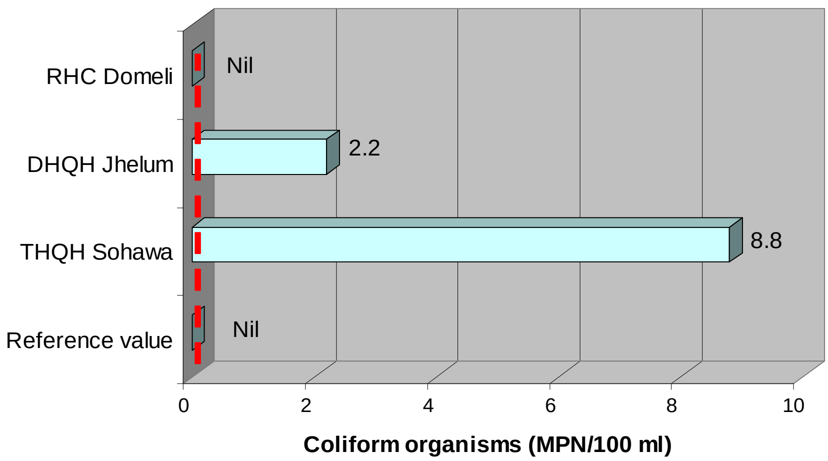


- WHO reference value for total coliform count is zero. Reference value for most probable number of coliform organisms is also zero. Graphs 3.4 and 3.5 show values for some visited facilities. Most of them overcome the maximum permissible limit.

Graph 3.4 Total Coliform Count Values

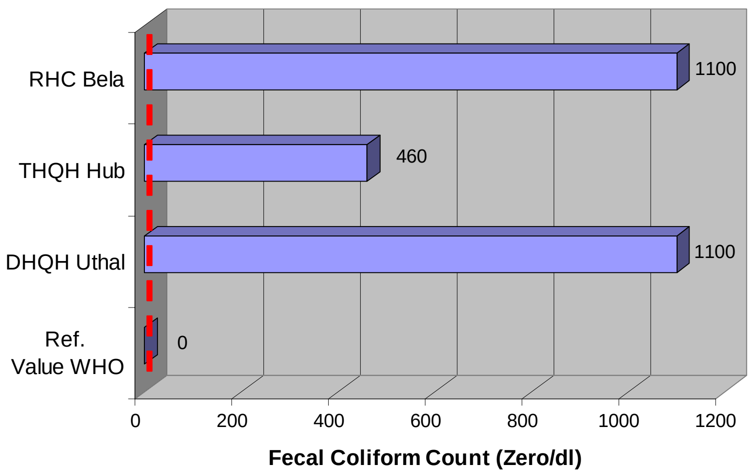


Graph 3.5 Most probable number of coliform organisms



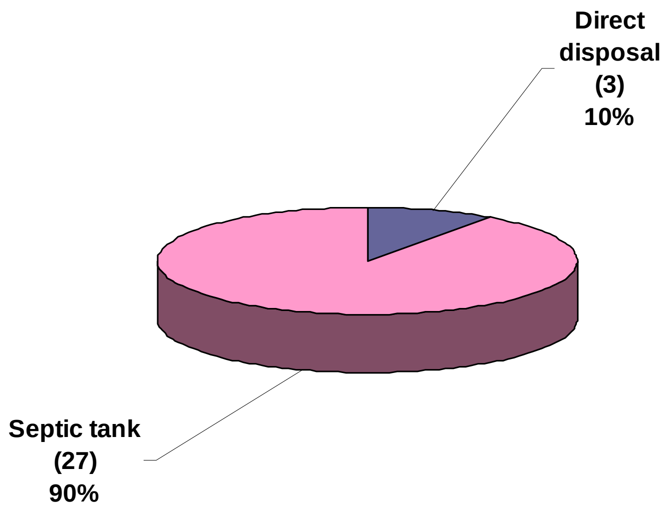
- Fecal coliforms should not be present in drinking water. WHO reference value is zero, however, some facilities also overcome this limit, as it is shown in graph 3.6.

Graph 3.6 Fecal Coliform Count Values



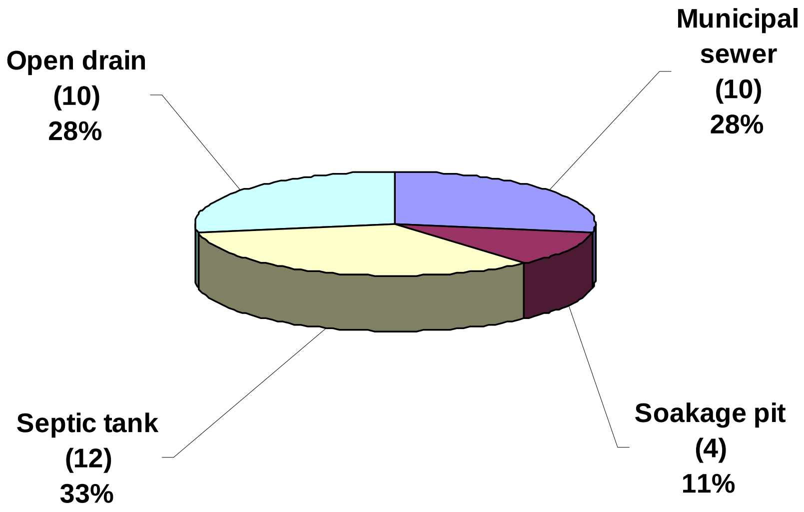
- Concerning physical-chemical analysis, no facility has overcome reference values for magnesium concentration, conductivity value, potassium concentration, Total Suspended Solids value, total alkalinity value, and pH range.
- In relation to other physical-chemical analysis, only RHC Bela has overcome the limit value for sodium concentration and for total dissolved solids. THQH K.N. Shah has overcome the limit for Total Solid Matter, nitrite concentration, calcium concentration and total hardness. THQH K.N. Shah and RHC Bela have also overcome the limits for chloride concentration and sulphate concentration. Annex 6 contains detailed data and comparative graphs related to the results of physical / chemical and bacteriological analysis performed in all water samples.
- Regarding wastewater management, 10% of the selected facilities discharge it directly to the municipal sewer, without any primary storage or preliminary treatment (no grinders use, no septic tank). The remaining 90% discharge wastewater in septic tanks inside the premises, as it can be seen in Graph 3.3.

Graph 3.3 Wastewater primary storage



- Septic tanks are, in most of the visited facilities, damaged and not properly functioning (they are clogged with solid wastes, have broken covers or do not have covers at all). It seems they do not receive regular maintenance and therefore are causing environmental pollution and health risks to the population, besides of the understandable nuisance due to bad odors.
- With respect to final disposal of waste water, 28% of the visited facilities discharge wastewater to open drains, which poses major environmental and health risks due to the nature of this liquid waste. 33% of them have only septic tanks and no soakage away system, 11% have soakage pits and 28% of them use municipal sewerage as the final disposal system (see graph 3.4).

Graph 3.4 Final disposal of wastewater



- Septic tanks in visited facilities need to be assessed in detail. A work plan is needed, to make them fully operational.
- Proper wastewater treatment is required in all facilities. Hospital wastewater could be a source of environmental pollution and health risks. It is loaded with pathogenic microorganisms (some of which are resistant to antibiotics), heavy metals, disinfectants, detergents, solvents, pharmaceuticals, among others. Uncontrolled discharge from hospitals enhances the eco-toxicological risk for environment and toxic or infectious risk for humans.
- Minimal requirements for small facilities would be installation of proper septic tanks and soakaway systems. It is fundamental to ensure a proper and on-time maintenance to the system, including a periodic monitoring.

Chapter III – Proposals

3.1 Hospital waste management plan

3.1.1 Definition of policies and objectives

3.1.1.1 Policies

Mismanagement of hospital waste is associated with strongly negative health and environmental impacts. It is a responsibility of the national government the proper regulation and enforcement of hospital waste management.

The hospital waste management policy should state, through the appropriate legislation, the safe management of risk and non-risk waste to protect public health and the environment. It is essential that handling, storage, treatment, transportation and final disposal of all hospital waste are performed in the safest, most appropriate way.

The hospital waste management policy cannot be isolated in relation to other solid waste management policies (municipal or industrial waste management). It must be considered along with other national and local waste management regulations.

A national strategy and action plan for hospital waste management should be developed directly with the appropriate decision-making authorities, led by a task force that includes representatives from all the relevant governmental institutions and specialists; who need to be committed to the process.

Hospital waste in Pakistan is regulated by the Hospital Waste Management Rules, 2005, enacted in Islamabad, the 3rd of August, 2005. According to this document, every hospital shall be responsible for the proper management of the waste, from generation to final disposal, in accordance with the provisions and rules of the Act.

In view of the fact that national regulations in Pakistan are not being implemented properly, it is necessary to perform a revision in order to prepare and implement a national hospital waste strategy, including all aspects of waste management (worker safety, adoption of segregation, transportation, treatment, and final disposal systems). The first step is conducting a national sector assessment, followed by the development of a national strategy and action plan.

a) National sector assessment

The national sector assessment should comprise information about the health care sector, types of facilities and current hospital waste management practices. The information may be collected by interviewing national and regional authorities, as well as by gathering data from a representative sample of facilities.

General information on health care facilities gathered for the assessment includes the total number of health care facilities (public, private, and military); the total number of beds at all hospitals (nationwide, private and public); the total national health care budget; and the estimated annual budget for health care programs nationwide.

Regarding hospital waste issues, it is necessary to estimate the total quantity of hospital waste and infectious hospital waste generation nationwide. Key figures on hospital waste generation per bed per day from other studies might be used, and extrapolate that to the number of occupied beds nationwide. If a proper segregation is implemented, approximately 20% of hospital waste is considered infectious hospital waste.

A rapid diagnostic on current hospital waste management practices, including segregation, storage, internal and external transportation, and final disposal, should be conducted nationwide. The distribution of responsibility between all ministries/authorities involved in hospital waste management should be identified, along with relevant legislation on hospital waste management, municipal solid waste management and other hazardous waste management.

Identifying international donor agencies that can provide technical and financial support would be convenient and helpful.

b) National Strategy and Action Plan

Since a national legislation on hospital waste management already exists, an analysis of this legislation should be performed, identifying its limitations and recommending needed changes. Some preliminary comments on the Hospital Waste Management Rules, 2005 (Islamabad, 3rd of August, 2005) are presented in Chapter I (item 5) of this study.

It would be convenient to have national guidelines for hospital waste management, providing practical and technical advice for the implementation of the national strategy stated in the correspondent legislation. Since Pakistani regions present great differences between them, it would be reasonable to analyze the necessity of having sub-national guidelines.

The national action plan should consider initial measures to be taken to improve internal handling of infectious waste such as sharps (devices for simple segregation from all other waste), construction of low-cost, low-maintenance treatment systems where needed, the implementation of a demonstrative pilot project (as it is proposed in item 3, Chapter III of this report), gradual construction of treatment facilities that comply with regulations, and the possibility of PPP strategy for treatment and final disposal of hospital waste.

A national training program should also be considered, along with the appropriate budgetary and technical means for the implementation of the hospital waste management plan. The training program should be aimed at several levels: decision makers, authorities (municipal, regional), healthcare personnel (managers, workers, technicians), sanitary personnel, among others.

3.1.1.2 Objectives

General objective and specific objectives for the Hospital Waste Management Plan at selected facilities are:

a) General objective

To improve the hospital waste management at selected facilities implementing appropriate and safe systems for risk and non-risk waste, to protect the public health and the environment.

b) Specific objectives

- To reduce risks associated with hospital waste handling, from generation to final disposal.
- To implement integrated hospital waste management systems in an efficient, economical and environmentally sound way.
- To improve the safety measures and hygiene at work.
- To reduce the amount of hazardous waste.
- To comply with national hospital waste regulations.

3.1.2 Hospital waste management procedures

The safe management of hospital waste involves, as a first step, a correct identification and segregation of hazardous waste from non-hazardous waste, to avoid risks to staff, patients and the environment.

It is essential not to mix general waste with risk-waste, to avoid incurring extra costs of treatment and special disposal unnecessarily. This action also offers the opportunity of maximizing the benefits of recycling, when applicable.

Some basic actions performed at selected facilities include assessment of waste production and evaluation of local treatment and disposal options. Based on this information, segregation of hazardous waste from common (or municipal) waste; establishment of internal rules for waste handling (storage, color coding, collection and transportation, etc.); assignment of responsibilities within the health-care establishment; and choice of suitable treatment and disposal options are recommended.

3.1.2.1 Definitions

Some definitions included in the Hospital Waste Management Rules, 2005 (Islamabad, 3rd of August, 2005), are:

"hospital waste" includes both risk waste and non-risk waste

"hospital" includes a clinic, laboratory, dispensary, pharmacy, nursing home, health unit, maternity centre, blood bank, autopsy centre, mortuary, research institute and veterinary institutions, including any other facility involved in health care and biomedical activities.

"Risk waste" means infectious waste, pathological waste, sharps, pharmaceutical waste, genotoxic waste, chemical waste, and radioactive waste.

"Non-risk waste" includes paper and cardboard, packaging, food waste and aerosols and the like.

3.1.2.2 Classification

An adequate classification facilitates appropriate wastes segregation and allows an efficient, economic and safe management; reducing sanitary risks and costs, since the safest and most expensive systems will be applied only to those wastes that require it and not to all of them.

There are several classification systems for hospital wastes: the German, the World Health Organization, and the EPA classification, among others. Taking into account the characteristics of the selected facilities, a simple and practical way to classify solid wastes according to their hazardous level is proposed. Hospital wastes have been classified in hazardous (risk waste) and non-hazardous (non-risk waste).

Hazardous waste comprises infectious and special wastes and should be separated. Non-hazardous wastes are those of similar characteristics to household waste.

Specific characteristics of these three types of waste (infectious, special and non-hazardous or non-risk) are: (adapted from: Guidelines for the internal management of solid wastes at health care centers. CEPIS/PAHO-WHO. 1996).

a) Infectious wastes

Wastes generated during the different medical care stages (diagnosis, treatment, immunization, research, etc.), containing pathogens. They represent different levels of potential danger, according to the degree of exposure to infectious agents. These wastes may be, among others:

a. *Material from patient's isolation wards*
Biological wastes, body fluids, discharges or wastes from isolation wards of patients with communicable diseases. Any type of material that has been in contact with patients of these rooms is also included.

b. *Biological material*
Cultures; samples of infectious agents; culture media; Petri dishes; instruments used for handling, mixing or to inoculate microorganisms; expired or spoiled vaccines; contaminated filters; etc.

c. *Human blood and derived products*
Blood, blood bags with expiration data or positive serology, blood samples for analysis, serum, plasma; and other by-products. Materials packed or saturated with blood are also included; as well as containers such as plastic bags, intravenous tubes, etc.

d. *Pathological and anatomical wastes*
Human pathological wastes, including tissues, organs, analyses samples, body parts and fluids removed during autopsies, surgery or others.

e. *Sharps*
Sharps that were in contact with patients or infectious agents, including hypodermic needles, syringes, Pasteur pipettes, scalpels, tubes, culture plates, entire or broken glassware, etc. Any discarded sharp is also considered, even if it has not been used.

f. *Animal wastes*
Corpses or parts of infected animals, as well as bedding from medical or veterinarian research laboratories.

b) Special wastes

Wastes generated during auxiliary activities that have not been in contact with patients or infectious agents. They pose a health risk due to their hazardous characteristics such as corrosivity, reactivity, inflammability, toxicity, explosivity and radioactivity. These wastes are generated mainly during diagnosis and treatment; direct or complementary services; and general auxiliary services.

These wastes may be, among others:

a. *Hazardous chemical wastes*
Substances or chemical products with toxic, corrosive, inflammable, explosive, reactive, genotoxic or mutagenic characteristics, such as chemotherapeutic agents, antineoplastics, chemicals not used, pesticides without specification, solvents, chromic acid (used to clean laboratory glassware), thermometer's mercury, solutions for x-rays development, spent batteries, oils, spent lubricants, etc.

b. *Pharmaceutical wastes*
Expired, contaminated, and unused drugs.

c. *Radioactive wastes*
Most of the selected and visited facilities do not generate radioactive wastes since they do not offer this type of attention.

c) Non-risk wastes (common, general)

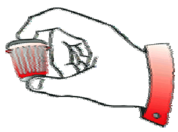
Wastes generated by administrative, auxiliary and general activities not included in any of the above categories. These wastes do not pose a health risk and their characteristics are similar to those of the common domestic wastes.

This category includes paper, cardboards, boxes, plastics, food leftovers, and waste from gardens, among others.

3.1.2.3 Minimization

Waste minimization is defined as the prevention of waste production and/or its reduction (WHO). It involves specific strategies, changes in management and behavioral change. No actions should however be taken that would impact on the quality and limit the access to health care. Methods of waste reduction include:

- Use of recyclable products.
- Purchasing policy (less packaging materials, supplies that are less wasteful or less hazardous)
- Segregation, recycling.



Consideration should be given to segregation of materials that could be recycled. However, it is very important first analyze the market opportunities.

3.1.2.4 Segregation

Segregation is the separation of wastes according to the adopted classification (infectious, special, and non-risk (common, general waste, similar to household waste)). It is a fundamental procedure for waste handling and it must be done at the source, to ensure a selective handling for infectious waste. It reduces the quantity of wastes which are hazardous and therefore require special attention and treatment.

The advantages of waste segregation at the source are:

- To reduce health and environmental risks, preventing contamination of other wastes with infectious or special wastes.
- To reduce costs, since only a fraction will receive special treatment and not all the generated wastes.
- To reuse directly some wastes that does not require previous treatment or conditioning.

Infectious waste comprises several items, but it must be separated in two: sharps and infectious non-sharps. Therefore, risk waste should be separated in three: sharps, infectious non-sharps, and special wastes.

Due to the implicated hazards, sharps should be stored into rigid containers, made of plastic or cardboard. Non-risk waste (as those described in item 1.2.2.3), should be separated in other containers. Figure 1 shows the proposed way to segregate hospital wastes.

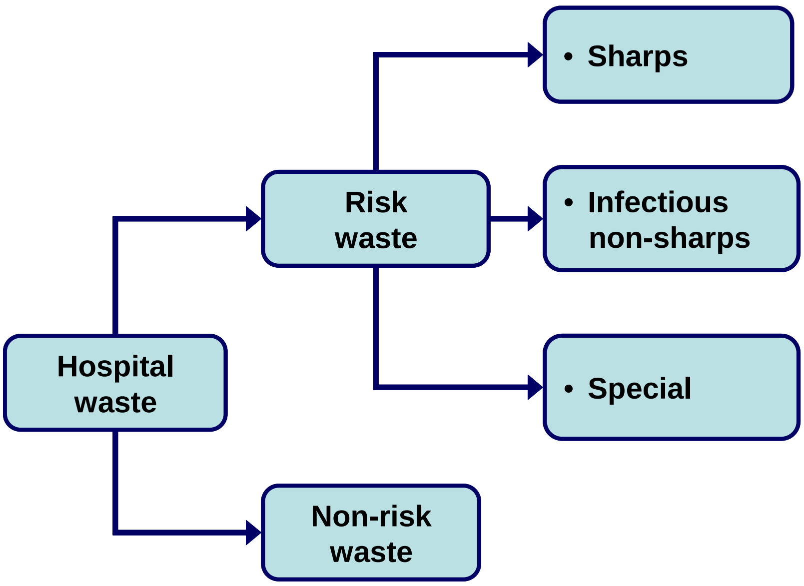


Figure 1. Segregation at source for hospital wastes

Considering that most of the selected facilities do not generate radioactive wastes since they do not offer this type of attention, and that they almost do not generate pharmaceutical wastes (like expired drugs), quantities of special wastes generated in these facilities are very small, corresponding mainly to some chemical wastes.

Consequently, a more simplified way of segregation can be implemented in these facilities, separating risk waste only in two, sharps and non-sharps risk waste. Non-sharp risk waste comprises infectious and special wastes. Figure 2 shows the proposed way of segregation in this case.

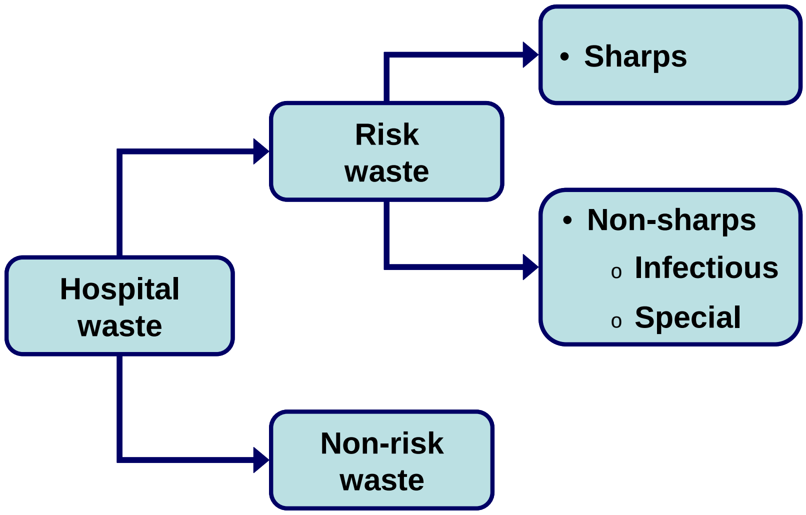


Figure 2. Simplified segregation at source for hospital wastes

All solid waste must be segregated according to the type of waste at the source: doctor's offices, operating rooms, wards, laboratories, among others. The active participation of all health-care personnel is the most important thing to allow a good waste segregation. Waste storage at source is known as "primary storage".

3.1.2.5 Primary storage

a) *Plastic bags*

The use of plastic bags inside rigid containers is necessary, to appropriately pack the wastes. Bags should be opaque to avoid visibility of the content; it can be of high density polypropylene (for autoclaves) or polyethylene; and have appropriate thickness and size, according to the composition and weight of the wastes. Plastic bags must not be used to store sharps. Figure 3 shows the proposed color coded bags for infectious waste, special waste (chemicals, pharmaceuticals) and non-risk waste.

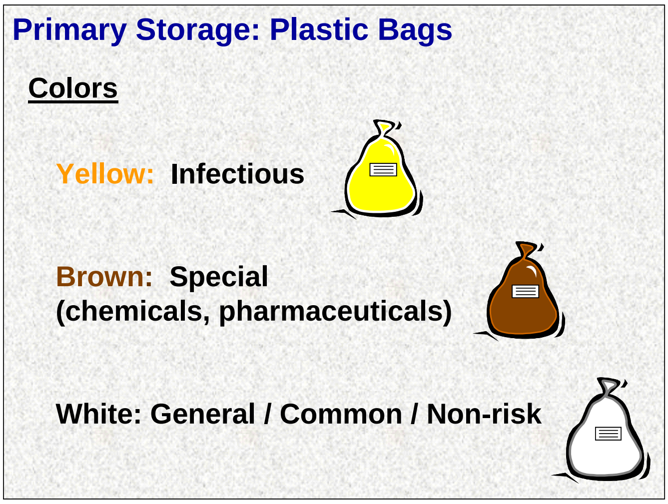


Figure 3. Color coded bags for hospital waste

For those hospitals that due to their characteristics generate very small quantities of special wastes (mostly chemical waste) and do not generate radioactive wastes, a simplified form of primary storage is recommended, implementing only two types of bags: yellow bag for the storage of infectious and special wastes, and white bags, for non-risk wastes, as it is shown in figure 4.

Figure 4. Simplified color coded bags for hospital waste

Figure 5 shows the main characteristics of primary storage.

PRIMARY STORAGE – Plastic Bags

Material: Polypropylene or polyethylene

Thickness: 60 to 120 microns

Capacity: Variable, it depends on waste generation, frequency of collection and type of containers. Recommended maximum capacity: 30 liters.

Bags should not be transparent. The use universal hazardous symbols for infectious and radioactivity is recommended.

Figure 5. Characteristics of primary storage

b) *Rigid containers*

Appropriate containers should be available for each type of wastes, according to the adopted classification. Containers should be hermetic to avoid unnecessary exposure, resistant to sharps, stable, easy to wash, light weight and easy to transport, among others.

The most appropriate materials are those of high density polyethylene, fiberglass, or stainless steel, among other rigid materials. Figure 6 shows the main characteristics of rigid containers for hospital waste. Some examples of rigid containers can be seen in figure 7.

PRIMARY STORAGE – Rigid containers

Material
High-density polyethylene, fiberglass, stainless steel.

Form
Cylindrical, inverted trunk-conic and other easy–washing / disinfection containers.

Size and dimension
Variable, depends on generation and frequency of collection.

Color and symbol
Color-coding and visible printed label, that indicate the type and risk of waste.

Figure 6. Characteristics of rigid containers for hospital waste

Figure 7. Examples of rigid containers for hospital waste

c) *Containers for sharps*

Sharps require leak-resistant, rigid, puncture-resistant containers. It can be made of plastic, cardboard or metal (see figure 8). These containers shall be taped closed or tightly lidded to prevent loss or leakage of contents. After proper packaging, sharps containers may be placed in infectious waste bags

Types of sharps that can be placed in these containers are:

Uncontaminated or contaminated only with infectious waste:

- Needles
- Needles w/syringes
- Needles w/attached tubing
- Blades (razors, scalpels)

Contaminated only with infectious waste:

- Broken glass
- Pasteur and other pipettes
- Microscope slides
- Other contaminated sharps items

Figure 8. Rigid, disposable containers for sharps

d) *Use of colors and symbols*

Containers, bags and places where these are located should have a color code and visible indications of the type of waste and the risk it represents. According to the proposed classification, yellow for hazardous wastes, white for common wastes and brown for the special ones should be used.

The biohazard symbol or the radioactivity symbol are universal and should be used wherever necessary. Figure 9 shows the mentioned symbols.

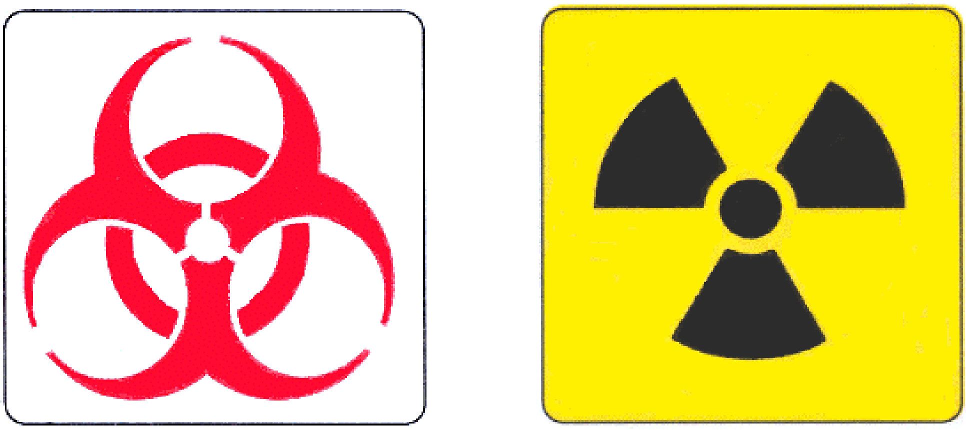


Figure 9. Universal symbols for infectious and radioactive wastes

3.1.2.6 Internal collection and transportation

The basic considerations for internal collection and transportation of hospital waste at selected facilities are:

- Adequately designed manual traction trolleys should be used, with an appropriate shock absorber and rubber tires, to avoid unnecessary noise (see figure 10). Other suggested types of wheeled vehicle for transportation of hospital waste can be seen in figure 11, one of them open sides, and another one partly opaque sides.

- The trolley should ensure stability and impermeability, to prevent accidents caused by spills, collisions or damages. Trolleys should be duly identified according to the type of waste.

- Collection and transportation should be performed in a hygienic, fast and silent way.

- Shifts, schedule and collection frequency should be established and well-known.

- Collection trolleys should not take wastes above its capacity.

- The collection route should be assigned and marked properly.

- Trolleys should not be left in corridors and should not interfere with other activities or visitors to avoid contamination risks.

- Preferably, collection must be differentiated, using different schedules for risk and non-risk waste.

- Trolleys for internal collection must be washed and disinfected at the end of the operation (see figure 12). In addition, preventive maintenance of these trolleys is necessary.

- All personnel in charge of collection and transportation should wear protective and safety equipment.

Figure 10. Manual traction trolleys for hospital waste collection

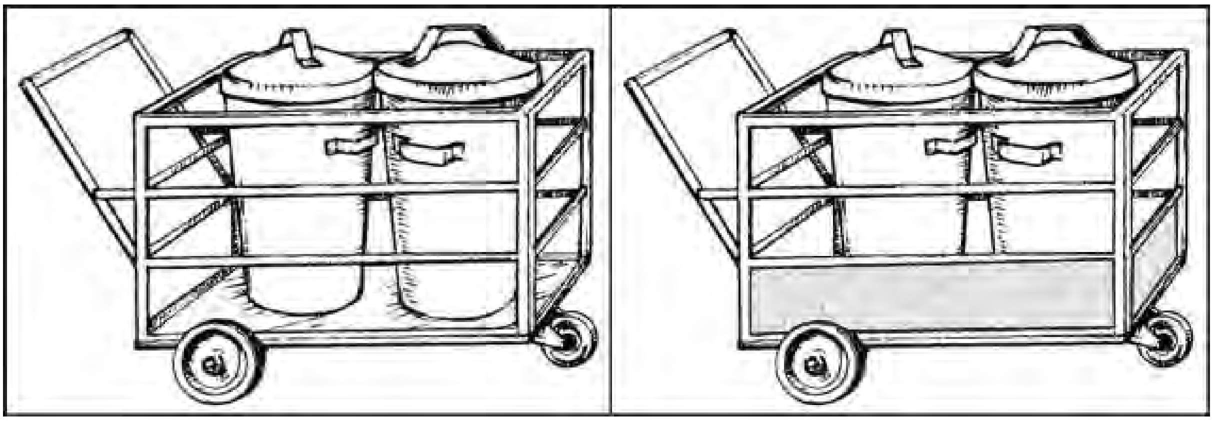


Figure 11. Suggested hospital waste collection and transportation trolleys (open sides and partly opaque sides)
(Adapted from: WHO. 1999.)

Figure 12. Washing and disinfection of manual traction trolleys

Figure 13. Do' and Don'ts of hospital waste collection

3.1.2.7 Central storage

All visited facilities require the construction of a central storage place, where the collected wastes will be centralized before being transferred to the treatment or final disposal site. The central storage place should meet the following characteristics (Guidelines for the internal management of solid wastes at health care centers. CEPIS/PAHO-WHO. 1996):

Accessibility: The place should be located and built to provide a fast, easy and safe access to the internal collection trolleys. Routes should be marked and the space should allow easy mobilization during the operations.

Hygiene and sanitation: The place should have good lighting and ventilation, plain floors and walls painted with light colors, preferably white. It must have a water system, with enough pressure to facilitate cleaning, as well as an appropriate sewerage system.

Exclusiveness: The place should be used only for temporary storage of hospital wastes; other materials must not be allowed. Depending on the infrastructure, there may be separate sites for each type of waste (see figure 14).

Security: The place should meet structural physical conditions to prevent sun, rain, winds, etc. from causing damages or accidents; the entrance of unauthorized persons, children or animals to the site should be forbidden. For this reason, the site should be adequately marked and identified.

Finally, the storage must be located away from the hospital rooms and close to the site's doors to facilitate the external transportation operations. Access to transportation vehicles and for loading and evacuation operations should be provided.

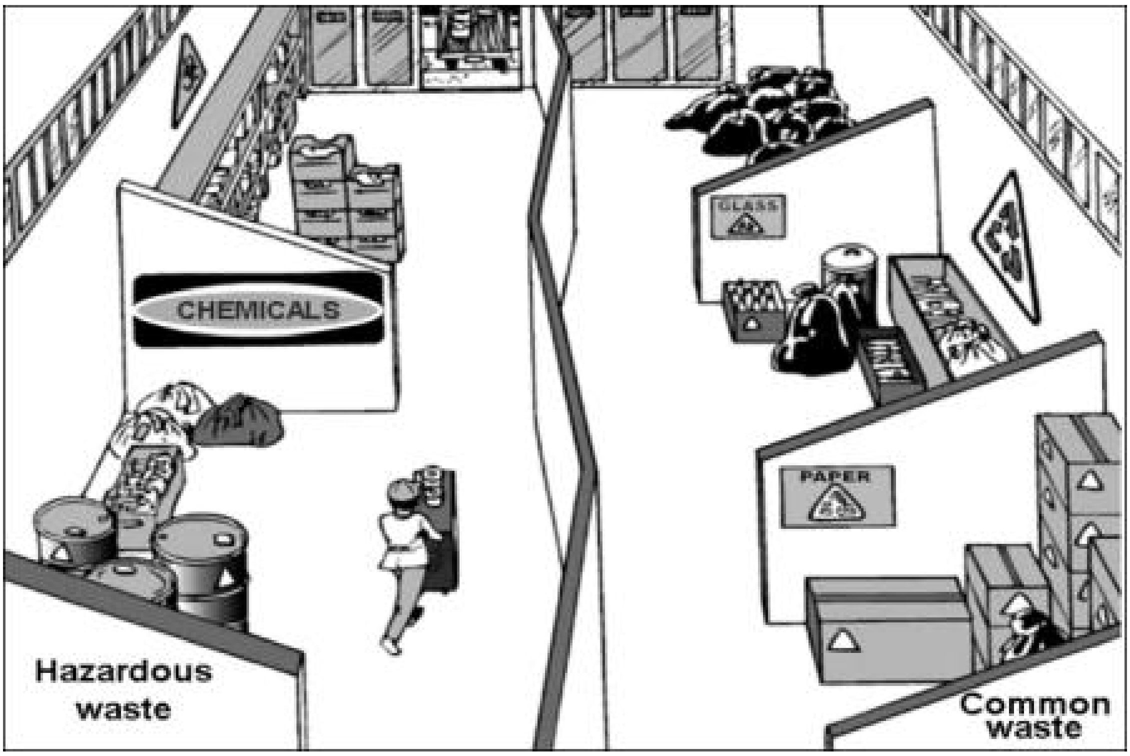


Figure 14. Example of a hospital waste central storage area

3.1.2.8 Treatment

Implementation of treatment systems for hospital wastes depend on the characteristics of wastes. There are no treatment systems without disadvantages and the final choice of the best available technology depends on the local conditions. Therefore, it is very important to adequately segregate hospital waste according to the adopted classification, in order to avoid increasing costs of expensive treatment systems.

Infectious wastes should be treated to reduce or to eliminate health risks. They cannot be disposed of without treatment. The most common treatments are incineration, chemical disinfection, and sterilization with autoclave or microwaves. Treatment operations should be continually monitored to avoid possible environmental pollution and health risks and should be carried out by trained personnel or specialized companies.

According to the characteristics of the selected facilities, and due to environmental and health considerations, sterilization with autoclave is recommended as the best treatment system.

However, taking into account the situation of small facilities, a low-cost, low-maintenance treatment system for infectious waste (sharps and non-sharps), such as De Monfort incinerator is suggested, providing that they will be gradually replaced for more environmental friendly options like autoclave.

De Monfort incinerator is recommended bearing in mind that the costs of not having a waste treatment system are much higher than having one, even if it is still inadequate. These incinerators are of a high thermal capacity design, and thus need to be heated up before infectious wastes are added. It follows that **they should be operated for long periods** (minimum 2 hours) to avoid using unnecessary amounts of fuel.

Installation of autoclaves should be considered in Tehsil Headquarter Hospitals (THQH) and some District Head Quarter Hospitals (DHQH). De Montfort incineration is recommended for small facilities, as a transition technology.

a) Autoclave

The recommended treatment system for Tehsil Headquarter Hospitals (THQH) and some District Head Quarter Hospitals (DHQH) is the sterilization with autoclave, which presents a low adverse environmental impact and low operating costs compared with a double-chamber incinerator with gas washing systems and particulate matter retention systems.

Autoclaving is an efficient wet thermal disinfection process. Typically, autoclaves are used in hospitals for the sterilization of reusable medical equipment. The autoclaving process is usually a batch system.

Waste is placed in a sealed chamber and exposed to steam at the required temperature and pressure for a specified time. Minimum contact times and temperatures will depend on several factors such as the moisture content of the waste and ease of penetration of the steam. Autoclaved waste can be disposed of in a sanitary landfill, together with common waste.

Research has shown that effective inactivation of all vegetative microorganisms and most bacterial spores in a small amount of waste (about 5–8kg) requires a 60-minute cycle at 121°C (minimum) and 1 bar (100kPa); this allows for full steam penetration of the waste material (WHO, 1999).

A major advantage of autoclaving is the capacity a single unit can provide without the spatial requirements associated with incineration systems. The capacity of an autoclave is a function of its size and throughput. For example, an autoclave capable of disinfecting 4,000 pounds per hour of medical waste measures 8 feet in diameter by 24 feet in length, which means it occupies about as much space as a 500-pound-per.hour incinerator (U.S. Congress, Office of Technology Assessment. Washington, D.C. 1990).

Autoclaving may be limited in some applications because wastes that are only autoclaved are still recognizable, unless they are shredded or compacted. But this consideration is due principally for aesthetic reasons. In any case, approximately 90 % of regulated medical wastes generated are suitable for autoclaving.

However, autoclaves are not suitable for cytotoxic and other toxic chemical wastes because of the hazardous nature of these wastes. Autoclaving hazardous materials such as antineoplastic agents, radioisotopes, solvents, or other toxic wastes could lead to chemicals being volatilized by the steam and could result in possible worker exposure between process cycles (U.S. Congress, Office of Technology Assessment. Washington, D.C. 1990).

A schematic figure on an autoclave can be seen in figure 15. An on-site steam autoclave for hospital waste treatment, installed in Lima, Peru, is shown in figure 16. Figure 17 shows two views of the autoclave operation. Table 2 shows information about types and operation characteristics of different autoclaves, from different provider companies.

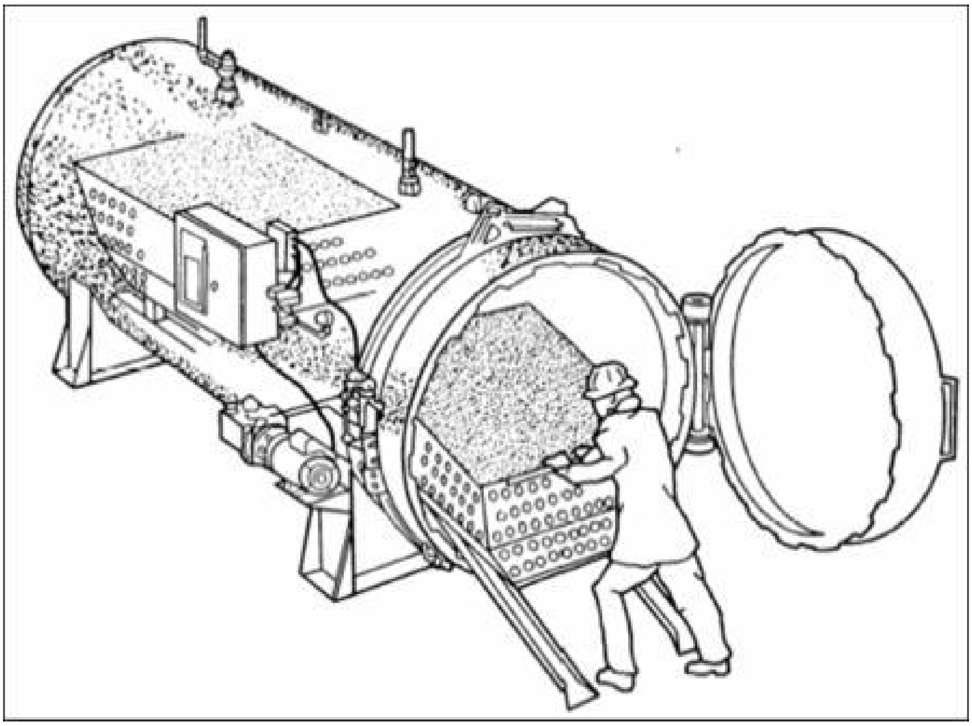


Figure 15. Autoclave
Source: U.S. Congress, Office of Technology Assessment. Washington, D.C. 1990

Figure 16. On-site steam autoclave (Lima, Peru, 2004).

Advantages

- Equipment is simple to operate.
- Proven technology used for many years in health-care processes.
- It is capable of decontaminating most medical wastes.
- It reduces volume and renders some plastics non-recognizable.

Disadvantages

- If wastes are not shredded or compacted, it does not reduce considerably the mass of material to be disposed of.
- It can produce offensive odors which can be released into the ambient (eventually toxic emissions).
- Potential safety hazard due to the hot surfaces in the autoclaving.

Figure 17. Views of the steam autoclave operation

Table 2. Types and operation characteristics of autoclaves

Description	Comments	Picture
<u>Auto-Clave 230-2P Sterilizer</u> (Sanipak) Complete Cycle Time (includes auto discharge): 45 minutes Standard Sterilize time: 30 minutes. Operating Temperature: 270° F to 283° F Vacuum Performance: 22" to 26" Hg Control System: Programmable Logic Controller (P.L.C.) Construction Material: ASME Code 316L Stainless Steel Hourly Capacity (with autoclave bags): 87 lbs. per hour Chamber size: 32" I.D. x 42" L Cart Size: 3/4 Cu. Yd. Overall Width: 56" Overall Depth: 63" Frame Height: 81" Dump Height: 30" Load Height: 38"	No comments	
Reverse Polimerization (Environmental Waste International) The MD-1000 is a three-stage, three chambers, medical waste reduction unit that produces a sterilized carbon residue. It processes all types of medical and infectious wastes including packaging, plastics, anatomical waste, glass, and metal sharpes. The system components include the Reverse Polymerization System which generates and transmits direct microwave energy to the waste load. The Material Handling System allows efficient processing of waste and is designed for continuous batch processing and incorporates loading, Reverse Polymerization, and cooling & grinding chambers, as well as residue handling. A Nitrogen Generation System provides an oxygen depleted atmosphere in the Reverse Polymerization chamber to prevent oxidation of the waste during the treatment cycle. The MD-1000 achieves greater than 6 log10 reduction of test spores (Bacillus stearothermophilus - Seyfried, 1997). The Environmental Control System treats the very low gas flow.	- Weighing and purging. - Microwave reduction (Reverse Polymerization). - Cooling and grinding. The Model MD-1000 normally processes 2,700 lbs (1,225 kg)	

Description	Comments	Picture
McGill AirPressure's Medical Waste Sterilizer (MWS) autoclaves (McGill Air Pressure Corp.) Autoclave System - Can build any size autoclave on site. - Offer lower initial and operating costs than other waste treatment options, without the need for air pollution control equipment.	In addition to offering service on McGill autoclaves, we repair and refurbish most other autoclave brands	
Bondtech's Medical Waste Reduction System (Bondtech) Bondtech's Medical Waste Reduction System automatically collects, reduces and conveys the sterilized waste material to a compaction chamber or cart. This two stage system safely and securely handles bags, boxes, and cartons of waste including plastics, paper, steel, and aluminum for hospital environment or regional waste facility. - Bondtech's biomedical waste autoclaves are capable of treating from 200 Lbs. - 7,000+ Lbs./cycle.	- Turnkey projects - One stop turnkey equipment supply and installation - Many accessories, carts, bags, liners, etc. to get your system running, or keep it in perfect operation - Engineering, maintenance, and consulting	
Hydroclave . Modelo H-07 (Hydroclave System Corp.) Small in-house application, for small hospitals and clinics. Built-in electric steam boiler standard feature. Single load/discharge door. - Capacidad: 25 Kg/hr - Sterilizes the waste utilizing steam, similar to an autoclave, but with much faster and much more even heat penetration. - Hydrolyzes the organic components of the waste such as pathological material. - Removes the water content (dehydrates) the waste. - Breaks up the waste into small pieces of fragmented material. - Reduces the waste substantially in weight and volume. - Accomplishes the above within the totally sealed vessel, which is not opened until all waste it totally sterile. - There is no correlation between waste characteristics and treatment	No comments	

Source: CEPIS-PAHO/WHO. State of the art of treatment and final disposal of sharps and biological waste from immunization programs. Draft document. Lima, 2004.

b) Incineration

Incineration involves the combustion of waste at high temperatures, which converts waste into heat, sends gaseous emissions to the atmosphere and makes residual ash.

Acceptable operating conditions for small-scale incinerators include the continuous supply of combustible required for the selected design, and availability of protective equipment for the operators, such as gloves, boots and aprons (which should be available for all workers collecting or handling such wastes, and not only for the operation of incinerators).

Some locally-built incinerators can function without the need of combustibles, or just by adding other waste such as paper or cardboard. The available space on premises, a minimum distance to the community and the patients, the allocation of resources as well as staff training and most importantly respect of good practices are also prerequisites for incineration (WHO, 2005). Figure 14 illustrates schematically the process flow on an incinerator.

Wastes that should not be incinerated are:

- Pressurized gas containers.
- Large amounts of reactive chemical waste.
- Silver salts and photographic or radiographic wastes.
- Halogenated plastics such as polyvinyl chloride (PVC).
- Waste with high mercury or cadmium content, such as broken thermometers, used batteries, and lead-lined wooden panels.
- Sealed ampoules or ampoules containing heavy metals.

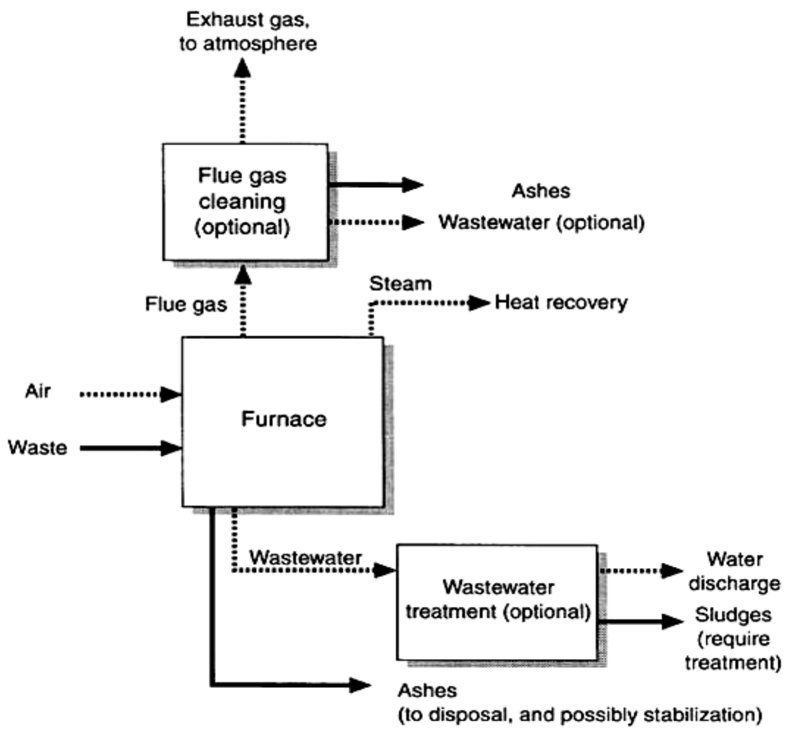


Figure 14. Simplified flow scheme of incinerator
Source: WHO. Safe management of wastes from health-care activities. 1999.

De Monfort Incinerator

The De Montfort incinerator was developed by Professor Jim Picken at De Montfort University in the United Kingdom in the Nineties. Early laboratory and field trials took place in 1999. More than 800 De Montfort incinerators were constructed from 2001 to 2004, many to destroy large quantities of sharps produced during measles campaigns.

If built according to specifications, maintained properly, and operated according to "Best Practices", the De Montfort incinerator can dispose of infectious and non-infectious waste simply, quickly and with minimal environmental consequence. A picture of this incinerator can be seen in figure 15.

The incinerator is made of firebricks and prefabricated metal components, which can be manufactured locally or imported. The structure is assembled and built at the site using mortar of Portland or refractory cement. No specialized tools are required. A scheme of this incinerator, showing its main components, can be seen in figure 16.

Figure 15. The De Montfort Incinerator

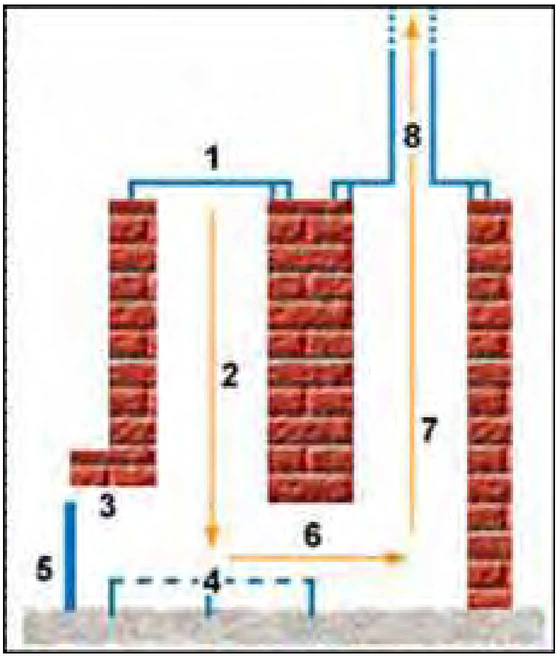


Figure 16. Main components of the De Monfort incinerator

1. Loading door	2. Primary combustion chamber
3. Air inlets	4. Fire grate
5. Ash door	6. Gas transfer tunnel
7. Secondary combustion chamber	8. Chimney (at least 4m high)

The incinerator comprises primary and secondary combustion chambers. The burning zone of the primary chamber is accessible through a door at the front, which lets in air, allows the operator to light the fire, and also allows her/him to remove the ash. The risk waste is dropped in through a loading door above the primary chamber.

The secondary chamber, which is inaccessible to the operator, is separated from the primary chamber by a brick column with an opening at the bottom to induce a cross draught during operation. Additional air is drawn into the secondary chamber through a small opening in the lower section of the rear wall of the secondary chamber. This air mixes with the partially burnt flue gas from the primary chamber and causes secondary combustion.

A self-adjusting draught control for regulating heat output and burn time is mounted at the base of the chimney and controls the flue gases in the chimney. A stove pipe thermometer mounted at the neck of the chimney indicates when the medical waste should be loaded. A 4 meter-high chimney mounted above the secondary combustion chamber releases the flue gases into the atmosphere.

A complete system is called the Waste Disposal Unit (WDU). A WDU comprises several elements, from which the De Monfort incinerator is the central part. These elements include (see figure 17):

- A De Montfort incinerator to burn waste and reduce it. There are several models of the De Montfort incinerator. One of them destroys 6-7 kg per hour (or 6 safety boxes per hour) if used as per recommended practices.
- An ash/needle pit, where residual ash, glass, metallic parts, including needles, are safely deposited after incineration. Needles from a needle cutter may also be deposited in the pit. The ash/needle pit is large enough to store incinerated residues for at least ten years without being emptied. Residue from one incineration session weighs approximately 0.5 kg. A pit of 3.25 m^3 stores ash from the burning of approximately 300 safety boxes per month over a period of twelve years.
- A shelter to protect the De Montfort incinerator, the operator and the waste being incinerated from rain. The shelter also protects the fuel, like wood or agro-residues, required to preheat the incinerator, and the operator's tools, protective clothing and records. Moreover, it supports the chimney that is four meters in height.
- A waste store to securely accumulate waste that is to be incinerated, and where tools, records and protective equipment can be kept. The store has the capacity to stock at least 200 safety boxes, if neatly stacked.
- A fuel store to stock agro-residues or wood required to preheat the incinerator. The store has enough capacity to stock waste for at least five incineration sessions, both for pre-heating and supplementing medical waste.
- A storage box to keep tools, protective clothing and records.
- An enclosure with a lockable door to prevent access by children and unauthorized persons as well as scavenging animals and birds.
- A safety box deposit hole to allow the health worker to drop the safety box into the enclosed protected area when the incinerator operator is not present.
- A needle container deposit hole, which allows the health worker to empty the needles safely into the ash/needle pit when the incinerator operator is not present.

The WDU should be built at a location where:

- It is convenient to use.
- It is NOT close to patients' wards and other occupied or planned buildings.
- There is low public presence/passage.
- Flooding does not occur.
- No flammable roofs or inflammable materials are stored within a radius of 30 meters.
- Prevailing winds blow smoke away from buildings and NOT across cultivated land.
- Security risk is minimized.

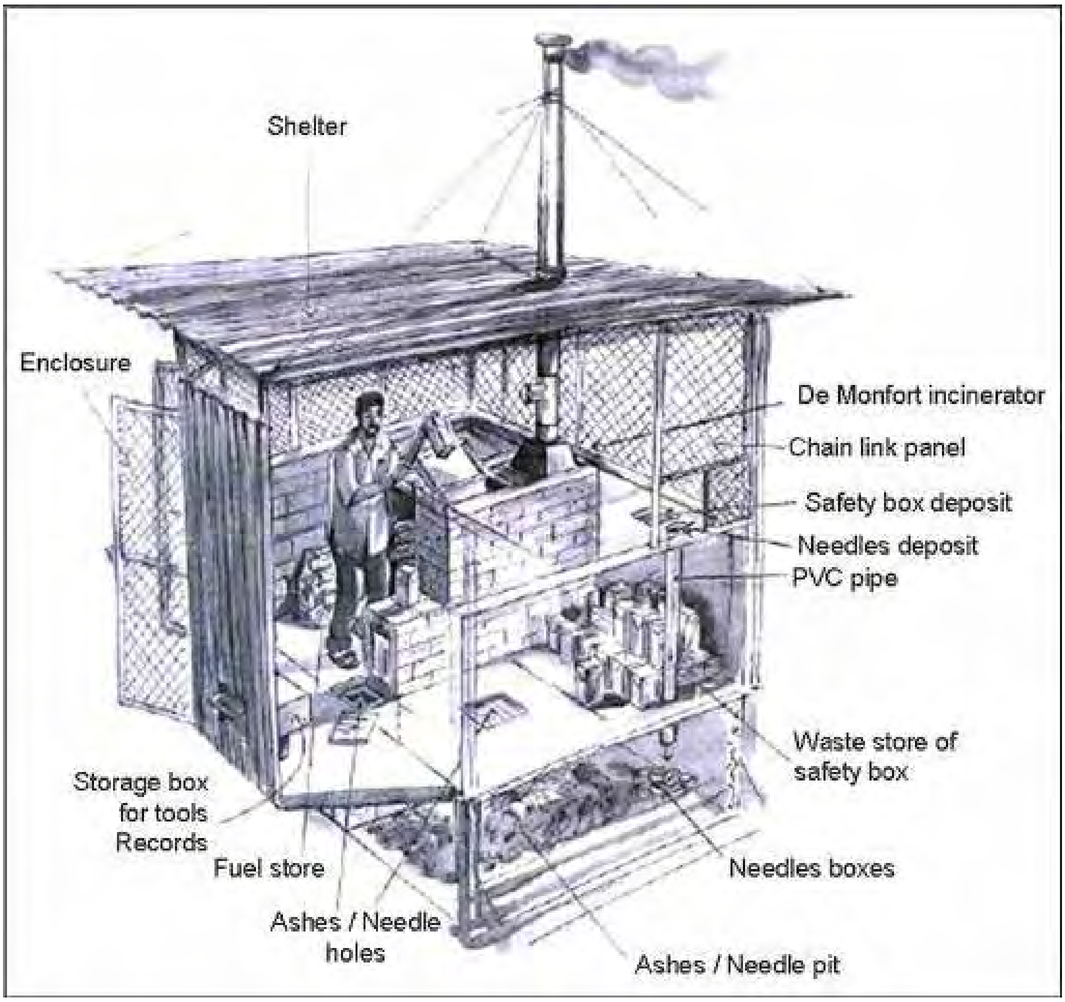


Figure 17. Components of the waste disposal unit

Design of the De Montfort incinerator has been subject to regular improvements and modifications. There are a range of recommended models, such as the Mark 7, the Mark 8a and the Mark 9. Specifications of the Mark 8a, which would be the recommended model for selected facilities, are:

The Mark 8a: Designed for use in areas where manufacturing facilities are limited and cost must be kept to a minimum. The Mark 8a body is brick-built.

Use: designed especially for most healthcare facilities, except large hospitals (more than 300 - 400 beds)

Capacity: 12 kg/h

Lifespan (average): 3-5 years

Investment cost in USD (materials only): 250-1,000, depending on the availability of refractory bricks.

Time necessary to build: 3-4 days

Remarks: Where the load to be burned consists almost entirely of **sharps boxes** filled with used hypodermics, special conditions apply:

- The plastic in the syringes has a very high calorific value and additional fuel will not be required after the initial warm up period.
- Boxes should be introduced **one at a time**. There will be a brief delay, then an increase in smoke level followed by a gradual decrease. The next box should be introduced when the smoke level is observed to be decreasing.
- Tests have shown that this means that boxes of up to 100 syringes can be burned at a rate of about **one every 10 minutes**.
- Introducing boxes at a higher rate than this will result in very high smoke rates and molten plastic at the base of the incinerator.

Maintenance: As with any type of equipment, there is a need to perform some regular maintenance to ensure both that the system will continue to work properly and to prolong the life span of the incinerator. One of the major reasons why incinerators don't operate properly – or don't work anymore – is simply due to a lack of proper maintenance. Spending a small amount of time on a regular basis to make sure the system is in good operating conditions will easily double the life span of your incinerator.

WDU Operator: An adequate training and motivation should be provided to the WDU operator. The following operator-related measures should be adopted to ensure good WDU performance:

- Only a trained, qualified and equipped operator should operate the incinerator.
- The operator must be on-site while the incinerator is functioning.
- The operator must be motivated to follow “Best Practices.”
- The WDU should be operated according to Best Practices to minimize emissions and other risks.
- Operators must have long-term contracts or be permanent hires.

Supervision: Even if operators are well-trained, supervision is essential. Supervision provides quality control and recourse to improve other aspects of waste management, in particular segregation and disposal practices. The facility should designate a hospital waste management supervisor, which responsibilities include:

- Training all primary health facility staff in HCWM practices;
- Ensuring good waste segregation practices;
- Coordination and supervision of waste transportation, packaging, storage and handling;

The major advantages of the waste disposal unit (WDU) are:

- ✓ **Economic**: A single shelter protects the incinerator, waste store, fuel store, records, tools, clothes, and ash and needle pit. This reduces costs substantially when compared with separate locations for waste storage, incinerator protection, etc.

- ✓ **Security**: A single, locked enclosure protects the waste store, fuel store, incinerator, ash pit and needle pit.
- ✓ **Convenience of use**: Waste, fuel, records, tools, clothes and ash deposit are placed at a single protected location.
- ✓ **Minimized exposure to toxic emissions**: Minimal ash handling; chimney emissions directly into outside atmosphere; good cross ventilation; and air extraction above loading door help to minimize exposure to toxic emissions.
- ✓ **Labor saving**: Collected waste can be safely deposited for storage in the WDU without involving the operator, as there are holes for safety boxes and needle containers in the WDU.
- ✓ **Motivation for operator**: The operator has the sole rights of access to the WDU location, hence a sense of ownership which encourages good operating practices.

Most materials of the WDU are locally supplied. Some outsourced components are shown in figure 18.

<table>
<tr>
<td>1) Stovepipe thermocouple and analogue dial indicator
Range 0-1200 ºC.

</td>
<td rowspan="2">3) A Self-adjusting Draft Control and Tee for Chimney
Operating temperature: 0-800° C; 6" Draft Control; fine-threaded Adjustment Stud with balance weight on end; gives good regulation; Draft regulated by turning adjustment screw; made of 28 gauge blued steel; adjustment range: 0.01 in. to 0.12" .
</td>
</tr>
<tr>
<td>2) Chimney Pipe
Black Stove Pipe 24" straight joint, 6" black, 6" X 24", 24 gauge; entirely self-locking; no tools needed to close seams; put together by simply inserting tongue on one edge and pressing together until it snaps. Joint can be cut to any length without destroying the lock.
</td>
</tr>
</table>

Figure 18. Outsource components of the De Montfort incinerator

Details about the De Montfort construction and installation guidelines can be found in “Managing Health Care Waste Disposal. Guidelines on How to Construct, Use, and Maintain a Waste Disposal Unit” IT Power India Private Limited. India, 2004; and De Montfort Mark 8a Incinerator. These documents provide detailed information on drawings, materials and components, sequence of construction process, maintenance, quality control and training program.

c) Special wastes

According to their characteristics, special wastes should undergo specific treatments or should be disposed of in secure landfills.

c.1) Chemical and pharmaceutical wastes

Small quantities of special wastes (chemical or pharmaceutical) at small facilities can be treated and disposed of together with infectious waste.

Chemicals and pharmaceutical wastes can be encapsulated with cement. Encapsulation involves filling containers with waste, adding an immobilizing material, and sealing the containers. The process uses either cubic boxes made of high-density polyethylene or metallic drums, which are three-quarters filled with sharps and chemical or pharmaceutical residues. The containers or boxes are then filled up with a medium such as plastic foam, bituminous sand, cement mortar, or clay material. After the medium has dried, the containers are sealed and disposed of in landfill sites.

This process is relatively cheap, safe, and particularly appropriate for establishments that practice **minimal programs** for the segregation of sharps and chemical or pharmaceutical residues. The main advantage of the process is that it is very effective in reducing the risk of scavengers gaining access to the hazardous health-care waste.

c.2) Radioactive wastes

Low-level radioactive wastes (LLW) are likely to be produced in some of the facilities being updated from administering radiopharmaceuticals and performing radio-immunology procedures. Medically useful radioactive tracers, which are extremely valuable in diagnostic procedures and medical research, usually have a very short half-life. Typically, half of the material decays to a non-radioactive form in hours to days.

Hospital LLW with short-lived radionuclides (i.e. less than 8 days) in low concentrations can be stored until its radioactivity is below detectable levels. The waste can then be disposed of as non-radioactive waste. Waste that is to be stored during radioactive decay should be labeled with the type of radionuclide, the date, and details of required storage conditions. Certain liquid hospital LLW that meet limits established by the Pakistan Nuclear Regulatory Authority for radioactivity concentration and solubility in water can be treated as wastewater and disposed of through the sewer.

Certain solid medical LLW can be disposed of without regard to its radioactivity, where the radiological hazard is considered small, but the non-radiological hazards warrant special handling and disposal. Controlled incineration of low-activity hospital LLW is an adequate treatment because any radioactivity released during the burning is well below accepted environmental levels (U.S. Congress, Office of Technology Assessment, *Finding the Rx for Managing Medical Wastes*, OTA-O-459. Washington, DC. 1990).

If at all possible, spent sealed sources should be returned to suppliers. This is particularly important for sources with high activity and those containing long-lived radionuclides. Higher-level radioactive waste of relatively short half-life (e.g. from iodine-131 therapy) and liquids that are immiscible with water, such as scintillation counting residues and contaminated oil, should be stored for decay in marked containers, under lead shielding, until activities have reached authorized clearance levels. Water-miscible waste may then be discharged to the sewer system and immiscible waste may be disposed of by the methods recommended for large quantities of hazardous chemical waste.

d) Common wastes

Common or non-risk wastes can be disposed of together with municipal wastes in sanitary landfills. Depending on their composition, characteristics, and market opportunities, they can be recycled and commercialized.

3.1.2.9 External collection and transportation

The hospital waste producer is responsible for safe packaging and adequate labeling of waste to be transported off-site and for authorization of its destination. Packaging and labeling should comply with Pakistan Environmental Protection Act 1997 and Hospital Waste Management Rules 2005 made there under.

A consignment note should accompany the waste from its place of production to the site of final disposal. On completion of the journey, the transporter should complete the part of the consignment note especially reserved for him and return it to the waste producer.

Waste bags may be placed directly into the transportation vehicle, but it is safer to place them in further containers (e.g. cardboard boxes or wheeled, rigid, lidded plastic or galvanized bins). This has the advantage of reducing the handling of filled waste bags but results in higher disposal costs.

For automatic discharge units, the loading height should not exceed 1.20 m. The body of the vehicle should be closed and hermetical. If the vehicle capacity exceeds 1 ton, it should have mechanical discharge devices. The color of transportation vehicles should be white and have visible printed label allusive to the type of waste.

The vehicle should carry, in a separate compartment, empty plastic bags, protective clothing, cleaning equipment, tools, and disinfectant, together with special kits for dealing with liquid spills. The vehicle for risk waste collection should not have a compaction system.

The international hazard sign should be displayed on the vehicle, as well as an emergency telephone number. A transportation vehicle used in Central America is shown in figure 19. The internal finish of the vehicle should allow it to be steam-cleaned and disinfected after every service (see figure 20). The internal angles should be rounded.

Figure 19. External collection and transportation vehicle

Figure 20. Washing and disinfection of transportation vehicle

Vehicles or containers used for the transportation of health-care waste should not be used for the transportation of any other material. They should be kept locked at all times, except when loading and unloading. Articulated or demountable trailers (temperature-controlled if required) are particularly suitable, as they can easily be left at the site of waste production.

Where the use of a dedicated vehicle cannot be justified, a bulk container that can be lifted on to a vehicle chassis may be considered. The container may be used for storage at the health-care establishment and replaced with an empty one when collected.

A separate waste storage and external collection facility for risk waste and non-risk waste can be seen in figure 21.

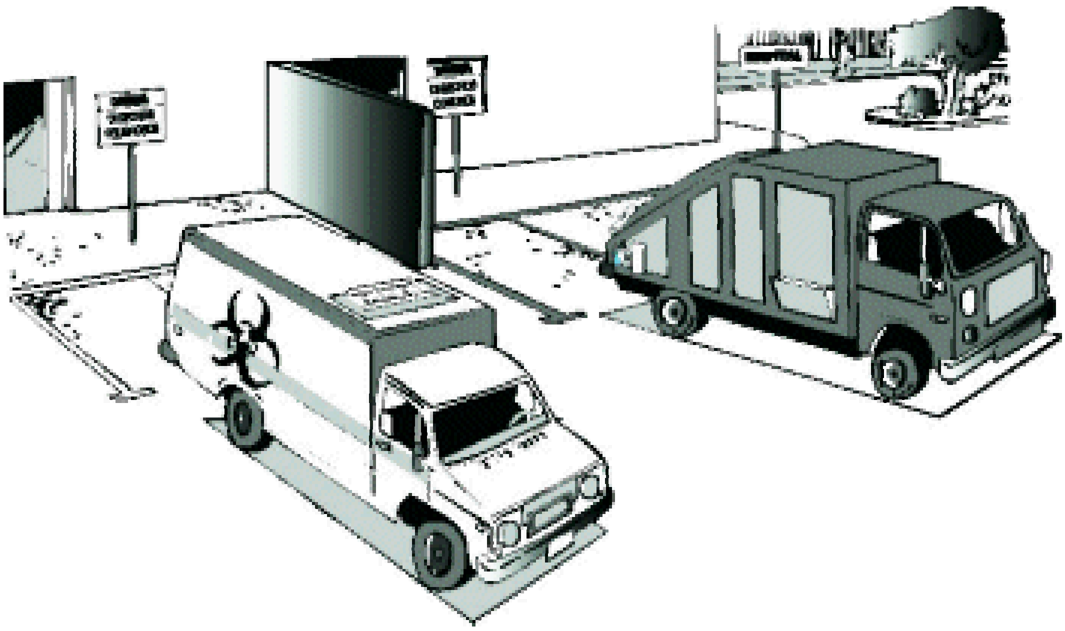


Figure 21. External collection of risk and non-risk waste

3.1.2.10 Final disposal

Uncontrolled land disposal in open dumps is not acceptable. Open dumps are characterized by the uncontrolled and scattered deposit of wastes at a site; this leads to acute pollution problems, fires, higher risks of disease transmission, and open access to scavengers and animals. Hospital waste should never be disposed in open dumps.

A variety of controlled land disposal options are available to hospital waste. The alternatives range from small pits to a modern sanitary landfill (which is a central facility). Non-risk hospital waste, also known as common, general, or municipal waste, can be disposed of in a sanitary landfill.

In facilities were a De Monfort incinerator is installed, non-risk waste such as paper, cardboard, plastic (other than PVC), can be used as combustible for primary chamber heating. Properly treated risk waste should be disposed of in a sanitary landfill.

If there is no a sanitary landfill, treated wastes can be disposed of in a burial pit lined with clay or other impermeable material. It can be constructed inside the premises, where there is land available. The pit should be 2 – 2.5 m deep and filled to a depth of 1.5 – 2 m. After each waste load, the waste should be covered with a soil layer 10–15cm deep. If coverage with soil is not possible, lime may be deposited over the waste. In case of outbreak of an especially virulent infection (such as Ebola virus), both lime and soil cover may be added (WHO, 1999).

Access to this dedicated disposal area should be restricted, and the use of a pit would make supervision easier and thus prevent scavenging. A typical example of pit design for health-care waste is shown in figure 21.

Non-treated risk-waste should be disposed of in secure landfills. A secure landfill is an installation that permits the confinement of certain types of hazardous waste in the soil, isolated from the environment. However, its utilization should be the last option as waste management technology.

Landfilling is considered as a “bottom of the list” option for disposal of untreated hospital waste, and is only recommended when the economic situation of the particular facility does not permit access to environmentally safer technologies, such as the ones previously described.

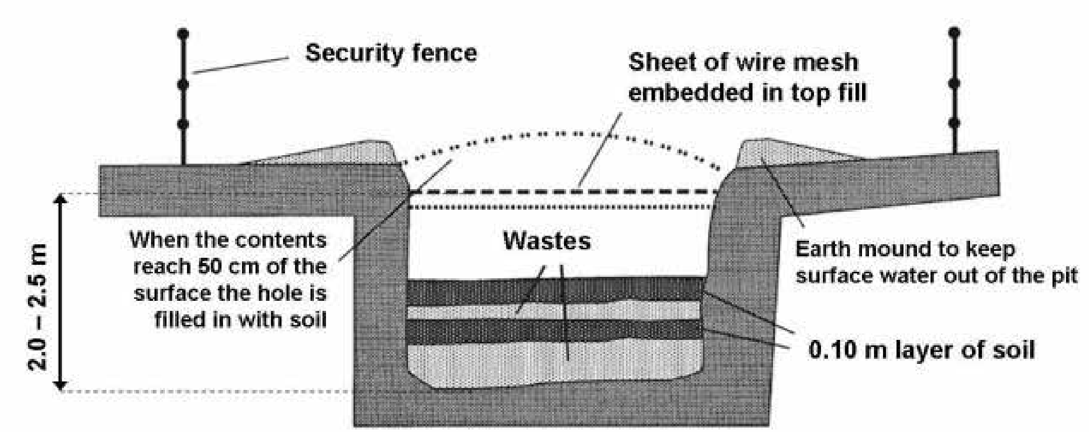


Figure 21. Example of a small burial pit for health-care waste
Adapted from: WHO. 1999.

3.1.2.11 Contingency plan, emergency procedures

A hospital waste management plan should include a contingency plan to face emergency situations. The personnel in charge of the waste management system, and the community in general; should be trained to face emergencies and to timely implement the foreseen measures.

One person should be designated as responsible for the handling of emergencies, including coordination of actions, reporting to managers and regulators, and liaising with emergency services, and a deputy should be appointed to act in case of absence.
In health-care establishments, spillage is probably the most common type of emergency involving infectious or other hazardous material or waste. Response procedures are essentially the same regardless of whether the spillage involves waste or material in use, and should ensure that (WHO, 1999):

- The waste management plan is respected;
- Contaminated areas are cleaned and, if necessary, disinfected;
- Exposure of workers is limited as much as possible during the clearing up operation;
- The impact on patients, medical and other personnel, and the environment is as limited as possible.

Health-care personnel should be trained for emergency response, and the necessary equipment should be to hand and readily available at all times to ensure that all required measures can be implemented safely and rapidly. Written procedures for the different types of emergencies should be drawn up. For dangerous spills, the clean-up operation should be carried out by designated personnel specially trained for the purpose (WHO, 1999).

Procedures for dealing with spillages should specify safe handling operations and appropriate protective clothing. An example of such a procedure is provided in Box 1. The preparation of a detailed report on the facts and procedures adopted is necessary.

Box 1. Example of general procedure for dealing with spillages

1. **Evacuate** the contaminated area.
2. **Decontaminate** the eyes and skin of exposed personnel immediately.
3. **Inform** the designated person (usually the Waste Management Officer), who should coordinate the necessary actions.
4. Determine the **nature** of the spill.
5. **Evacuate** all the people not involved in cleaning up if the spillage involves a particularly hazardous substance.
6. Provide **first aid** and medical care to injured individuals.
7. **Secure** the area to prevent exposure of additional individuals.
8. Provide adequate **protective clothing** to personnel involved in cleaning-up.
9. **Limit** the spread of the spill.
10. **Neutralize or disinfect** the spilled or contaminated material if indicated.
11. **Collect** all spilled and contaminated material. [**Sharps should never be picked up by hand**; brushes and pans or other suitable tools should be used.] Spilled material and disposable contaminated items used for cleaning should be placed in the appropriate waste bags or containers.
12. **Decontaminate or disinfect** the area, wiping up with absorbent cloth. The cloth (or other absorbent material) should never be turned during this process, because this will spread the contamination. The decontamination should be

carried out by working from the least to the most contaminated part, with a change of cloth at each stage. Dry cloths should be used in the case of liquid spillage; for spillages of solids, cloth impregnated with water (acidic, basic, or neutral as appropriate) should be used.

13. **Rinse** the area, and wipe dry with absorbent cloth.
14. Decontaminate or disinfect any tools that were used.
15. Remove protective clothing and decontaminate or disinfect it if necessary.
16. **Seek medical attention** if exposure to hazardous material has occurred during the operation.

Source: WHO,1999.

3.1.3 Assignation of responsibilities

The head of hospital should form a waste management team to develop and implement a waste management plan. Besides the Waste Management Officer (WMO) the team should be comprised by personnel who represent the most exposed sectors to occupational risks in the hospital waste management:

- Head of hospital
- Waste Management Officer
- Chiefs of service
- Nursing in-charge and hospital supervisor

It is recommended that the Waste Management Team has the responsibility of approving the waste management plan. The levels of responsibility for the waste management system may change from one facility to another, according to its flow chart. However, the main responsibilities of the work team are next described:

Responsibilities of the Head of Hospital:

- To form a work team
- To designate a Waste Management Officer (WMO)
- To ensure that the waste management plan is continuously updated
- To assign sufficient financial and human resources
- To guarantee the monitoring procedures
- To guarantee the suitable training of all personnel

Responsibilities of the Waste Management Officer (WMO):

- To formulate a proposal of a waste management plan at technical level.
- To coordinate the personnel training and responsibilities.
- To monitor technical aspects related to waste management, from generation to final disposal.
- To ensure that waste bags and other material for waste management are ordered on a continuous basis and there is regular supply.
- To liaise with Nursing Superintendent, Medical Superintendent and Heads of Departments to ensure all staff are familiar with their responsibilities for segregation and treatment.
- To prepare statistics on waste generated and maintain records

Responsibilities of Chiefs of Service

- To guarantee that all personnel from his/her service knows the established standards and procedures for hospital waste management.
- To be continuously connected with the WMO for monitoring purposes.
- To guarantee the appropriate training of all personnel from his/her service.
- To encourage the medical and nursing personnel to be alert to guarantee that the sanitary personnel follow the correct procedures at all times.

Responsibilities of the Nursing In-charge and Hospital Supervisor

- To liaise with the WMO and the team to keep the practices and procedures in its highest standards.
- To take part of continues personnel training.
- To liaise with chiefs of service to guarantee a good coordination.

The in-charge of supplying also has the responsibility of guaranteeing the continuous provision of appropriate materials for hospital waste management; and to analyze the possibilities of acquiring less pollutant products (like no PVC plastic elements).

3.1.4 Security and occupational hygiene

Concerning hospital waste management, hygiene and safety measures should be adopted by all personnel in-charge to protect their health. Main measures consider training, appropriate behavior, discipline, personal hygiene and protection. The actions should be complemented with a good work environment, such as illumination, ventilation, ergonomics, etc.

Safety measures that should be followed by personnel involved in hospital wastes management are (adapted from: CEPIS-PAHO/WHO. 1996):

- To know the work schedule, its nature and responsibilities, as well as the risk exposures.
- To be vaccinated against tetanus, typhoid and hepatitis B.
- To have passed a general medical checkup, including at least the tuberculosis and hemoglobin test to confirm health status.
- To be in perfect health, without any mild flu or small wounds in hands or arms.
- To begin the work wearing the personal protection equipment, since risks are always present. The basic personal protection equipment shall include: overall (or apron), gloves and rubber boots. In case of infectious waste management, a mask must be used.
- To use reinforced gloves to avoid any cuts and punctures in the palm and fingers, these should be put over the sleeve of the overall.
- To tie up the hair to avoid contamination; it is preferable to use a cap.
- To place trousers within the boot.
- To avoid eating, smoking or chewing any products during working hours.

- To have a medical kit with disinfectants, cotton, sticking plaster, bandage and germicidal soap.
- To dispose the gloves immediately in case of tear and do not reuse them for any reason.
- To wash and disinfect the personal protection equipment, specially gloves; once daily routine is over.
- To take a shower at the work center once the work day is over.

3.2 Training course for hospital personnel

One of the main components of a solid waste management system is human resources. It is as important as the organizational and technical-operational aspects. The system efficiency is based on the complementation of these three aspects.

It is essential and very important to develop sensitization and motivation campaigns and training courses among professionals, technicians and sanitary workers so that they identify themselves with their responsibilities.

Campaigns and training courses should be permanent and supported with posters, bulletins, lectures and films, in an adequate language, according to the educational level of the staff.

The suggested strategy to develop training courses should be “Training of trainees”. Steps to be followed in every selected facility are:

- Identification of training needs (personnel involved, training material, etc.).
- Preparation / adaptation of training materials.
- Workshops planning: schedule, number of persons, location, facility (multimedia, materials, etc.).
- Conduct training workshops.

3.2.1 Objectives of the training course

Adapted from WHO, 1999.

- **To raise awareness** on public health and environment hazards that may be associated with inappropriate segregation, storage, collection, transport, handling, treatment and disposal of hospital waste;

- **To identify waste management practices and technologies** that are safe, efficient, sustainable, economic and culturally acceptable; to enable the participants to identify the systems suitable for their particular circumstances;

- **To enable managers** of health-care establishments **to develop their waste management plans**;

- **To enable course participants to develop training programs** for the different categories of staff that handle, treat or dispose of health-care waste.

3.2.2 Course content and planning

A program for a three day training course is shown below. Should the course be expanded or condensed, then the course program should be adjusted to meet the objectives.

Course content

Part I

1.1 Environmental and health impacts of inappropriate health-care waste management
1.2 Introduction to current national and local legislation
Workshop 1: Environmental and health impacts of hospital waste in your community
1.3 hospital waste management program for a health-care establishment

Part II

2.1 Definition and classification of health-care waste
2.2 Minimization, recycling and segregation
2.3 Handling, storage and transportation
Workshop 2: Identification of minimization, segregation and handling options
2.4 Treatment systems
2.5 Final disposal
Workshop 3: Treatment and disposal options (policy and local considerations, medium and small establishments)

Part III

3.1 Worker's health and safety
3.2 Waste management related costs
3.3 Methodology for the implementation of an integrated hospital waste management plan
Workshop 4: Waste management plan design and action plan for implementation
3.4 Evaluation of the course
3.5 Final discussions and closure

The last ten minutes of each lecture should always be dedicated to questions by the participants.

Planning

It is essential that there is one course coordinator, who takes on the responsibility for planning and delivering the course. Sufficient time should be given to these activities.

Lectures and presentations are an important way of disseminating information. Presentations should be well prepared, and there should be a question and answer session at the end of the lecture.

Evaluation aims at assessing the extent to which the course objectives have been attained and at determining the quality of the teaching. The evaluation results will allow the course to be improved or adapted as necessary for future use. An evaluation of the course can be made by carrying out a short initial assessment of the level of the participants' knowledge, right at the beginning of the course and by comparing it to the knowledge assessed at the end of the course.

The participants should also be consulted on the content, visual aids and teaching methods at the end of the course. This can be carried out by asking them to complete an anonymous written questionnaire.

3.3 Demonstrative pilot project on appropriate hospital waste management

A demonstrative pilot project on appropriate hospital waste management is recommended to implement. It allows hospital personnel to see the system in place and functioning. Main purposes of the pilot project are:

- ✓ Merges the planning stages and implementation stages of project development.
- ✓ Serves as a way to 'educate' and build support for project.
- ✓ Verifies costs and benefits
- ✓ Allows evaluation of design, procedures and implemented alternatives.

Recommended steps to prepare and implement a pilot project on hospital waste management system are:

- Selection of the most suitable health facility, in order to ensure the project success.
- Formulation of pilot project:
  - Assessment and design: identification of specific requirements for a proper hospital waste management, planning, etc.
  - Details planning
  - Provision of materials and equipment.
  - Construction of an appropriate treatment system.
- Training (medical and paramedical personnel, technicians, sanitary workers, etc.)
- Implementation of pilot project.
- Monitoring and Evaluation
- Technical visits from other selected facilities
- Replication of pilot project

The pilot project title could be "Appropriate hospital waste management in "Name of selected facility"

Suggested location for the project implementation would be Rawalpindi (THQH Gujjar Khan or THQH Murree are recommended)

The main objective of this pilot project would be to improve the hospital waste management in the selected health facility, implementing a safe, efficient, sustainable, affordable and culturally acceptable system for the treatment and disposal of health-care waste.

3.4 Drinking water supply

Water has been called the universal solvent because so many substances will dissolve in it. Water also can carry many materials in suspension. Normally, treated water should contain chlorine and varying amounts of dissolved minerals including calcium, magnesium and sodium, chlorides, sulphates and bicarbonates, depending on its source. It is also not uncommon to find traces of iron, manganese, copper, aluminum, nitrates, insecticides and herbicides although the maximum amounts of all these substances are limited by the regulations. These are usually referred to as 'contaminants'. Most of these substances are of natural origin and are picked up as water passes round the water cycle. The water will also contain a relatively low level of bacteria which is not generally a risk to health.

Results from various investigations and surveys indicate that water pollution has increased in Pakistan. The pollution levels are higher particularly in and around the big cities of the country where cluster of industries have been established. The water quality deterioration problems are caused by the discharge of hazardous industrial wastes including persistent toxic synthetic organic chemicals, heavy metals, pesticide products and municipal wastes, untreated sewage water to natural water bodies. These substances mixed with water then cause widespread water-borne and water-washed diseases (PCRWR. National Water Quality Monitoring Program).

Disease caused by poor water quality is very high in Pakistan. According to Pakistan's National Conservation Strategy (1992), about 40 percent of communicable diseases in Pakistan are water-borne. A World Health Organization (WHO) report notes that 25 to 30 percent of hospital admissions in Pakistan are associated with water-borne bacterial and parasitic conditions. The impact on mortality is severe. According to the World Conservation Union (IUCN), 60 percent of infant deaths in Pakistan are caused by water borne diarrhea and dehydration caused by diarrhea is a major cause of mortality among children (Embassy of the United States. Islamabad, Pakistan. Press Release. December 2006).

Taking into consideration the strong sewerage smell in some water samples in selected districts, it is also possible to assume that harmful bacteria or other pathogens have found their way into drinking water from a municipal water source or well. If these organisms are in the water illness can occur.

Situation of drinking water supply in selected facilities is critical. Improving this situation is imperative and essential. The following strategy is recommended:

- Identify drinking water requirements according to the level of services: an assessment should be performed in selected facilities, considering the present and future drinking water demand and sources.
- Detailed assessment of available water characteristics; considering determination of the source of identified pollutants, and decides the most suitable treatment system.
- Formulation of the technical project, according to water quality regulations. Consider coagulation and flocculation systems; clarification; filtration and adsorption processes; disinfection (chlorine, ozone, chlorine dioxide, ultraviolet light, among others); organics removal and inorganics removal (nitrate, arsenic, iron and manganese, lead, among others); according to the specific characteristics of water source.
- Implementation of the water treatment system.

- Staff in–charge training
- Monitoring.

A scheme of the suggested drinking water system for selected facilities is shown in figure 22. A meeting was held with representatives of Water Tech. Private Limited Pakistan, providers of this technology, who informed that most of the components of the treatment plant are locally found. The Water Tech. Private Limited Pakistan is an affiliate of an American company called EcoTech International Inc. USA.

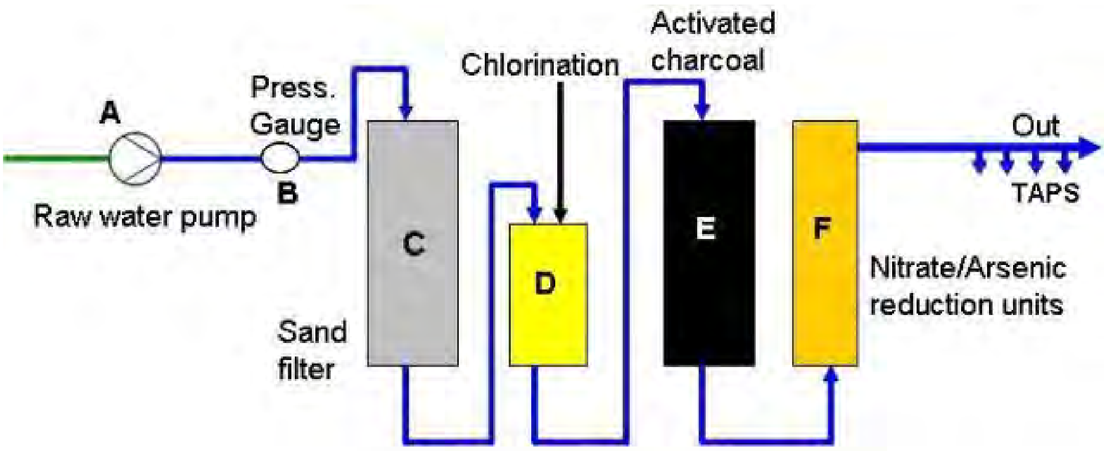


Figure 22. Proposal for drinking water treatment system
Source: Adapted from Water Tech. Private Limited Pakistan. (an Affiliate of EcoTech International Inc. USA)

Keys
A. Raw Water Pump
B. Pressure Control Gauge
C. Slow Sand Bio/ Multi Media Filter
D. Chlorination Tank
E. Granularly Activated Charcoal (GAC)
F. Nitrate/Arsenic Reduction Units

3.5 Wastewater management

Hospital wastewater contains pathogenic microorganisms, pharmaceuticals, hazardous chemicals, etc., which may have an impact on the environment and public health. Hospital effluents in the visited facilities are generally discharged towards the urban sewer network, towards septic tanks coupled to wastewater disposal well, or to open drains.

The health-care establishment should ideally be connected to a sewerage system. Where there is no sewerage systems, technically sound on-site sanitation should be provided (WHO, 1999). Discharging of hospital wastewater to municipal sewers without pretreatment is not recommended.

An on-site treatment or pre-treatment of hospital wastewater comprises ***primary treatment*** (screening, grit chamber, sedimentation tank), ***secondary treatment*** (biological treatment processes, such as activated sludge, trickling filters, lagoons),

tertiary treatment (physical, biological, or chemical processes to remove nutrients such as nitrogen and phosphorus, and carbon adsorption to remove chemicals); ***chlorine disinfection***; ***sludge treatment*** (anaerobic digestion, natural drying beds and incineration).

Small facilities in selected districts that cannot afford to implement the above mentioned treatment system; should consider the installation of a proper septic tank and soakaway system, as the minimal requirement. However, special care should be taken to ensure a good design, construction, functioning, and monitoring of septic tank and soakaway system, otherwise odor nuisance, flooding and pollution problems could be generated.

3.5.1 Septic Tank

The purpose of a septic tank is to reduce the bacterial and nutrient load (e.g. phosphates and nitrates) of the effluent discharged into it and to avoid the effluent from polluting watercourses or drinking water sources in the vicinity. After leaving the septic tank, wastewater has two options: pass into the subsoil to a soakaway system (which is the usual method in selected facilities) or be conveyed by a system of pipes to a communal treatment point, which may be off-site treatment works reached either via existing sewerage or by tanker (see figure 23).

Septic tank is a type of biological sewage treatment system. Waste material is allowed to settle in the tank and is digested by natural bacteria which must be allowed to breed within the tank. The liquid flows out and is discharged via a drainage system under the ground called a "soakaway". Over time partially-decomposed solids build up on the bottom of the tank. This sludge has to be removed regularly to make sure the tank continues to work properly and to prevent the soakaway becoming choked.

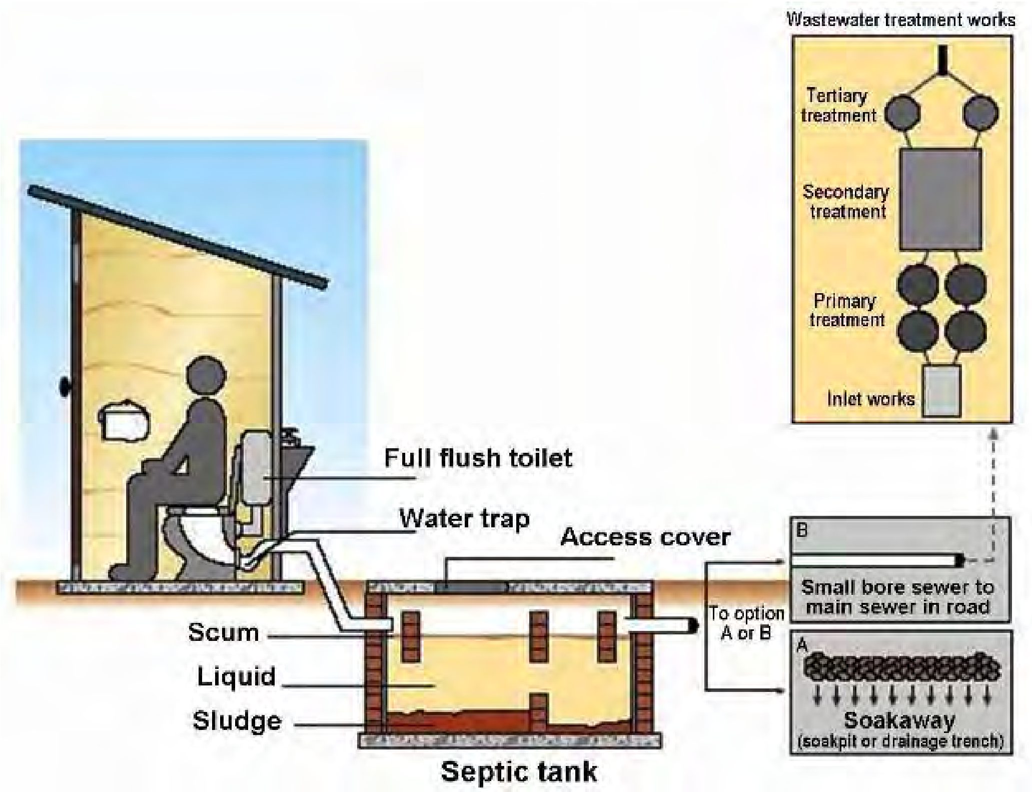


Figure 23. Septic tank and soakaway or small bore solid-free sewer

A septic tank is usually either a large rectangular box made of brick, stone or concrete, although modern types are pre-formed in reinforced fiberglass. Modern septic tanks (often onion-shaped plastic tanks) comprise a watertight primary compartment in which solids are deposited and further watertight secondary settling/treatment compartments in which bacteria break down the waste. Together the primary solids and outcomes from the bacterial activity create sludge (as it has been mentioned), that accumulates in each compartment. The effluent from the secondary compartments discharge into a network of underground pipes or a stone filled soakaway that allows the effluent to percolate into the soil.

When installing and operating a septic tank, it is important to ensure that:

- The septic tank is properly maintained and emptied regularly;
- The septic tank access lids are secure and in good working order; and
- The drains to and from the septic tank, including the soakaway, are free-flowing and free from blockages

Do's and Don'ts of Septic Tanks

Do

- Have the septic tank system professionally fitted, following local guidelines and regulations.
- Have the system inspected regularly.
- Desludge the tank when necessary.
- Act immediately if you find a blockage or any sign of a problem
- Keep note of any maintenance work.
- Ensure all manhole covers are accessible.
- Ensure that any air vents are not blocked.
- Keep the drainage field protected.
- Divert other sources of water, like roof drains, away from septic tank systems.
- Use mild detergents and washing powders and liquids in moderation without upsetting the natural balance of the septic tank. Prefer biodegradable soap and detergents.
- Use bleaches and disinfectants in moderation, as they can kill the friendly bacteria which make the septic tank work.

Don't

- Fats, oils or heavy grease should not be poured down the drain.
- Paints, solvents and motor oils should not be put down the drain.
- Never dispose of pesticides into the septic tank.
- Don't empty chemical toilets into drains or septic tanks.
- Nappies, sanitary items, plastic or similar items should not be disposed of into the system – "bag it and bin it" instead.
- Don't dig or drive over the drainage field, or cover it with a hard surface.
- Don't block air vents.

- Don't desludge the tank too often.
- Don't allow effluent to collect on the surface of the ground.
- Don't enter a septic tank – dangerous gases are produced by the natural treatment process.

3.5.2 Soakaway

A soakaway pit has a perforated lining through which effluent from the septic tank can soak into the surrounding soil (see figure 24). This effluent contains dissolved polluting material and also many pathogens that can cause illness. Soakaway trenches or drains perform the same function as a soakaway pit, but are usually more efficient.

The soil type and pit configuration will control the rate at which the effluent will soak away. As the effluent seeps through the surrounding soil, a process of natural purification occurs. This process includes the breakdown of the polluting material by bacteria occurring naturally in the soil, and the eventual "die off" of the pathogens. Adequate purification can only be achieved after the effluent has traveled a fairly long distance through the ground.

A soakaway drain typically comprises a length (around 20+ meters) of perforated pipe laid at a 'flattish gradient' (probably along the contour), in a trench backfilled with poorly graded (ie, of a similar size) stone chippings (single-sized aggregate). The idea is that the liquid from the tank will percolate through the stone chippings and into the soil. It is not uncommon for the chippings to be laid inside a wrap of geotextile material, which impedes the silting up of the soakaway with fine particles (silt) from the surrounding trench.

The size of the soakaway drain must be sufficient to absorb the tank effluent. If the drain is too short or the soil is too impermeable the drain will become clogged. Typical evaluation of the permeability of the soil will include a 'percolation test' to see how quickly liquid will disappear into the soil. Clay soils will be less absorbent than coarser sandier soils

When constructing a soakaway, it is necessary to beware of the risk of poisoning local aquifers and water courses:

- Beware of a high water table. A soakaway should not be constructed where the ground water table is close to surface.
- In fine soil, the penetration distance of bacteria may be around 3m from the soakaway. Coarser soils will enable greater penetration. Coliforms (gut bacteria) reportedly can survive for as much as a month if they reach a source of groundwater.
- A limestone or dolomitic geology will most probably be fissured, enabling septic tank effluent to flow away freely. As such, soakaways are unsuitable in areas where this geology occurs.

Overflow from septic tank or soakaway pit, or direct discharge without passing through a soakaway system, is polluting and should not be permitted.

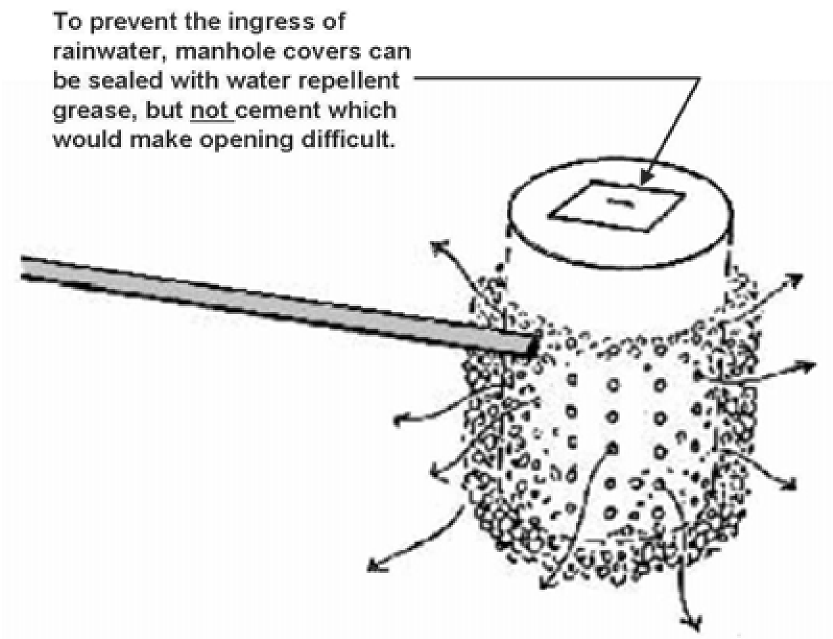


Figure 24 . Soakaway pit

3.6 Civil works plan review and recommendations to address environmental concerns in light of the USAID Negative determination including 22 CFR 216

The renovation and up-gradation of selected health facilities in ten districts of Pakistan involves civil works in areas such as, but not limited to, washrooms, water supply, operation theatre, labor room, waiting areas, floors, drainage / disposal, etc. These activities aroused concerns for any potential environmental hazards resulting from the civil works.

According to the assessment performed during the field visits, and taking into consideration the present environmental, sanitation, and infrastructure conditions of selected health facilities, no big negative environmental impacts have been identified, since only existing building is being renovated, there are no interventions in new areas of those health facilities, and there are not new constructions being built.

Some of the civil works being carried out are:

- Restoration of existing water supply lines
- Replacement of choked sewer lines
- Replacement of manholes
- Provision of underground collecting tank for water
- Provision of fiber glass overhead tank for water
- Cleaning of external sewerage septic tank / soakage pit
- Replacement of water supply pipes
- Provision of sanitary Installations
- Roof treatment

- Tiles work for refurbishment of floors and walls

As mentioned before, it is considered that the above mentioned activities are not going to produce big environmental impacts; however, they might cause some minor impacts that need to be addressed, such as:

- Impacts on existing flora and fauna due to the placement of construction materials nearby the areas being renovated.
- Impacts on air, due to the generation of dust during excavation works and odors from the construction materials (paints, resins, etc.).
- Noise pollution, because of the construction works and heavy equipment utilized.
- Construction and demolition hazards (fire, debris management), due to the utilization of hazardous construction materials, such as petroleum products (lubricating oils and greases), fuels (gasoline, kerosene), solvents, paints, batteries.
- Occupational hazards.
- Hazards to nearby patients. Special care should be taken due to the compromised immune status of some patients, which leaves them more susceptible to infections. The main cause of construction-related infection is airborne fungal spores, which originate on water-damaged building materials (gypsum board is prone to fungal growth/contamination). Construction procedures that can heighten infection risk in health-care environments include demolition using inadequate barriers, exterior-wall removal. Water leakage with mold growth, poor ventilation, and utility outages also can increase risk (Streifel; Hendrickson. Assessment of Health Risks Related to Construction. 1972)

Impacts on the environment are considered insignificant, since there are not environmentally sensitive areas (such as wetlands and threatened or endangered species habitats) under intervention. In addition, existing flora (mainly only grass) and fauna (minor animals such as insects) have no economic value. Noise disturbance will be insignificant, for a short period of time, and confined to a small part of the facility.

In order to minimize environmental and health impacts of civil works, the following mitigation measures are recommended:

- The plan should include the re-vegetation of areas disturbed by construction. Affected grass should be restored after completion of works.
- Areas being renovated should have preventive fabric isolation.
- Ensure water sprinkling while excavation works if required.
- Determination of a barrier and airflow for the containment of airborne fungal spores should be considered.
- If the work cannot be done during non-patient-care hours, care must be taken to contact the nursing supervisor before workers begin to determine the most sensitive patients and coordinate the progress of the Project.
- Workers should wear protective equipment (masks, glasses, gloves, boots, uniform, etc.).
- Provide break areas and bathroom facilities for workers.

- Store gypsum board in a weather-protected area.
- Construction and demolition debris should be disposed of in a sanitary landfill. If a sanitary landfill is not available, they can be disposed of in a small pit lined with clay or other impermeable material (see figure 21, Chapter III, Final disposal).
- Explore opportunities of debris recycling and reusing. Non-hazardous, uncontaminated materials that result from construction, restoration, repair, or demolition of structures (construction and demolition debris) can be utilized in later construction processes.

In conclusion, PAIMAN civil works are designed to protect public health and environment. Taking into consideration the recommended mitigation measures, and the extent and duration of projects, environmental and health impacts are considered insignificant. PAIMAN civil works will improve hygienic conditions, working environment, facilities for patients, enhance staff availability and facility utilization.

References

1. CEPIS-PAHO/WHO. *Guidelines for the Internal Management of Solid Wastes at Health Care Centers*. Lima, Peru. 1996.
2. Government of Pakistan. Ministry of Environment. *Hospital Waste Management Rules, 2005*. Islamabad. 2005.
3. Hart, Terry; Nitant, Mat. IT Power India Private Limited (ITPI). *Managing Health Care Waste Disposal. Guidelines on How to Construct, Use, and Maintain a Waste Disposal Unit*. India. 2004.
4. Pakistan Initiative for Mothers and Newborns (PAIMAN). CONTECH International Health Consultants. *District Health Profiles*. Pakistan. 2006.
5. The Gazette of Pakistan. *Pakistan Environmental Protection Act, 1997*. Islamabad. December, 1997.
6. U.S. Congress, Office of Technology Assessment, *Finding the Rx for Managing Medical Wastes*, OTA-O-459. Washington, DC. 1990.
7. United Nations Environment Programme (UNEP). *Draft Guidelines on BAT and BEP for Medical Waste Incineration*. Chile. 2003.
8. World Health Organization (WHO). *Management of Solid Health-Care Waste at Primary Health-Care Centres. A Decision-Making Guide*. Geneva. 2005.
9. World Health Organization (WHO). *Safe health-care waste management. Policy Paper*. Geneva. 2004.
10. World Health Organization (WHO). *Safe management of wastes from health-care activities.* Geneva. 1999.

Annexes

Annex 1. Questionnaire

HOSPITAL GENERAL INFORMATION

1. General data

Date: ____________________

1.1 Hospital ownership: Ministry of Health (**M**) or ____

1.2 Name of the Hospital: ....

1.3 Address: ....

District: .... Province: ……………………..

1.4 Total area: .... (m^2) Open area: ....(m^2)

1.5 Type of attention: (✓ the corresponding number below)

General	**1**		Maternity	**7**		Psychiatry	**13**	
Surgery	**2**		Dentistry	**8**		Traumatology	**14**	
Emergencies	**3**		Neurology	**9**		Cardiology	**15**	
Neoplasic diseases	**4**		Ophthalmology	**10**		Gastroenterology	**16**	
Medicine	**5**		Ear, nose & throat	**11**		Urology	**17**	
Paediatric	**6**		Physical rehab.	**12**		Endocrinology	**18**	

1.7 Year of establishment of hospital: [ ]

2. Types of services offered
(Write in the boxes the letter "**Y**" for those that are offered and "**N**" for those that are not)

2.1 Blood bank		2.10 Chemotherapy ward	
2.2 Out patient department		2.11 Surgery ward	
2.3 Emergencies		2.12 Delivery ward	
2.4 General laboratories		2.13 Pharmacy	
2.5 Bacteriology laboratories		2.14 Kitchen	
2.6 Mortuary		2.15 Lunchroom	
2.7 Hemodialysis ward		2.16 Printing	
2.8 Isolation ward		2.17 Cafeteria	
2.9 Medical ward		2.18 Laundry	

3. Statistics Data

3.1 Total number of persons working in the Hospital					
3.2 Number of medical personnel (lab technicians, doctors, nurses, etc)					
3.3 Total number of beds (Including nursery)					
3.4 Total number of out patients (day average)					
3.5 Total number of in-patients (day average)					
3.6 Total number of deliveries (annual average)					

HOSPITAL SOLID WASTES

1. Is there a department responsible for the solid waste management in the institution? Y/N ☐

2. Who is responsible for the solid wastes management? ☐

S Shared with Hospital personnel and a private company
H Hospital employees
P Private Company

3. Working hours of the persons that manage the solid waste (total persons _____)

Shifts	# of persons
1st:	
2nd:	
3rd:	

4. Generation of solid wastes:

Indicate the quantity of wastes generated — Time

Kilograms [K] — Day [D] — Week [W]

	Quantity	Units
4.1 General waste (offices, library, dining room, gardens, etc.)		
4.2 Hospitalization wastes (eg. Wards)		
4.3 Wastes from out-patient rooms and emergency		
4.4 Wastes from dressing rooms		
4.5 Laboratory wastes		
4.6 Kitchen and food wastes		
4.7 Ware houses		
4.8 Total wastes generated		

5. Segregation of solid waste

(Y for yes and **N** for no) ☐

6. Primary storage (Write in the boxes the letter **Y** for those that are used and **N** for those that are not)

6.1 Container with plastic bags (eg. plastic bin, box, etc.) ☐
6.2 Container without plastic bags (eg. plastic bin, box, etc.) ☐

7. Internal collection of the solid wastes
(Write in the boxes the letter **Y** for those that are used and **N** for those that are not)

7.1 Container without wheels ☐ — Collection time: ____________________
7.2 Open cart ☐ — ____________________
7.3 Closed cart ☐ — ____________________
7.4 Garbage bags ☐

____

____

8. Interim storage of the solid wastes within the facility is done in:

6.1 Cylinders ☐

6.2 Dischargeable ☐

6.3 The ground ☐

6.4 No interim storage ☐

Central Storage

The storage of the solid wastes:

C In a closed environment ☐

A Open to the air ☐

AO Open to the air with **brick outskirts** ☐

Comments: ____

____

____

____

9. Recovery and recycling of the solid wastes:

	Yes	No
Can you make use of the wastes		
Have you thought of recycling the wastes		
Have you thought of using it as an energy source		
Have you thought of selling the wastes		

____

____

____

10. Recovery is done by:

	Yes	No
The hospital employees		
Third parties		
Informal recovery - hospital employees		
- scavengers		

The selling is done by:

	Yes	No
The hospital employees		
Third parties		
Informal recovery - hospital employees		
- scavengers		

11. Transportation of solid wastes for final disposition:

Municipality ☐
Contractors ☐
Hospital employees ☐

Frequency:

1. Daily ☐
2. Every other day ☐
3. Twice per week ☐
4. Once a week ☐
5. Fortnightly ☐

Collection time [:]

Type of vehicle ……………………………………

1. Open back truck or similar
2. Enclosed back truck
3. Dump
4. Compactors
6. Other

____
____
____

12. Treatment:

a. Incinerator

	Yes	No
It has an incinerator	☐	☐
Is it working properly?	☐	☐
Renders service to third parties	☐	☐

b. Others ____
____
____

13. Final disposal:

Sanitary landfill	☐
Open dumps	☐
Open fire	☐
Buried near or within the Hospital center	☐
Does not know	☐

In the final disposal place:

	Yes	No
Are there people recovering recyclables?	☐	☐

If yes, how many? Men: _______ Women: ______ Children: ______

14. Radioactive wastes generation:

	Yes	No
1. Are there radioactive wastes	☐	☐
2. Do they have previous treatment	☐	☐

3. Actual state of wastes ☐ { L Liquid / S Solid / A Both }

4. Final disposition of radioactive wastes

Domestic wastewater	☐
Incinerator from other Hospital center	☐
Sanitary landfill	☐
Dumps	☐
Open fire	☐
Buried near or within the Hospital center	☐
Does not know	☐

WATER SUPPLY AND WASTEWATER MANAGEMENT

15. Liquid wastes management

	Yes	No
Grinders use	☐	☐
Septic tank	☐	☐

---

16. Final disposal of waste water

	Yes	No
Municipal sewer	☐	☐
Soakage pit	☐	☐
Open drain	☐	☐

---

17. Type of water supply source

	Yes	No
Direct pumping from ground	☐	☐
If yes, the approximate depth of the well is: ________ ft / m		
Municipality water	☐	☐

---

18. Water testing

	Yes	No
Tested	☐	☐
If yes, frequency of testing:		
- Quarterly	☐	
- Half yearly	☐	
- Yearly (or more)	☐	

19. Is there a policy of monitoring for water quality testing? _______ What is that policy?

____

20. Who is the person in charge of it? ____

21. Have you ever requested for water testing? If yes, what happened? ______________________

____

22. Why did you request it?
   - Change of color ☐
   - Bad odor ☐
   - Visible suspended solids ☐
   - Other: ☐

   ____

23. Frequency of cleaning of Over Head Reservoir
   - Monthly ☐
   - Quarterly ☐
   - Half yearly ☐
   - Yearly ☐
   - More than year ☐
   - Never ☐

24. Is PAIMAN providing repair / maintenance of water supply / sewerage lines?

Yes ☐ No ☐ Not applicable ☐

25. Do you think the civil works carried out by PAIMAN contributes to negative environmental impacts?

Yes _____ No _____ If yes, how? ____

____

26. Do you think the civil works carried out by PAIMAN are beneficial? Yes _____ No _____

If yes, how? ____

____

____

____

Persons contacted at the Hospital center:

Names / Contact number	Duty
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________

Recorder:

Name of recorder: ___________________________ Signature: ________________________

Annex 2. Final schedule

Hospital waste management and environmental assessment

September 13 – october 4, 2006

Persons involved: CTO, COP, Peter Hatcher (PH), Javade Khwaja (JK), Shahzad Bajwa (SAB), FOMs, Dr. Shehzad Awan (SA), Eng. Javed Bashir (JB)

Day&Date	Time	Activity	Venue	Participants	Comments
Wednesday, 13 September	6 a.m.	Arrival by BA129	Islamabad airport	GM	PAIMAN driver to pick
Wednesday, 13 September	7 a.m.	Check-in Marriott Hotel	Marriott Hotel	GM	Booking confirmed
Wednesday, 13 September	11 a.m. – 3 p.m.	Initial briefing/meeting	PAIMAN Office	GM, PH, JK, SAB	Hand over documents / discuss logistics
Thursday, 14 September	9 a.m. – 1 p.m.	Review of documents / work on plan and tools.	PAIMAN Office	GM	
Thursday, 14 September	2 – 5 p.m.	Working meeting. Preparation of detailed plan.	PAIMAN Office	GM, SA, JB	
Friday, 15 September	9.30 a.m. – 1 p.m.	Discussion on detailed plan and tools to be used (questionnaire).	PAIMAN Office	GM, PH, JK, SAB, SA, JB	
Friday, 15 September	2:30 – 4:30 p.m.	Presentation of plan by GM	PAIMAN Office	CTO, COP, PH, GM, JK, SAB, SA, JB	Presentation of plan to include methodology, tools, etc.
Saturday, 16 September	9.30 a.m. – 5 p.m.	Field work: Health facilities of Rawalpindi	THQH Gujjar Khan, RHC Mandara & Final disposal places	GM, SA, JB	Transport by PAIMAN. FOM may join if feasible
Monday, 18 September	9 a.m. – 5 p.m.	Field work: Health facilities of Rawalpindi	THQH Murree	GM, SA	Transport by PAIMAN. FOM may join if feasible
Tuesday, 19 September	10 a.m.	Flight to Sukkur	Islamabad / Karachi airport	GM, SA	Stay at Sukkur. Airport pick by hotel
Wednesday, 20 September	9 a.m. – 5 p.m.	Field work: Health facilities of Sukkur	DHQH Sukkur, THQH Rohri	GM, SA	Transport from car rental. FOM may join; Security situation be

Day&Date	Time	Activity	Venue	Participants	Comments
					assessed.
Thursday, 21 September	9 a.m. – 5 p.m.	Field work: Health facilities of Sukkur	RHC Kandara & Final disposal place	GM, SA	Transport from car rental. FOM may join; Security situation be assessed.
Friday, 22 September	9 a.m. – 5 p.m.	- Field work: Health facilities of Dadu - Flight to Islamabad	DHQH Dadu, THQH Khairpur Nathan Shah & RHC Seta Road	GM, SA	Transport from car rental. FOM may join if feasible. Security situation be assessed.
Sunday, 24 September	2 p.m.	Travel to Peshawar		GM, SA	Stay at PC Peshawar – PAIMAN car
Monday, 25 September	8 a.m. – 5 p.m.	- Health facilities of Buner - Travel to Islamabad	DHQ Daggar, THQH Chamla & RHC Jowar	GM, SA	Stay at PC Peshawar – PAIMAN car
Tuesday, 26 September	- 9 a.m. - 3 p.m.	- Data assessing - Meeting in JSI Office	JSI Office	CTO, COP, PH, GM, JK, SAB, SA, JB	Stay at Islamabad
Wednesday, 27 September	Morning	Flight to Multan		GM	Stay at Multan Airport pick by hotel
Wednesday, 27 September	Afternoon	Field work: Health facilities of Khanewal	DHQH Khanewal & THQ Mian Channu	GM, SA	Transport from car rental. FOM may join if feasible
Thursday, 28 September	9:30 a.m. – 5 p.m.	Work on preliminary proposals	Multan hotel	GM	Stay at Multan
Friday, 29 September	- Morning - Afternoon	- Flight to Islamabad - Meeting at JSI office	Multan airport JSI office	GM	Stay at Islamabad
Thursday, 28 September	7 a.m. – 5 p.m.	Field work: Health facilities of DG Khan	DHQH DG Khan & Final disposal place	SA	Transport from car rental
Thursday, 28 September	3 p.m.	Flight to Lahore		SA	
Friday, 29 September	9:30 a.m. – 5 p.m.	Field work: Health facilities of Jhelum	DHQH Jhelum, THQH Sohawa & RHC Domeli	JB	Transport by PAIMAN. FOM may join if feasible
Saturday, 30 September	9 a.m. – 5 p.m.	- Meeting with staff from Water Tech. Private Limited Pakistan - Data assessment and validation	JSI Office	GM, SA	
Sunday, 01 October	9 a.m. – 5 p.m.	Data processing	JSI Office	GM, SA	

Day&Date	Time	Activity	Venue	Participants	Comments
Monday, 02 October	9 a.m. – 5 p.m.	Work on debriefing and preliminary report	JSI Office	GM, SA	
Tuesday, 03 October	9 a.m. – 5 p.m.	Debriefing, next steps.	JSI Office	CTO, COP, PH, GM, JK, SAB, SA,	
Wednesday, 04 October	9 a.m.	Travel to Upper Dir		SA	Stay at Dir
Thursday, 05 October	6 a.m. – 5 p.m.	Health facilities of Upper Dir	DHQH Dir, THQH Warri & Final disposal place	SA	Stay at Dir
Friday, 06 October	9 a.m. – 5 p.m.	Health facilities of Upper Dir Travel to Peshawar	RHC Barawal	SA	Stay at Peshawar
Wednesday, 04 October	9 a.m.	Travel to Sukkur		JB	Stay at Sukkur
Thursday, 05 October	7 a.m. – 6 p.m.	Field work: Health facilities of Jafferabad	DHQH Dera Allah Yar, THQH Usta Muhammad, RHC Rojhan Jamali	JB	Stay at Sukkur
Friday, 06 October	9 a.m.	Flight to Karachi	Sukkur airport	JB	Stay at Karachi. Airport pick by hotel
Saturday, 07 October	9 a.m. – 5 p.m.	Field work: Health facilities of Lasbela	DHQH Uthal, THQH Hub & RHC Bela	JB	
Saturday, 07 October	Night	Travel to Lahore		JB	

Due to security reasons, field visits to these districts were not performed by the consultant. Visits were done by Dr. Shehzad Awan and Eng. Javed Bashir.

Annex 3. List of persons contacted

1. Rawalpindi

Facility	Name	Duty	Contact
THQH Gujjar Khan	Dr. Shahida Mir	Additional Principal Woman Medical Officer	
	Dr. Zamir Hussain Butt	Surgeon	
RHC Mandara	Dr. Khalil ullah	In-charge Medical Officer	0333-5184462
	Dr. Farzana Murtaza	Woman Medical Officer	051-3592140
	Dr. Mehfooz	Homeo Physician	
THQH Murree	Dr. Shahid Tanvir	Medical Surperintendent	0300-4310642
	Dr. Nasir Saddiqui	Surgeon	0345-5991019
	Ms Farhat Israr	Charge Nurse	
	Nadeem	Sanitary worker	

THQH Gujjar Khan. Medical staff

RHC Mandara. Medical staff

THQH Murree

2. Khanewal district

Facility	Name	Duty	Contact
DHQH Khanewal	Dr. Mohammad Rafi	Medical suprientendent	0300-6892701
	Malik Altaf Hussain	Store Keeper	
	Saleema Jan	Nursing superintendent	
	Rizwan Ahmad	Assitt. Contech Intl. District Coordinator	0333-6236863
	Ali Gohar	Store keeper dispensary	
THQ Mian Channu	Dr. Mushtaq Ahmad	Medical suprientendent	0300-6896158, 065-2660942
	Dr. Shahbaz Khan	Pediatrician	
	Hafeez ur Rehman	Office Clark	
	Rizwan Ahmad	Assitt. Contech Intl. District Coordinator	0333-6236863
RHC Kacha Khuh	Dr. Umer Farooq	In-charge Medical Officer	065-2610057
	Dr. Syed Ahad Ali Termizi	Senior Medical Officer	0300-8632606
	Rizwan Ahmad	Assitt. Contech Intl. District Coordinator	0333-6236863


EDO Health Khanewal


DHQH Khanewal. In - charge


THQH Mian Channu. In-charge


RHC Kacha Khuh. In-charge

3. DG Khan district

Facility	Name	Duty	Contact
DHQH DG Khan	Dr. Capt. Farhat Hussain	Medical suprientendent	0641-9260224-6
	Dr. Hamid Hayat	Deputy Medical superintendent	
	Syed Abdul Hamid	Sanitary Inspector	
	Dr. Sabiha Khanum	Nursing superintendent	
	Dr. Syed Sajjad Sarwar	Contech Intl. District Coordinator	0300-6782014
THQH Tounsa	Dr. Wamiq ur Rehman	Medical suprientendent	064-2006970, 064-2602970
	Dr. Sher Mohammad	Senior Medical Officer	064-2602860
	Dr. Syed Sajjad Sarwar	Contech Intl. District Coordinator	0300-6782014
RHC Choti Zaren	Dr. Abdul Karim Ramdani	In-charge Medical Officer	0345-7131769, 0642-566022
	Ghulam Sarwar	Medical Technician	
	Dr. Syed Sajjad Sarwar	Contech Intl. District Coordinator	0300-6782014


DHQ DG Khan. In-charge and medical staff


THQ Tounsa. In-charge.


RHC Choti Zerin. In-charge

4. Sukkur district

Facility	Name	Duty	Contact
DHQH Sukkur	Dr. Mumtaz Ali Mughal	Civil Engineer/In-charge	
	Dr. Hazoor Boksh Tunio	Chief Resident Medical Officer	0334-2900214, 071-5613851 (res)
THQH Rohri	Dr. Capt. Javed Ali Shiekh	Medical superintendent	0300-3154514, 071-5651115
	Dr. Agha M. Ashfaq	Contech Intl. District Coordinator	0301-3427096
	Dr. Aftab Ahmad	Pathologist	
	Dr. Zulfiqar Ali	Surgeon	
	Dr. Bushra Karim	Gynecologist	
RHC Kandara	Dr. Mir Asghar Ali	In-charge Medical Officer	071-5004392


In-charge of teaching hospital Sukkur


THQH Rhori. In-charge


RHC Kandara. In-charge

5. Jhelum district

Facility	Name	Duty	Contact
DHQH Jhelum	Dr. Shahid Tanvir	Medical suprientendent	0544-9270262
	Dr. Naseer Ahmad	Contech Intl. District Coordinator	0544-9270261
THQH Sohawa	Dr. Shoukat Mehmood	Medical suprientendent	0333-5856355
	Dr. Naseer Ahmad	Contech Intl. District Coordinator	0544-9270261
RHC Domeli	Dr. Riaz Ahmad Kayani	In-charge Medical Officer	0544-680214
	Dr. Naseer Ahmad	Contech Intl. District Coordinator	0544-9270261

6. Dadu district

Facility	Name	Duty	Contact
DHQH Dadu	Dr. Syed Ghous Ali Shah	Medical Superintendent (Civil Surgeon)	025-9200080
	Mr. Niaz Ali	Store Keeper	
	Dr. Manzoor Khoroo	Contech Intl. District Coordinator	0300-3270393
THQH Khairpur Nathan Shah	Dr. Muhammad saddique	Medical superintendent	0254-720292
RHC Seta Road	Dr. Aftab Ali Jokhio	In-charge medical officer	0301-3493382
	Dr. Syed Sikhanadar Ali Shah	DO (H) ADMN	
	Dr. Manzoor Khoroo	Contech Intl. District Coordinator	0300-3270393
	Ms. Rukhsana Qadir	LHV	


DHQH Dadu. In-charge


THQH K.N. Shah. In-charge & WMOs


RHC Seta Road. In-charge

7. Buner

<table>
<tr><th>Facility</th><th>Name</th><th>Duty</th><th>Contact</th></tr>
<tr><td rowspan="2">DHQ Daggar</td><td>Dr. Fazli Azim</td><td>Medical suprientendent</td><td></td></tr>
<tr><td>Dr. Tahir Nadeem</td><td>Field Operation Manager JSI</td><td>0300-5551236</td></tr>
<tr><td rowspan="3">THQH Chamla</td><td>Dr. Sher Zaman</td><td>In-charge Medical Officer</td><td>0939-530908</td></tr>
<tr><td>Dr. Nasim Akhtar</td><td>Woman Medical Officer</td><td></td></tr>
<tr><td>Dr. Tahir Nadeem</td><td>Field Operation Manager JSI</td><td>0300-5551236</td></tr>
<tr><td rowspan="3">RHC Jowar</td><td>Dr. Mohammad Aslam</td><td>In-charge Medical Officer</td><td>0939-551202</td></tr>
<tr><td>Dr. Sher Abdullah</td><td>Medical Officer</td><td></td></tr>
<tr><td>Dr. Tahir Nadeem</td><td>Field Operation Manager JSI</td><td>0300-5551236</td></tr>
</table>

EDO Health Buner

DHQH Daggar. In-charge

THQH Chamla. Incharge and WMO

RHC Jowar. In-charge.

8. Upper dir

Facility	Name	Duty	Contact
DHQH Dir	Dr. Sami ur Rehman	Deputy Medical Superintendant/Sr. Medical Officer	0944-881012
	Dr. Sami ullah	Pediatrician	
	Dr. Nazar Mohammad	Contech Intl. District Coordinator	0944-881618
	Mr. Mohammad Naeem	Civil sub-engineer	
THQH Warri	Dr. Sahibzada Fazal e Baseer	Senior Medical officer/Depty incharge	0945-846022
	Ghulam Hazrat	Medical Technician	
	Dr. Ikram	Medical officer	
	Abdullah Shah	Dispensar	
RHC Barawal	Dr. Rehmat ullah	In-charge Medical Officer	0944-830718
	Dr. Fazal Rahim	Medical Officer	
	Dr. Nazar Mohammad	Contech Intl. District Coordinator	0944-881618

Deputy in-charge DHQH Dir


In-charge THQ Warri and Medical Tech


In-charge RHC with other Medical officers

9. Jafferabad

Facility	Name	Duty	Contact
DHQH Dera Allahyar	Dr. Syed Mohammad Ashraf	ENT specialist	0302-3362985
	Dr. Qudrat ullah Jamali	Contech Intl. District Coordinator/SMO	0302-3680365
THQH Usta Mohammad	Dr. Sushil Kamal	Medical Superintendent	0838-400137
	Dr. Qudrat ullah Jamali	Contech Intl. District Coordinator/SMO	0302-3680365
RHC Rojhan Jamali	Dr. Sri Chand	In-charge Medical Officer	0300-3709456
	Dr. Qudrat ullah Jamali	Contech Intl. District Coordinator/SMO	0302-3680365

10. Lasbela

Facility	Name	Duty	Contact
DHQH Uthal	Dr. Ghulam Qadir	Medical Superintendent	0853-610306
	Dr. Hayat Rhonjho	Contech Intl. District Coordinator/DDHO	0300-2542494
THQH Hub	Dr. Abbas Ali Lasi	Medical Superintendent	0300-9256029
	Dr. Hayat Rhonjho	Contech Intl. District Coordinator/DDHO	0300-2542494
RHC Bela	Dr. Abdul Rasheed	In-charge Medical Officer	0301-2955282
	Dr. Hayat Rhonjho	Contech Intl. District Coordinator/DDHO	0300-2542494


In-charge DHQ Uthal


In-charge RHC


In-charge THQH

Annex 4. Detailed report of hospital waste management situation at selected facilities

4.1 Rawalpindi

4.1.1 THQH Murree

- **Handling and primary storage**

Handling and primary storage in THQH Murree is not adequate. An example can be seen in photos 1 to 4. Bins do not have bags inside, infectious and common wastes are mixed, both solid and liquid; and in some cases together with sharps (photo 4). This is a general practice all over the facility.

Photo 1: Waste bin in the labor room

Photo 2: Waste bin in the laboratory

Photo 3: Waste bin in male surgical ward

Photo 4: Waste bin in female ward

There are safety boxes in the vaccination center, but they are not properly used (see photo 5). Sharps mixed with general wastes (like paper), are disposed in these boxes. In some places wastes are disposed in the floor, like in the nursing station (see photo 6).


Photo 5: Safety box in vaccination center


Photo 6: Nursing station

- **Internal collection**

There is no proper collection and transportation system. The employees take all the wastes by themselves to the disposal place.

- **Central storage**

There is no a central storage place for solid waste. The wastes are scattered in many places as can be seen in photos 7 to 9.

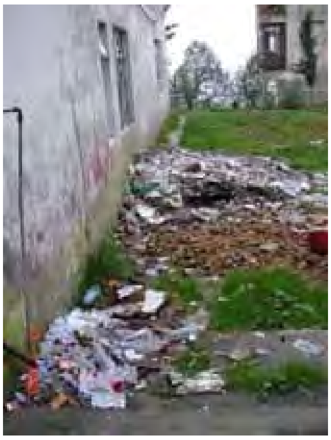


Photo 7: Scattered wastes


Photo 8: Bulky waste


Photo 9: Outside dental unit

- **Treatment**

There is no treatment system. According to the hospital staff, the possibility of recycling is very high but it needs to be analyzed.

- **Final disposal**

There is not an adequate final disposal of hospital wastes. The solid wastes (risk and non-risk) are thrown into an open drain where it goes with the wastewater and rain water to an unknown destination, as can be seen in photos 10 to 12.

Photos 10 - 12: Views of open drain used as final disposal place

4.1.2 RHC Mandara

- **Handling and primary storage**

Bins were used without bags and infectious and common wastes were mixed inside. The inappropriate use of the bins can be seen in photos 13 and 14.

Photo 13: Bin at female ward

Photo 14: Bin at laboratory

- **Central storage / Final disposal**

The central storage place (that is also the final disposal site) was inaccessible. It needs earth filling and leveling around, as can be seen in photos 15 and 16. The hospital employees carry all the generated wastes to the central storage place by themselves. There are not means of transportation. Some scavengers used to recover waste before the construction of the boundary wall.

Photo 15: Central storage area and final disposal place

Photo 16: Unused central storage area covered by vegetation

4.1.3 THQH Gujjar Khan

- **Handling and primary storage**

Some waste bins have plastic bags inside, which are wrapped around and are retained and reused, while the bins are being emptied (see photo 17). Other bins have plastic bags outside instead of inside the bin (see photo 18).

Photo 17: Waste bin at the female general ward

Photo 18: Waste bin outside the female general ward

Most of the waste bins do not have plastic bags and are not used appropriately as can be seen in photos 19 and 20.

Photo 19: Waste bin at dressing room

Photo 20: Waste bin at X - ray dark room

- **Central storage**

The central storage place is located near the septic tank and it is an open area where all the wastes are scattered and mixed, as can be seen in photos 21 to 24. There was a cat stepping on the solid wastes.

Photos 21 and 22: Central storage area, near the septic tank

Photo 23: Wastes scattered

Photo 24: Cat in the central storage area

- **External collection**

The external collection is made by the municipality. A truck is used to transport all the generated wastes, mixed with municipal wastes, as can be seen in the photos 25 and 26.

Photos 25 and 26: Municipality transportation truck

- **Final disposal**

The final disposal place is located near residential houses (see photo 27) and there are children looking for recyclables, as can be seen in photo 28.

Photo 27: Final disposal place

Photo 28: Presence of children

4.2 Sukkur

4.2.1 RHC Kandara

The in–charge medical officer stated that has been working for 19 years at Kandara hospital but has never received training on hospital waste management. There is also no trained person for the laboratory at the present; because the last laboratory technician was transferred 3 months ago. The medical staff encourages not using injections unless it is necessary.

- **Handling and primary storage**

Waste bins are used, with no bags inside. All wastes (infectious, general) are mixed. The inappropriately use of the bins can be seen in photos 29 and 30.

Photo 29: Waste bin at dental section

Photo 30: Waste bin at emergency room

- **Internal / External collection**

There is no a formal internal collection system, neither an external collection system.

- **Central storage / Final disposal**

In the central storage place, which is also the final disposal place, wastes are all scattered in open air, as can be seen in photos 31 and 32.

Photo 31: Central storage - final disposal place

Photo 32: Disposal place outside ward

4.2.2 DHQH Sukkur

It was stated that the civil surgeon and chief resident medical officer have received training for hospital waste management but they can not conduct any kind of training to the hospital staff or practice a good waste management due to lack of resources (technical and financial).

Despite of being an EPA office located in Sukkur, solid waste is dumped everywhere in the city and also disposed near and in open sewerage drains, which can be clogged. An example of this situation can be seen in photos 33 and 34, where wastes are scattered at the streets.

Photo 33 and Photo 34: Solid wastes scattered everywhere in the city

- **Handling and primary storage**

There is a cutting device that cut the needles and then they are emptied into plastic bags or boxes (photo 35). This plastics bags or boxes are taken to the disposal site. Bins are not appropriately used, as can be seen in photos 36 to 40.

Photo 35: Syringe needle cutter

Photo 36: Waste bin in Blood bank

Photo 37: Waste bin in children ward

Photo 38: Waste bin in female ward

Photo 39: Waste bin in laboratory

Photo 40: Waste bin male ward

- **Internal collection**

The internal collection is made by the hospital staff in bare hand, with no personal protection equipment: no gloves, apron, boots, mask (see photos 41 and 42). They are exposed to several health risks.

Photo 41: Sanitary worker

Photo 42: Sanitary worker holding waste bin after emptied

- **Treatment**

There is no treatment for hospital waste at this facility. Hospital staff informed that an incinerator has been requested with no response yet. They also need an autoclave for sterilization of medical equipment.

- **External collection**

It was informed that external collection is done by the Municipality once a week, after repeated requests and when the stored waste has significant amounts.

- **Central storage / Final disposal**

The central storage place (also the final disposal site) is located near the community residential area within the hospital, where there is an evidence of waste burning (photos 43 and 44). The final disposal site for community and hospital solid waste is located in front of a water treatment plant. In a future, this site will be used to construct wards and there will be no place for central storage.

Photo 43: Central storage and final disposal site

Photo 44: Open air burning at the central storage place

Near the final disposal site there is a municipal open dump, where scavengers look for recyclables and animals are fed (see photos 45 and 46).

Photo 45: Municipal open dump

Photo 46: Scavenger and animals at open dump

4.2.3 THQH Rohri

- **Handling and primary storage**

Wastes stored in bins without bags are transferred into plastic bags which are re–used after emptying them (photos 47 to 50). Needles are cut with a cutting device which retains the cut needles and are taken into plastic bags or box to the disposal site (photo 51).

Photos 47 – 49: Waste bins in laboratory, male ward, and labor room

Photo 50: Waste bin at nursing station

Photo 51. Needle cutter - emergency room

- **Central storage**

There is no a proper central storage place.

- **External collection**

It was informed that collection and transportation of hospital waste is performed by the municipality.

- **Treatment**

There is no a treatment system.

- **Final disposal**

Laboratory and operation theater waste have been dumped into a trench for open air burning (photo 52). The hospital employee stepped into the trench without tools or personal protection equipment. A final disposal site is located adjacent to main gate (photo 53)

Photo 52: Sanitary worker burning waste in trench - bare handed

Photo 53: Final disposal site adjacent to main gate

4.3 Dadu

4.3.1 DHQH Dadu

- **Handling and primary storage**

Bins in the ward and laboratory are damaged and not used properly (no bags inside, mixed wastes, solid and liquid), as can bee seen in photos 54 and 55.

Photo 54: Waste bin in ward

Photo 55: Waste bin at laboratory

- **Internal collection**

Hospital staff informed that an open cart is used for internal collection but it could not be seen because it was under lock and key.

- **Central storage**

There is no central storage place. Wastes are scattered in several open areas as can be seen in photos 56 and 57.

Photos 56 and 57: Views of the central storage area, from a balcony

- **Treatment**

There is no treatment system.

- **External collection**

It was informed that external collection is made by the Municipality in a daily basis. However, it does not seem to be true because there was a huge amount of hospital wastes at multiple sites within the premise.

4.3.2 THQH Khairpur Nathan Shah

The in–charge of the facility states that a person for hospital waste management is needed.

- **Handling and primary storage**

Bins are damaged, without bags and wastes are mixed inside. There was no waste bin in the examination room. It was informed that in the labor room, placentas are collected in plastic bags for disposal. And in the laboratory the bins are used without bags inside as can be seen in photos 58 and 59.

Photo 58 and 59: Waste bins in laboratory and maternity OPD (with used disposable gloves)

- **Internal collection**

Hospital staff informed that some arrangements for internal collection were made but it was not shown. It is presumed that the bins are emptied directly to the multiple central storage places inside the premise (that are also final disposal places).

- **Central storage**

Solid wastes were disposed in open areas within the premise, near the wards and septic tank. Some wastes are disposed around the open space across maternity block, as can be seen in photo 60 and there are solid wastes behind MCH Center (photo 61).

Photo 60: Waste disposed across maternity block

Photo 61: Solid waste behind MCH Center

- **External collection**

There was no external collection and transportation of solid waste.

- **Final disposal**

Scattered wastes are burnt in open air as can be seen in photo 62.

Photo 62: Open air fire of solid waste

4.3.3 RHC Seta Road

In–patients do not stay overnight; they go home and return next morning for treatment. For advanced treatment they are referred to Tehsil or district hospitals.

- **Handling and primary storage**

Plastic, metal, or cardboard bins are used, which are damaged. A cardboard box can be seen in photo 63, used as a waste bin. Furthermore, the used syringes were not stored appropriately (photo 64).

Photo 63: Box used in dispensary

Photo 64: Inappropriate storage of used syringes in a window

- **Internal collection**

Internal collection is made through a damaged cardboard box.

- **Central storage**

There is no central storage place. After collection, solid wastes are disposed, since long time ago, outside the boundary wall where, surface water was present.

- **Treatment**

There is no treatment system. A written request signed by the District Officer, Administration Accounts and Development, Health Department Dadu was given for incinerator.

- **External collection**

There is no external collection system.

- **Final disposal**

Final disposal is made outside the hospital and scattered wastes are placed near the water, as can be seen in photos 65 and 66.

Photos 65 and 66: Final disposal place

4.4 Buner

4.4.1 THQH Chamla

- **Handling and primary storage**

There are metal, plastic and cardboard bins, which are damaged and without bags. Wastes are mixed inside (see photos 67 and 68).

Photo 67: Waste bin in emergency room

Photo 68: Waste bin in female ward

- **Treatment**

There is no treatment system in this facility. Wastes are burnt in open air at several places within the premise. Placenta is given to the patients who bury it near their premises. Syringes go out of the hospital and are not burned inside.

- **Central storage / Final disposal**

Wastes are scattered and disposed of within the premise in several places. Final disposal places have no fence or boundary, wastes are disposed at multiple sites and was found burnt near general ward, as can be seen in photo 69. Photo 70 shows a nurse after emptying a waste bin near pit toilets.

Photo 69: Final disposal site with open air burning waste

Photo 70: Birth attendant disposing waste near pit toilets

4.4.2 DHQH Daggar:

The in–charge of the facility considers that waste must not be sold to prevent infections' spread. They have requested 50 sanitary workers since 2002 but without any response. Only five workers have been posted to look after this huge hospital.

- **Handling and primary storage**

Bins are not properly used, no bags inside and wastes are mixed, as can be seen in photos 71 and 72.

Photo 71: Waste bin in labor room

Photo 72: Waste bin outside children ward

- **Internal collection**

It was stated that an open cart is available for internal collection and transportation but it was not shown.

- **Central storage / Final disposal**

Solid wastes are collected in the corridors of the wards and transported to the central storage place which is also the final disposal place (photos 73 and 74). Waste was found disposed out of the bounded area of this place and a sanitary worker was handling and moving waste with a piece of wood and no personal protection equipment. Scavengers recover waste from the hospital central storage place.


Photos 73 and 74: Final disposal site

- **External collection**

There is no external collection and transportation system.

4.4.3 RHC Jowar:

- **Handling and primary storage**

Plastic, metal, and cardboard bins are used, many of them are damaged. No bags inside bins and wastes are mixed (see in photos 75 to 78).


Photo 75: Bin for burnig syringes in emergency room


Photo 76: Bin under delivery table


Photo 77: Waste bin in lab


Photo 78: Waste bin in vaccination room

- **Treatment**

There is no treatment system. Solid wastes are burnt in open air after two or three days, syringes and needles are burnt in a metallic container. It was informed that plastic is segregated and sold for medicines and cotton for the patients.

- **Central storage / Final disposal**

Wastes are disposed in open air where there are children playing around, as can be seen in photo 79. Waste bins are directly emptied into the final disposal site (photo 80) within the facility, located adjacent to the residence of the dental surgeon.


Photo 79: Children playing around storage place


Photo 80: Final disposal place

4.5 Khanewal

4.5.1 DHQH Khanewal

- **Handling and primary storage**

The interim storage is performed in big blue plastic bins which are placed outside the wards as can be seen in photo 81. Cardboard boxes are prepared to storage sharps, but it is difficult to put syringes in these rigid containers without pushing the small inlet's cover (photo 82), furthermore the nursing staff was not able to explain how they empty those containers, which are retained for re-use.


Photo 81: Interim storage

Photo 82: Used syringe disposal devise

The used syringes are placed everywhere like for example in the laboratory and they are put in plastic boxes, as seen in photos 83 and 84.


Photo 83: Used syringes with blood


Photo No. 84: Syringe in plastic bag

- **Central storage / Final disposal**

The syringes and needles were found mixed at multiple central storage places (and also final disposal place) as can be seen in photos 85 and 86.



Photo 85 and 86: Mixed waste and open air burn-central storage place

There is also a burner at the central storage place constructed to burn syringes (photo 87). It seems that has never been used because was very clean, instead the wastes are burnt around as seen in photo 88.


Photo 87: Reported burning site for used syringes and needles


Photo 88: Open-air waste burning

- **Treatment**

There is no treatment system in this facility. The cutter needle devices are placed in some wards (photo 89) and once full, they are emptied into a metallic bucket for disposal, as can be seen in photo 90. There is a burner for sharps that is used regularly, however, during the visit the burner was found clean, without evidence of burning.

Photo 89: Used syringe disposal devise and needle cutter

Photo 90: Metallic bucket reported for collection of used needles

- **External collection**

The municipality conducts external collection once a week but waste was seen disposed at multiple sites in significant quantities.

4.5.2 RHC Kacha Khuh

- **Handling and primary storage**

There are no available bins at most places in the facility for waste collection. The community is not educated and people throw waste on floor even if there is a bin. In other cases, the bins are incorrectly used as seen in photos 91 and 92.

Photo 91: Mixed waste bin in female ward

Photo 92: Used syringes in vaccination room

- **Internal collection**

Internal collection is performed with a container without wheels but it was not shown.

- **Central storage / Final disposal**

Bins are taken directly to the central storage place for emptying. All the waste is scattered and burnt in an open area as can be seen in photos 93 and 94.


Photo 93: Central disposal site


Photo 94: Open air fire

The central storage is also used as final disposal area where the children of the hospital staff play, as can be seen in photo 95.


Photo 95: Children playing around hospital waste (barefoot girl)

- **External collection**

There is no external transportation system.

4.5.3 THQH Mian Channu

- **Handling and primary storage**

Handling and primary storage is inadequate. Wastes are mixed in the bins, as can be seen in photos 96 and 97.


Photo 96: Mixed waste-bin in surgical ward


Photo 97: Mixed waste-bin in female ward

- **Internal collection**

Internal collection of solid waste is performed by an open cart but was not shown, presuming that this cart does not exist.

- **Central storage**

In the central storage the wastes are all scattered in an open area as can be seen in photo 98. Many needles were found in this area mixed with other wastes (photo 99).


Photo 98: Scattered waste


Photo 99: Used needles

- **Treatment**

There is no treatment system. Recycling is possible but it needs to be analyzed.

- **External collection**

External collection is made by Municipality but only after several requests.

4.6 Dera Ghazi Khan

4.6.1 DHQH Dera Ghazi Khan

This Hospital is now being extended from 250 beds capacity to 450 beds.

- **Handling and primary storage**

Waste bins were not available with each bed in the ward and contained mixed waste inside (photo 100). Interim storage is performed in plastic drums placed outside the wards with wheels that are emptied daily.


Photo 100: Mixed waste in bin and on floor corridor of female ward

Needle cutter is used for storing syringes and needles instead of its purposeful use at the nursing station of female ward (photo 101). An empty cardboard is used to put the used needles as can be seen in photo 102.


Photo 101: Needle cutter


Photo 102: Used needles

- **Internal collection**

It was stated that internal collection is performed by an open cart that was not shown.

- **Central storage**

There are many areas used as central storage. Wastes are disposed in open air, where are also burnt as can be seen in photos 103 and 104.


Photo 103: Mixed waste


Photo 104: Open air fire

- **Treatment**

There is no treatment system functioning is this facility. There is a burner constructed to burn solid waste but is not operating now (photo 105). It is a single chamber burner not suitable for hospital waste treatment. Some parts of this burner have been stolen by the addicts as informed by the hospital staff.

Photo 105: Waste burning area

- **External collection**

The external collection is made by the Municipality each Saturday.

- **Final disposal**

The final disposal site for municipal and hospital waste is located at the edges of a large open drain passing across the city, as can be seen in photo 106. There is open fire at different places along the drain.

Photo 106: Final disposal site

4.6.2 THQH Tounsa:

- **Handling and primary storage**

Waste bins were not available with each bed in the ward. Many of the bins contained all type of solid waste (injections, syringes, ect.) as can be seen in photos 107 and 108.

Photo 107: Used injections

Photo 108: Used syringes in emergency treatment area

- **Internal collection**

The internal collection is performed by a closed cart. Only two carts were seen in the entire facility.

- **Central storage**

Central storage place is in a private property that has been already sold. In this place all the waste are scattered as can be seen in photo 109. There are also used open needles all over the area as seen in photo 110, and open air burns in the central storage place (photo 111).

Photo 109: Central storage place

Photo 110: Used open needles at Central storage place

Photo 111: Central storage place with open air burn

- **External collection**

Solid wastes were dumped just outside the boundary of hospital in a deep-seated piece of land which has now been filled with waste. They have now made arrangement for external transportation by municipality.

4.6.3 THQ Choti Zerin:

- **Handling and primary storage**

Solid waste including syringes, sharps and needles were scattered around, as seen in photos 112 and 113.

Photo 112: Bin with sharps

Photo 113: Used syringes-bin in laboratory

- **Central storage / Final disposal**

The central storage place (also the final disposal site) is located just behind the staff residential area over the open area. Wastes are burnt here (photos 114 and 115).

Photo 114: Central storage place

Photo 115: Open air fire

- **Final disposal**

It was informed that this facility has a trench for disposal of solid waste but it was incorrect.

4.7 Upper Dir

4.7.1 DHQH Dir

During winter season, the number of patients decreases because of cold. A heating system is required for this hospital.

There are not expired medicines. The hospital staff keeps a record of all the medicines.

- **Handling and primary storage**

Solid wastes were found on the floors of the treatment areas. Many of the bins have mixed waste inside as can be seen in photo 116; the boxes are used to put all kind of wastes (photo 117).

Photo 116: Bin with mixed waste in emergency treatment room

Photo 117: Waste bin in laboratory

- **Central storage**

Solid wastes were scattered all over the open area adjacent to the central storage place (photo 118). There are also open air burns in this place (photo 119).

Photo 118: Scattered waste

Photo 119: Open air burn

The central storage place is within the premises of the hospital and is adjacent to the overhead water reservoir, as can be seen in photo 120.

Photo 120: Central storage place below overhead water reservoir

- **Treatment**

There is no treatment system.

- **External collection**

There is no arrangement between the municipality and the hospital to transport or dispose the generated waste. Occasionally and after repeated requests, the municipality tractor trolley transports the waste.

4.7.2 THQH Warri

Only normal deliveries are conducted and minor surgical procedures are performed in the hospital. The pharmacy, like all other visited health facilities, serves the purpose of storing medicines. There are only three sanitary workers in the morning shift and no sanitary worker is available during evening or night working shifts.

- **Handling and primary storage**

There was no waste bin in the male ward except a carton for waste collection. Also, one large steel bin was placed in the female ward for all the patients use, it contained used syringes and other types of medical and general waste (photo 121).

Photo 121: Used syringes and other solid waste

- **Central storage / Final disposal**

It was informed that the sanitary worker empties the contents into reusable garbage bags with bare hand for transportation to central disposal site. In this place the solid wastes were scattered around the residences of hospital staff, despite there are multiple storage sites within the premises of hospital. The central disposal site is located behind the male ward and x – ray room, within the hospital premises, and it is also the final disposal site.

Photo 122: Old central storage place

- **Treatment**

There is no treatment system. Placenta is always demanded and taken away by the attendants of delivering mother for burial.

- **External collection**

There is no arrangement from municipality for transportation or disposal of waste generated in the hospital.

4.7.3 RHC Barawal

The sanitary staff is available only in the morning shift.

- **Handling and primary storage**

There were no proper waste bins and the wastes are mixed inside them (photo 123 and 124)

Photo 123: Used syringes in bin of Laboratory

Photo 124: Waste bin with medical and sharp waste in emergency treatment room

- **Central storage**

Waste bins are emptied directly into the multiple central storage places within the promises of health center, once in the morning time. The waste was found scattered all around staff residences, as can be seen in photos 125 and 126.

Photo 125: Mixed waste

Photo 126: Hospital waste scattered

- **Final disposal**

The final disposal site is behind the maternal and child health center where the waste is scattered and burnt (photo 127).

Photo 127: Disposal site

4.8 Jhelum

4.8.1 DHQH Jhelum:

A waste segregation should be initiated to prevent spreading diseases.

- **Handling and primary storage**

The metallic buckets are used as waste bins. These buckets do not have plastic bags inside and waste is not segregated, as can be seen in photos 128 and 129.

Photo 128: Mixed hospital waste in bin-labor room

Photo 129: Waste bin-maternity ward

- **Internal collection**

The internal collection is performed with an open wheeled cart in the morning and evening hours (photo 130)

Photo 130: Internal collection cart

- **Central storage**

The central storage is an open air area with brick outskirts. In this area the waste is burnt as can be seen in the photo 131.

Photo 131: Open dump open fire within hospital premises

- **External collection**

The municipality performs external transportation of waste but on fortnightly basis and therefore they have to burn mixed waste in open air.

- **Final disposal**

In the final disposal place, the hospital waste is mixed and burnt with the community waste (photo 132). The scavengers live nearby the final disposal site and do recovery of recyclables as can be seen in photo 133.

Photo 132: Final disposal site

Photo 133: Scavenger residing nearby final disposal site

4.8.2 THQH Sohawa

The in-charge staff of the facility reported a segregation of waste but it could not be confirmed.

- **Handling and primary storage**

Waste bins had plastic bags in most of the places (photos 134 and 135). It therefore seems that plastic bags are retained in the bins.

Photo 134: Mixed waste in bin at male ward

Photo 135: Used syringes in bin at Maternity ward

- **Internal collection**

Internal collection is done three times daily with reusable garbage bags.

- **Central storage**

The central storage place in an open air area and a pit was nearby for disposal of waste. Mixed waste is also disposed just outside the boundary wall as 2nd central storage place (photo 136).

Photo 136: Central storage place outside boundary wall of hospital

- **Treatment**

There is no treatment system in this facility. The x-ray film developing chemical waste is buried in ground within the hospital premises.

- **External collection**

The Municipality performs external transportation of the waste once in a fortnight basis on an open back tractor trolley but it appeared very irregular.

- **Final disposal**

The final disposal site is within the hospital premises. The wastes were all scattered as can be seen in photo 137.

Photo 137: Final disposal site

4.8.3 RHC Domeli

Only one sanitary worker is posted in the facility that performs duty in the morning shift only.

- **Handling and primary storage**

The waste bins were not available at most of the places.

- **Internal collection**

There is no internal collection in this facility.

- **Central storage**

Waste bins are emptied directly to central storage place once in the afternoon. The central storage place is also the final disposal place.

- **Treatment**

There is no treatment system. It was reported that the waste is burnt in an open air area and then buried within the facility premises.

- **External collection**

There is no arrangement for external transportation by town committee.

4.9 Jafferabad

4.9.1 DHQHDera Allahyar:

- **Handling and primary storage**

There were no proper waste bins available in the hospital and most of the bins were very old. The wastes are not segregated as can be seen in photos 138 and 139.

Photo 138: Used syringes in damaged bin at maternity ward

Photo 139: Waste bin in male ward

- **Central storage**

The central storage is open to the air with brick outskirts. It was located just behind the maternity ward (photo 140).

Photo 140: Central storage place

- **External collection**

The municipality performs external transportation of waste on a weekly basis in an open back tractor trolley.

- **Final disposal**

There is a pit for disposal and burial of waste within hospital premises, as can be seen in photo 141.

Photo 141: Place for final disposal

4.9.2 THQ Usta Mohammad:

It is the oldest hospital amongst the selected health facilities.

- **Handling and primary storage**

Waste bins are old, damaged, and are not used properly (no bags inside). Wastes are all mixed, like syringes, as can be seen in photo 142.

Photo 142: Used syringes mixed with other waste in maternity ward

- **Central storage / Final disposal**

Waste bins are directly emptied into the central storage place (also the final storage place) within the hospital premises, as can be seen in photo 143. There are also cattle eating in this place (photo 144)

Photo 143: Central storage place with open-fire

Photo 144: Cattle feeding and open-air fire at final disposal

4.9.3 RHC Rojhan Jamali

Only one sanitary worker is posted in the facility that performs duty during the morning shift.

- **Handling and primary storage**

Waste bins were not available at most places. Most of them do not have bags inside and the wastes are mixed as can be seen in photos 145 and 146.


Photo 145: Used injections and waste in dressing room


Photo 146: Waste bin outside female OPD

- **Internal collection**

There is no a formal internal collection system in this facility. The hospital staff carries the waste bins to the central storage place.

- **Central storage / Final disposal**

Waste bins are emptied directly to the central storage place once in the afternoon. The wastes were found scattered in the open area of the hospital courtyard, as can be seen in photo 147. The central storage is also the final disposal place.


Photo 147: Hospital waste scattered

- **External collection**

There is no arrangement for external transportation by town committee.

4.10 Lasbela

4.10.1 DHQH Uthal:

- **Handling and primary storage**

There were not proper waste bins available in the hospital and most of the bins needed to be replaced. Also, waste is not segregated (photos 148 and 149).

Photo 148: Used syringes & glass slides in Laboratory

Photo 149: Waste bin in male ward

- **Internal collection**

The internal collection is performed with an open wheeled cart twice a day, but it was not shown.

- **Central storage**

Central storage is open to the air. In this place wastes are scattered as can be seen in photos 150 and 151.

Photo 150: Central storage place just outside boundary wall of hospital

Photo 151: Open air fire at central storage place

- **External collection**

Municipality performs external transportation of waste on a weekly basis in an open back tractor trolley but the condition of the central disposal site within the hospital premises disproved it.

- **Final disposal**

The final disposal site was close to the residential area of the town. The wastes were dumped into open air where is burnt. There was a goat feeding in this place (photo 152).

Photo 152: Final disposal site

4.10.2 THQ Hub:

It is probably the most recently constructed hospital amongst the selected ones. There was no sanitary worker posted in this hospital since long time and a worker is hired time to time for hospital cleaning.

- **Handling and primary storage**

Wastes are all mixed inside the waste bins as can be seen in photos 153 and 154. The waste bins do not have bags inside also.

Photo 153: Bin in corridor OPD

Photo 154: Bin in Gyne OPD

- **Internal collection**

Internal collection is made with the reusable garbage bags. Interim storage is reported but this is not actually practiced and there was no such place available.

- **Central storage**

A municipality bin is used as central storage place, where the wastes are all mixed as can be seen in photo 155.


Photo 155: Municipality bin

- **External collection**

The municipality has provided a waste bin which is transported by the municipality on a fortnightly basis.

4.10.3 RHC Bela

- **Handling and primary storage**

Waste bins were not available at most places. A disposable syringe was found in one of the bins as can be seen in photo 156. Also there was mixed waste inside the bins, as can be seen in photo 157.


Photo 156: Used syringe in maternity ward


Photo 157: Waste bin in pediatrics ward

- **Internal collection**

It was informed that internal collection is performed with an open wheeled cart but it was not shown.

- **Central storage**

Central storage place is an open area where all the solid wastes were found scattered.

- **External collection**

The municipality performs the external transportation (only after many requests) in an open back tractor trolley usually in a fortnightly basis.

Annex 5. Detailed report of water supply and wastewater management at selected facilities

5.1 Rawalpindi

<table>
<tr><th colspan="2">THQ Hospital Murree</th></tr>
<tr><th>Drinking water supply</th><th>Wastewater management</th></tr>
<tr><td>Overhead reservoirs are shown in first picture. The second one shows water supply pipes near to toilet pipes and open drain for wastewater. Risk of water contamination.

Over head reservoirs

Water supply pipes</td><td>There is no municipal sewerage, only open drains. Open drains are also used for solid waste disposal and were covered with all kind of wastes (infectious, special, general).

Hospital open drain</td></tr>
<tr><th colspan="2">Recommendations</th></tr>
<tr><td>Regular drinking water testing</td><td>Construction of a proper wastewater treatment system.</td></tr>
<tr><th colspan="2">RHC Mandara</th></tr>
<tr><th>Drinking water supply</th><th>Wastewater management</th></tr>
<tr><td>According to hospital staff, wells chlorination in all union councils is conducted by the TMA and for that reason a water testing is not required. Within the premises there is an over head reservoir and water well.

Water well and overhead reservoir</td><td>A septic tank was reported to be there but was not visible. Furthermore, the system for the final disposal of sewer waste is inadequate and infiltrates into the ground from the septic tank.</td></tr>
</table>

Recommendations	
Regular drinking water testing	Assessment of existing septic tank and making it functional. Construction of a soakaway system.
THQ Hospital Gujjar Khan	
Drinking water supply	**Wastewater management**
Drinking water is supplied by Municipality. The Overhead reservoir can be seen in the picture. No policy of monitoring. Never requested for water testing. Frequency of cleaning OHR is more than year.  Overhead reservoir	The septic tank has a damaged cover; it was filled with solid waste. Collection tank for sewer waste is uncovered. The septic tank is located adjacent to the central storage place. All the chemical and biological wastes are drained into the sewer of the laboratory.   Septic tank and collection tank
Recommendations	
Regular drinking water testing	Assessment of existing septic tank and making it functional. Also the construction of a soakaway system.

5.2 Sukkur

RHC Kandara	
Drinking water supply	**Wastewater management**
Drinking water is provided by the municipality, but it is hard water that contains suspended solids and it is not potable. The hospital staff reported that the water supply was insufficient and with	A septic tank used to be there when the building was being constructed, but now its walls are broken and do not work. The wastewater remains within the premise and infiltrates underground.

low pressure and have to transport water from other sources by themselves. No policy of monitoring. Never requested for water testing. It was also reported that the OHR was being cleaned quarterly, but it does not seem to be true.	 Septic tank
Recommendations	
Regular drinking water testing. Drinking water filtration and softening is required.	Construction of a proper septic tank and a soakaway system
DHQ Hospital Sukkur	
Drinking water supply	**Wastewater management**
Drinking water has a poor quality and has no filtration system. No testing, no policy of monitoring. Never requested for water testing.	The wastewater goes directly to the municipal sewerage and is also present around solid wastes.  Hospital sewer open drain
Recommendations	
Regular drinking water testing. Drinking water filtration and softening is required.	Construction of a proper wastewater treatment system.
THQ hospital Rohri	
Drinking water supply	**Wastewater management**
Drinking water is provided by a municipal supply, but does not have a filtration system available. It was tested once and was reported as contaminated. The population is advised to use boiled water, but not every one can afford it.	The sewer waste is drained directly into municipal sewerage through a septic tank which was containing solid waste.

 Water storage tanks-underground and overhead	 Septic tank full of sludge
Recommendations	
Regular drinking water testing. Drinking water filtration and softening is required.	Construction of a proper septic tank may be executed under PAIMAN. Also construction of a soakaway system

5.3 Dadu

DHQ hospital Dadu	
Drinking water supply	**Wastewater management**
There is no OHR for drinking water and there is only two sources of water: • The borehole water (hard water) is for cleaning purposes. Inside the hospital there are multiple water reservoirs, which have never been cleaned, for storing borehole water at the roof of different blocks. There are 15 boreholes at all. • The municipality water is supposedly for drinking but has dark color, a strong sewerage smell and is used sometimes after boiling. The whole population uses this water for drinking, but not all of them can afford boiling water. No written request has been made for water testing.	Wastewater is collected and pumped out into open municipal drains without any treatment. The sewerage of the children ward was chocked and the wastewater was being disposed on an open surface  Chocked sewer lines
Recommendations	
Regular drinking water testing. And drinking water treatment and softening is required	Construction of a proper wastewater treatment system.
THQ Hospital Khairpur Nathan Shah	
Drinking water supply	**Wastewater management**
There is a reservoir for water storage that has multiple leakages and has never been cleaned. There is a newly constructed water reservoir which has not been used since its construction about one year ago and has not been connected to the municipal water supply yet. Municipal water supply pressure is very low and	Septic tank is damaged and there is no soakage pit, for that reason the wastewater infiltrates into the ground. Sewer lines and manholes needed to be replaced.

water must be pumped and stored at a higher place while the newly constructed reservoir is just 2 or 3 feet above the ground level.  Leakage in overhead reservoir	 Chocked sewer lines and manholes
Recommendations	
Regular drinking water testing. Drinking water treatment and softening is required	Construction of a proper septic tank along with a soakaway system.
RHC Seta Road	
Drinking water supply	**Wastewater management**
Municipal water is collected in underground tanks and is pumped into a water storage tank that is about 2 or 3 feet above the ground level, just above the underground tank. This water was not potable and was being stored in under ground tank before pumping to a tank for drinking. It was informed that there is another source of drinking water supply outside the hospital but was not municipal supply. Water sample was sent about 5 months ago on advice of EDO Health but no feedback has been received. It was informed that EDO Health advised for water testing on orders of Director General Health Sindh.  Municipal supply	There is no final disposal system for wastewater, it infiltrates into the ground through the septic tank.

 Drinking water from other source	
Recommendations	
Regular drinking water testing. And drinking water treatment and softening is required	Construction of a proper septic tank along with a soakaway system.

5.4 Buner

THQ Hospital Chamla	
Drinking water supply	**Wastewater management**
The in–charge personnel informed that water quality is good and safe for drinking. There is an overhead reservoir within the premises.  Overhead reservoir	The only septic tank that was visible is completely covered by concrete, has no soakage pit and the wastewater infiltrates into ground. It was also informed that there was a separate septic tank with each building in the hospital but these have been buried since long time ago and now their locations are not even known.  Septic tank Because the level of the hospital is lower than the area around, the rain water is confined in hospital and there were problems of water drainage.
Recommendations	
Regular drinking water testing	Construction of a proper septic tank along with a soakaway system.
DHQ Hospital Daggar	
Drinking water supply	**Wastewater management**
The hospital had its own source of water from borehole and hospital staff said that	The hospital wastewater needs septic tanks because the existing ones are

<table>
<tr><td>drinking water is good. However, wastewater infiltrates into the ground and it could be polluting drinking water source, since they get water from boreholes.

There are 2 OHR of 10000 gallons each one and since four years they have never been cleaned because there is no regular schedule for this purpose, except when the hospital staff feel that water has some odor or change in taste.</td><td>becoming full of sludge. There is an open drain that is partly full with wastes.


Open drain</td></tr>
<tr><td colspan="2">Recommendations</td></tr>
<tr><td>Regular drinking water testing. Drinking water assessment.</td><td>Construction of a proper wastewater treatment system.</td></tr>
<tr><td colspan="2">RHC Hospital Jowar</td></tr>
<tr><td>Drinking water supply</td><td>Wastewater management</td></tr>
<tr><td>The in–charge personnel of the facility informed about the acute shortage of drinking water. The head reservoir had not been used for 12 years because there are not means to fill the reservoir and water quantity is also not enough. About 4 years ago they constructed a small OHR for water storage purposes and it is functioning actually.</td><td>There is an open wastewater drain of the community passing across the facility which is usually chocked with solid waste especially during rainy season. According to the medical staff opinion, there is a septic tank with no problem of sewer management because wastewater infiltrates very easily.


Community open drain at its exit from RHC</td></tr>
<tr><td colspan="2">Recommendations</td></tr>
<tr><td>Regular drinking water testing. Drinking water assessment.</td><td>Construction of a proper septic tank along with a soakaway system.</td></tr>
</table>

5.5 Khanewal

DHQ Hospital Khanewal	
Drinking water supply	**Wastewater management**
Water testing have never been requested, except seven months ago when water was informally tested (not biological, just physical-chemical analysis) and it was reported to be fit.	The wastewater produced in the X ray area is disposed into the sewer.  X ray film developing area
Recommendations	
Regular drinking water testing. Drinking water assessment.	Construction of a proper wastewater treatment system.
RHC Hospital Kacha Khuh	
Drinking water supply	**Wastewater management**
The overhead reservoir is cleaned by the sanitary worker.  Overhead water reservoir	Wastewater is disposed in an open drain connected to municipal open drain.  Wastewater collection tank
Recommendations	
Regular drinking water testing. Drinking water assessment.	Assessment of newly constructed septic tank and construction of a proper soakaway system.
THQ Hospital Mian Channu	
Drinking water supply	**Wastewater management**
Water supply was through a borehole and it was informed that water quality is satisfactory.	The in-charge personnel of the facility reported the management of broken sewerage pipes as main environmental problem, now they have arranged Rs 1.4 million from district government for sewerage and water supply. Septic tank is partially functional. It needs reparation.

	 Water supply pipes
Recommendations	
Regular drinking water testing. Drinking water assessment.	Assessment of newly constructed septic tank and construction of a proper soakaway system.

5.6 Dera Ghazi Khan

DHQ Hospital Dera Ghazi Khan	
Drinking water supply	**Wastewater management**
The in-charge personnel of the hospital informed that the most important problem is related to drinking water. There are two sources of water. The first one is from the Municipality, which is always insufficient, for drinking purposes. Recently they have had an outbreak of gastro-enteritis in the city and it was due to contamination of Municipality water with sewer water. About 6 Km away there is a source of suitable drinking water but it needs a separate supply line to the hospital to solve the problem. A water softening and filtration treatment are the only solution for drinking water in the hospital and community.  Overhead reservoir	Hospital sewerage is drained directly into the Municipality sewer. It was informed that the Municipality sewer level is higher compared to that of the hospital and even slight blockage in Municipality sewer leads to back flow of sewerage water into the hospital sewerage system creating lots of problems.  Man hole near central storage place clogged with waste

 Underground water storage tank	
Recommendations	
Regular drinking water testing. Drinking water assessment.	Assessment for separating the hospital sewerage from the Municipal sewerage and construction of a proper wastewater treatment system. Borehole water assessment is needed.
THQ Hospital Tounsa	
Drinking water supply	**Wastewater management**
This facility has boreholes for water and it was informed that this water is satisfactory for drinking purposes.	All the external sewerage pipes have been replaced. And now, new septic tanks are under construction. Until now wastewater is being disposed in open drain outside the hospital boundary wall. External sewer disposal will be through a pump into saline water drain.  Under construction septic tank area
Recommendations	
Regular drinking water testing.	Assessment and construction of a proper septic tank and a proper soakaway system.
RHC Choti Zerein	
Drinking water supply	**Wastewater management**
The OHR as been renovated and water supply from local authority is potable. The water is tested only when there is outbreak of some diseases (epidemics of gastro-enteritis).	All the sewerage pipes have been replaced. The wastewater is collected in a septic tank and pumped out of facility into an open drain.

 Under ground water reservoir and overhead reservoir	
Recommendations	
Regular drinking water testing.	Assessment and construction of a proper septic tank and a proper soakaway system.

5.7 Upper Dir

DHQ Hospital Dir	
Drinking water supply	**Wastewater management**
Drinking water is provided by the Municipality. It has never been tested and there is no policy of monitoring. Frequency of cleaning of Over Head Reservoir is more than a year.	All the sewerage water is drained into the septic tanks, from where water infiltrates underground. Furthermore, all chemicals used in developing X – ray films are drained directly into open drain. Now the newly constructed blocks of the hospital have separate soakage pits being constructed with septic tanks.  New septic tank under construction

New soakage pit under construction

There was one large water channel flow down the mountains and the sewerage from settlements in hills and from Dir city is drained directly into this channel. The water of this channel is used for washing cloths and bathing by the populations living down the stream.

Mountain water canal containing sewerage drain from city and populations

Also solid waste is thrown into the open drains of the city area around hospital which goes with wastewater and rain water down the hills.

Open drain with hospital waste

Recommendations	
Regular drinking water testing.	Construction of a proper wastewater treatment system.

<table>
<tr><th colspan="2">THQ Hospital Warri</th></tr>
<tr><th>Drinking water supply</th><th>Wastewater management</th></tr>
<tr><td>The overhead water reservoir is cleaned more than once a year. Drinking water has never been tested.

Overhead water reservoir</td><td>All the wastewater is drained into the septic tanks from where water infiltrates underground and it does not have a soakage pit. Also the chemicals used in developing X-ray films are drained directly into sewerage drain.

Furthermore, the wastewater from inhabitants around is drained into a water channel down the mountains

Waste in open drain</td></tr>
<tr><th colspan="2">Recommendations</th></tr>
<tr><td>Regular drinking water testing.</td><td>A soakaway system is required to be constructed.</td></tr>
<tr><th colspan="2">RHC Barawal</th></tr>
<tr><th>Drinking water supply</th><th>Wastewater management</th></tr>
<tr><td>The overhead water reservoir is newly constructed and not used yet. The waste was scattered all around this area.

The suction pump of the water well has been reported out of order for the last 4 days and no water was available in the hospital. The water pump was repaired by the contribution of residing staff.

Newly constructed overhead reservoir still not used</td><td>The septic tank is the final disposal place of liquid waste which infiltrates underground. And the open drains of staff residences are flowing nearby open drinking water well covered by a metallic sheet.</td></tr>
</table>

 Waste scattered below overhead water reservoir	
Recommendations	
Regular drinking water testing.	Assessment of existing septic tank/s and construction of a soakage pit. And construction of proper open drains of staff residences and proper disposal of waste water.

5.8 Jhelum

DHQ Hospital Jhelum	
Drinking water supply	**Wastewater management**
Water supply is from a 61 m depth well. A water testing was requested (because of change of color) for more than a year ago and it was found contaminated. There is no a policy for monitoring.	The sewer waste is collected in an underground constructed tank and then is pumped out in the open drain which empties into open pond at the back of hospital.  Waste water collecting tank and pumping site  Waste water flow channel on open ground

	 Waste water pump
Recommendations	
Regular drinking water testing. Drinking water assessment.	Construction of a proper wastewater treatment system.
THQ Hospital Sohawa	
Drinking water supply	**Wastewater management**
It was informed that water quality is satisfactory and water testing is never performed.	The sewer waste is drained into the municipal sewer.
Recommendations	
Regular drinking water testing. Drinking water assessment.	
RHC Domeli	
Drinking water supply	**Wastewater management**
A water testing has never been done and the overhead reservoir has never been cleaned.	
Recommendations	
Regular drinking water testing. Drinking water assessment.	

5.9 Jafferabad

DHQ hospital Dera Allahyar	
Drinking water suplí	**Wastewater management**
A water testing has never been done. The overhead reservoir is regularly cleaned.	The sewer waste is collected in the septic tank and then drained into the municipal sewer. The x-ray film developing chemical waste is drained into the domestic wastewater.
Recommendations	
Regular drinking water testing. Drinking water assessment.	Construction of a proper wastewater treatment system.
THQ Hospital Usta Mohammad	
Drinking water supply	**Wastewater management**
The water supply is from the municipal source and its quality testing has never been performed. The overhead reservoir is cleaned	The liquid hospital waste is collected in a septic tank which is the final disposal as seepage underground. Its level is lower compared to the open drain outside the hospital. A pump would

once in a year.	be required for the final disposal hospital sewer into open drain or by the construction of a proper septic tank and soakage pit. The open drain outside the hospital was clogged with sludge and solid waste and the wastewater of this drain was coming into the hospital premises through holes in boundary wall. These holes probably resulted from this stagnant water in the open drain. Also the x-ray film developing chemical waste is drained into hospital sewerage.  Septic tank  Open drain outside hospital adjacent to boundary wall
Environmental impacts of civil works under PAIMAN	
PAIMAN is carrying out civil works to improve the internal sewerage system of the hospital but a pump or soakaway system for the disposal of wastewater is not included in the scope.	
Recommendations	
Regular drinking water testing. Drinking water assessment.	Installation of pump for drainage of waste water and regular cleaning of wastewater open drains by town committee to prevent spillage of sewer into the hospital
RHC Rojhan Jamali	
Drinking water supply	**Wastewater management**
The overhead reservoir has never been cleaned and a water testing has never been done.	The sewer waste of the hospital seeps underground from the septic tank.
Recommendations	
Regular drinking water testing. Drinking water assessment.	

5.10 Lasbela

DHQ Hospital Uthal	
Drinking water supply	**Wastewater management**
The overhead reservoir was reported to be cleaned monthly but it did not seem to be true. Also a water testing has never been done.	The septic tank and soakage pit are there for disposal of sewer waste. The x-ray film developing chemical waste is drained with the domestic wastewater.
Recommendations	
Regular drinking water testing. Drinking water assessment.	Construction of a proper wastewater treatment system.
THQ Hospital Hub	
Drinking water supply	**Wastewater management**
There is no water available in the hospital and for that reason the hospital administration bought a tank of water but is not fully functional. The overhead reservoir has never been cleaned. The municipality water supply is not available despite the fact that water supply lines are connected with the main water supply lines of public health engineering department. There is a single borehole being used by the hospital inhabitants which is the brackish shallow water.	The liquid hospital waste is drained into open drain and finally into the agriculture farms. The x-ray film developing chemical waste is drained into the hospital sewerage.
Recommendations	
Regular drinking water testing. Drinking water assessment.	
RHC Bela	
Drinking water supply	**Wastewater management**
The water supply is from the municipality. The water testing has never been done and the overhead reservoir is cleaned on a yearly basis.	The sewer waste of the hospital is drained into septic tank and soakage pit.
Environmental impacts of civil works under PAIMAN	
PAIMAN will carry out repairs of water supply and sewerage lines.	
Recommendations	
Regular drinking water testing. Drinking water assessment.	.

Annex 6. Physical / Chemical Analysis – Bacteriological Analysis

6.1 Physical / Chemical Analysis

6.1.1 Sukkur

6.1.1.1 DHQH Sukkur

Report on the analysis of a sample of water No.: 6 Referred to letter No.: ------
Dated 22.9.2006 Received on: 22.9.2006 From: G.M.C. Sukkur
And labelled as: G.M.C. Sukkur

Physical Characters
1. Colour: Colourless
2. Odour: Odourless
3. Taste: Tasteless

<u>Chemical Characters (Result of Analysis is expressed in mili grams per litre)</u>

Tests		Findings	Maximum Permissible Limits Under Pakistan Standard For Drinking Water No: Ps 1932-2002 Second Revision of Pakistan Standard And Quality Control Authority
1	Reaction	Alkaline	Alkaline
2	pH	7.5	7.0 – 8.5
3	Fee Chlorine	Not found present	
4	Chlorides	32.0	250.0
5	Nitrates	Not found present	10.0
6	Nitrites	Not found present	0.020
7	Lime (Calcium)	12.8	200.0
8	Sulphate	100.0	400.0
9	Total Solid Matter	240.0	1000.0
10	Temporary Hardness	32.0	
11	Permanent Hardness	96.0	
12	Total Hardness	128.0	500.0
13	Lead	Not found present	0.010
14	Zinc	Not found present	
15	Iron	Not found present	
16	Copper	Not found present	1.0
17	Hydrogen Sulphide	Not found present	

Opinion: This sample of water conforms to the standard of drinking water of Pakistan standard No. PS: 1932 – 2002 2nd Rev: with respect to the test performed.

6.1.1.2 THQH Rohri

Report on the analysis of a sample of water No.: 2 Referred to letter No.: ------
Dated 22.9.2006 Received on: 22.9.2006 From: T.H.Q.H Rohri
And labelled as: Taluka Head Quarter Hospital Rohri

Physical Characters
1. Colour: Colourless
2. Odour: Odourless
3. Taste: Tasteless

Chemical Characters (Result of Analysis is expressed in milli grams per litre)

Tests		Findings	Maximum Permissible Limits Under Pakistan Standard For Drinking Water No: Ps 1932-2002 Second Revision of Pakistan Standard And Quality Control Authority
1	Reaction	Alkaline	Alkaline
2	pH	7.5	7.0 – 8.5
3	Fee Chlorine	Not found present	
4	Chlorides	140.0	250.0
5	Nitrates	5.0	10.0
6	Nitrites	Not found present	0.020
7	Lime (Calcium)	4.0	200.0
8	Sulphate	100.0	400.0
9	Total Solid Matter	180.0	1000.0
10	Temporary Hardness	100.0	
11	Permanent Hardness	40.0	
12	Total Hardness	140.0	500.0
13	Lead	Not found present	0.010
14	Zinc	Not found present	
15	Iron	Not found present	
16	Copper	Not found present	1.0
17	Hydrogen Sulphide	Not found present	

Opinion: This sample of water conforms to the standard of drinking water of Pakistan standard No. PS: 1932 – 2002 2nd Rev: with respect to the test performed.

6.1.1.3 RHC Kandara

Report on the analysis of a sample of water No.: 5 Referred to letter No.: ------
Dated 22.9.2006 Received on: 22.9.2006 From: R.H.C Kandhra
And labelled as: Rural Health Centre Kandhra

Physical Characters
1. Colour: Colourless
2. Odour: Odourless
3. Taste: Tasteless

Chemical Characters (Result of Analysis is expressed in milli grams per litre)

Tests		Findings	Maximum Permissible Limits Under Pakistan Standard For Drinking Water No: Ps 1932-2002 Second Revision of Pakistan Standard And Quality Control Authority
1	Reaction	Alkaline	Alkaline
2	pH	7.5	7.0 – 8.5
3	Fee Chlorine	Not found present	
4	Chlorides	120.0	250.0
5	Nitrates	1.0	10.0
6	Nitrites	Not found present	0.020

Tests		Findings	Maximum Permissible Limits Under Pakistan Standard For Drinking Water No: Ps 1932-2002 Second Revision of Pakistan Standard And Quality Control Authority
7	Lime (Calcium)	64.0	200.0
8	Sulphate	150.0	400.0
9	Total Solid Matter	520.0	1000.0
10	Temporary Hardness	160.0	
11	Permanent Hardness	160.0	
12	Total Hardness	320.0	500.0
13	Lead	Not found present	0.010
14	Zinc	Not found present	
15	Iron	Not found present	
16	Copper	Not found present	1.0
17	Hydrogen Sulphide	Not found present	

Opinion: This sample of water conforms to the standard of drinking water of Pakistan standard No. PS: 1932 – 2002 2nd Rev: with respect to the test performed.

6.1.2 Dadu

6.1.2.1 DHQH Dadu

Report on the analysis of a sample of water No.: 1 Referred to letter No.: ------
Dated 22.9.2006 Received on: 22.9.2006 From: DHQH, DADU
And labelled as: District Head Quarter Hospital Dadu

Physical Characters
1. Colour: Colourless
2. Odour: Odourless
3. Taste: Tasteless

Chemical Characters (Result of Analysis is expressed in milli grams per litre)

Tests		Findings	Maximum Permissible Limits Under Pakistan Standard For Drinking Water No: Ps 1932-2002 Second Revision of Pakistan Standard And Quality Control Authority
1	Reaction	Alkaline	Alkaline
2	pH	7.5	7.0 – 8.5
3	Fee Chlorine	Not found present	
4	Chlorides	80.0	250.0
5	Nitrates	1.0	10.0
6	Nitrites	Not found present	0.020
7	Lime (Calcium)	88.0	200.0
8	Sulphate	150.0	400.0
9	Total Solid Matter	540.0	1000.0
10	Temporary Hardness	220.0	
11	Permanent Hardness	118.0	
12	Total Hardness	328.0	500.0

Tests		Findings	Maximum Permissible Limits Under Pakistan Standard For Drinking Water No: Ps 1932-2002 Second Revision of Pakistan Standard And Quality Control Authority
13	Lead	Not found present	0.010
14	Zinc	Not found present	
15	Iron	Not found present	
16	Copper	Not found present	1.0
17	Hydrogen Sulphide	Not found present	

Opinion: This sample of water conforms to the standard of drinking water of Pakistan standard No. PS: 1932 – 2002 2nd Rev: with respect to the test performed.

6.1.2.2 THQH Khairpur Nathan Shah

Report on the analysis of a sample of water No.: 4 Referred to letter No.: ------
Dated 22.9.2006 Received on: 22.9.2006 From: T.H.Q.H K.N. Shah Dadu
And labelled as: M.C.H. Taluka Head Quarter K.N. Shah Dadu

Physical Characters
1. Colour: Colourless
2. Odour: Odourless
3. Taste: Saline

Chemical Characters (Result of Analysis is expressed in milli grams per litre)

Tests		Findings	Maximum Permissible Limits Under Pakistan Standard For Drinking Water No: Ps 1932-2002 Second Revision of Pakistan Standard And Quality Control Authority
1	Reaction	Alkaline	Alkaline
2	pH	7.5	7.0 – 8.5
3	Fee Chlorine	Not found present	
4	Chlorides	1400.0	250.0
5	Nitrates	1.0	10.0
6	Nitrites	1.0	0.020
7	Lime (Calcium)	496.0	200.0
8	Sulphate	1200.0	400.0
9	Total Solid Matter	6420.0	1000.0
10	Temporary Hardness	1240.0	
11	Permanent Hardness	1160.0	
12	Total Hardness	2400.0	500.0
13	Lead	Not found present	0.010
14	Zinc	Not found present	
15	Iron	Not found present	
16	Copper	Not found present	1.0
17	Hydrogen Sulphide	Not found present	

Opinion: This sample of water does not conform to the standard of drinking water of Pakistan standard No. PS: 1932 – 2002 2nd Rev: as sample has higher values of

Chlorides, Nitrites, Sulphates, Total Solids, Total Hardness, Calcium and also is saline in the test Hence sample can not be recommended for drinking

6.1.2.3 RHC Seta Road

Report on the analysis of a sample of water No.: 3 Referred to letter No.: ------
Dated 22.9.2006 Received on: 22.9.2006 From: R.H.C Sita Road
And labelled as: Rural Health Centre Sita Road

Physical Characters
1. Colour: Colourless
2. Odour: Odourless
3. Taste: Tasteless

<u>Chemical Characters (Result of Analysis is expressed in milli grams per litre)</u>

Tests		Findings	Maximum Permissible Limits Under Pakistan Standard For Drinking Water No: Ps 1932-2002 Second Revision of Pakistan Standard And Quality Control Authority
1	Reaction	Alkaline	Alkaline
2	pH	7.5	7.0 – 8.5
3	Fee Chlorine	Not found present	
4	Chlorides	32.0	250.0
5	Nitrates	5.0	10.0
6	Nitrites	0.01	0.020
7	Lime (Calcium)	38.4	200.0
8	Sulphate	100.0	400.0
9	Total Solid Matter	280.0	1000.0
10	Temporary Hardness	96.0	
11	Permanent Hardness	44.0	
12	Total Hardness	140.0	500.0
13	Lead	Not found present	0.010
14	Zinc	Not found present	
15	Iron	Not found present	
16	Copper	Not found present	1.0
17	Hydrogen Sulphide	Not found present	

Opinion: This sample of water conforms to the standard of drinking water of Pakistan standard No. PS: 1932 – 2002 2nd Rev: with respect to the test performed.

6.1.3 Jhelum

6.1.3.1 DHQH Jhelum

<u>Laboratory Report Chemical Analysis of Water</u>

Client Name: 455 / 293, J.S.I., H. No. 6, St. No. 5 Dated: 03 – 10 – 2006
Address: F – 8 / 3, Islamabad
Water Source / Location: Tap Water No. 1 / D.H.Q. Hospital Jhelum
Brand Name / Manufacturer: --------

Analytical parameters	Ref. value mg/L	Results mg/L	Analytical parameters	Ref. value mg/L	Results mg/L
Calcium	≤ 200	140	Chloride	≤ 200	60
Chlorine	≤ 0.3	Nil	Nitrate	≤ 10	0.2
Magnesium	≤ 150	14	Sulphate	≤ 200	121
Sodium	≤ 200	102	Nitrite	≤ 0.1	--
Hardness	≤ 500	410	Bicarbonate	≤ 500	--
Potassium	≤ 100	5	Iron	≤ 0.3	--
Ozone	≤ 0.5	--	Fluoride	≤ 1.5	--
TDS	≤ 1000	--	Colour	Colourless	Normal
pH value	≤ 6.5 – 8.5	7.2	Odour	Odourless	Normal
Turbidity	≤ 5.0	--	Taste	Tasteless	--
Conductivity (uS/cm)	≤ 1334	--			

Reference: Pakistan Standard Quality Control Authority (Former PSI) Standard No. 1032 – 1987

Assessment: Satisfactory
Treatment: Not applicable

Physical Parameters

Physical Appearance: Particles Present
Type of Sample: S. No. 1, Tap Water
Packing: Sterilized bottle

6.1.3.2 THQH Sohawa

Laboratory Report Chemical Analysis of Water

Client Name: 457 / 293, J.S.I., H. No. 6, St. No. 5 Dated: 03 – 10 – 2006
Address: F – 8 / 3, Islamabad
Water Source / Location: Tap Water No. 3 / The Headquarter Hospital Sohawa
Brand Name / Manufacturer: --------

Analytical parameters	Ref. value mg/L	Results mg/L	Analytical parameters	Ref. value mg/L	Results mg/L
Calcium	≤ 200	36	Chloride	≤ 200	30
Chlorine	≤ 0.3	Nil	Nitrate	≤ 10	1
Magnesium	≤ 150	38	Sulphate	≤ 200	47
Sodium	≤ 200	65	Nitrite	≤ 0.1	--
Hardness	≤ 500	250	Bicarbonate	≤ 500	--
Potassium	≤ 100	3	Iron	≤ 0.3	--
Ozone	≤ 0.5	--	Fluoride	≤ 1.5	--
TDS	≤ 1000	--	Colour	Colourless	Normal
pH value	≤ 6.5 – 8.5	7.8	Odour	Odourless	Normal
Turbidity	≤ 5.0	--	Taste	Tasteless	--
Conductivity (uS/cm)	≤ 1334	--			

Reference: Pakistan Standard Quality Control Authority (Former PSI) Standard No. 1032 – 1987

Assessment: Satisfactory
Treatment: Not applicable

Physical Parameters

Physical Appearance: Particles Present
Type of Sample: S. No. 3, Tap Water
Packing: Sterilized bottle

6.1.3.3 RHC Domeli

Laboratory Report Chemical Analysis of Water

Client Name: 456 / 293, J.S.I., H. No. 6, St. No. 5 Dated: 03 – 10 – 2006
Address: F – 8 / 3, Islamabad
Water Source / Location: Tap Water No. 02 / R.H.C. Domelli
Brand Name / Manufacturer: --------

Analytical parameters	Ref. value mg/L	Results mg/L	Analytical parameters	Ref. value mg/L	Results mg/L
Calcium	≤ 200	60	Chloride	≤ 200	137
Chlorine	≤ 0.3	Nil	Nitrate	≤ 10	5
Magnesium	≤ 150	42	Sulphate	≤ 200	45
Sodium	≤ 200	125	Nitrite	≤ 0.1	--
Hardness	≤ 500	325	Bicarbonate	≤ 500	--
Potassium	≤ 100	3	Iron	≤ 0.3	--
Ozone	≤ 0.5	--	Fluoride	≤ 1.5	--
TDS	≤ 1000	--	Colour	Colourless	Normal
pH value	≤ 6.5 – 8.5	7.4	Odour	Odourless	Normal
Turbidity	≤ 5.0	--	Taste	Tasteless	Normal
Conductivity (uS/cm)	≤ 1334	--			

Reference: Pakistan Standard Quality Control Authority (Former PSI) Standard No. 1032 – 1987

Assessment: Satisfactory

Treatment: Not applicable

Physical Parameters

Physical Appearance: Normal
Type of Sample: S. No. 2, Tap Water
Packing: Sterilized bottle

6.1.4 Lasbela

6.1.4.1 DHQH Uthal

Test report No. ILD/ATR - 3823/2006 Date: 07-11-2006

1. Name and address of client: M/s. Executive District Office (Health) District Lasbela
   Ref. No: Date of receipt: 28-10-2006

2. Description of the sample:
   Item: Water sample (District Headquarter Hospital Uthal) Make: Nil
   Lab Code No: ILDA/ATR-3823/2006 Mark if any: Nil
   Condition found on receipt: Normal
3. Sample Plan / Procedure used: N.A. Date of sampling: N:A:
4. Environmental conditions: Temp: 31°C Humidity: N.A.
5. Method used: (1) Standard Methods for the Examination of Water & Wastewater, 20 th edition, American Public Health Association, 1998 (2) ISO – 9308, Part-2.
6. Results

Chemical Analysis	Results	WHO Guideline
pH	8.2	6.5 – 8.5
Calcium	69 ppm	
Magnesium	36 ppm	
Sodium	112 ppm	200 ppm
Potassium	4.6 ppm	
Chloride	147 ppm	250 ppm
Sulfate	167 ppm	250 ppm
Total dissolved solids	765 ppm	1000 ppm

7. Statement of compliance: N.A.
8. Opinion / Interpretation: The provided sample of water is not fit for human consumption, according to WHO guideline.

6.1.4.2 THQH Hub

Test report No. ILD/ATR - 3822/2006 Date: 07-11-2006

1. Name and address of client: M/s. Executive District Office (Health) District Lasbela
   Ref. No: Date of receipt: 28-10-2006

2. Description of the sample:
   Item: Water sample (Jam Ghulam Qadir Government Hospital, Hub) Make: Nil
   Lab Code No: ILDA/ATR-3822/2006 Mark if any: Nil
   Condition found on receipt: Normal
3. Sample Plan / Procedure used: N.A. Date of sampling: N:A:
4. Environmental conditions: Temp: 31°C Humidity: N.A.
5. Method used: (1) Standard Methods for the Examination of Water & Wastewater, 20 th edition, American Public Health Association, 1998 (2) ISO – 9308, Part-2.
6. Results

Chemical Analysis	Results	WHO Guideline
pH	7.5	6.5 – 8.5
Calcium	35 ppm	
Magnesium	10 ppm	
Sodium	70 ppm	200 ppm
Potassium	8.5 ppm	
Chloride	66 ppm	250 ppm
Sulfate	93 ppm	250 ppm

7. Statement of compliance: N.A.
8. Opinion / Interpretation: The provided sample of water is microbiologically not fit for human consumption, according to WHO guideline.

6.1.4.3 RHC Bela

Test report No. ILD/ATR - 3824/2006 Date: 07-11-2006

1. Name and address of client: M/s. Executive District Office (Health) District Lasbela
   Ref. No: Date of receipt: 28-10-2006
2. Description of the sample:
   Item: Water sample Make: Nil
   (Rural Health Center, Bela)
   Lab Code No: ILDA/ATR-3824/2006 Mark if any: Nil
   Condition found on receipt: Normal
3. Sample Plan / Procedure used: N.A. Date of sampling: N:A:
4. Environmental conditions: Temp: 31°C Humidity: N.A.
5. Method used: (1) Standard Methods for the Examination of Water & Wastewater, 20 th edition, American Public Health Association, 1998 (2) ISO – 9308, Part-2.
6. Results

Chemical Analysis	Results	WHO Guideline
pH	7.5	6.5 – 8.5
Calcium	104 ppm	
Magnesium	79 ppm	
Sodium	220 ppm	200 ppm
Potassium	66 ppm	
Chloride	449 ppm	250 ppm
Sulfate	406 ppm	250 ppm
Total dissolved solids	1396 ppm	1000 ppm

7. Statement of compliance: N.A.
8. Opinion / Interpretation: The provided sample of water is not fit for human consumption, according to WHO guideline.

6.1.5 Other hospitals

Test Report

Test Report # 416 Lab. Code # MBC-136/189-191/06 Date: 02-10-2006

Case # ILS/ATR/416/06

1. Name and address of client: Dr. Tahir Nadeem Khan, JSI/PAIMAN Project, Peshawar.
2. Description of the sample (s):
   Item: Chemical analysis of water sample Mark if any
   Conditions found on receipt: Packed in glass bottles
3. Environmental conditions: Temp: 32°C Humidity: 55%
   (Where applicable)
4. Method Used / Statement of compliance: a. APHA/AWWA/WEF (1998) b. Analytical use of EDTA (1958)
5. Measurements & Results:

Parameters	Method No.	Units	Water sample			WHO limits for drinking water
			DHQ Daggar Buner	RHC Jowar	THQ Hospital Chamla	
pH	4500-H^+ B	--	7.5 ± 0.16	7.74 ± 0.17	7.40 ± 0.16	6.5 – 9.20
Conductivity	2510.B	uS/cm	590.00 ± 5.02	402.00 ± 3.52	419.00 ± 3.66	
Total Dissolved Solids (TSD)	2540.C	mg/L	319.00 ± 5.99	213.00 ± 5.63	259.00 ± 5.77	1000.00
Total Suspended Solids (TSS)	2540.D	mg/L	4.00 ± 0.00	4.00 ± 0.00	5.00 ± 0.00	5.00
Total Hardness as $CaCO_3$	2340.C	mg/L	312.00 ± 4.95	204.00 ± 4.77	144.00 ± 4.70	500.00
Calcium as $CaCO_3$	3500-Ca.B	mg/L	200.00 ± 4.76	160.00 ± 4.72	104.00 ± 4.67	250.00
Magnesium as $CaCO_3$	3500-Mg.B	mg/L	112.00 ± 0.00	44.00 ± 0.00	40.00 ± 0.00	150.00
Total alkalinity as $CaCO_3$	2320.B	mg/L	332.00 ± 4.99	210.67 ± 2.93	240.00 ± 4.82	500.00

Parameters	Method No.	Units	Water sample			WHO limits for drinking water
			DHQ Daggar Buner	RHC Jowar	THQ Hospital Chamla	
P – alkalinity as $CaCO_3$	2320.B	mg/L	BDL	BDL	BDL	30.00
Chloride as Cl^{-1}	4500-Cl.B	mg/L	25.81 ± 1.17	15.88 ± 1.16	16.87 ± 1.16	250.00
Sulphate as SO_4^{-2}	329	mg/L	57.60 ± 1.49	65.28 ± 1.70	19.20 ± 0.50	250.00
Sodium as Na^{+1}	3500-Na	mg/L	10.50 ± 0.15	7.27 ± 0.09	45.50 ± 0.40	200.00
Potassium as K^{+1}	3500-K	mg/L	1.30 ± 0.12	2.00 ± 0.12	2.30 ± 0.12	75.00
Nitrite as NO_2^{-1}	4500-NO_2^{-1}.B	mg/L	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.10

6. Remarks / Comments (where required): On the basis of the above results, chemically the parameters of all samples are within the permissible limits of WHO standards. Microbiological examination of water samples is however also required to ascertain their potability.

6.2 Bacteriological analysis

6.2.1 Jhelum

6.2.1.1 DHQH Jhelum

Bacteriological Examination of Water

Client name: J.S.I. House No. 6, St. No. 5, F – 8 / 3 Date: 30 – 09 – 2006
Address: Islamabad
Sample Source / Location: DHQ Hospital Jehlum
Lab. Code: WR – 293 / 276 – G / 2006 – WM

Laboratory Findings

Analytical Parameters	Results	Ref. Value
Total Viable Count / ml	3.6×10^3	$< 10^2$ / ml
Most Probable Number of *Coliform* Organisms / 100 ml	2.2	Nil / 100 ml
Most Probable Number of *Faecal Coliform* Organisms / 100 ml	Negative	Nil / 100 ml

Results: Unsatisfactory
Remarks: Boling / Filteration / Chlorination of water is recommended

6.2.1.2 THQH Sohawa

Bacteriological Examination of Water

Client name: J.S.I. House No. 6, St. No. 5, F – 8 / 3 Date: 30 – 09 – 2006
Address: Islamabad
Sample Source / Location: Sohawa, Islamabad
Lab. Code: WR – 293 / 278 – G / 2006 – WM

Laboratory Findings

Analytical Parameters	Results	Ref. Value
Total Viable Count / ml	5×10^2	$< 10^2$ / ml
Most Probable Number of *Coliform* Organisms / 100 ml	8.8	Nil / 100 ml
Most Probable Number of *Faecal Coliform* Organisms / 100 ml	Negative	Nil / 100 ml

Results: Unsatisfactory
Remarks: Boling / Filtration / Chlorination of water is recommended

6.2.1.3 RHC Domeli

Bacteriological Examination of Water

Client name: J.S.I. House No. 6, St. No. 5, F – 8 / 3 Date: 30 – 09 – 2006
Address: Islamabad
Sample Source / Location: RHC Domeli
Lab. Code: WR – 293 / 277 – G / 2006 – WM

Laboratory Findings

Analytical Parameters	Results	Ref. Value
Total Viable Count / ml	Nil	$< 10^2$ / ml
Most Probable Number of *Coliform* Organisms / 100 ml	Nil	Nil / 100 ml
Most Probable Number of *Faecal Coliform* Organisms / 100 ml	Negative	Nil / 100 ml

Results: Unsatisfactory
Remarks: Boling / Filteration / Chlorination of water is recommended

6.2.2 Lasbela

6.2.2.1 DHQH Uthal

Microbiological Analysis	Results	Ref. Value
Total Coliform Count	1100	Zero/dl
Faecal Coliform Count	1100	Zero/dl
Total Bacterial Count	1.4×10^2 cfu/ml	100 cfu/ml

6.2.2.2 THQH Hub

Microbiological Analysis	Results	Ref. Value
Total Coliform Count	460/dl	Zero/dl
Faecal Coliform Count	460/dl	Zero/dl
Total Bacterial Count	2.6×10^3 cfu/ml	100 cfu/ml

6.2.2.3 RHC Bela

Microbiological Analysis	Results	Ref. Value
Total Coliform Count	1100/dl	Zero/dl
Faecal Coliform Count	1100/dl	Zero/dl
Total Bacterial Count	2.8×10^3 cfu/ml	100 cfu/ml

6.2.3 Other hospitals

Test report

Test Report # 416 Lab. Code # PLC/FTC/337/06 Date: 30.9.2006

Case # ILS/ATR/416/06

1. Name and address of client: Dr. Tahir Nadeem Khan, JSI/PAIMAN Project, Peshawar.
2. Description of the sample (s):
   Item: Drinking water Mark if any
   Conditions found on receipt: Packed in glass bottles
3. Sampling Plan / Procedure used: American Public Health Association / American Water Woks; Association 9215 B, 9221 B, 1998
   Date of sampling
4. Environmental conditions: Temp: 27°C Humidity: 53%
   (Where applicable)

5. Method Used / Statement of compliance: American Public Health Association / American Water Works; Association 9215 B, 9221 B, 1998
6. Measurements & Results:

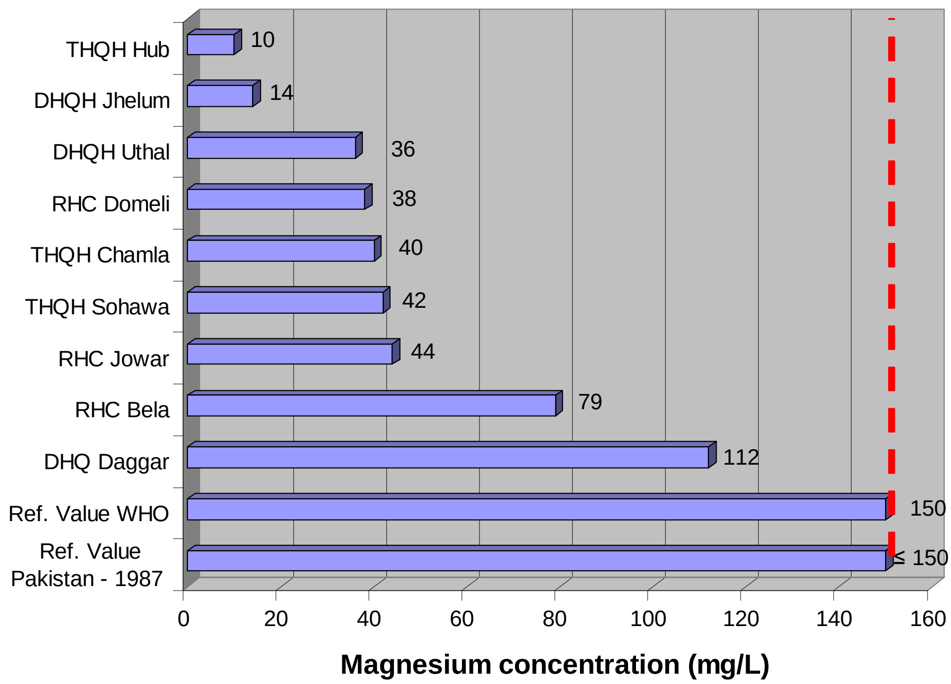
Bacteriological analysis of drinking water

S. #.	Sample ID #	Parameters	Results	Standard	Method #
1	THQ Hospital Chamla Bunner	Total Plate Count	300 cfu / ml	< 100 cfu / ml	9215 B
		Coliform Bacteria	Nil	Nil	9221 B
2	RHC Jawar Bunner	Total Plate Count	150 cfu / ml	< 100 cfu / ml	9215 B
		Coliform Bacteria	Present	Nil	9221 B
3	DHQ Hospital Daggar Bunner	Total Plate Count	750 cfu / ml	< 100 cfu / ml	9215 B
		Coliform Bacteria	Present	Nil	9215 B

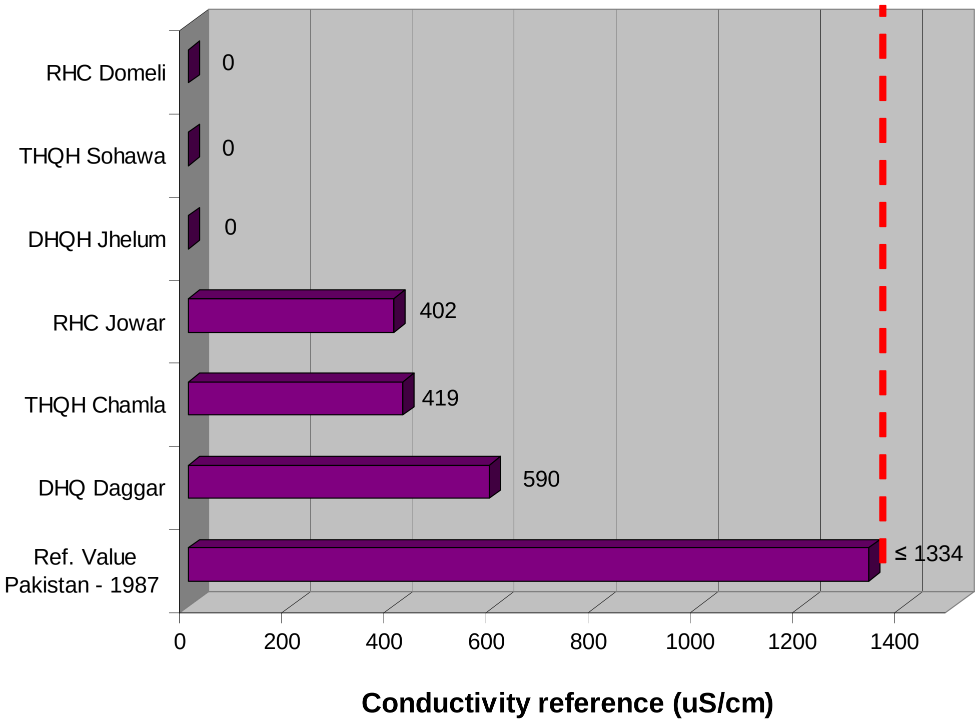
7. Remarks / Comments (where required): Total plate count of water samples S # 1, 2 & 3 are bigger than the permissible limits of WHO Standard whereas coliform bacteria are present in Sample No. 2 & 3.

6.3 Comparative graphs

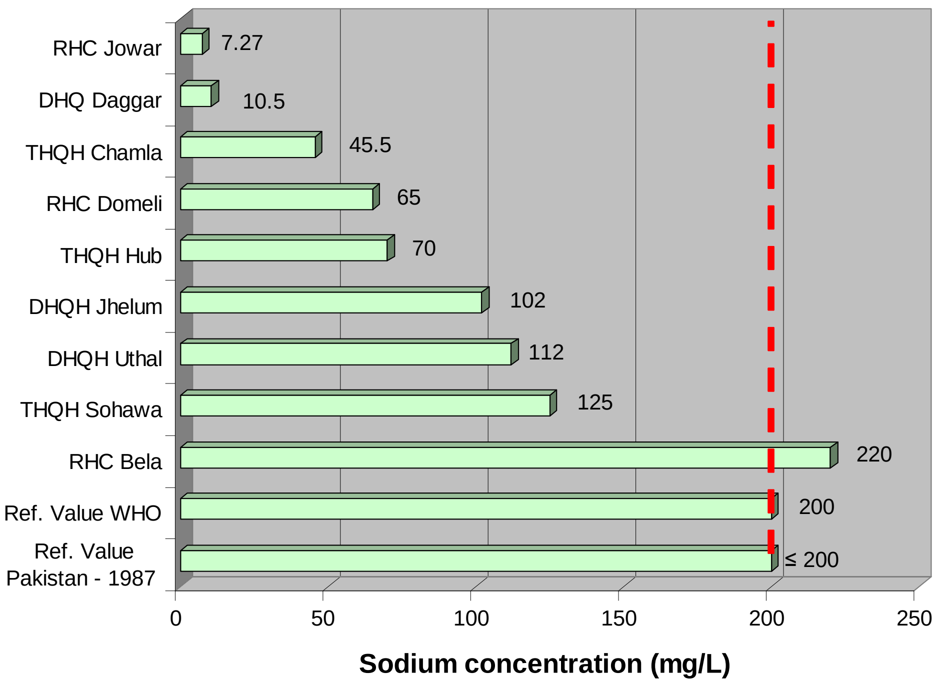
6.3.1 Magnesium values comparison



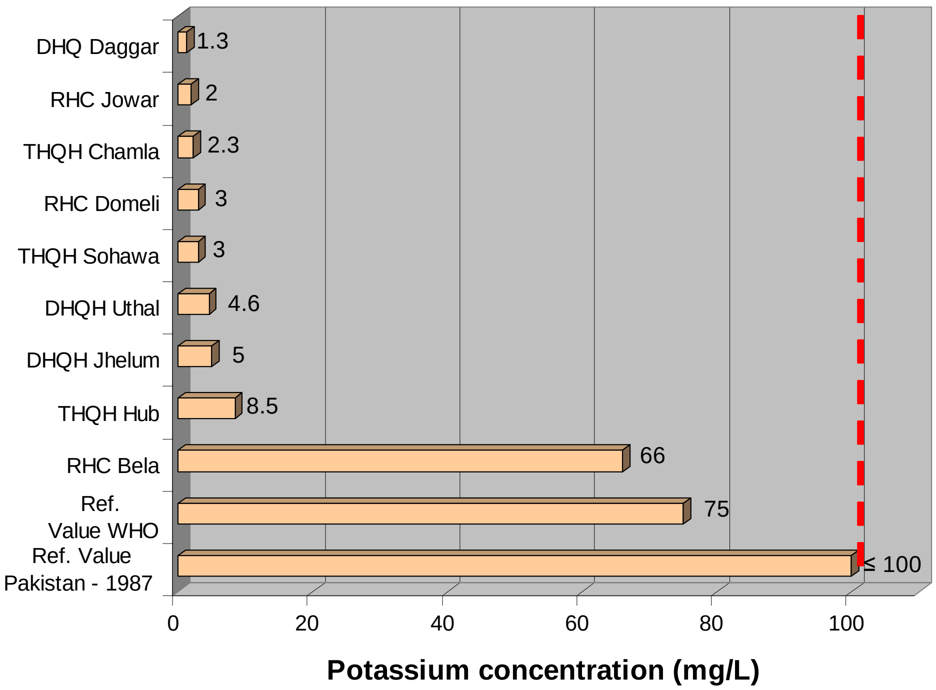
6.3.2 *Conductivity values comparison*



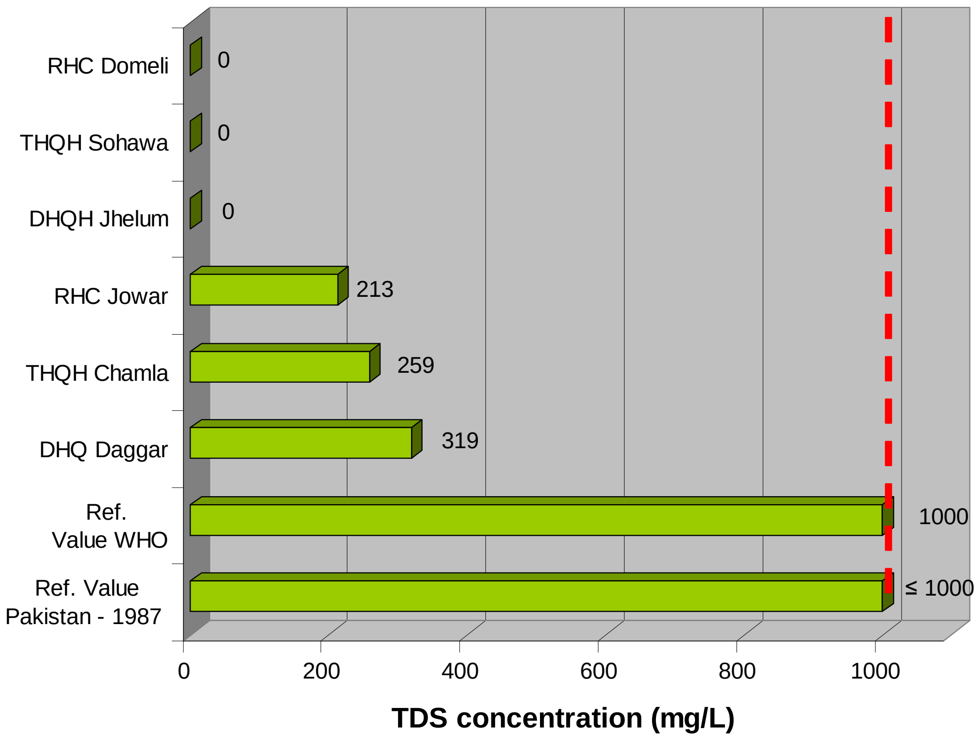
6.3.3 *Sodium values comparison*



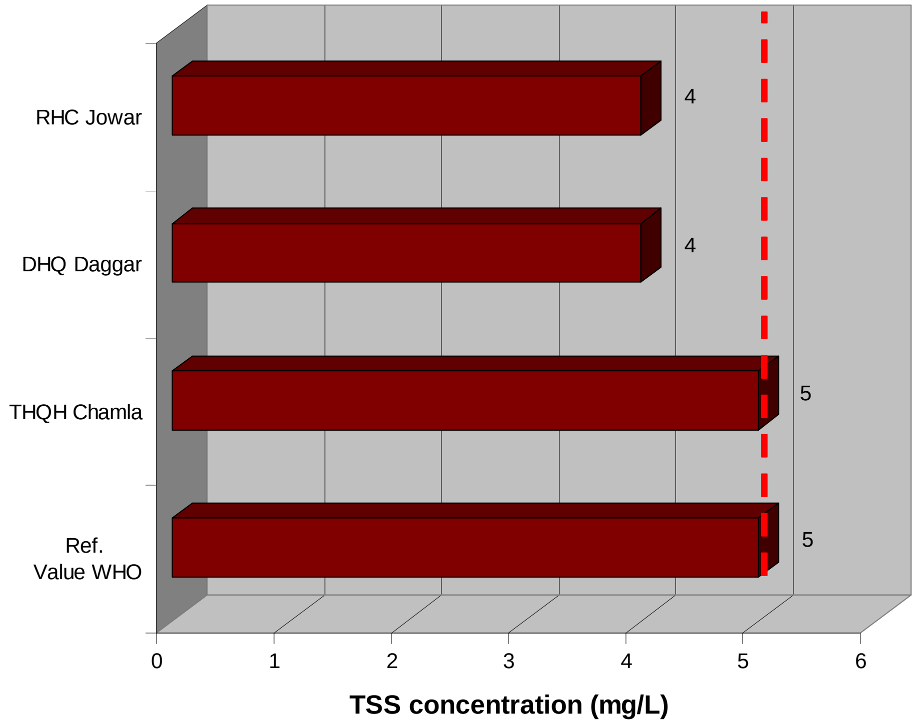
6.3.4 *Potassium values comparison*



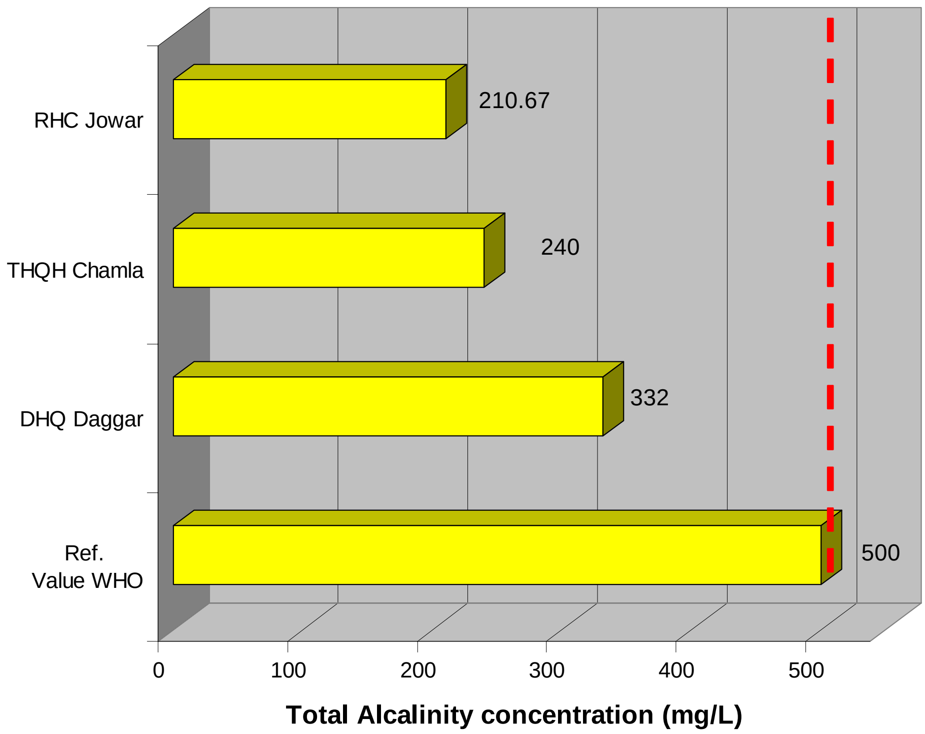
6.3.5 *TDS values comparison*



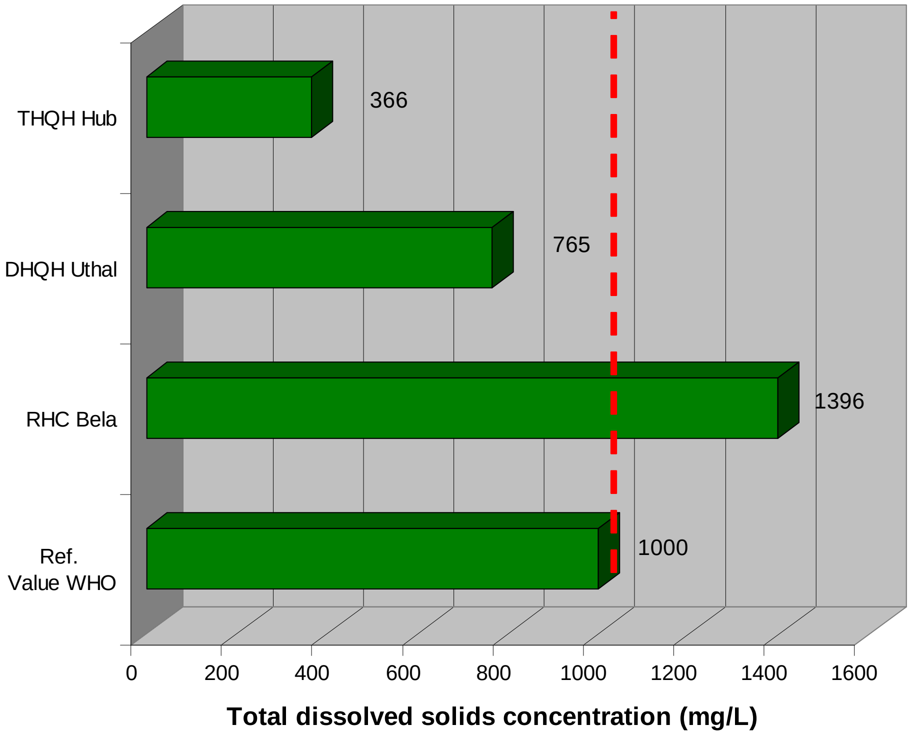
6.3.6 TSS values comparison



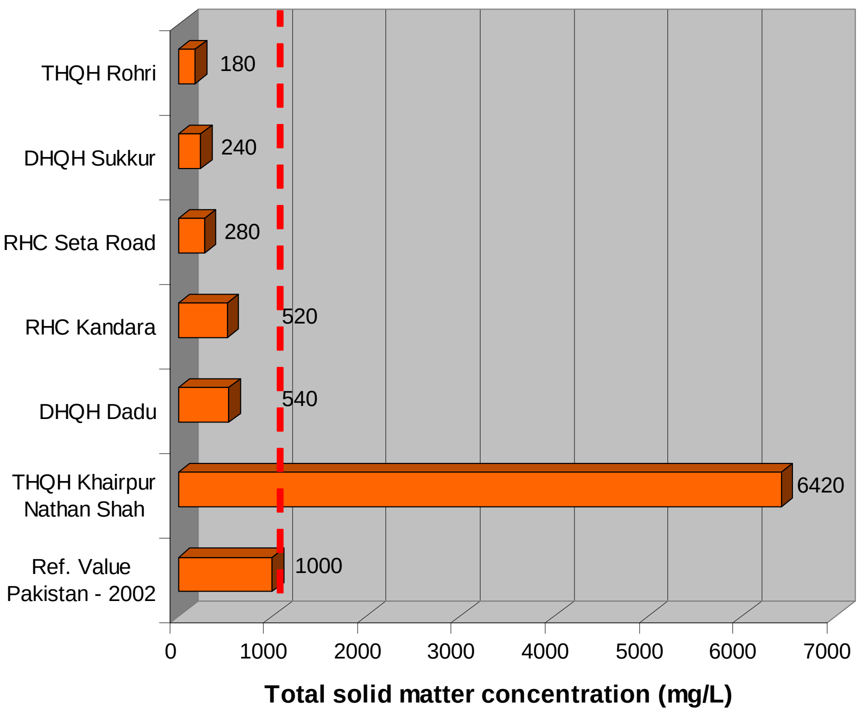
6.3.7 Total alkalinity values comparison



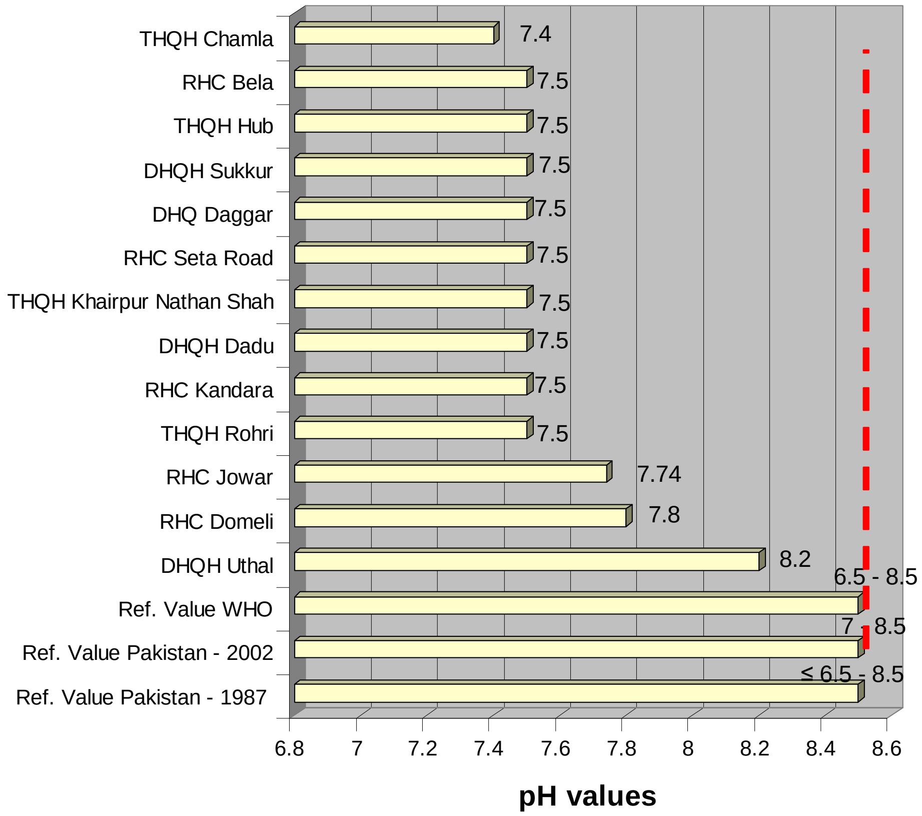
6.3.8 *Total dissolved solids values comparison*



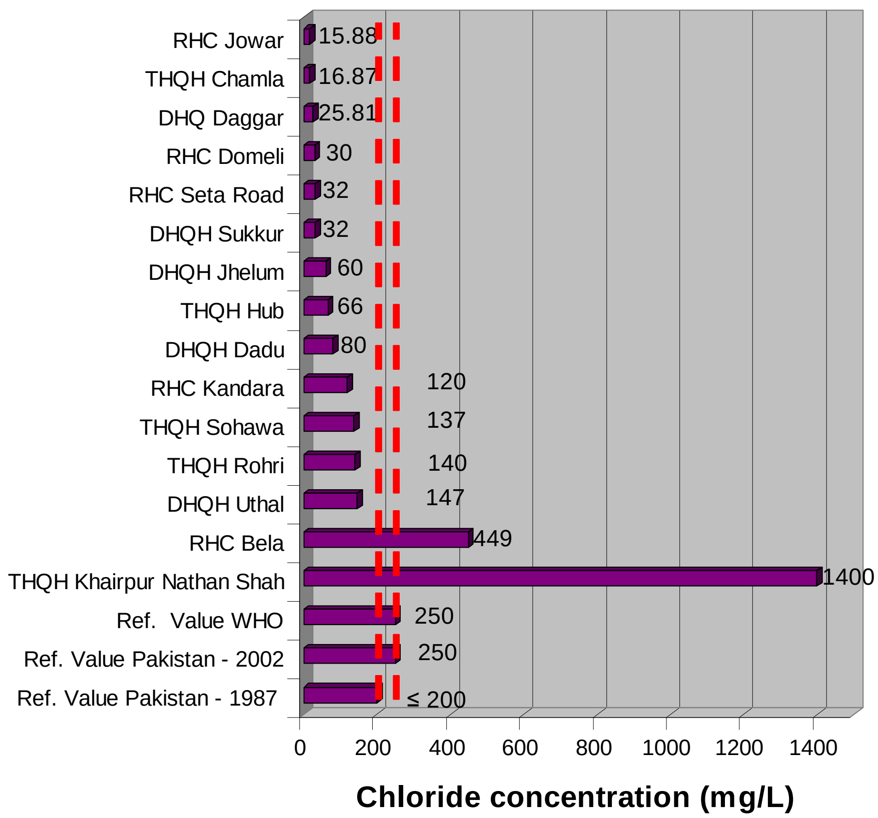
6.3.9 *Total solid matter values comparison*



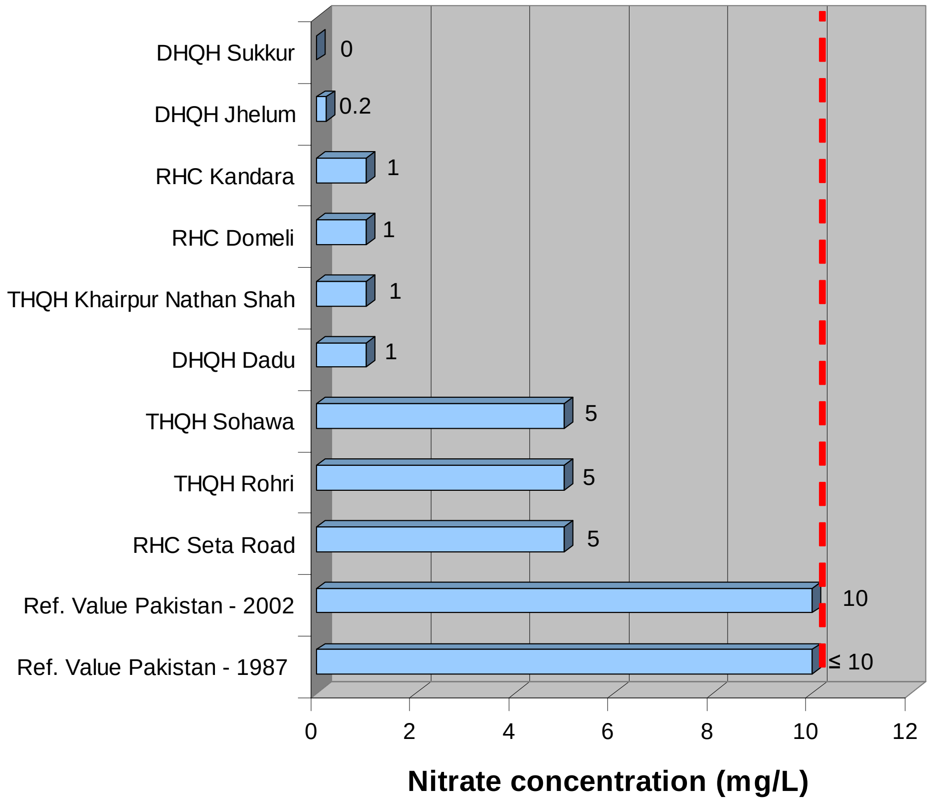
6.3.10 pH values comparison



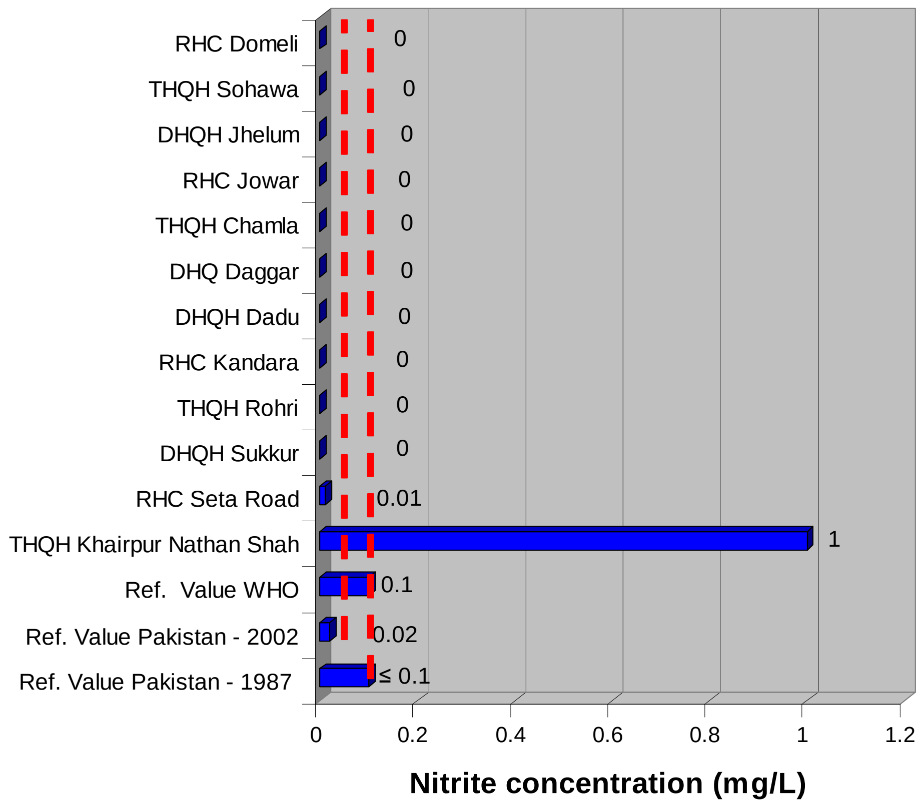
6.3.11 Chloride values comparison



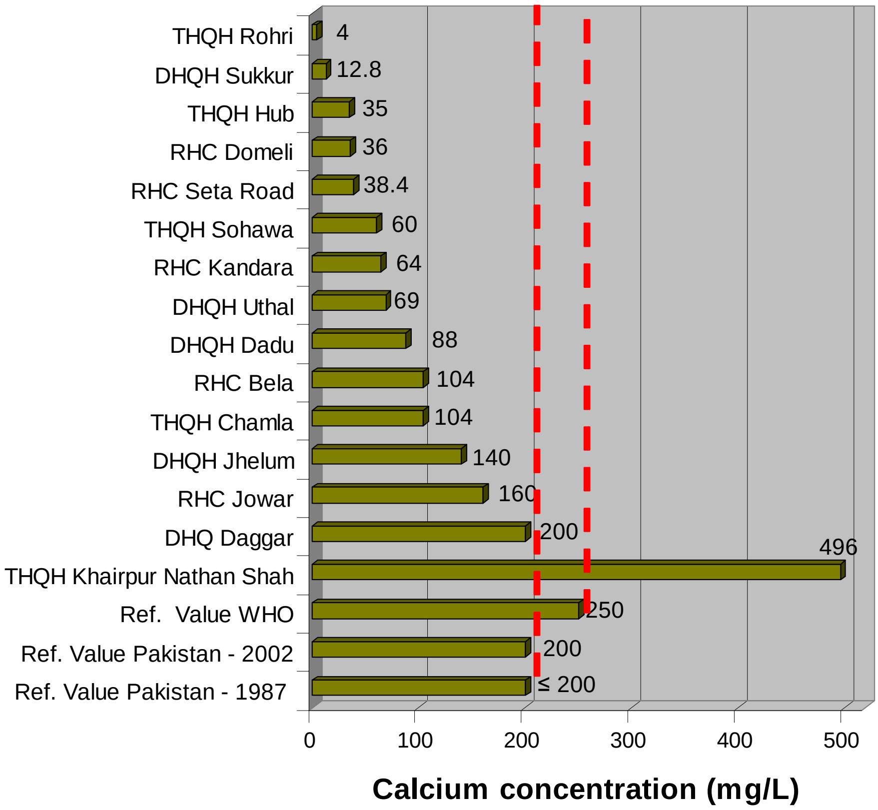
6.3.12 Nitrate values comparison



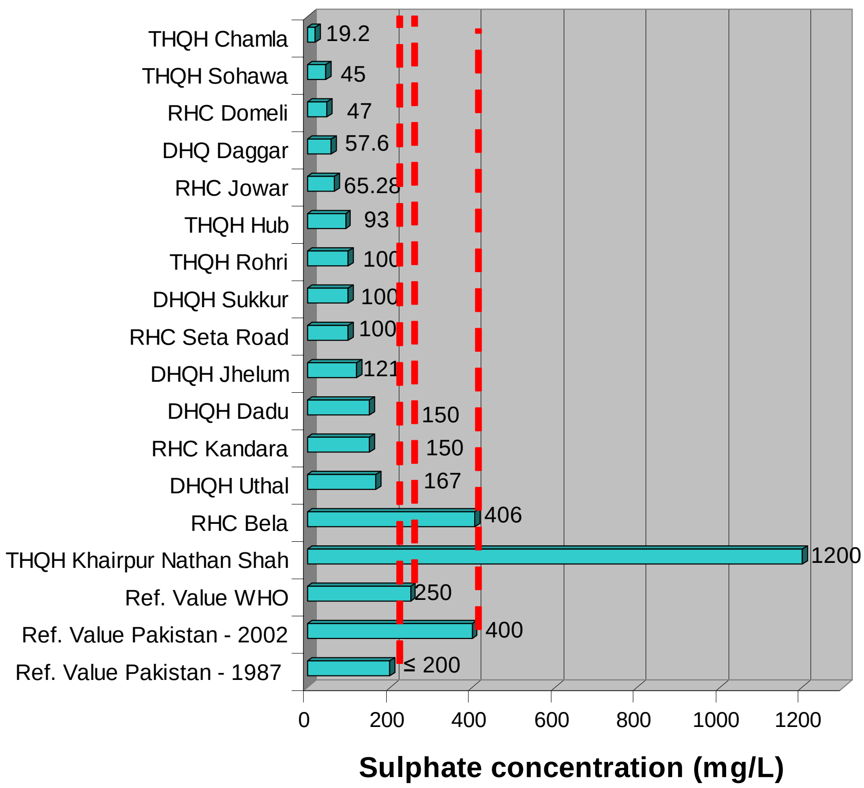
6.3.13 Nitrite values comparison



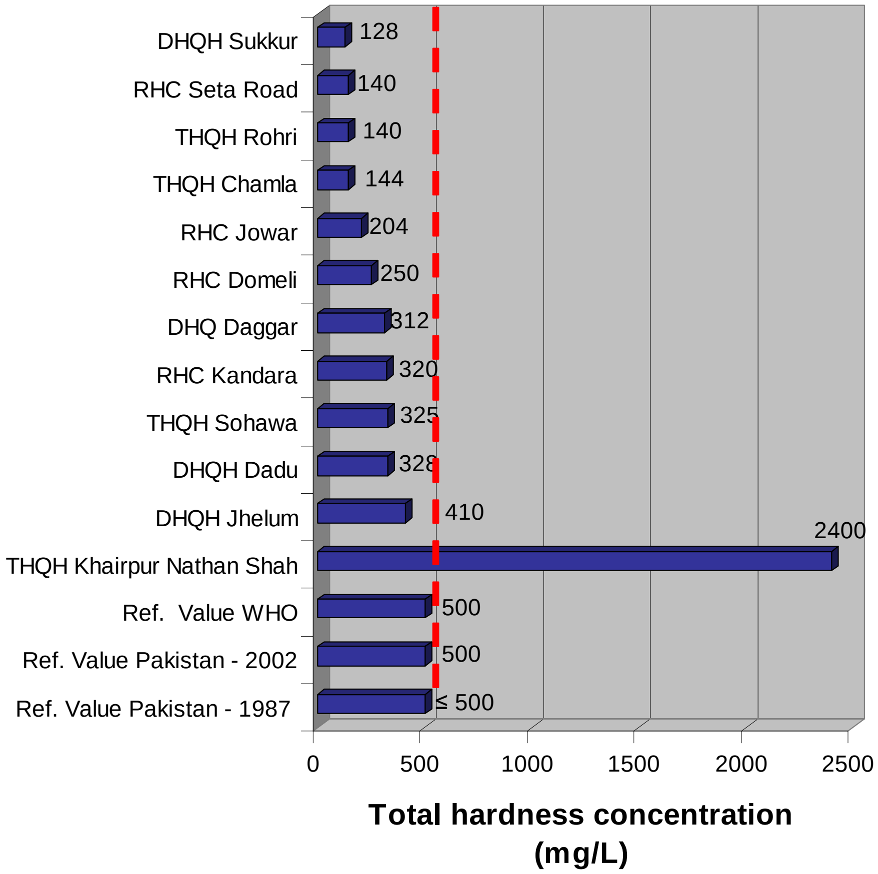
6.3.14 Calcium values comparison



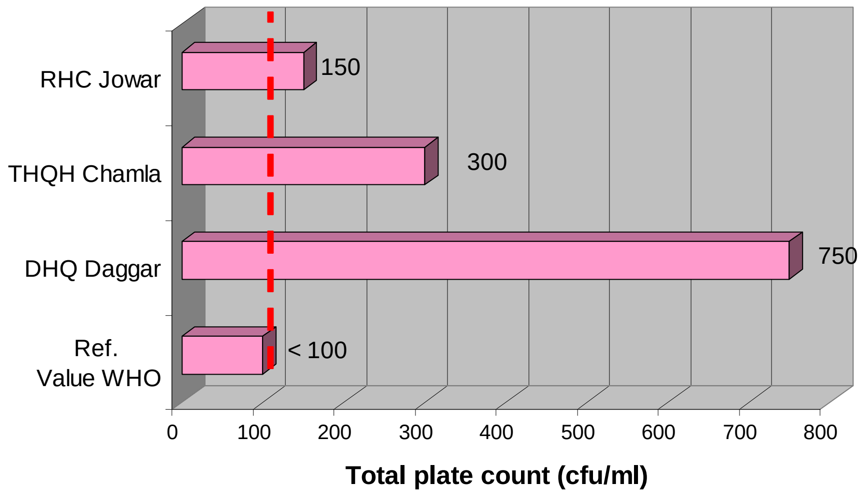
6.3.15 Sulphate values comparison



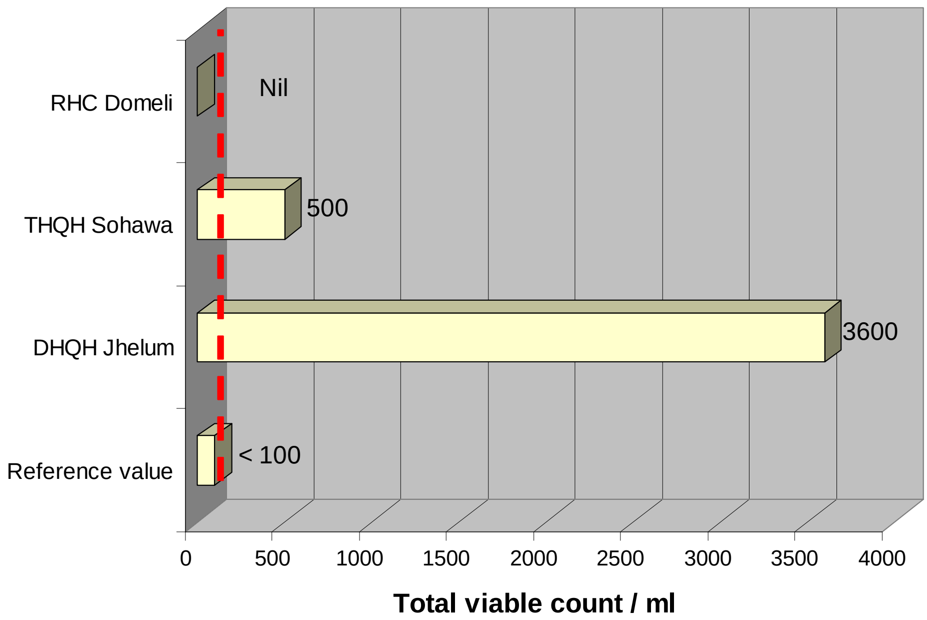
6.3.16 Total hardness values comparison



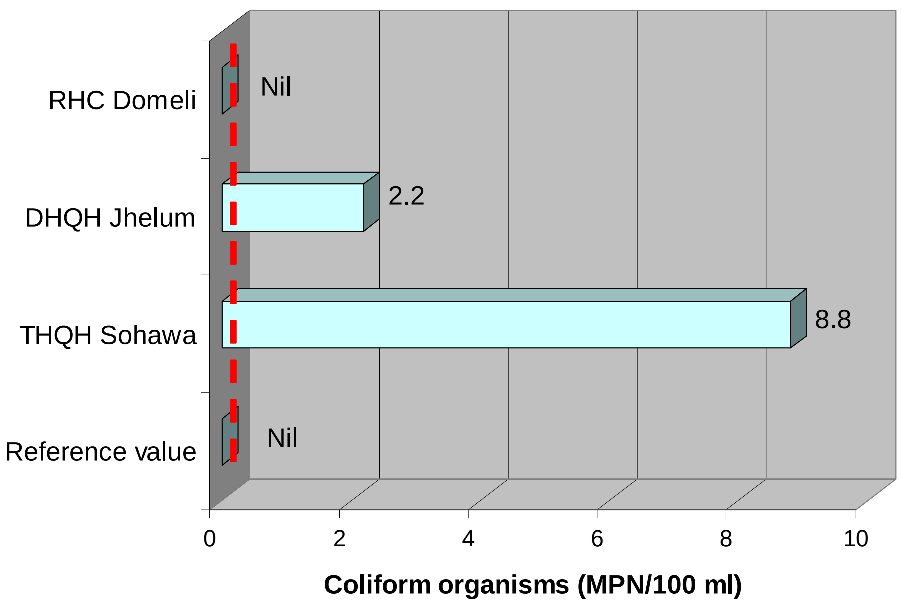
6.3.17 Total plate count values comparison



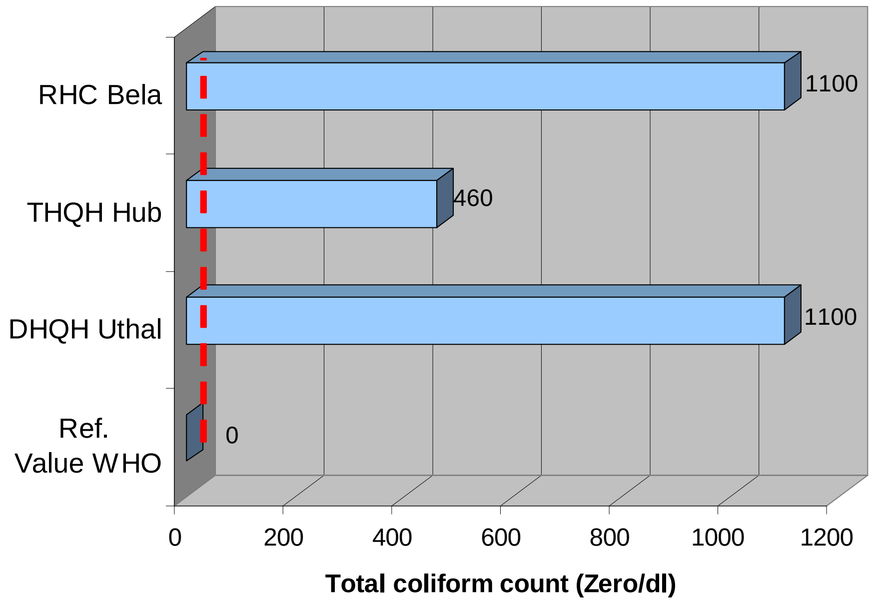
6.3.18 Total viable count values comparison



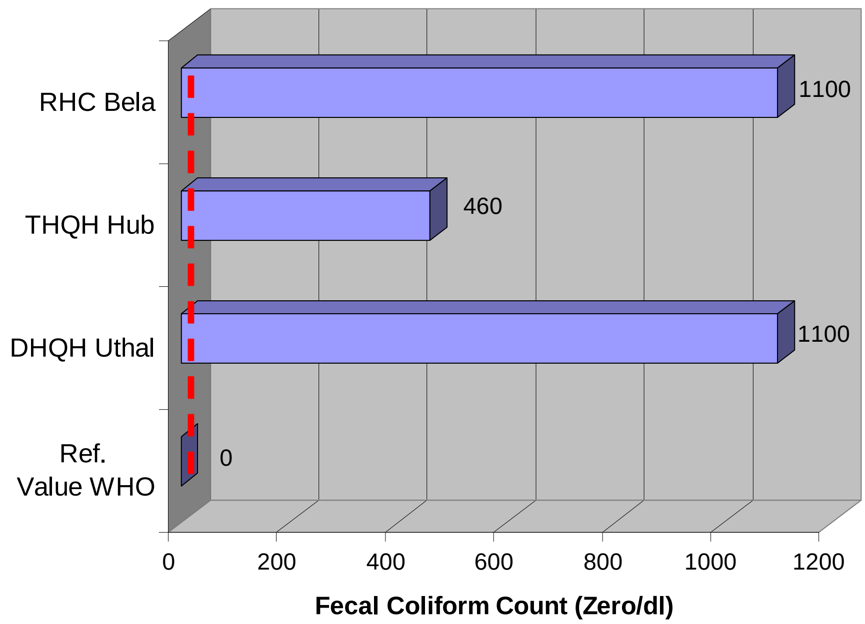
6.3.19 Most probable number of coliform organisms values comparison



6.3.20 Total coliform count values comparison



6.3.21 Faecal coliform count values comparison



6.3.22 Total bacterial count values comparison