

Chapter 8

**INSTITUTIONAL
ALTERNATIVES**

CHAPTER 8 INSTITUTIONAL ALTERNATIVES

8.1 ISSUES IN INSTITUTIONAL DEVELOPMENT

8.1.1 Immediate Problems

The two most immediate issues driving the need for institutional reform are:

- the virtual financial collapse of most of the waste collection companies; and
- serious environmental problems due to non-collection of waste and illegal disposal of waste in inappropriate dump sites

The financial condition of most of the enterprises in the sector is of most immediate concern to potential aid donors. Aid donors are unlikely to be prepared to offer assistance to provide the capital equipment needed for the sector until it becomes clear that the enterprises in the sector will be viable, and can cover the costs of ongoing operations. Unfortunately it is clear that recapitalization of the existing companies without any other changes to their commercial environment will not resolve the problems and that a more fundamental restructuring of the sector is therefore required.

Resolution of environmental problems also requires fundamental institutional reform. Despite a proliferation of agencies whose ostensive role is monitoring and enforcement, environmental conditions associated with solid waste services have deteriorated over the past decade. A major overhaul of both the standards that are in theory being imposed and enforcement procedures used to impose these standards is needed.

8.1.2 Universal Coverage

One of the key objectives of institutional reform must be to ensure that there is universal coverage by SWM services. This is both a public health and environmental issue. In the interests of public health it is necessary that waste is collected from all households and other areas of the city whether or not the individuals can pay for this service. The application of "user pay" principles is important to ensure rational allocation and use of resources and to prevent over-servicing. But in this case there is also an over-riding public interest requiring that the service is provided even to those community members that cannot afford to pay for it, to protect the environment and to protect the public health of other community members.

SWM services are different from some other utilities such as electricity. If an electricity supply is disconnected where a consumer cannot or refuses to pay for the service, there is little or no impact on their neighbours; but if garbage collection from a household that cannot or will not pay is discontinued, there may be serious impacts on their neighbours.

The current "fully privatized" system fails to provide universal coverage for three main reasons

- there is no incentive for companies to ensure that they provide a universal service;
- companies do not possess powers to enforce acceptance of, and payment for a service;
- with the change in land ownership patterns, it is sometimes difficult to identify responsibilities for waste management.

Theoretically it might be possible to solve all of these problems and enforce universal coverage by the existing "fully privatized" system with a complex enforcement regime. Such an option was considered, but was rejected. The "fully privatized" option has been rejected in all developed countries, where in all cases Governments have retained some overall management control of SWM services to ensure universal coverage.

8.1.3 Ability and Willingness to Pay

Due to the current economic crisis, there are many poor people, particularly pensioners, living at or below the poverty line. Many of these are genuinely unable to pay for this essential service. This problem is exacerbated by a more universal failure of existing accounting practices in Kazakhstan to recognise bad debts.¹ When tariffs for waste collection are set, they are based on a fiction that the tariff will be collected from all recipients of the service.

The reality that not all recipients can pay must be recognized. If the SWM services are to be self supporting tariff levels must be raised to allow for non-payment by some (a form of cross-subsidy), or else the SWM service must be subsidized by Government to compensate for non-payment by the poorest sections of the community.

Refusal to pay by some richer households is also a significant problem though no company or co-operative was able to provide hard data on the scale of the problem. Their anecdotal evidence however suggests that this is almost as significant a problem as the inability to pay by the poorest parts of the community.

This problem is observed in some undeveloped countries where infrastructure services are poor and tax evasion is rife amongst the wealthy strata of society who often feel that they are above the law. There is little hard research on this payment problem in Kazakhstan, but given that tax evasion is also rife in Kazakhstan it is quite possible that similar linkages and attitudes prevail in Kazakhstan. In any event, significantly stronger powers are needed to enforce collection of tariffs.

8.1.4 Price Control and Monopoly Regulation

Monopolies are seen as a major issue, and the Anti Monopoly Committee (AMC) has become actively involved in tariff setting in this sector.

Certainly as a result of the way privatization was effected in this sector, there is currently very little if any effective competition. Essentially the original state enterprise that managed all SWM services in the city was broken up into its regional branches which were then converted into Joint Stock Companies which by and large have continued to operate in their original areas. Some of these have since been restructured into Limited Liability Partnerships after bankruptcy or virtual bankruptcy overtook the original Joint stock companies. Many of these seem recently to have been taken over by

¹ While Kazakhstan has on paper introduced international accounting standards, there is little or no understanding of these. Debts which a creditor has no realistic hope of collecting frequently remain in accounts of creditors at their face value until the debtor is actually declared bankrupt. In turn bankruptcy proceedings are only infrequently used, and when they are usually much later than is appropriate. This practice, which is clearly contrary to international accounting standards which require that assets be valued at the lower of book or likely realizable value, has been forced on creditors by the tax authorities that are fearful that provisioning for bad debts will be used as a tax avoidance measure.

Parasat, but neither Parasat nor the akimate has responded to detailed questions from the study team on these recent changes.

Certainly there is some understanding that the current tariffs are too low and that these low tariffs are one of the reasons that nearly all the enterprises in the sector are in financial crisis. However the more fundamental question "Is any form of price control necessary?" is still not being asked.

Within the waste collection sub-sector, the eight medium sized companies formed from the branches of the original state enterprise do not appear to be competing amongst themselves. Only signs of competition are small operations set up by some KSKs/KSDs to service their own needs. These appear to have been set up because these KSKs/KSDs were dissatisfied with the quality of service, rather than the price. These small internal operations all appear to be losing substantial amounts of money, though their owners do not appear to be aware of the extent of the losses due to poor accounting standards.

There does not appear to be any real barrier to competition. Partly lack of actual competition is a reflection of lack of entrepreneurship amongst these companies. But the main reason for no competition is that at current prices, there is no incentive to try to win additional market share. This is more likely to lead to larger losses rather than additional profits.

The current price controls set uniform tariffs throughout the city, though it is clear that costs vary across regions. This was not a practical concern where the one company covered the whole city but is clearly important now that operations have been separated.

In designing a new institutional structure the emphasis has been placed on developing competition and removing price controls, rather than trying to estimate actual costs more accurately. This is extremely difficult for any regulatory body to do accurately, even in a stable economy, and is even more difficult in the current conditions in Kazakhstan.

Operation of the transfer station and disposal site do prima facie offer more opportunities to exercise monopoly powers as direct competition between competing facilities is unlikely. Furthermore in Kazakhstan there is a perception that control over these facilities is the key to establishing highly profitable recycling businesses. Experience in developed countries has been that recycling is rarely particularly profitable. Rather many countries have had to introduce artificial financial incentives to encourage recycling. Such incentives of course have from time to time been manipulated to produce large profits, but rarely has recycling itself been economically (i.e. intrinsically) particularly profitable.

Again the key issue is how to control the potential market power of the operator(s) of the transfer and disposal site(s). In later sections alternatives to control this power by promotion of competition for the rights to operate these sites rather than direct price control are outlined as part of the selected option.

8.1.5 Separation of Operations and Enforcement

Following the "full privatization" of SWM services, the City administration has no formal responsibilities for management or operation of these services, though it does

appear to be involved in an informal way. However with the reforms proposed to ensure universal coverage, the City administration will again take a role in overall management. Thus the question of separation of operations from enforcement of standards will again arise.

Such a separation was not feasible under the previous political system. Separation of such powers would now be possible. The concept is still rarely discussed, though it is a central tenet of most current theories of good government. Historically this may not have been a major issue in SWM in Almaty City². But it is worthwhile reflecting on some of the major environmental problems now besetting Kazakhstan (such as Semi-Palitsk, the Caspian and Aral Seas). Could these disasters have been avoided if the entities responsible for environmental control had been kept separate and been vested with independent powers to the entities responsible for exploitation of these regions?

8.1.6 Rationalization of Enforcement

Within the SWM sector there are significant environmental and public health problems due to non-collection of wastes or illegal dumping of wastes. The first priority must be to improve compliance with existing standards rather than changing of those standards.³

Compliance seems to have deteriorated markedly over the past decade. This is hardly surprising given the many other changes to the economic system.

Firstly the economic changes are attempting to promote entrepreneurship amongst independent economic agents within the economy. This requires a shift in approach to enforcement of a whole range of regulations. Under the previous economic system it was perhaps a tenable philosophy to rely on harsh penalties to enforce any regulation. In the new environment it would be very sensible for the Government to look at the incentives for individuals to circumvent regulations and to minimize these incentives wherever possible, rather than rely totally on the imposition of penalties.

Illegal dumping is a good example of this problem. The total revenue that can be collected by the companies is restricted by AMC controls. This is then further reduced by the inability of the companies to collect charges from some citizens. At the same time the charges levied on the collection companies at the transfer station or disposal site are high relative to the tariffs that they are allowed to charge their customers. In practice these collection companies cannot remain solvent if they deliver the waste they have collected to the transfer station or Karasai disposal site, so they are virtually forced to dump this waste illegally. Certainly the Government must retain and impose penalties for illegal dumping, but at the same time it should reduce the incentives for illegal dumping by the collection companies as much as is possible.

The second systemic problem is that with the breakdown of public finances, fines and penalties have been given undue importance by various parts of Government as a source

² Some questions have been raised about the design and development of the existing disposal site at Karasai, and whether environmental procedures were followed properly at the time. Whatever the answer to these historic questions, the resulting problems do not appear to be insurmountable. Treatment of existing illegal dump sites appears to be a far more urgent issue.

³ Elsewhere in this report some suggestions are made on upgrading of standards particularly relating to the classification of industrial wastes. At an institutional level the skills to analyse and develop such standards appear to exist, but the ability to enforce them is more questionable

of finance for their own operations. Many departments seem to view the imposition of fines as a method to finance their activities, rather than a mechanism to enforce standards. Increasingly the imposition of fines has become a negotiated arrangement between departments, their officers and members of the community and resembles more an informal taxation system than a law enforcement operation. This change has been associated with a fragmentation of "enforcement" activities.

The focus on enforcement needs to be changed. Enforcement activities need to be consolidated in a single agency whose key objective is improving compliance, rather than raising revenue for particular parts of local budgets.

8.2 INSTITUTIONAL IMPROVEMENT OPTIONS CONSIDERED

Three different basic institutional models were considered as outlined in the following table. A decision in principle was taken at the steering committee on 17 May to follow the second option.

Table 8.2.1 Institutional Alternatives considered

| | Private operation (existing system) | Contract out | Mixed operations |
|--------------------------------------|---|---|---|
| Overall management and co-ordination | Government sets standards. Other co-ordination informal | City manages overall operations and is responsible for ensuring that contracts are let to cover all areas | Government sets standards. City becomes a service provider of last resort |
| Operations and day to day management | Private companies under contracts with KSK's KSD's | Private companies under contracts with the City | Some municipally managed operations where private initiatives have failed. |
| Fee collection | By private company | By city or state enterprise | By city or private company depending on collection arrangements |
| Investment | By private investors or by city with equipment then leased to private companies | By city with equipment then leased to private companies | By private investors or by city with equipment then leased to private companies |
| Ownership of equipment | Private company or by city and leased to private company | Private company or by city and leased to private company | Private company or by city and leased to private company |
| Ownership of facilities | City | City | City |
| Management of facilities | Under management contract (preferred) or lease (current arrangement) | By city or under management contract | Under management contract (preferred) or lease |
| Other Government responsibilities | Setting of tariffs (current arrangement) or monitoring of competition | Effectively manages tariffs through negotiation of collection contracts | Monitoring of competition |

8.3 SELECTED INSTITUTIONAL IMPROVEMENT PLAN

The basic approach that has been selected, the second alternative above - "Contract out" - is the approach that has been taken in most countries where services such as SWM have been "privatized". This chapter explains the basic concepts of contracting out and how it addresses the key issues identified in section 8.1.

Under this system a public entity or Waste Authority will assume overall responsibility for waste services. The two main functions of the Waste Authority are the collection of fees and the letting of contracts for operation of collection services, transfer station(s) and disposal site(s). The Waste Authority is an operational entity. The setting of standards and monitoring of those standards would remain the responsibility of ACDEP and the Sanitary and Epidemiology Station (which might be amalgamated to ensure more effective enforcement at a later stage).

8.3.1 Management of Container Platforms

The team recommends that the Waste Authority would be responsible for the supply of containers to the designated container sites as well as ensuring that there are container sites located to ensure universal coverage of collection services.⁴ These containers would remain the property of the Waste Authority. The supply of additional containers will be required. Manufacture and delivery of these should of course be contracted out.

The Authority will also be responsible for adjusting the number of containers at sites so that overflows are eliminated. Where the Authority has to increase the number of containers at a site, it will increase the tariffs charged to the households or commercial properties that are served by that site. This process will quite quickly bring the charges levied on households more closely into line with the quantities of waste actually generated. It would also be an important step towards separation of wastes at source and the development of recycling systems. As the economy changes it must be expected that the rate of waste generation from packaging materials (much of which is easily recycled) will increase. A system where the users have to pay according to the volume of wastes collected for landfill will encourage those users to separate the easily recycled materials for separate collection.

The existing KSK's would continue to be responsible for the cleaning and general maintenance of the container platforms.

8.3.2 Tariff Setting

Effectively the Waste Authority is responsible for organizing a system for collection of the contents of specified container(s) (or a fraction thereof) from each household and commercial organization. It is responsible for increasing the capacity of this collection system to ensure that waste overflows do not occur. However the Authority has the right to set tariffs charged to these organizations in proportion to the capacity for collection that is actually provided. Ideally the rights of the Authority to collect these charges from

⁴ The Waste Authority would have to satisfy the requirements of the Town Planning and Architectural Committee on the siting and location of these container platforms.

all landholders⁵ in the city would be specified in a Local Government Act, Housing Act or Land tenure Acts.

Initially the Waste Authority will be responsible for waste collection in all domestic, commercial and public service areas of the city. This responsibility will be specified in the foundation documents of this Authority. Enterprises in industrial areas would still be responsible for organizing collection of wastes either using their own resources or by contracting directly with the collection companies. The Waste Authority will also be responsible for the management of the transfer stations and the disposal sites.

Large commercial organizations should be given the opportunity to "opt out" where they can show that they have made satisfactory alternative arrangements. Again this "opt out" arrangement should encourage recycling. For example a large retail organization generating large volumes of cardboard packaging or a large office generating a large quantity of waste paper might find it cheaper to arrange for collection of cardboard waste by a paper recycler, who prefers such a source because of better separation.

At a later stage as the industrial structure of the city changes and more small scale industrial enterprises are established consideration might be given to "opting in" for small industrial enterprises. Typically a modern industrial economy has many small enterprises as well as medium and large enterprises. These small enterprises are often housed in "Industrial Parks" which from a services planning perspective often resemble residential areas. When these Parks start to emerge consideration might be given to extending the responsibility of the Waste Authority to cover these areas. This could easily be done following the same principles and procedures used in Commercial areas.

The Waste Authority will set tariffs for use of the transfer station(s) and disposal site(s) by parties delivering waste not covered by the collection contracts managed by the Authority. These tariffs will be based on the total costs of operations of these sites. Contractors who are collecting waste under contract to the Authority will not be charged for access to these sites. These contractors will be supplied with coupons covering the volume of waste that they were contracted to deliver.

The Authority will recover its costs of operation of these sites (both the financial costs of ownership and the operational costs paid to the site managers) from the tariffs that they charge to households and enterprises. Some contribution to these costs will be made by fees charged to third parties for discharging waste not covered by the contracts managed by the Authority.

As far as possible these tariffs will follow "user pays" principles. These tariffs may include a component for the existing "Environment fee" for use of the disposal site. Such a fee is justified to cover possible future costs for tip closure as well as rectification of problems related to the tip.

⁵ In most developed countries these charges are levied on the land-owner or holder of the lease or land use right granted by the state. It is then the responsibility of the landowner or head lessee to recover this charge from his tenant if he has subleased or rented this land part of a building to another person. Current practice in Kazakhstan, inherited from the previous system where all land was owned by the state, is to charge the "land or building user". With the change of land and building ownership this arrangement needs to be reviewed and a firm legal basis for liability for payment of these charges established.

However the existing double dipping whereby some industrial organizations are charged first for a licence to generate waste and then for the transport and disposal of that waste does not appear to be justified in theoretical terms. In practice this double dipping is at least partially offset as the collection charges have been set well below actual costs. Nevertheless the total charges levied on industrial enterprises appears to be higher than justified by a user pays principle, and is almost undoubtedly counter-productive in controlling pollution. In aggregate these charges seem to be sufficiently high that they are encouraging illegal dumping to avoid the licence fee. The risk of being fined for illegal dumping (in any case the size of the fine is often "negotiable") is not a sufficient deterrent given the pressure to reduce costs in the current economic crisis.

Licensing purely as a revenue collection tool is also counter-productive in the broader economic context, but is justified where it is necessary to control toxic or hazardous waste handling. The licensing arrangements for waste disposal should be reviewed and restructured as part of the management system for toxic and dangerous goods rather than as a revenue measure.

8.3.3 Liability for Collection Charges

The tariff setting system will clearly identify all the entities that are liable to pay for the service. Under the previous economic system liability for charges appears to have been based on the registration of citizens (for households) and registration of enterprises for commercial and industrial organizations.

Over the past few years with all the other changes that have accompanied the privatization of the collection service, it is doubtful whether there has been any effective basis for identifying all individuals or organizations that should be liable for payment of these tariffs. Essentially collection companies have been relying on old lists that are rapidly getting out of date. It is therefore time to review this process and the basis for determining liability to pay these tariffs in the new environment where ownership of land has become more diverse and the registration of residency and of business activity has become less reliable.

In most countries, a person or entity is liable to pay these charges if:

- He is the owner of the land or
- He is the holder of a lease or land use right granted by the state.

Normal practice is for the owner of the land or the lessee of the land (from the state) to pass these charges on to the actual occupier or user of the land.

This is consistent with the usual "user pays" principles. It is simply more efficient for the state to collect the charge from the land owner or lessee from the state, as the state's records of land ownership should be totally accurate⁶, while state records on residency or economic activity are never as accurate. The actual land owner has a very strong incentive to recover these charges from his tenant or lessee, and can do this far more effectively than the state.

⁶ At present records of land ownership in Kazakhstan are not complete. There has simply been insufficient time to develop the cadastral and land registration systems. However developing these systems must be a very high priority for the Government if it wishes the economic transition to continue as it provides one of the foundations of private property rights and development of a financial system.

The team recommends that a similar approach is taken in Kazakhstan. An accurate record of land ownership is absolutely critical to the whole economic transformation process, and will have to be established by the Government whatever changes happen to be made to the SWM System. Use of the land ownership records will avoid the need to establish and maintain separate registers for levying waste collection charges.

This would inter alia allow the current licensing of enterprises to generate waste to be wound back to a much smaller licensing scheme to cover only the generation and handling of hazardous wastes.

8.3.4 Collection Contracts

The Waste Authority would be responsible for dividing the city into collection zones (example of such division given in Chapter 9). The Authority would then let tenders for the emptying of containers in each zone run and delivery of the contents to a waste transfer station. It might let contracts for individual zones or bundle zones into groups. It will be the responsibility of the Authority to "bundle" zones together into packages that will attract competition in the tendering process. A contract for collection of garbage in a zone will require that all containers in the zone are emptied in correspondence to a determined collection frequency. The contract price will be negotiated based on the number of containers, with a provision to vary the price if the number changes during the life of the contract.

Given current financial conditions, nearly all prospective tenderers will have to lease trucks from the city or a state leasing entity, most likely financed by international aid. To encourage competition it is essential that all prospective tenderers have the opportunity to lease vehicles on the same terms and conditions. The lease rates should be set based on commercial financing interest rates, not concessional aid finance interest rates to discourage over-investment.

If this tendering process is run properly, it will remove the need for the AMC to set tariffs. Competition will determine prices which will presumably vary across the city depending on the ease of operation of the routes and the distance to the transfer station(s). The role of the AMC should be changed to overseeing the tendering process to ensure that this is managed in an open and fair manner.

8.3.5 Transfer Station and Disposal Site Operation

The team recommends that the transfer station(s) and disposal sites should remain state property, but that management of these sites should be contracted out. As nearly all the assets employed would be state assets, the investment needed by the management company would be small, and so it would be commercially realistic to let these contracts for relatively short periods – say one or two years.

Again assuming that the tendering process is conducted in a fair manner, competition for renewal of these management contracts will control the prices for operation of these facilities and remove the need for the involvement of the AMC.

Use of a management style contract rather than leasing of the facilities to a private operator should facilitate the maintenance of environmental standards at these sites.

The team recommends that the operators of the transfer station(s) and disposal site(s) should not be allowed to tender for collection contracts to avoid unfair competition for collection contracts. Once better accounting standards are established, this prohibition might be reviewed, but for the time being it is highly unlikely that costs could be quarantined and fair competition guaranteed.

8.3.6 Financial Stability

This approach should increase the financial stability of the system. Firstly, if the tendering of contracts is properly conducted, the actual costs of operation of the system will be established more accurately by market processes, rather than by theoretical calculations by the AMC. There is of course a risk that political interference will be tolerated in the tendering process to try to depress tariffs charged to households, but at least the impact of that interference will become evident more quickly as potential tenderers fail to submit bids for further contracts.

Secondly the contractors should not face the same non-payment or bad debt problem currently faced by the waste management companies. There is of course still the risk that the revenues collected by the public entity responsible for waste services are diverted to other sectors, and that this entity cannot then pay the contractors on time. Such an eventuality must be guarded against as far as possible in the legal framework establishing this entity, but there is a limit to the safeguards that can be provided until there is change in attitude in Kazakhstan towards the rule of law over commercial activities.

In principle however this (public) entity should have little difficulty in matching its revenues to its costs which are clearly established through the tendering process. As a public entity it can be given taxation or quasi taxation enforcement powers to collect tariffs from households, and to force households that are able to pay to actually pay. As a public entity it can also be given the power to waive tariffs for households that are unable to pay. To make up for this lost revenue, this entity must either collect a subsidy from the city or republican budget to cover this concession, or else allowed to set a tariff above the average cost per household, essentially causing more affluent households to subsidize the poorest households.

8.3.7 Achieving Universal Coverage

This new public entity will quite clearly be responsible for ensuring universal coverage. If there is an area or areas where wastes are not collected, then the primary responsibility must lie with this entity which has failed to let a contract covering this area, and would be liable for prosecution by the environmental protection and/or public health protection agencies. The team strongly recommends that some form of Local Government Act is introduced which clearly states the responsibility of the city Administration (or an entity owned by it) for the management of these services and other similar services. While current regulations require that all wastes are collected and disposed of at appropriate sites, they are effectively unenforceable. These new arrangements establish a responsible body that can be held accountable.

8.3.8 Enforcement and Separation of Functions.

Under the proposed arrangements the Waste Authority is essentially a management body. Final responsibility for establishing and enforcing standards should remain with the ACDEP and the Sanitary and Epidemiology Station. At a later stage these two bodies might be merged to improve the co-ordination setting and enforcing of public health and environmental standards which are frequently related. This is not a core issue for the immediate rehabilitation of Waste Management Services. Given the limited capacity to manage institutional change, such reform should be left until after these new Waste Management Institutions are fully established and operating smoothly.

Chapter 9

MASTER PLAN

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9.1 SOLID WASTE FLOW

The M/P has been prepared with the target year of 2010. Accordingly the solid waste flow in 2010 is shown in Figure 9.1.1. Table 9.1.1 shows the annual flow.

Waste amounts were forecast annually by type. The flow of these amounts of solid waste has been estimated based on the assumptions summarized in Table 9.1.1. The annual waste flow over the M/P period is shown in Table 9.1.2.

Table 9.1.1 Basic Assumptions for Preparing the M/P Waste Flow

| Basic assumption | Remark |
|--|--|
| 1. Waste generation rates | |
| Explained in chapters 5 and 6 of this report. | Based on the field surveys carried out for both winter and summer seasons |
| 2. Waste recycling | |
| 10% of generated domestic and commercial waste shall be recycled in 2010 | Recycling shall be mainly through recycling centers, named Amenity Centers and introduction of source separation by the year 2010. End users shall collect the recyclable waste brought to the Amenity Center. |
| 3. Waste collection | |
| Remaining 90% of generated domestic and commercial waste, and 100% of medical, street sweeping and non-hazardous industrial waste shall be collected. | |
| 4. Transfer Stations | |
| Excluding non-hazardous industrial waste, all collected waste will be brought to the transfer stations. The new transfer stations will start operation in the year 2002 for West Transfer Station and 2003 for Spasskaya Transfer Station. | Each transfer station will receive the collected waste from collection zones closest to it. |
| 5. Disposal Site | |
| All the waste hauled to the transfer stations will be transported to Karasai disposal site. | The present practice of dumping the waste at unsanctioned sites will cease as more efficient transfer stations and collection trucks are introduced. By 2005 the rate of waste illegally dumped will fall to 5% from the present rate of roughly 20% and drop to 0% by 2010. |

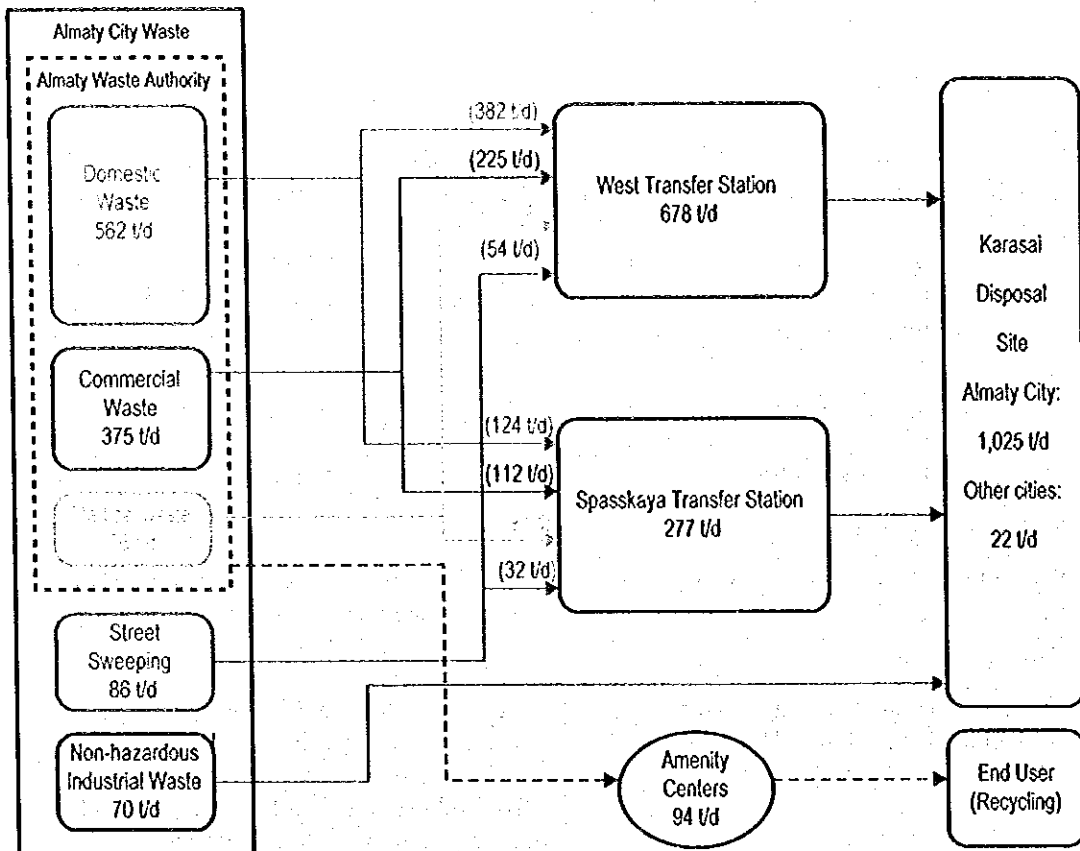


Figure 9.1.1 Solid Waste Flow in the Year 2010

Table 9.1.2 Annual Solid Waste Flow during the M/P Period

| No. Item | unit | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|--|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1 Waste Amount Generated | | | | | | | | | | | | |
| a) Domestic waste | t/d | 481 | 487 | 493 | 500 | 506 | 513 | 523 | 532 | 542 | 552 | 562 |
| b) Commercial waste | t/d | 320 | 325 | 329 | 333 | 338 | 342 | 348 | 355 | 362 | 368 | 375 |
| c) Medical waste | t/d | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 25 | 26 | 26 |
| d) Street sweeping waste | t/d | 78 | 78 | 79 | 80 | 81 | 82 | 82 | 83 | 84 | 85 | 86 |
| e) Non-hazardous industrial waste | t/d | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 |
| Total waste amount generated in Almaty City | t/d | 971 | 982 | 994 | 1,006 | 1,018 | 1,030 | 1,048 | 1,066 | 1,083 | 1,101 | 1,119 |
| 2 Recycled waste amount (from domestic and commercial) | t/d | 8 | 8 | 8 | 8 | 8 | 9 | 17 | 44 | 63 | 83 | 94 |
| 3 Self disposal, illegal dumping, etc. | t/d | 360 | 365 | 123 | 42 | 42 | 43 | 44 | 0 | 0 | 0 | 0 |
| 4 Waste amount collected under contract from | | | | | | | | | | | | |
| a) Waste Authority | | | | | | | | | | | | |
| Domestic waste | t/d | 454 | 461 | 714 | 806 | 817 | 827 | 835 | 868 | 866 | 863 | 869 |
| Commercial waste | t/d | 259 | 263 | 415 | 470 | 476 | 482 | 487 | 506 | 504 | 503 | 506 |
| Medical waste | t/d | 173 | 177 | 277 | 313 | 317 | 321 | 324 | 337 | 336 | 335 | 337 |
| Street sweeping organization | t/d | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | 25 | 26 | 26 |
| b) Non-hazardous industrial waste generators | t/d | 78 | 78 | 79 | 80 | 81 | 82 | 82 | 83 | 84 | 85 | 86 |
| d) Waste Authority Collection coverage rate (excl. recycl) | % | 55% | 55% | 85% | 95% | 95% | 95% | 95% | 100% | 100% | 100% | 100% |
| 5 Waste flow by SWM facility | | | | | | | | | | | | |
| a) West Transfer Station | t/d | --- | --- | 653 | 653 | 653 | 653 | 652 | 686 | 685 | 664 | 678 |
| b) Spasskaya Transfer Station | t/d | --- | --- | --- | 240 | 240 | 257 | 253 | 253 | 253 | 273 | 277 |
| c) Karasai disposal site | t/d | 617 | 625 | 879 | 973 | 985 | 998 | 1,006 | 1,041 | 1,041 | 1,040 | 1,047 |
| d) Other cities waste entering Karasai disposal site | t/d | 15 | 16 | 16 | 17 | 17 | 19 | 19 | 20 | 21 | 21 | 22 |

Notes: (1) Waste collected amounts in 4, are estimated as daily average of seven days

(2) Waste Authority Collection coverage rate is estimated after excluding recycling amount

(3) Waste flow amounts by SWM facility in 5, are all estimated as daily average of seven days

(4) From year 2007 a portion of the recycled waste amount will be deposited at the Amenity Centers

9.2 COLLECTION AND TRANSPORT

9.2.1 Collection

1) Understanding of the Collection Service

The Collection Plan in this M/P has been prepared based on a clear understanding of the objectives and workings of the collection service. It is worthwhile briefly restating these:

(1) Objectives of the Collection Service

- a. Collection service should be extended to all parts of the city. Public sanitation knows no boundaries. Uncollected waste in one part of the city will adversely effect the sanitary conditions of other parts of the city enjoying the service. Therefore all waste discharged on a certain day should be collected on the same day.
- b. Collection equipment should be used efficiently. Collection service can be very expensive and tiring work. Therefore means of improving operational efficiency are incorporated in the M/P.
- c. Community cooperation is very important for the success of the collection operation. A high degree of citizens' cooperation is required to ensure an efficient service.

(2) Workings of the Collection Plan

- a. All the waste discharged at the authorized collection points and in accordance with the authorized discharge rules shall be collected on the same day. This is a very important point of the plan and should be strictly observed by both the citizens and collection operators. The Waste Authority should set the rules for discharge and make sure that the citizens are aware of them and that the majority are convinced that the rules are necessary. Increasing public awareness of the SWM system is very important. The collection operators must collect the waste as specified in the rules or else they will lose the citizens' confidence. Failure by either side will lead to unsanitary conditions.
- b. Collection frequency will be 2-3 days per week and two transfer stations will be operated. The first measure aims to reduce the amount of time the collection truck must spend on the collection route. The second measure aims to reduce the transit time to reach the waste unloading facility. Therefore more trips are expected for each truck.
- c. Suitable equipment will be operated. The compactor trucks proposed have high loading capacities and dump trucks will not be used in principle. Although the proposed arm roll trucks have comparatively low loading capacities they have the advantage of performing a large number of trips per day. Collection will be from designated collection points. The majority of these points will be equipped with containers for mechanical loading. In IH areas packed waste will be manually loaded. The number of workers are set taking into consideration the equipment used and discharge system.
- d. Collection system will be cost efficient. Items (b) and (c) described above will contribute to providing a more cost efficient system.
- e. Clear collection operation requirements by collection zone. The city shall be divided into a number of collection zones where the work shall be put out to tender by the proposed Waste Authority. This will allow for universal coverage for the city and more efficient operation based on competitive bidding.

(3) Major Operation Indicators

In accordance with the objectives and operational characteristics of the collection system, the collection plan has been prepared as described in this section. If the plan is implemented the expected operation indices in the year 2010 will be as follows:

- a. Collection coverage rate: 100% of discharged waste
- b. Average no. Trips/collection truck: 3.8
- c. Average Haul/trip: 2.6 ton
- d. Average ton/field collection staff: 2.6 ton/person
(only collection and transfer station staff, i.e. supervisors, drivers, and workers)
- e. Cost: 1,228 T/ton (US\$ 10.7/ton)
(cost only includes collection and transport to unloading facility costs)

2) Equipment Plan

(1) Type of Equipment

Three collection truck types are proposed in the M/P, namely small compactor (8m³), medium size compactor (12m³) and arm roll truck (6m³). The reasoning behind the selection of these equipment types has been discussed in Chapter 7 and is briefly summarized in the following Table 9.2.1.

Table 9.2.1 Types of Collection Equipment

| Equipment type | Considerations in Selection |
|------------------------------------|---|
| 1) Compactor 12 m ³ | <ul style="list-style-type: none"> • High haul capacity per trip (0.45 t/m³ compacted density x 11.5m³ x 0.85 = 4.4 t) • Large number of trips per day (2.9 trips/shift under conditions of rear mechanical loading, 3 day/week discharge and 10 km one way distance to unloading facility) • Highly suited for block housing areas in terms of size • Suitable for collection of commercial waste from large dischargers such as hotels, restaurants, etc. |
| 2) Compactor 8 m ³ | <ul style="list-style-type: none"> • Medium haul capacity per trip (0.45 t/m³ compacted density x 8m³ x 0.85 = 3.1 t) • Large number of trips per day (3.8 trips/day under conditions of rear mechanical loading, 3 day/week discharge and 10 km one way distance to unloading facility) (2.4 trips/day under conditions of rear manual loading, 3 day/week discharge and 10 km one way distance to unloading facility) • More suited for IH, compared with dump trucks and larger compactors. Collection from open stations by manual loading so trip production will drop somewhat. • Suitable for collection points in BH areas located within the block area where access is difficult. |
| 3) Arm roll 6 m ³ | <ul style="list-style-type: none"> • Haul capacity similar to dump truck but trip production is high (0.25 t/m³ density x 6 m³ x 0.9 = 1.4 t) (8.0 trips/day by hauling loaded containers and 10 km one way distance to unloading facility) • Very suitable for collection of commercial waste from large dischargers such as hotels, restaurants, etc. |
| 4) Container 1.1 m ³ | <ul style="list-style-type: none"> • Used at the collection points for domestic (BH areas), mixed domestic/commercial, commercial and medical waste. • Containers made of metal, on rollers and equipped with cover. |
| 5) Container 6 m ³ | <ul style="list-style-type: none"> • Used with arm roll trucks for commercial waste from large generators • Containers made of metal with latched openings for waste insertion. |

Some additional information and data is provided on the collection trucks in the Supporting Report. These truck types are widely used in Japanese and European cities, and for cost purposes Japanese manufactured trucks were used. Russian made trucks used in Almaty are all side loading and achieve little compaction of the waste.

(2) Equipment Requirements

Based on the waste collection amount, haulage capacities and trip production rates per day as discussed in the preceding section, collection equipment requirements were estimated. Equipment requirements are shown in Table 9.2.2.

Table 9.2.2 Collection Equipment Requirements

| Item | Compactor (8 m ³) | Compactor (12 m ³) | Arm roll (6 m ³) |
|---|----------------------------------|---|---------------------------------|
| 1) Waste collection types | - IH (100%) - BH (30%) | - BH (70%) - Comm. (40%) - Medical (100%) | - Comm.(60%) |
| 2) Total waste amount collected (ton/day) | 290 | 488 | 236 |
| - Domestic waste | 290 | 300 | -- |
| - Commercial waste | -- | 157 | 236 |
| - Medical waste | -- | 31 | -- |
| 3) Truck number by collection section | | | |
| (1) Almalinski | 3 | 6 | 4 |
| (2) Auezovski North | 2 | 5 | 3 |
| (3) Auezovski South | 4 | 6 | 3 |
| (4) Bostandiski | 4 | 6 | 1 |
| (5) Zhetesuski West | 2 | 3 | 4 |
| (6) Zhetesuski East | 3 | 3 | 4 |
| (7) Medeuski North | 4 | 2 | 2 |
| (8) Medeuski South | 3 | 2 | 1 |
| (9) Turksibski North | 4 | 3 | 2 |
| (10) Turksibski South | 4 | 4 | 4 |
| Total Almaty | 33 | 40 | 28 |

In total 101 collection trucks are required in the year 2010, along with 6,276 containers of 1.1m³ capacity and 188 containers of 6m³. An increase of 10% has been added to the actual requirements to serve as standby.

3) Operation Conditions

Operation of the collection has been determined to secure the efficient utilization of trucks and offer collection service to the whole city. The operation conditions are given in Table 9.2.3.

Planning and monitoring of truck routing is very important in order to avoid waste of time on the collection routes. Considerations on routing methods are reviewed in the Supporting Report.

Table 9.2.3 Collection System Operating Conditions

| Item | Operation Condition | Remark |
|---|--|---|
| 1) Working days | 6 days/week and 1 shift/day (shift time may extend to 10 hours with overtime payment to meet the required collection quota) | Working 7 days a week would require payment of overtime and operation of transfer stations and disposal site without stopping. As necessary the seventh day may be better utilized for maintenance/ repair works. |
| 2) Collection crews - Supervisor - Driver - Worker | One supervisor for about 10 trucks One driver per truck - 3 on compactors in IH areas - 2 on compactors in BH areas - 1 on arm roll | An additional 10% to the estimated figures is included for standby crews, leaves, etc. |
| 3) Discharge system | - Discharge day will be fixed based on the collection area. - Discharge time will start from the evening of the day before the designated collection day to 8 AM on that day only in BH areas where containers are available. - Packed waste will be discharged in IH areas. | - In BH areas the number of containers is estimated based on two days waste. Practically waste may be discharged on off collection days as well but this will be discouraged as much as possible. On Mondays and after holidays it may be necessary to extend shift working hours. This has been considered in costs estimates. |
| 4) Maintenance of collection points | The citizens will be responsible for the maintenance of the collection points. | The collection workers should not waste time at the collection points as this would affect the truck trip production rate. |

4) Contract Out System

To facilitate implementation of the Contract Out system the city's six districts were divided into ten (10) collection sections and the waste amounts and equipment requirements for each section were estimated. Figure 9.2.1 shows daily collection volumes, number of trucks and manpower required for each section.

This division took into consideration two important factors:

- Ease of monitoring contractor obligations
- Provision of collection zones with a suitable waste collection volume (not less than 6 trucks per section and averaging 10 trucks)

The actual tender procedures are discussed elsewhere in this report and only issues related to technical matters are considered hereafter.

(1) Definition of the Contractor's Responsibility

The contract conditions must clearly define the services required. The following aspects should be specified:

- a. Service section (defined on maps with street names, number of households, buildings, commercial and institutional concerns, etc.)
- b. Service level; collection frequencies to be 3 or 2 days/week and on which days. Also what provisions will be made for Mondays and days following holidays in terms of working extra hours or increasing truck numbers.
- c. Estimates of waste collection quantity with explanation of the methods adopted to make these estimates.
- d. Destination of collected waste and times when waste will be accepted at the transfer facility.
- e. The collection system to be used; such as container system or open station system and the collection hours.
- f. The minimum requirements in terms of collection trucks and containers to be used (e.g. if the Waste Authority is providing the containers then trucks used by the contractor should be compatible)
- g. Contractor's obligation to conduct periodic meetings with the general public being served and dispense information as necessary and in accordance with the Contract (e.g. collection days and hours, discharge method, etc.)
- h. Cooperation with the Waste Authority's monitoring responsibilities by issuing periodic reports on waste amounts collected and conditions of equipment used.

(2) Monitoring and Supervision of the Contractor's Performance

The Waste Authority should ensure that the Contractor is executing the services in accordance with the contract through the following measures:

- a. Estimate the daily total waste to be generated in the collection section on a periodic basis to take into account any changes in the land use during the contract period.
- b. Monitor the collection service provided through site visits, meetings with citizens and society representatives and existence of open dumping points in the collection area.
- c. From time to time observe the actual performance of the collection truck to determine the cleansing conditions at the waste collection points and the interaction between the collection crew and the citizens served.
- d. Monitor contractor facilities such as garage and workshop to evaluate truck operating conditions.
- e. Design report formats to be submitted by the contractor showing total waste collected, truck operation indicators (number of trips per shift, working hours per shift, operating rate per week, breakdowns and maintenance records, etc.)
- f. Supervise truck scale facilities used for recording the collected total waste at the transfer station facilities and disposal site.

5) Workshop and Maintenance

Both periodic and continuous preventive maintenance are the best way to protect collection trucks and increase their lives. Private collection companies using their own trucks understand very well the need to keep their fleet operating. On the other hand when the trucks owned by the Waste Authority are leased to the private companies then there is a need to ensure that the trucks are being properly maintained and repaired.

The private companies should have the facilities to provide daily preventive maintenance and periodic maintenance. Heavy repairs and maintenance may be contracted out to specialized workshops. There are a number of such workshops in the city which are considered capable and ready to provide repair services to major systems such as hydraulics and engines of the proposed compactors. IVECO Co. is one example.

Each truck should have an operation and maintenance record. The working hours, total waste collected, breakdowns, major repair works (with description, repair period, parts replaced, expense, etc.) should be recorded.

The formats for daily and inspection lists used in Japan are reproduced in the Supporting Report for reference.

9.2.2 Transfer Station

Transfer stations are planned to re-load solid waste collected by small collection trucks into large vehicles (semi-trailers) then transfer the waste to the final disposal site. The new West transfer station is planned to serve Auezovskii, Zhetysuskii, Bostandykskii and Almalinskii Districts and the Spasskaya transfer station is planned to serve Medeuskkii and Turksibskii Districts (as shown in Figure 9.2.1 in the preceding section).

1) Facility Plan

Outline of each transfer station is shown in Table 9.2.4.

Table 9.2.4 Outline of Transfer Stations

| No | Item | West T/S | Spasskaya T/S |
|----|---|---|---|
| 1 | Site area | 3 hectare | 2 hectare |
| 2 | Waste amount to be transferred | 676 ton/day (average) 782 ton/day *) | 290 ton/day (average) 318 ton/day *) |
| | Plant capacity (per working day) **) | 800 ton/day | 480 ton/day |
| 3 | Type of waste re-loading | Direct-load type | Direct-load type |
| 4 | Number of waste re-loading stations | 3 | 2 |
| 5 | Staging level of reloading station | GL+4.00m | GL+4.00m |
| 6 | Transfer Trucks (40m ³ semi trailer) | | |
| | - Trips/truck | 4 | 3 |
| | - Number of trucks | 15 | 8 |

Note: *) shows actual incoming waste amount per working day (310 working days per year)
**) Plant capacity is determined by the peak hour capacity

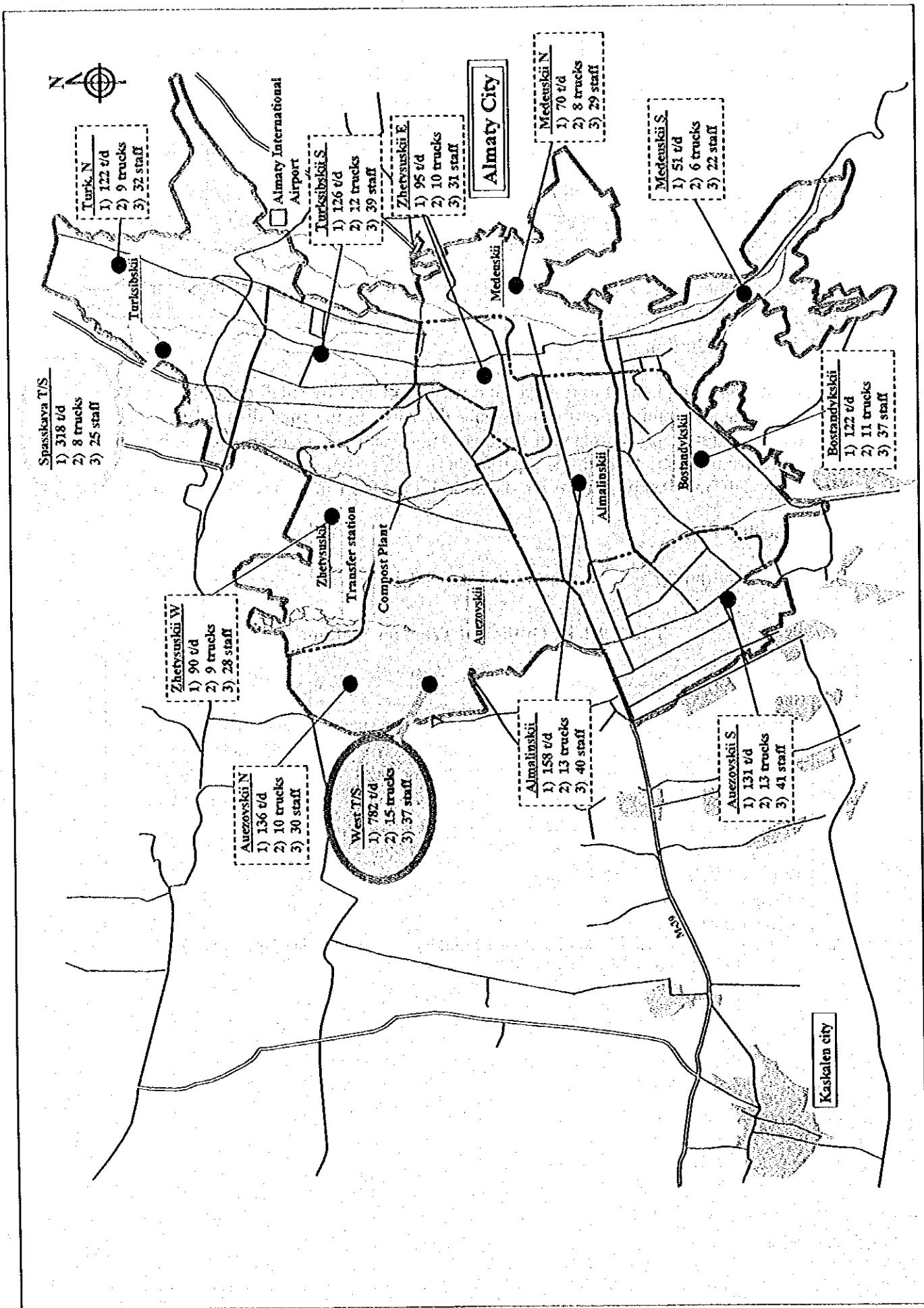


Figure 9.2.1 Equipment and Manpower Requirements by Collection Zone in 2010

The number of waste re-loading stations in each transfer station are calculated as follows.

(1) Conditions

- Waste haulage amount at the peak hour of the day : 15% of total incoming waste
- Unit weight of the waste : 0.35 ton/m³
- Applied waste transfer vehicle : 40m³ trailer
- Waste re-loading time at the transfer station : 20 minutes/vehicle

(2) Calculations

a. New West transfer station
 $790 \text{ ton/day} \times 15\% / 0.35 \text{ ton/m}^3 = 339 \text{ m}^3$
 $339 \text{ m}^3 / 40 \text{ m}^3 \times 20/60 = 2.8.$
 Therefore, 3 re-loading stations are required.

b. Spasskaya transfer station
 $340 \text{ ton/day} \times 15\% / 0.35 \text{ ton/m}^3 = 146 \text{ m}^3$
 $146 \text{ m}^3 / 40 \text{ m}^3 \times 20/60 = 1.21$
 Therefore, 2 re-loading stations are required.

The layout plan and required facilities for West transfer station and Spasskaya transfer station are shown in Chapter 16 of this report and in the Supporting Report.

2) Operation/ Maintenance and Equipment Plan

Table 9.2.5 shows the staffing of transfer stations for their operation and maintenance.

Table 9.2.5 Staffing at the Transfer Stations

| Staff Category | West T/S | Spasskaya T/S |
|--------------------------------------|-----------|---------------|
| A. Transfer Station Operation | | |
| 1) Site Manager | 1 | 1 |
| 2) Secretary (accountant) | 1 | 1 |
| 3) Truck scale operator | 3 | 2 |
| 4) Chief Engineer | 1 | 1 |
| 5) Inspector | 3 | 2 |
| 6) Chief mechanic | 1 | 1 |
| 6) Operator/ Wheel loader | 2 | 1 |
| 7) Workers | 8 | 6 |
| 8) Security Guards | 2 | 2 |
| B. Transfer Operations | | |
| 9) Drivers | 15 | 8 |
| Total A and B | 37 | 25 |

9.3 DISPOSAL

9.3.1 Facility Plan

1) Disposal Site Capacity Requirement

Total disposal site capacity required for the period 2000 until 2010 is shown in Table 9.3.1. A total capacity of 3.96 million cubic meter is required at Karasai up to 2010.

Table 9.3.1 Capacity Requirement for the Disposal Site at Karasai

| Year | (1) Waste Amount ¹ (m ³ /day) | (2) Street Sweeping ² (m ³ /day) | (3) Landfill Waste (m ³ /year) (1) × 365 + (2) × 365/2 ² | (4) Cover Soil (m ³ /year) (3) × 0.12 ³ | (5) Cumulative amount disposed (m ³) |
|-------|--|---|---|--|--|
| 2000 | 539 | 78 | 210,970 | - | 210,970 |
| 2001 | 547 | 78 | 213,890 | - | 424,860 |
| 2002 | 800 | 79 | 306,418 | 36,770 | 768,048 |
| 2003 | 893 | 80 | 340,545 | 40,865 | 1,149,458 |
| 2004 | 904 | 81 | 344,743 | 41,369 | 1,535,570 |
| 2005 | 916 | 82 | 349,305 | 41,917 | 1,926,791 |
| 2006 | 924 | 82 | 352,225 | 42,267 | 2,321,283 |
| 2007 | 958 | 83 | 364,818 | 43,778 | 2,729,879 |
| 2008 | 957 | 84 | 364,635 | 43,756 | 3,138,270 |
| 2009 | 955 | 85 | 364,088 | 43,691 | 3,546,048 |
| 2010 | 961 | 86 | 366,460 | 43,975 | 3,956,483 |
| Total | - | - | 3,578,095 | 378,388 | 3,956,483 |

Note: ¹ Bulk density of waste in the site varies from 0.4 to 1.7, so that it is assumed to be 1.0 in the estimation. This amount excludes the collection amount of street sweeping.

² Street sweeping is carried out only during half of the year. The total amount of landfill waste is slightly different from the result of this equation due to rounding.

³ Sanitary landfill system with application of cover soil will be undertaken from year 2003. The total amount of cover soil is assumed to be 12% of waste volume.

2) Estimation of the Existing Landfill Capacity

Based on the result of the topographic survey in the second study period, the present waste dumped in the site is estimated to be approximately 820,000 m³.

3) Major Components of the Disposal Site

Facilities for the Karasai disposal site needed to achieve a Sanitary Level of 3+ are tabulated in Table 9.3.2. Based on the results of the Environmental Survey, it would be desirable to implement a higher sanitary level, i.e., Level 4 at this site. However a liner system will be installed only for the leachate retention pond as it is unrealistic to establish the liner system under the existing dumping area.

The leachate treatment facility consists of both retention and treatment ponds. Both capacities are calculated using simulated climatic conditions based on meteorological data (mainly precipitation records) collected between 1988 and 1997.

Table 9.3.2 Major Components of the Disposal Site

| Component | | Definition |
|--|---------------------|---|
| 1. Access Road | | <ul style="list-style-type: none"> a. Connect the site with the existing public road b. Constructed as an essential component of the landfill site |
| 2. Structure for solid waste retention | 2-1. Enclosure Dike | <ul style="list-style-type: none"> a. Made of soil in principle b. Limit the range of dumping area c. Placed along the boundary of the site |
| | 2-2. Divider Dike | <ul style="list-style-type: none"> a. Made of soil in principle b. Limit the range of dumping area c. Placed on the boundary of the partition for the demarcation of annual operation |
| | 2-3. Landfill Area | <ul style="list-style-type: none"> a. Area for waste placement b. Installed with on-site road, sub-surface drain for leachate and gas vent according to the progress of the landfill operation |
| 3. Leachate Control Facility | | <ul style="list-style-type: none"> a. Consists of collection facility and reservoir b. Collection system should collect rainwater which seeps through the garbage pile c. Supply air into the garbage |
| 4. Leachate Treatment Facility | | <ul style="list-style-type: none"> a. Consists of retention pond and treatment pond b. Treat leachate by biological process and discharge |
| 5. Rainwater Drainage | | <ul style="list-style-type: none"> a. Consists of collection facility and discharge facility b. Collection facility should collect the rainwater before it reaches landfill. |
| 6. Gas Vent | | <ul style="list-style-type: none"> a. Made of porous material to facilitate passage of gas b. Installed vertically through the garbage layers and cover soil c. Connected with the sub-surface drain |
| 7. Monitoring Facility | | <ul style="list-style-type: none"> a. Consists of wells b. Monitor groundwater for escaped leachate |
| 8. Administrative Facility | | <ul style="list-style-type: none"> a. Consists of building and other miscellaneous facilities b. Provides facilities for operations and administrative staff c. Controls the landfill activity at the site |

4) Design of the Disposal Site

Layout plan and cross section of the Karasai disposal site are designed as shown in Figures 9.3.1 and 9.3.2, respectively. The plan is formulated based on Level 3+ including all components shown above in Table 9.3.2.

5) Design Landfill Capacity and Useful Life

The elevation of final cover is set at 860 m taking into consideration the surrounding topographical features. The design landfill capacity is thus calculated at 3,991,900 m³. The relationship between the elevation and design landfill volume is shown in Figure 9.3.3. This capacity is enough to store the total amount of solid waste carried in the site until 2010, which is calculated at 3,956,483 m³. On the basis of this calculation, the useful life of the disposal site is extended until the beginning of year 2011.

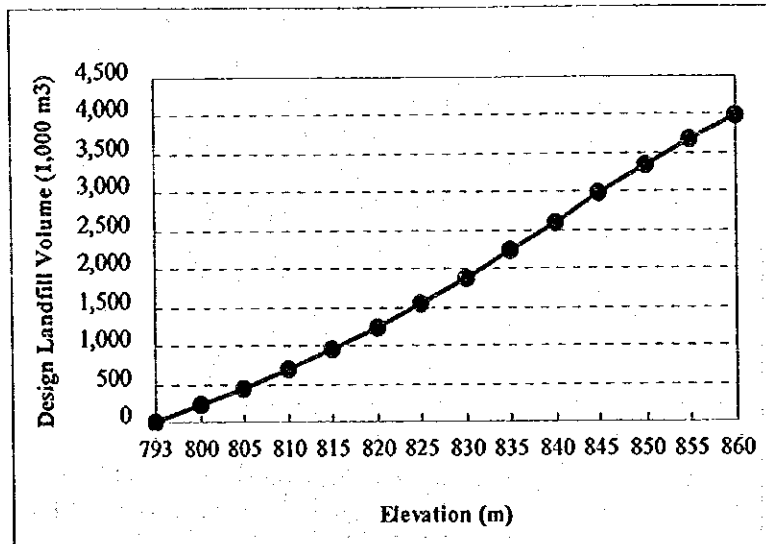


Figure 9.3.1 Relationship between Elevation and Design Landfill Volume of Karasai Disposal Site

6) Management of Landfill System

The functions of the landfill system will only be realized if appropriately managed. Therefore, management of the sanitary landfill system must be thoroughly examined. In principle, planning of the management system must consider the following points:

- (1) Strict adherence to the technical standards should be maintained for proper operation and control of the landfill system.
- (2) The following data should be recorded and stored in order to correctly control the volume of solid waste dumped into the site and for the planning of efficient operations:
 - Volume of solid waste disposed;
 - Volume of cover material used;
 - Condition of the landfill site.
- (3) Environmental quality during the landfilling process as well as after its completion should be monitored. Table 9.3.3 shows an outline of the proposed monitoring.
- (4) Inspection and maintenance of each facility in the landfill system should be carried out periodically and after a heavy downpour or the occurrence of a natural disaster.
- (5) Management system should be flexible taking into account the actual site condition, prevailing social conditions in the region and technical level of the cleansing operators.

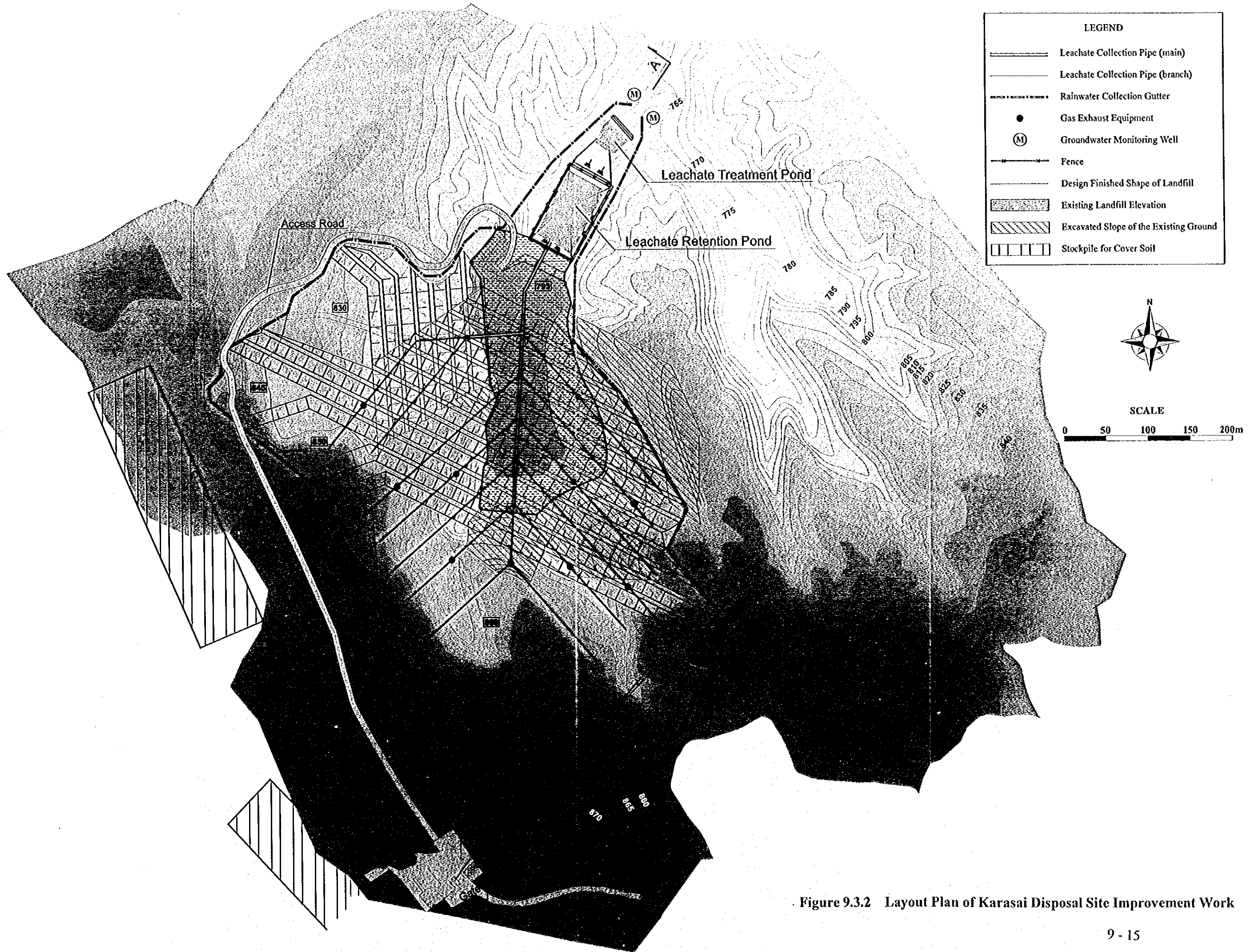


Figure 9.3.2 Layout Plan of Karasai Disposal Site Improvement Work

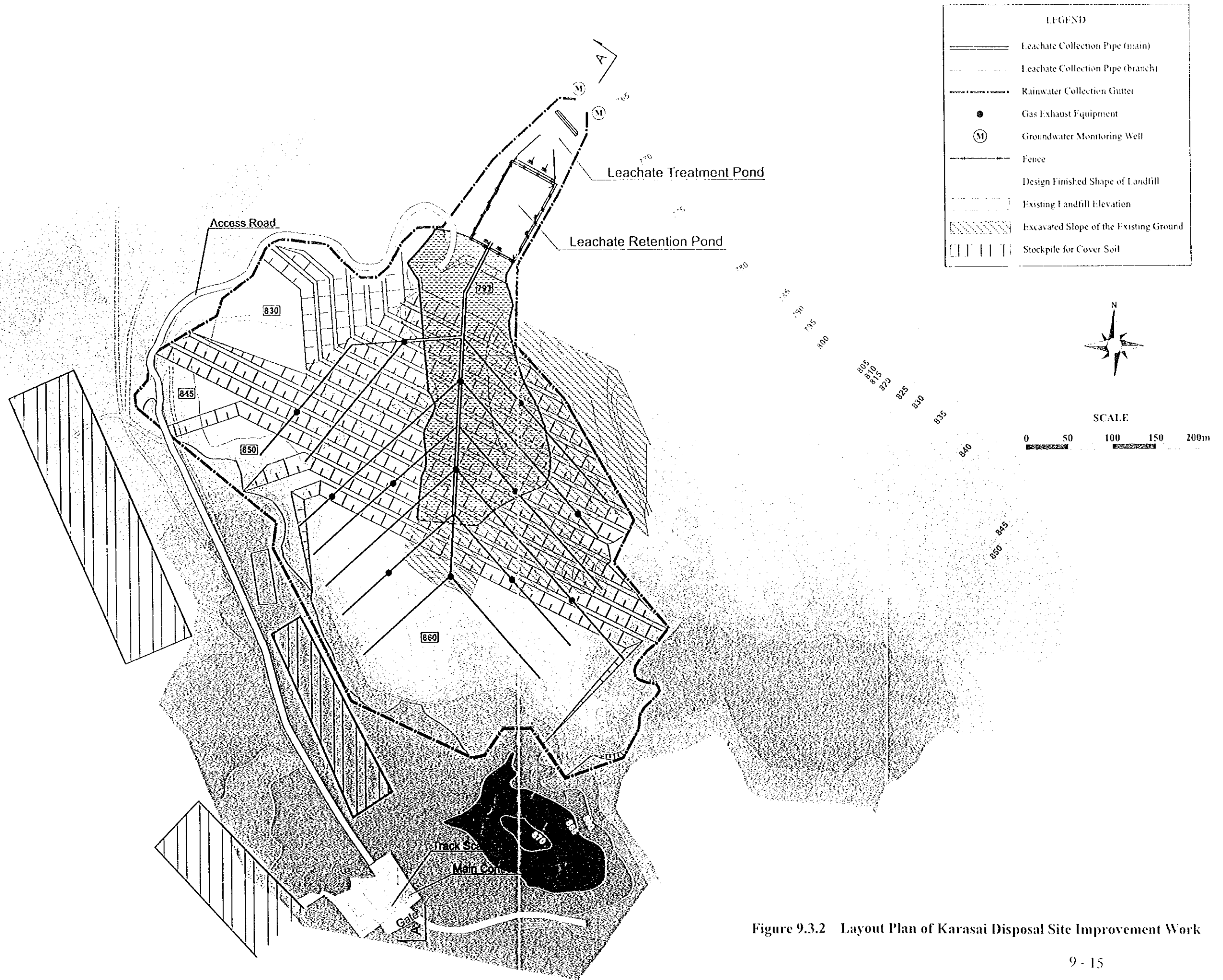


Figure 9.3.2 Layout Plan of Karasai Disposal Site Improvement Work

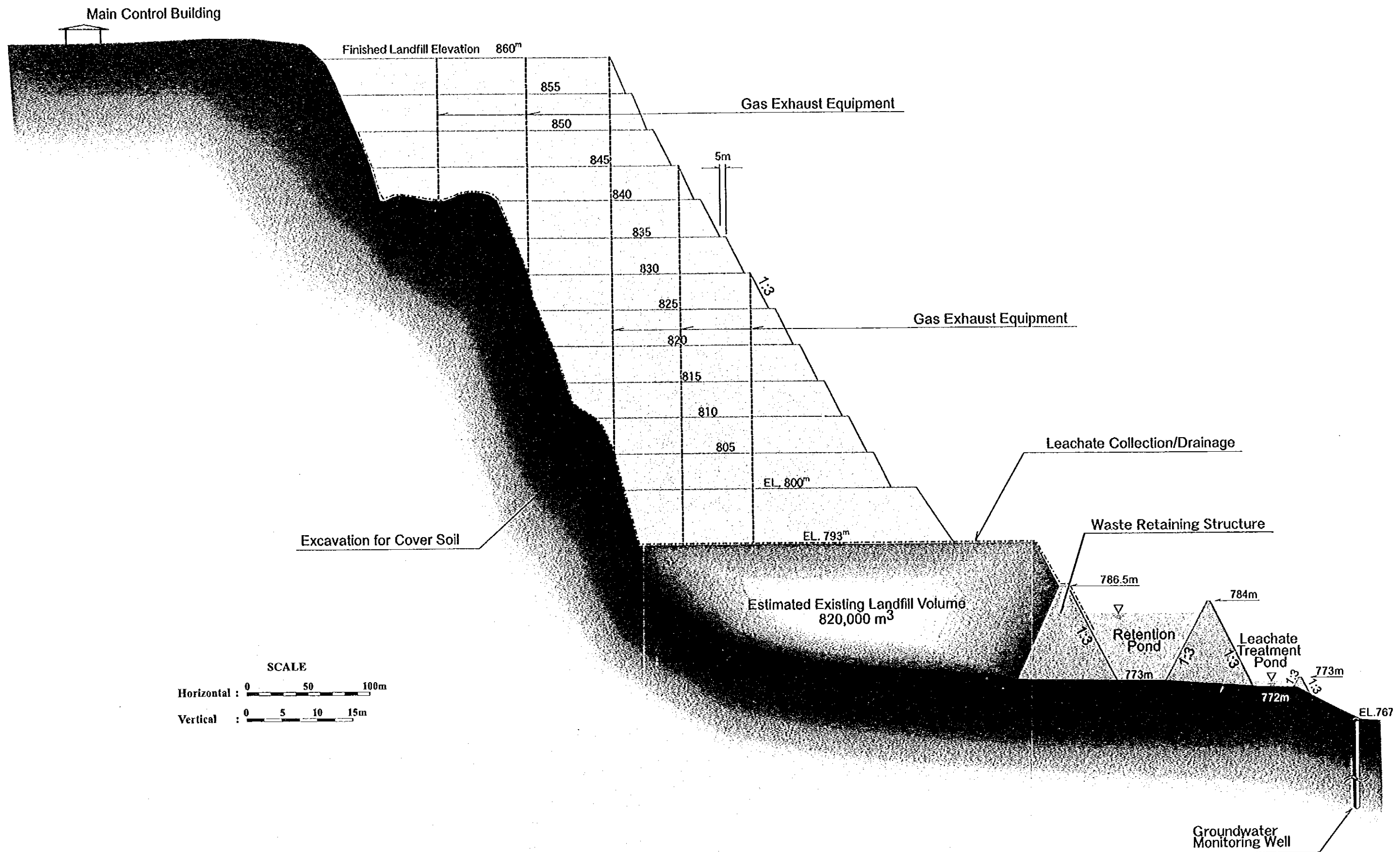


Figure 9.3.3 Longitudinal Section of Karasai Disposal Site Improvement Works (Section A-A)

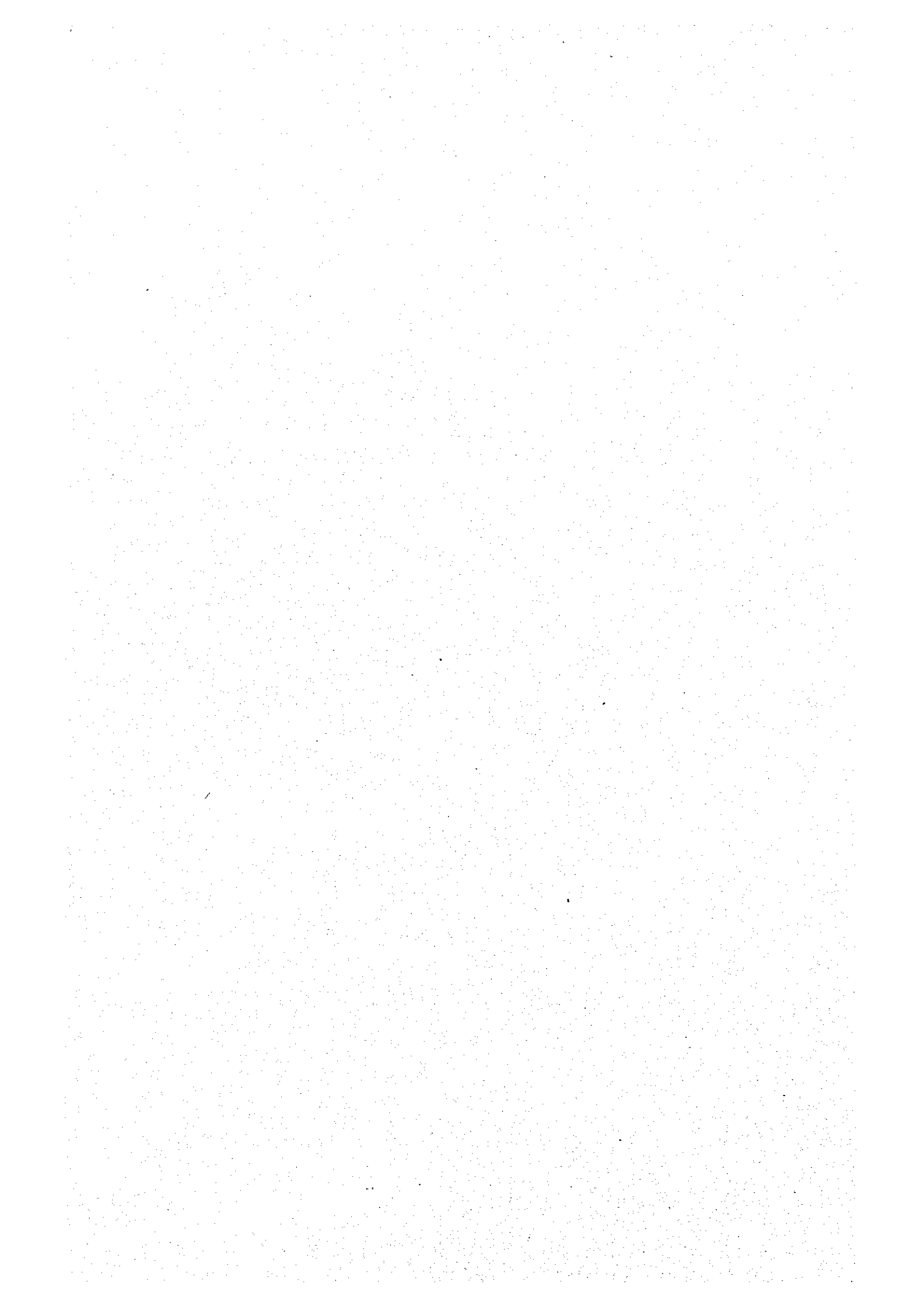


Table 9.3.3 Proposed Monitoring Items for Karasai Disposal Site

| Monitoring Items | Monitoring Facility | Inspection Items | Frequency |
|---|---------------------------------|--|-----------|
| Groundwater | Groundwater monitoring well | pH, CN, Pb, T-Hg, Cd, BOD, COD, SS, Color | 1/month |
| Gas | Gas outlet pipe | Temperature and humidity of original air, Temperature and volume of gas, component analysis (CH ₄ , CO ₂) | 4/year |
| Settlement | Ground surface settlement board | Settlement of ground level | 1/month |
| Odor | - | Item should be selected by surrounding conditions | 2/year |
| Leachate | Leachate retention pond | pH, CN, Pb, T-Hg, Cd, BOD, COD, SS, Color | 1/month |
| Effluent water from leachate treatment facility | - | pH, CN, Pb, T-Hg, Cd, BOD, COD, SS, Color | 1/month |

7) Landfill Operation

(1) Application of Cover Soil

Dumped waste should be covered with soil everyday. Daily application of cover soil is required to:

- a. Reduce smoke and odor;
- b. Reduce the number of insects and rodents; and
- c. Accelerate waste decomposition.

(2) Bedding and Compaction

Solid waste must be sufficiently compacted so as to stabilize the landfill foundation and prolong use period of landfill. A layer of cover soil must be systematically placed after each layer of solid waste is placed. The waste is unloaded at the toe of the earth dike and spread and compacted on the slope of the dike in a series of layers that vary in depth from 30 to 60 cm. The recommended slope of these layers is 1 is to 3. At the end of each day's operation, a 15 cm to 30 cm layer of cover soil is placed over that day's completed fill. The volume of cover soil required each day will be about 10 to 15% of the volume of waste deposited. The daily cover soil should be prepared and stored ahead of time by excavation work or selection of suitable construction work.

The cell method is recommended for sanitary landfill in view of the large area of landfill, and the uphill method is recommended for bedding and compaction. Daily covering by soil should be carried out.

(3) Safety and Sanitary Control

A landfill system should be designed to consider safety and sanitary conditions for its workers. Most work at a sanitary landfill site is outdoors. Workers will be affected by dust, odor and gas emissions. In addition, they may have some contact with chemicals.

Working environment requirements then need to be considered.

(4) Safety and Sanitary Control for Workers

In order to ensure health and safety for workers at a landfill site, it is necessary to consider the working conditions and examine the following items:

- a. Dust from landfill operations
- b. Gas formation
- c. Use of chemicals
- d. Accidents such as falls
- e. Vectors and animals
- f. Others

(5) Welfare Facilities and Health Check

Health care for workers should be one aspect of the overall sanitary landfill system plan. Particular consideration should be given to the following points for safety and ease of work.

- a. Canteen, welfare and rest facilities
- b. Regular health checks
- c. Maintenance of first-aid kits

8) Construction Schedule

The new collection and transportation system will be operated from the year 2002; simultaneously sanitary landfill operation should be started using heavy equipment. Therefore, by the year 2002, the improvement work of the site, which will take 8 to 9 months, should be completed.

The present landfill operation must continue with the existing equipment until the new heavy equipment is procured. Present equipment at the site is 2 bulldozers, 1 excavator and 2 dump trucks.

9) Possibility of Future Expansion of the Site

As previously estimated, the Karasai site will be filled to capacity in 2011; therefore, the existing site capacity should be expanded or another disposal site should be developed before the site is full of waste. Based on a topographic map dated 1976, it is possible to build a new landfill site adjacent to the present site but more detailed studies including geological and topographical surveys should be carried out to justify the location. This possible site for new landfill is shown in Figure 9.3.4.

9.3.2 Equipment Plan

1) Heavy Equipment and Vehicles Required

Estimates of numbers and major specifications of equipment are based on the projected quantity of waste to be placed at the site in the year 2010. Some heavy equipment is required for bedding and compaction of waste and cover material. Based on the amount of waste and cover material to be handled, it is estimated that five 21 ton capacity bulldozers with wide caterpillars will be required for the planned sanitary landfill

operation. Excavators and wheel loaders will also be required for ancillary jobs that are difficult to carry out with a bulldozer, such as leveling of waste piles, building up of soil banks and digging water drainage trenches on the landfill site. Dump trucks will be required for transportation of cover soil. In addition, a water tanker will be required for road and site sprinkling to keep the dust down and compact the road surface. The list of heavy equipment required is given in Table 9.3.4 below.

Table 9.3.4 List of Heavy Equipment for Landfill Operation and Maintenance

| Items | Number | Remarks |
|-----------------|--------|---|
| 1. Bulldozer | 5 | - Spread and Compaction (Capacity: 70 – 80 m ³ /hour, Availability: 90%) Waste: $(1,192 \times 1.12 \text{ t/day}) / (70 \text{ m}^3 \times 7 \text{ hours} \times 0.9) = 3.1$; Say, 4 Soil: $(1,192 \times 0.12) / (80 \text{ m}^3 \times 2 \text{ hours} \times 0.9) = 1.0$; Say, 1 |
| 2. Excavator | 2 | - Soil Excavation (Capacity: 60 m ³ /hour, Availability: 90%) Soil: $(1,192 \times 0.5) / (60 \times 7 \times 0.9) = 1.6$; Say, 2 |
| 3. Wheel Loader | 1 | - Soil Excavation and Transportation (Capacity: 100 m ³ , Availability: 90%) Soil: $(1,192 \times 0.12) / (100 \times 2 \times 0.9) = 0.8$; Say, 1 |
| 4. Dump Truck | 5 | - Soil Transportation (Capacity: 16 m ³ /hour, L = 500 m, Availability: 90%) Soil: $(1,192 \times 0.12) / 16 / 2 / 0.9 = 5.0$; Say, 5 |
| 5. Water Tanker | 1 | - Soil Transportation (Capacity: 16 m ³ /hour, L = 500 m, Availability: 90%) Soil: $(1,192 \times 0.12) / (16 \times 2 \times 0.9) = 5.0$; Say, 5 |

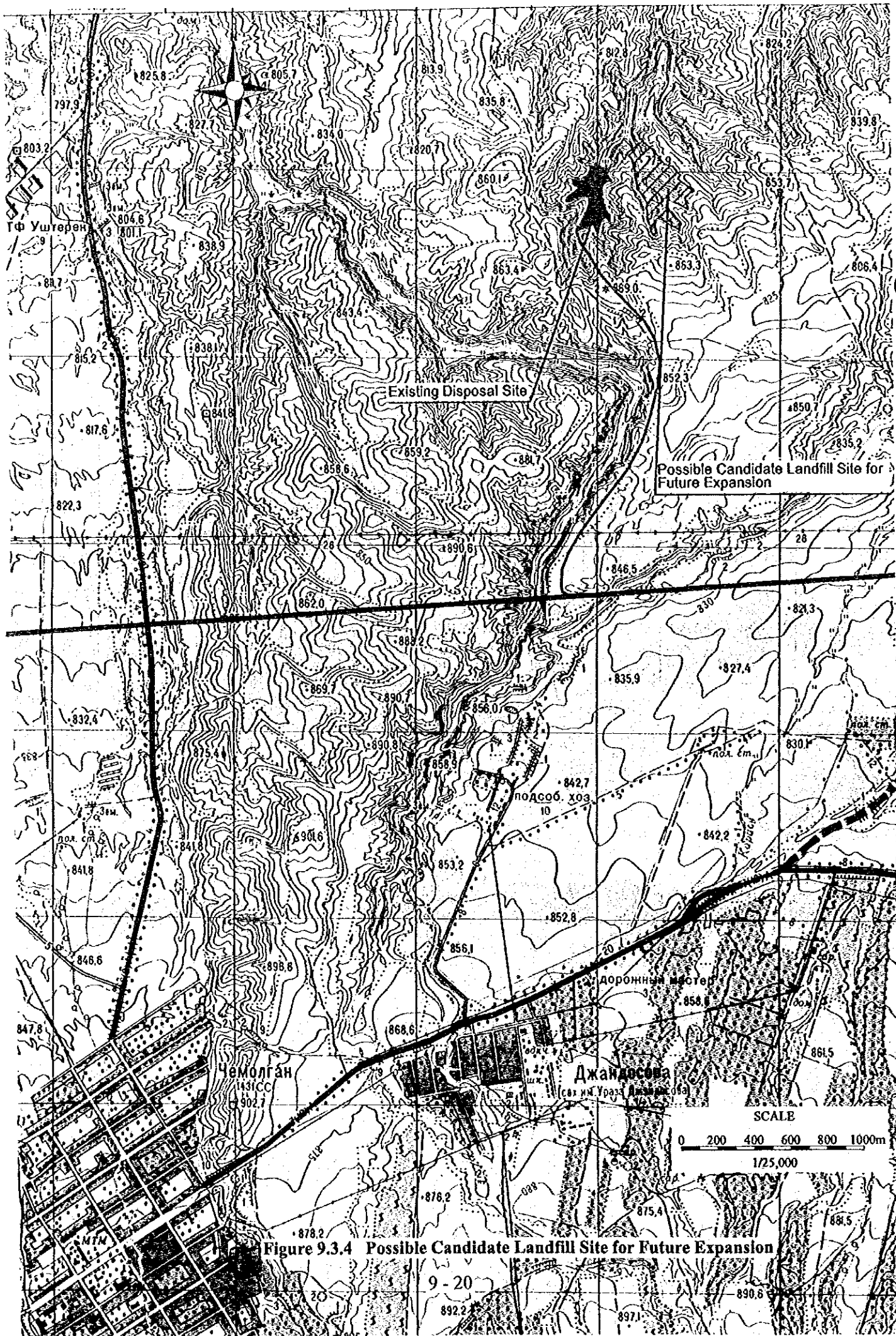


Figure 9.3.4 Possible Candidate Landfill Site for Future Expansion