INTERGRATED WATER RESOURCES MANAGEMENT FOR TRANSBOUNDARY CATCHMENTS IN INDONESIA: A Case Study of Krueng Aceh Catchment, Aceh Province

by

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ABSTRACT

Integrated Water Resources Management (IWRM) may face a range of challenges and barriers when it is implemented in a transboundary catchment, which is a catchment that lies in different administrative or governance areas. Successful implementation requires both hydro-technical approaches to engineering design and hydro-political attention in negotiations that can create holistic policy areas across transboundary catchments. This research focuses on the Krueng Aceh catchment that covers the two administrative authorities of Banda Aceh City in the downstream area and Aceh Besar Regency in the upstream area. Both of these decentralized areas are under the governance of Aceh Province, Indonesia.

This research explores the hydrological responses and externalities that arise due to land use/land cover (LULC) change in the Krueng Aceh catchment. It utilises HEC-HMS modelling, sediment transport analysis, water balance simulation and economic valuation analysis to investigate the impacts of LULC change in the upstream and downstream areas. Moreover, this research develops solutions using multi criteria decision making (MCDM) and analytic hierarchy process (AHP) analyses for IWRM implementation based on an economic compensation scheme, where payment for environmental services (PES) can be applied in cooperation between the decentralized areas.

The research found that LULC change from 1988 to 2012 resulted in significant forest loss and increased open land cover types and has altered the long-term hydrological regime of the catchment. This has resulted in increased high flow events during the wet season and decreased low flow in the dry season. As a consequence of this, sediment transport has increased in the catchment during this period. The changing hydrological regime and sediment delivery result in externalities for the catchment to the water service provider (PDAM Tirta Daroy) in the downstream area through increased cost for water purification, it also impacts paddy fields in the upstream area due to shortage of water. For PDAM Tirta Daroy, the cost for water purification increased from USD 205,232 under LULC 1988 to USD 215,192 under LULC 2012, and the cost is predicted to increase to USD 447,442 by 2040 if the same trends in LULC change continue. In the upstream areas of the catchment, it is predicted that the paddy field water shortages cause significant economic losses from reduced rice production. In this research various scenarios of LULC change under potential climate change effects on rainfall patterns and projected water demands in 2040 have been modelled to predict impacts and to provide a framework for decision making by government in IWRM. It is found that when controls are implemented to manage LULC change in combination with the application of payment of environmental services (PES) to the upstream communities, and with consideration of factors of crop management practice, land management and reduced sediment transport, significant social, economic and environmental outcomes can be achieved in the catchment.

DECLARATION

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

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Joni

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LIST OF ACRONYMS AND GLOSSARIES

BAPEDAL	Badan Pengendalian Dampak Lingkungan (Environmental Protection Agency)
BAPPEDA	Badan Perencanaan Pembanguan Daerah (Regional Planning Agency)
BAPPENAS	Badan Perencanaan Pembangunan Nasional (National Planning Agency)
BMKG	Badan Meteorologi, Klimatologi dan Geofisika (Bureau of Meteorology, Climatology and Geophysics)
BPP	Balai Penyuluhan Pertanian (Agriculture Counselling Centre)
BPS	Biro Pusat Statistik (Bureau of Statistics)
DAS	*Daerah Aliran Sungai* (Catchment)
Dinas Pertanian	Agriculture Agency
Dirjen Cipta Karya	Directorate of Settlement of the Ministry of Public Works
DPR	Dewan Perwakilan Rakyat (House of Representative)
DSDA	Dinas Sumberdaya Air (Water Resources Agency)
FAO	Food and Agriculture Organisation of the United Nations
HEC-HMS	Hydrological Engineering Centre – Hydrological Modelling System
IBM	Integrated Basin Management
ICM	Integrated Catchment Management
IDR	Indonesia Rupiah
IRBM	Integrated River Basin Management
IWM	Integrated Water Management
IWRM	Integrated Water Resources Management
Kabupaten or Kota	Regency or City (Decentralized area in a province)
Kecamatan	Subdistrict in a regency
KEMDAGRI	Kementerian Dalam Negeri (Ministry of Home Affair)
Kepmen	Keputusan Menteri (Ministry Decree)
Keppres	Keputusan Presiden (President Decree)
KIMPRASWIL	Pemukiman dan Prasarana Wilayah (Urban and Infrastructure Agency)
KLH	Kementerian Lingkungan Hidup (Ministry of the Environment)
LULC	Land Use/Land Cover
MCA	Multi Criteria Analysis
MCDM	Multi Criteria Decision Making
MDGs	Millennium Development Goals
PDAM	Perusahaan Daerah Air Minum (Water Service Provider Company owned by regional government)
PES	Payment for Environmental Services

PP	Peraturan Pemerintah (Government Regulation)
PROKASIH	Program Kali Bersih (Clean River Program)
Propinsi	Province (Decentralized area in national level)
REPELITA	Rencana Pembangunan Lima Tahun (Five-Year Development Plan)
RTRW	Rencana Tata Ruang Wilayah (Spatial Panning Regulation)
RUPES	Rewards for Poor Farmer for Their Environment Service
S.	River (*Sungai* in Indonesian, *Kreung [kr.]* in Acehnese language)
SCS-CN	Soil Conservation Service-Curve Numbers
SDR	Sediment Delivery Ratio
SWS	Satuan Wilayah Sungai (Regional Catchment Units)
TEV	Total Economic Values
TSS	Total Suspended Sediment
Undang-Undang	Law (*Qanun* in Aceh Province)
WRM	Water Resources Management
WTA	Willingness to Accept
WTP	Willingness to Pay

Currency conversion:
1 USD = 9,670 IDR (mid-rate of the Central Bank of Indonesia noted at 28 December 2012)

CHAPTER 1
INTRODUCTION

1.1. Introduction

Water resources management has been an important concern for nations and human society for centuries. Roman society developed river management for public and private common good some 2000 years ago (Sadoff & Grey, 2002). Nowadays, water resources management is a complex problem that must consider a range of spatial factors as well as a variety of stakeholders. Water availability depends on a hydrological system of the land surface that drains into a particular water body, rates of evapotranspiration and infiltration, but also on human interactions and climatic conditions. Moreover, management becomes more complex when the resource is situated across fragmented authorities and political divides; and when it has different socio-economic and natural conditions. Managing transboundary catchments is highly challenging in that it requires hydro-technical approaches to engineering designs and hydro-political attention in negotiations, which are focused on creating holistic policies between parties. The balancing of water supply and demand is a key factor in the sustainability of the hydrological system. As a basic principle in water resources management, there should be an equality of benefits and responsibilities among water users. These goals may be achieved when stakeholders work together to create integrated water resources management and determine policies on water allocation.

Sadoff and Grey (2002) state that "transboundary rivers" not only refer to international border rivers, but also intra-national rivers, which cross borders of two or more different administrative areas. Sadoff and Grey (2002) conclude that the essential meaning of a transboundary river is a river that may require a different approach to management. Transboundary water resources include surface water resources and groundwater resources, because the resources are connected and are directly impacted by Land Use/Land Cover (LULC). Savenije and Van der Zaag (2008) argue that the major difficulty in transboundary water resource management is the gaps that exist between stakeholders in application

of policy, planning and implementation. Conflicts may occur in areas where resources are limited, or the demands are increased (Kliot *et al.*, 2001).

Problems among users regarding water demands and management preferences often occur across decentralized levels in a transboundary catchment. Sadoff and Grey (2002) state that transboundary water management within a country needs strong national institutions, strong state legislature, and equitable distribution of authority, hence the potential for conflict and cooperation is clearly exposed. However, Kemper *et al.* (2007) argue that transboundary catchments in many countries have traditionally been managed at central government level, but especially in some developing countries this concept does not work effectively. Wolf (2007) states that international transboundary catchments involve about 40% of the world's population, include two or more political boundaries and cover 45.3% of the Earth's land surface and about 60% of surface flow. Surprisingly, Kemper *et al.* (2007) add that 145 countries are in transboundary catchments and 33 nations are located within the catchments. The high number of shared catchments causes problems in holistic management of rivers such as the Danube (17 countries), Nile (10 countries) and Mekong (6 countries). Therefore, World Bank vice president Ismail Serageldin argues that war in the next centuries will be caused by water conflicts (Wolf *et al.*, 2005), which is similar to a statement by Secretary-General of the United Nations Ban Ki-moon based on his observation in Darfur published in the Washington Post in 14th September 2007. Ki-moon (2007) wrote that environmental crisis is a conflict that rises from scarcity of natural resources especially water.

For national transboundary rivers, the largest number occur in the United States, with some also being international transboundary rivers involving Canada and Mexico (Seligman, 2011; Kammerer, 1990). The Murray-Darling catchment is the most important catchment in Australia and involves the states of South Australia, Victoria, the Australian Capital Territory and New South Wales (MDBA, 2013). India is a country where most of the disputes among the decentralized government levels occur over water (Jamil *et al.*, 2012). Indonesia has over 5,590 catchments, which are grouped into 133 regional catchment units *[Satuan Wilayah Sungai or SWS]* based on the decree of Ministry of Public Works No. No.11A/PRT/M/2006. Precisely, 51 of those units are inter-regency (sub

provincial), 64 units are cross provincial and 5 units are transnationals with the countries of Malaysia, Papua New Guinea and Timor-Leste (Decree No.11A/PRT/M/2006; Kodoatie & Sjarief, 2010).

Coordination and relationships among decentralized government levels are the most critical issues in transboundary catchment management at the national level. In Australia, water resources are a major public concern due to water scarcity and irregular rainfall patterns. Although the Australian Federal Government has made significant progress on catchment water resources management by implementing the Murray Darling Basin Plan 2001-2010 that focuses on shared responsibility, active involvement, support and assistance among stakeholders, it sees many problems for the future. These problems relate to water quality and decline in environmental health due to pressures on land use allocation and environmental problems, competitions and conflicts among users due to water scarcity, increase the unequal distribution and potential for climate change to exacerbate these (Shaw, 1994; MDBA, 2013). With national government cooperation, however, the state governments have coordinated intergovernmental arrangements in controlling and operating the Murray flow and addressed other issues on the catchment management (Blomquist *et al.*, 2007b).

Problems with transboundary rivers also occur in the United States, where all transboundary rivers have been "federalized" and are managed by the federal government (Seligman, 2011). The federal government takes responsibility for construction and operation of infrastructure on transboundary river systems through the federal agencies of the U.S Army Corps of Engineers and the U.S Bureau of Reclamation. However, authority on non-federal rivers, such as dam constructions within the state need to be approved by the Federal Energy Regulation Commission (FERC) creating disharmony between states and federal government (Seligman, 2011).

Transboundary water disputes have also occurred in India where national regulations and policies might be interpreted differently by various levels of government. Jamil *et al.* (2012) state that most issues on transboundary rivers between the states in India are on water allocations, costs and benefits in projects, compensations in project implementation, and disputes relating to agreement interpretation. The national transboundary catchment problems in India are

similar to those in Indonesia, which Hasibuan (2005, cited in Tampubolon, 2007) and Tampubolon (2007) identifies in their research on the Citarum catchment in Java. The upstream area of the catchment is the West Java province and the downstream area is Jakarta where upstream agricultural intensification has impacts on water supply companies and two power plant companies in the downstream area. Tampubolon (2007) found that deforestation had reduced forested land cover by 2.23% (1992-2003), increased sediment transport to dams by 12.86 million m^3 per year and decreased potential discharge by 1.49% per year and inflow by 4.2% per year. The situation has reduced potential profit by 4.63% for power production and by 10.61% for water production. The Brantas catchment in the province of East Java experiences similar problems. Agricultural development, industrialisation and population growth in the past three decades are critical problems in the catchment and various levels of government authorities cannot manage these properly. Some of these problems relate to the application of decentralisation. Application of a decentralization policy that has been focussed on authority distribution directly to regency levels has resulted in some overlapping authority over water resources management, which has created confusion on relationships among different levels of authorities (Bhat *et al.*, 2007).

The Citarum catchment and Brantas catchment illustrate the current catchment problems in Indonesia where deforestation for agricultural and industrial purposes is a major public issue along with population expansion. Economic development and population growth are key factors on degradation of environmental quality, which places pressure on natural resources by changing local LULC patterns. Folmer and van Ierland (1989) state that population growth and increasing consumption, which results from increasing per capita income, may accelerate environmental degradation and natural resources depletion. Deforestation has occurred since the Indonesian Government implemented intensification of agriculture and industrial production through the First Five-Year Development Plan program (REPELITA I) in 1969. The program succeeded in increasing Indonesian economic growth by 6 - 7% per year until the end of 2000s. In addition, Indonesia's population doubled between 1971 and 2010 (BPS Indonesia, 2012b). Economic and population growth increasingly exploits significant environmental resources. Locally, this growth places pressure on land

allocation, and global environmental degradation may potentially change rainfall systems and climate conditions.

Deforestation in Indonesia can be stated as occurring due to a lack of balance between economic interests and natural resource concerns. Increasing economic growth from deforestation and agricultural/industrial intensification is not balanced with an analysis of environmental and social impacts. Although this was identified by the government of Indonesia in establishing the Ministry of the Environment in 1982 (KLH, 2012) and regulating laws on the environment in 1990 and 1997 (Law No. 5/1990 on the Conservation of Natural Resources and Ecosystems *[Konservasi Sumberdaya Alam Hayati dan Ekosistemnya]* and Law No. 23/1997 on the Environmental Management *[Pengelolaan Lingkungan Hidup]*, the environmental degradation continues. One problem relates to the lack of effective coordination between stakeholders. Another problem is that no holistic approaches are applied, in which parties have equal access in planning, policy formulation, implementation, and collecting benefits. Moreover, the problems become more complex in transboundary resources issues when Indonesian decentralization policies were implemented in the late 2000s with a lack of clarity in regard to the laws. Decentralization policies were drafted without a general blueprint (Brojonegoro, 2009). A government decentralization policy, where the government determines the goals, is likely not integrated with regional policies or national policies. As a result, natural resources that are located in transboundary regions were not properly managed or protected.

Although Indonesia is now trying to focus on holistic approaches through the Integrated Catchment Management Plan *[Rencana Pengelolaan Daerah Aliran Sungai Terpadu]* and through the Law No. 7/2004 on Water Resources Management *[Sumberdaya Air]*, more discussions on the meaning of integrated management are still needed. The law states that water resource management policies may be held by regional authorities (article 18), which in turn may be interpreted by regional governments conducting partial management of a catchment, which seems opposite to the concept of Integrated Water Resources Management (IWRM). Other specific issues are intensely debated upon introduction of the law; the issues relate to water privatization, which put water closer to being an economic good, and another is farmers' capacity to manage

irrigation by themselves with minimum subsidies from government. The debates are around the interpretations of Law No. 7/2004 based on the Indonesia constitution (UUD 1945) that states that water resources has to be managed by government and cannot be mandated to other parties. Moreover, farmers cannot be charged for water resources incentives as long as the resources are used for basic demands.

The IWRM concept implemented around the world is that of one river, one management, through comprehensive action on natural and human resources to achieve specific objectives (Dixon, 2006). Expressed more simply, the core of IWRM is a balance among social, economic and environmental aspects (Lenton & Muller, 2009), in which ideally the upstream area has to be protected from environmental degradation to protect the water quality and quantity for the downstream area. The collaboration between the upstream and the downstream areas has to be equal and similar in taking and receiving responsibilities and benefits. The action will be successful if the upstream area and downstream area work together with one vision and one purpose. Sadoff and Grey (2002) conclude that the transboundary water resources may create tensions among stakeholders, which may result either in cooperation or conflicts. Therefore, a catchment has to be viewed as one management unit involving all social, economic, natural resources and ecological aspects through applying IWRM, which concern the sustainability of the system and ecological conditions. The basic IWRM principle is harmonious coordination in decision-making in setting policies and goals. It may be successful when the parties have the same interests and are equal in all steps of the decision-making process.

1.2. Aims and background of the study

In a catchment where IWRM is implemented, collaboration between upstream and downstream areas may promote sustainability of the management, if an environmental payment approach can be applied in managing transfer of material and energy within the catchment. Ecological and economic factors therefore play an important role on how the environmental and economic systems interact (Costanza & Ruth, 1998; Asafu-Adjaye, 2005), where the concept of "mass-balance principle" is presented (Ayres *et al.*, 1996; Ayres, 1998). In support

of this concept, many principles have been developed such as the polluters pay principle. However, often the polluter pay principle is ineffective due to the difficulty in determination of non-point sources of pollution, intensity of environmental impacts and actors. Therefore, the user pay principle, which is a user's involvement in financing of catchment conservation, is a constructive alternative in catchment management (Tampubolon, 2007). Such kinds of compensation as Payment for Environmental Services (PES) have been successfully implemented in the New York City–Catskill catchment management program where responsibilities on the catchment management involve multiple stakeholders who share benefits (UN, 2007). Figure 1.1 illustrates the framework for this research based on IWRM within a catchment system that involves transfer energy and material over the catchment.

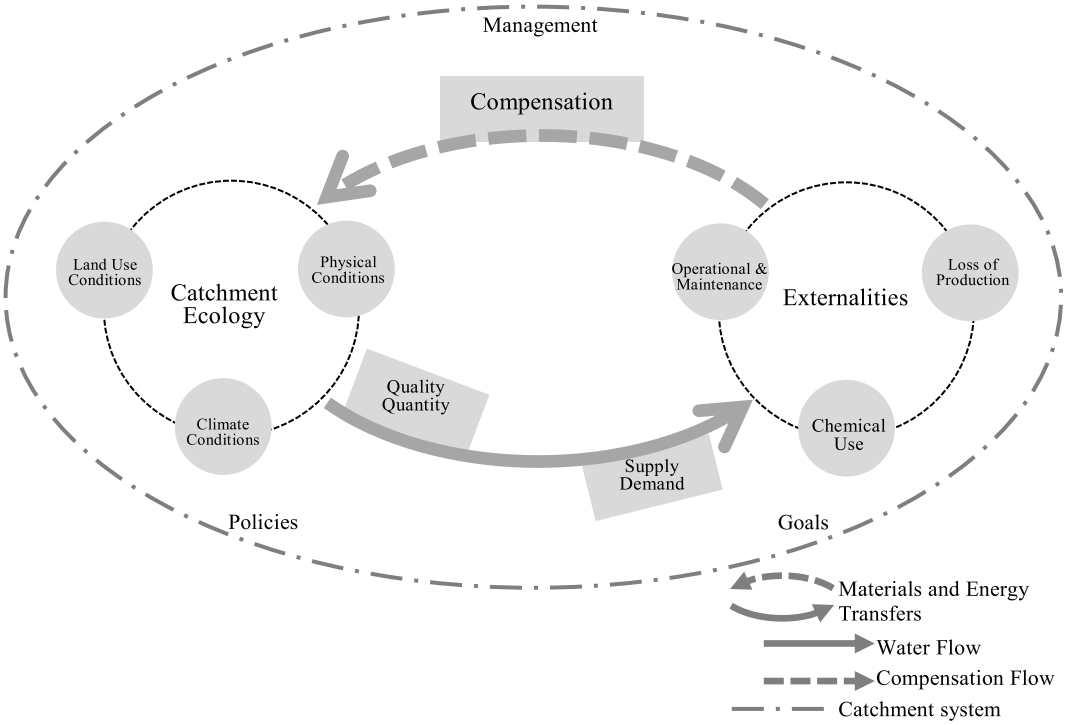

Figure 1.1 An approach to IWRM within a catchment system.

Based on Figure 1.1, the approach to IWRM within a catchment system recognises that a catchment, which involves the LULC system, physical conditions and climate conditions, produces water in enough quantity and quality. Outside of these, a catchment system may also involve management, policy application and catchment goals. The integrated management needs to integrate all these together

and incorporate the upstream and downstream areas; and inside and outside of the catchment system. In the Krueng Aceh catchment the upstream area is the area where water is produced and the downstream area is the area where benefit from water production is received. A compensation scheme, therefore, from the downstream to upstream areas could be incorporated into IWRM to preserve water quality and quantity.

Water reliability both quantity and quality depends on the health of the catchment system. When this worsens, it will impact the water production through decreasing water quality and quantity, increasing operation and maintenance (O&M) costs, costs for additional chemical treatment and loss of opportunity to produce more water to meet increasing demand. There exists a relationship between environmental damage and economic losses through increasing externalities, which are termed environmental marginal costs (Kermanshahi *et al.*, 1990). An externality is either economic losses or economic benefits for agents, due to environmental quality change (Pearce *et al.*, 2006; Tietenberg, 2000).

The aim of this study is to develop approaches based on IWRM principles through alternative decisions that can be introduced in LULC management for transboundary catchments. As this research is focussed on a transboundary catchment, the essential issue is regional decentralization that fragments the catchment into different regional autonomous areas and applies different approaches to management, policies and goals for the catchment. The process identifies actors who are involved in catchment management and catchment ecological parameters (land use, physical characteristics and climate) affecting sustainability of water resources. Furthermore, this research examines the relationship between the downstream area, which may be identified as a receiver of benefits, and the upstream area, which is a giver of benefits. Based on these relationships, alternatives based on environmental compensation models are proposed. Finally, the alternative models are introduced within the catchment under the concept of an IWRM to explain how the models may address transboundary catchment problems.

The research focuses on a case study of the Krueng Aceh catchment in the province of Aceh Indonesia. The catchment is divided among two autonomous sub province (regency) areas, which are the downstream Banda Aceh City and the

upstream Aceh Besar Regency. As an inter-sub provincial catchment within the provincial level government, the catchment is also under the authority of the provincial government of Aceh. Moreover, the catchment is also managed by the central government for issues on irrigation, forest protection and economic development.

The following research question on these issues are addressed in this study: How can environmental compensation address problems on land use/land cover (LULC) changes in Krueng Aceh catchment as a transboundary catchment that is fragmented by different authorities, policy concerns, socio-economic aspects and natural conditions?

Many studies have been carried out on the Krueng Aceh catchment. Based on a study in the Krueng Agam subbasin, Kartiwa & Sutrisno (2006) concluded that LULC changes within the Krueng Aceh catchment have modified the discharge of the Krueng Aceh River. Kasuri (2006) investigated how water resources availability meets the demands of agriculture especially for irrigated rice production. SDC (2009d) found that there are many activities in the Krueng Aceh catchment affecting water resources that do not support the sustainability of the river, such as illegal logging, forest burning, legal and illegal sand mining along the rivers, soil mining, garbage dumping and water contamination by agricultural activities. Moreover, some instruments on the hydrological monitoring network, which are climatology stations, rainfall stations and gauging stations for Water Level Record (WLR) are not managed properly (SDC, 2009c; USAID, 2006). Climate change is also a serious issue that has impacted the rainfall and results in precipitation of shorter duration in Aceh (SDC, 2009b; Boer & Suharnoto, 2012). To our knowledge, there is no specific research that examines transboundary catchment issues on collaboration between upstream and downstream areas relating to land use allocation and water availability based on the principles of IWRM within in the decentralization system in Indonesia.

1.3. Research Plan

Firstly, the analysis examines a relationship between LULC change and river discharge. LULC classification layers are compared with discharge records in the

same selected years to show how LULC changes affect river discharge. Predictions on discharge trends based on LULC change are created using hydrological modelling. Furthermore, prediction of LULC change in a predicted year is being created under scenarios of LULC condition, and then the scenarios are analysed using hydrological modelling to predict hydrological response. Through an assumption that LULC degradation in the Krueng Aceh catchment has a negative impact on environmental quality, which affects water quality and quantity, this research predicts loss of environmental service values through increasing externalities for the downstream water service provider. These are addressed by developing a sharing model between downstream and upstream areas, in which replacement costs for environmental services are applied. The replacement costs that are being covered by the water service provider are based on the Payment for Environmental Services (PES) principle, which recognises the benefits that the water service provider has received and predicts potential externalities that may arise if there is no intervention in LULC management. Scenarios are introduced through decision alternatives on LULC management where a group of alternatives are chosen based on expectations of water quality and quantity in the predicted year. Moreover, the decision alternatives consider regulations and decentralization issues at various government levels. These issues relate specifically to LULC allocation and water resources management. Figure 1.2 below shows the research design, data required, steps of analysis and the anticipated results.

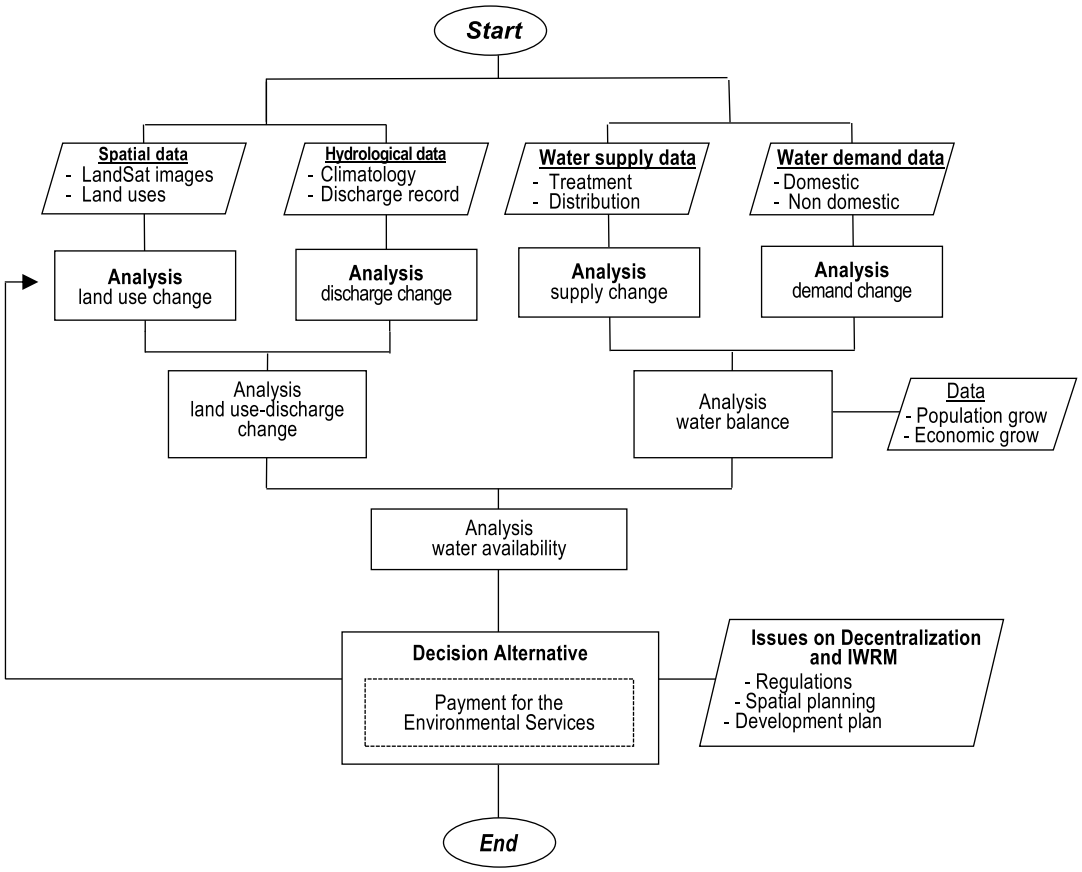

Figure 1.2 Conceptual model of the research

As shown in Figure 1.2, the research begins with an analysis of spatial, hydrological, water supply and water demand datasets. The data are classified into qualitative data and quantitative data. However, the major focus of the research is the quantitative analysis, with qualitative data considered in developing decision alternatives. The quantitative data includes GIS layers on Land Use/Land Cover (LULC); hydrological and precipitation data; river discharge records; water quality data; geological data on lithology, hydrogeology and groundwater discharge; water usage data on water demand; water supply; population data and economic development data. The qualitative data relates to regulations, policies and program implementations including data on governmental policies, legislation products, social culture and natural resources conditions.

1.4. Scope and Limitations of the Study

Integrated Water Resources Management (IWRM) provides the framework to control the quality and quantity of water resources in consideration

of socio-economic and environmental aspects, which are interconnected and dependent on each other. This research explicitly discusses the application of IWRM within a transboundary catchment in terms of compensation between upstream and downstream areas. However, while groundwater is an integral part of IWRM and important for ecosystems, groundwater is not explicitly included in this research analysis as water users in the study area do not use groundwater for commercial purposes.

The data on climatology, discharge records, population, economic growth, water supply and demand are based on records between 1990 and 2012, mainly sourced from the government of Aceh. Land cover analysis is based on satellite images from 1988 and 2012. Due to lack of discharge records available for the whole catchment, the analysis of LULC changes on discharge is simulated only for the Darang station, which is one of four gauging station within the Krueng Aceh catchment. The simulation results are applied for the whole of Krueng Aceh catchment area with an assumption that similar processes occur throughout the catchment.

This research is focussed on impacts of LULC change on hydrological responses, which creates externalities. Environmental compensation refers to the economic value of actions of the water service provider as resulting from increased costs of water purification and loss of opportunity to produce water to meet demands. However, an analysis of *a Willingness to Pay* (WTP) where the water resources provider is willing to pay an amount of compensation in order to receive goods or to avoid something undesired from the environment, and *a Willingness to Accept* (WTA) where an individual is compensated in tolerating a loss or accepting to abandon a good for different environmental benefits (Pigram, 1997; Keohane & Olmstead, 2007; Pearce & Seccombe-Hett, 2000; Emerton & Bos, 2004), are not analysed. This is because these analyses require individual perspectives that have to be collected through interviews and questionnaires that are beyond the scope of this research.

1.5. Significance of the Study to Catchment Management

This research seeks solutions for IWRM on a catchment through Payment for Environmental Services (PES) by water services providers, in particular. This is based on user pays principles, where a scheme of environmental compensation is being applied based on the parties who receive benefits and share them with the parties who provide the benefits. As this research focuses on a case study in Indonesia, where a decentralization policy has already been implemented over the last decade, there are many essential aspects of decentralization that are not yet regulated, therefore some of the implementations are theoretical rather than currently realised. The critical issues on natural resources management policies relate to distribution of authority among the levels of government that are still under discussion. The research will therefore be significant in finding solutions on transboundary natural resources management especially in the context of transboundary water resources management of Indonesia.

The motivation for doing this research came from awareness that decentralization issues among various levels of government in Indonesia might not be harmonious with transboundary resources management. Decentralization policies, which encourage lower government levels in managing their own resources are welcome, because they know their needs, and they are better in encouraging stakeholders at grassroots levels who are involved in decision making. However, the most challenging aspect of decentralization lies in the relationships between the levels of government, because while they are autonomous, they potentially "lose" their authority in managing transboundary issues. Strong legislation that dictates relationships between various levels of the government is not adequate, because of the potential for misinterpretation and overlap in relation to roles of responsibilities. Moreover, strong legislation might potentially be interpreted as reducing the autonomy that has been granted. Therefore, instead of focusing on setting legislation for managing transboundary resources, the promise lies in establishing relationships, responsibilities and sharing benefits in the future.

1.6. Overview of the Chapters

The chapters that make up this thesis are as follow:

Chapter 1 introduces the problems on transboundary water resources management. The focus is especially on the Indonesian context and the concept of integrated water resources management (IWRM) that may be a solution for these problems, which can be approached through an economic compensation between stakeholders who are involved.

Chapter 2 is literature review that discusses terminology on catchments as a system, the water balance concept, political and policy contexts on decentralization and water resources management. It reviews concepts on Integrated Water Resources Management (IWRM) and Payment for Environmental Services (PES), and discusses the models that have already been implemented.

Chapter 3 describes the data sets and explains the methodology that is being used in this research. The chapter also discusses data quality and some data limitations.

Chapter 4 presents the data analysis on LULC change and its effects on discharge and water quality changes using hydrological modelling.

Chapter 5 predicts the potential economic losses from forest degradation of the Krueng Aceh catchment as an impact of LULC change. The discussion is divided into the impacts in terms of economic costs to the downstream water service provider due to changing water quality and quantity and the impacts on paddy production in the upstream area.

Chapter 6 presents decision alternatives for the Krueng Aceh catchment, which are created based on the evidence from the previous chapters. The alternatives refer to regulations and objectives that relate to water demand in the future and land allocation that has to be available to support the demand.

Chapter 7 summarises the contributions of this research in addressing transboundary catchment management issues based on the principles of IWRM.

CHAPTER 2
LITERATURE REVIEW

2.1. Introduction

The global phenomenon in Water Resources Management (WRM) is a more integrated approach, which links human society and natural resources to allow the system to be sustainable (Rahaman & Varis, 2005; Castelletti & Soncini-Sessa, 2007; Savenije & Van der Zaag, 2008), and it focuses on participation among stakeholders (Rieu-Clarke *et al.*, 2010). Integrated Water Resources Management (IWRM) concepts have been developed by 65% of countries around the world in their national water resources management plans since being defined by the Technical Advisory Committee of the Global Water Partnership in the Johannesburg World Summit on Sustainable Development (WSSD) in 2002 (UNEP, 2012a; Rahaman & Varis, 2005). The IWRM definition is *"a process, which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems".*

The guiding principles in IWRM were originally drafted at the International Conference on Water and Environment in Dublin (1992) based on 'four Dublin Principles' of Agenda 21, which has at its core the linkages between environmental aspects of the water cycle, and social and economic issues (GWP, 2003; Grizzetti *et al.*, 2010). Water Resources Mmanagement (WRM) therefore has fundamental links with water values (Luken *et al.*, 1992), where its implementation has to view water as an economic matter. However, the implementation of the value may vary, depending on spatial consideration, water availability, social-cultural and political conditions. The joint costs among users for financing WRM are not only the implicit assumption that the targeted users are close to the optimal scale of development, but also an estimation of benefit (Young *et al.*, 1982).

This literature review discusses the theoretical frameworks and key research concepts regarding the application of IWRM for transboundary catchment

management. The discussion focuses on the principles of IWRM, and decentralization issue related to transboundary catchment management. Moreover, water has fundamentally important values, as economic goods and services, as well as social considerations and political matters when the values relate to LULC management. These aspects are combined into alternative decisions that are developed under the principles of IWRM.

2.2. Water Rights and Values

Water is a basic requirement for human life. Water is one of the most important elements of human interactions with the environment (Gandy, 2006), therefore every person should have equal access to water. Water rights and values are used widely in WRM, and cannot be separated. Issues on water rights may arise when water values change due to increasing demands and scarcity of the resource as a consequence of population growth, environmental degradation and uncertain future climatic conditions. An example is that global population has risen from 2.5 billion (1950) to 6.1 billion (2004), reducing renewable water supply by 58% for every person. The growth has also led to a seven-fold increase in water demands through domestic demand, agriculture and industrialization (Scanlon *et al.*, 2004). Moreover, fragmented management, lack of adequate water institutions, and changing diversion of public resources for private goods and services have directly impacted water access (Gleick, 2012).

2.2.1. Water Rights

A utilization of environmental resources depends on property rights concerning those resources. The rights refer to entitlements defining the owner's rights, privileges and scarcity of the resources (Tietenberg, 2000). The rights also refer to a sense of water resources property entitlements as tradable and leads to regulatory norms for minimum standards demand (Morgan, 2011). Property rights can be described as water consumed and diverted, quality and quantity, time and place of diversion and its allocation to include where and when the changes in these rights may directly affect users (Howe *et al.*, 1986). Water rights should ensure that humans have equal access to sufficient, acceptable and safe water for

personal and domestic uses through physical and economic means. The right to water is implicitly part of the right to food, health and life (Gleick, 2002). Moreover, the United Nations (UN) declared that water and sanitation are a part of human rights on 28 July 2010 and the declaration has been ratified by 122 countries (UN, 2010). The UN's declaration refers to the General Comment No. 15 of the Committee on Economic, Social and Culture Right on November 2002 (UN, 2002) on water rights, which states that:

1. *Sufficient*. Water supplies for persons have to be sufficient and continuous for domestic uses and personal demand. The World Health Organization (WHO) states that the basic demand for water for each person is between 50 and 100 litres per day.
2. *Safe*. Consumed water has to be safe from micro-organisms, radiological hazards and chemical contamination.
3. *Acceptable*. Water must be acceptable in colour, odour and taste. Water services and facilities must also be acceptable in term of access regarding to gender, privacy and lifecycle requirements. Physically access to water sources has to be no more than 1,000 metres from home and not exceed 30 minutes for collection time. Moreover, water costs should not exceed three per cent of the household income to be affordable (UNDP, 2006).

2.2.2. Water Values

The classic concept of value is very simple and originates from the things of which the objects are made (Smith, 1776; Max, 1906, cited in Straton, 2006). However, the modern neoclassical concept of value converges on supply and demand or market-clearing price, and this is a challenge for environmental goods and services as non-markets products (Pigram, 1997; Straton, 2006). Current meanings of value in natural resources management leads to many different interpretations (Reser & Bentrupperbäumer, 2005; Bentrupperbäumer *et al.*, 2006). Environmental values in conventional concepts of economics refer to individual preferences from environmental resources where the individuals are willing to pay for the satisfaction of these preferences (Turner, 2001). Reser and Bentrupperbäumer (2005) state that environmental values address overall values on environmental issues such as public salience, environmental sustainability and

ecological reserves. Reser and Bentrupperbäumer (2005) argue that environmental values refer to human or community values from the environment. Costanza *et al.* (1997) add that the environmental values may transform in types of environmental services and natural capital. These values are difficult to identify through functioning markets as there is scant relation between observable spending behaviour and values of service. For example, individuals may attach a value to forests, because they feel that it is important that the forests are properly protected for purposes of water resources protection, regardless of the individual's use of timber production (use value).

Before environmental goods and services are valued, there needs to be a list of the values that may be sourced from the environment (Pearce & Moran, 1994). Total Economic Values (TEV) from the environment can be accumulated from those values, and the TEV can be used to determine environmental quality change, which may happen through human activities and through TEV calculations on loss of values due to anthropological activities (Munasinghe, 1993a). Water as environmental goods and services are divided into use (instrumental or direct economic) value and non-use (indirect economic or intrinsic or passive) value (Munasinghe, 1993a; Asafu-Adjaye, 2005). Munasinghe (1993a) offers an example of the TEV on tropical forests as shown in Figure 2.1, which shows the relevant values of the environmental benefits. The tropical forests have use value from timbers (goods) and the value of timbers may be calculated through comparison of market price against cost of timber production. Non-use values of the forests include water infiltration and protection of indigenous habitats and carbon stocks, although these values may not be easy identified through market functions.

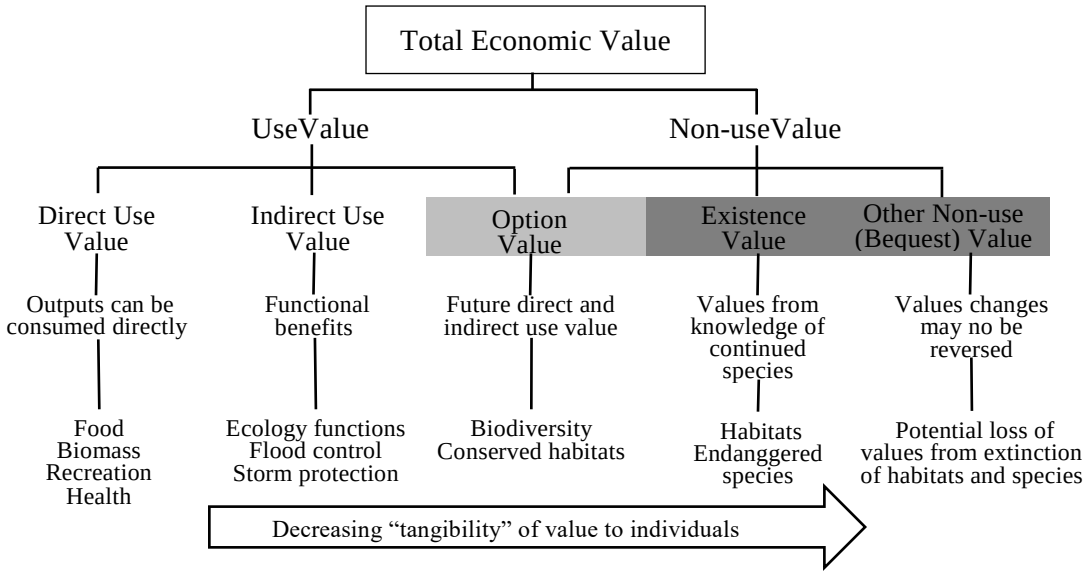

Figure 2.1 Hierarchy of the economic valuation from tropical forests. The optional values (shaded) may be determined as use or non-use values due to ambiguities in definition of these concepts (Adopted from Munasinghe, 1993a; Pearce & Turner, 1997; Tietenberg, 2000; Asafu-Adjaye, 2005).

Moreover, the distinction of values between "economic" value and "financial" value rarely corresponds and may be debated for water resources (Perry *et al.*, 1997). Perry *et al.* (1997) add that water as an economic good does not mean water has to follow the competitive market price, which reflects only financial and economic values. It is because the price for water is commonly controlled by regulation through applying subsides, royalties and fees, and social considerations, which include cultural and religious reasons, rather than by free market operation (Shevah & Kohen, 1997). However, Briscoe (1996) argues that the principle value of water as economic good is not complicated if it applies like other goods; for those who are willing to pay to get it and who are willing to use it, the benefits exceed the cost that is incurred.

Water values depend on the functions of quantity and quality of water. The values of quantity refer to water reliability in space and time of water supply, and the values of quality relate to consumption targets on grades of hygiene and purified water. For example, agriculture needs an amount of water (quantity) depending on stages of crop production, and paddy production requires more water during early stages rather than at harvesting time (final stages). Similarly,

water for drinking requires highest levels of hygiene (quality) than water use for flushing of toilets, cleaning or gardening.

a. Use values

Use values of water can be determined as utility good of consuming (Dobb, 1975; Munasinghe, 1993a), and these values may be easily identified through costs of production. Use values can be classified into direct use values, indirect use values and optional use values (Munasinghe, 1993a; Tietenberg & Lewis, 2000). Direct use values arise through production. For example, costs of water production include all of the company expenditures for water production, which are used to produce a unit volume of water. Indirect use values of water are the benefits from the other functional services from the environmental assets in supporting its production, such as value from forest function as natural filtration for water production. Optional values are determined as premium services that users are willing to pay (WTP) and have a willingness to accept (WTA) from unutilized environmental assets, especially to avoid risks in the future. For example, consumers are willing to pay (or willing to accept) water resources protection and its association with water production, which may be influenced by droughts, floods and potential climate changes.

Related to use values, costs of production needs to consider long-term production, which refers to all production factors and short-term production that refers to the changing of some production factors. The changing of those values through environmental quality changes, which may not be observed in behaviour, may give rise to passive use values (Adamowicz *et al.*, 1998). The passive values are important in water resources management especially in setting decision making, such as determination of LULC changes that affect water quality and quantity (discharge).

b. Non-use values

Water as both environmental goods and services may have non-use values (Heide *et al.*, 2010). Non-use values mostly associate with existence values from satisfaction with environmental assets, even if the users do not use them (Munasinghe, 1993a). Non-use value represents natural capital to produce goods

and services from the ecology and environment. However, the interpretation varies in different approaches, varies in concepts, and this value is difficult to trace. The definition of non-use values may lie outside of conventional economic theory, which is being associated with a utility or economic benefit (Pearce & Turner, 1997). Non-use values may differ from other forms of value and be transmitted to future generations, therefore the values can be significant in themselves (Reser & Bentrupperbäumer, 2005).

An estimation of non-use value from non-market ecosystem goods and services may be identified by two methodologies, which are demand-side methodologies and supply-side valuation methodologies (Straton, 2006). The demand-side methodologies ascribe value based on subjective preference, where the values are from individual minds and measured through their willingness to pay (WTP) for the unit of good and service at a marginal value or price. The supply-side valuation methodologies are used to estimate the values from actual costs of production where the value relates to biodiversity and endangered habitats conservation and potential loss of value from extinction of habitats and species (Munasinghe, 1993a).

2.2.3. Virtual Water Values

Virtual water values do not include the water but the values related to the water, such as food productions where water is consumed for their production. The virtual water values can be grouped based on visions, which are supply driven and demand driven visions (Renault, 2003). The supply driven vision is applied to water used in achieving optimal production, while the demand driven vision considers the volume of water required for production (Renault, 2003). For example, a demand driven vision is estimating the virtual values from paddy production, as Nurrochmad (2011) states that the ratio of water consumed per kg of paddy production is about three m^3, hence the price of one kilogram of paddy rice and three m^3 water can be compared.

The virtual water value can be useful in determination of marginal costs for a product that consumed water for its production. However, the importance of virtual water values lies in the site of production (Renault & Wallender, 2000),

where production in an area where water is limited has a higher virtual value than in the places where water is abundant. In case of catchment management, virtual water can be used to determine the variety of agricultural production based on their water requirement and site of their production, which can direct decision-making.

2.2.4. Externality

An externality is an environmental quality change that may result in costs or benefits to other parties (Pearce *et al.*, 2006). An externality will exist when the welfare of some agents in environmental activities impacts other agents activities including on their self-activities, and these effects may be either positive or negative (Tietenberg, 2000). Hartwick and Olewiler (1986) divide the externalities into private externalities and public externalities. The private externalities are the externalities on consumption and production of particular things, which may involve an externality to other agents. The public externality occurs when the consumption of a natural resource happens without compensation, which may involve many agents together and affect themselves or other agents. Water resources are an example of public externality that is difficult to internalize through the market price, when one agent wants to compensate for the resource, other agents may also get benefit from those compensations, and are called “free riders” (Hartwick & Olewiler, 1986), or vice versa.

Todaro and Smith (2011) state that catchment degradations result in high costs on its recovery, and the degradations directly affect groups of people who rely on agriculture lands. In the context of catchment degradation, an externality may cause water scarcity, floods and decrease water quality. The problem is who will cover the costs of the degradation or who will cover the costs in order to retain the quality of catchment against the degradation processes. Suparmoko (2009) argues that the externality costs should be covered by the polluters, or the polluters should give compensations for the environmental degradation, or the polluters should remove the pollutants from the environment. However, the polluter pays principle needs strong government intervention to control the actors to cover their external environmental costs, because social marginal costs, where the impact of externalities on social aspects by environmental damages is often

higher than private marginal costs on actors' activities (Keohane & Olmstead, 2007). An externality may also be covered by a charge or tax levied by the agents, which are the so-called "Pigouvian" or "price-control" approaches to environmental decision making (Munasinghe, 1993a) where the Pigou itself indicates the direction of externality correction, but the Pigouvian analyses the basis for a price that is impacted by negative externalities (Siebert, 2008).

Similarly, the environmental services beneficiaries should cover the externality in order to maintain environmental quality, where user pays principle can be applied (Salim, 2005). Rogers *et al.* (1998) state that the user pays principle can be applied through a partial equilibrium approach, in which opportunity costs are applied when water is used in a particular sector. Rogers *et al.* (1998) provide an example; industrial sectors may apply full economic costs in economic valuation of water usage, while the value of water to alternative sectors is forgone, such as households and agriculture. However, estimating opportunity costs for irrigation may be difficult when irrigation accounts more dominant than total share water usage. Figure 2.2 shows the components that contribute to estimation of water costs.

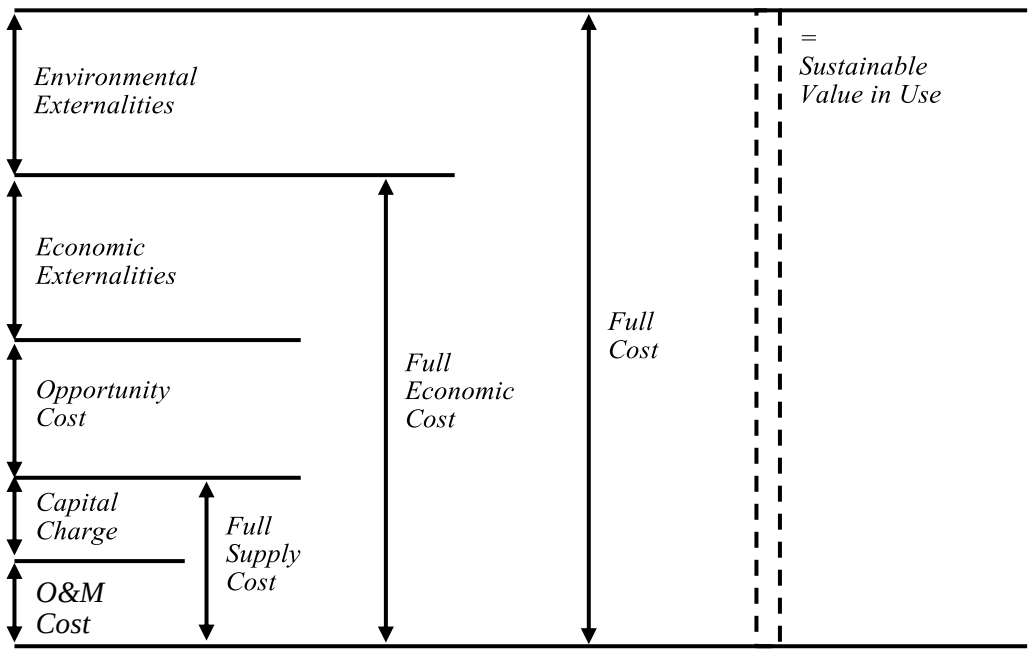

Figure 2.2 Schematic of components which contributes to water valuation (Rogers *et al.*, 1998)

In more detail, Rogers *et al.* (1998) explain the following costs of externalities:

1. *Full supply cost* associated with water supply to a consumer, which includes Operation and Maintenance (O&M) Cost and Capital Charge, both of which have to be evaluated as full economic cost of inputs. O&M costs that associate with water production include pumping, labour, treatment plan and distribution. Capital cost refers to capital consumption and interest costs associated with project investment.
2. *Opportunity cost* arises through an assumption that water consumed by a consumer has eliminated other consumers. Therefore, if another consumer has a higher cost, the opportunity costs are raised in society due to these misallocations of water. Avoiding these costs in water resources investment will lead to intermittent failures, because it creates mis-allocation of water.
3. *Economic externalities* are commonly associated with water resources usage in an upstream area that effect to downstream area. For example: agriculture in an upstream area may increase suspended solids in water to the downstream area, which causes increased production costs per unit volume of water.
4. *Environmental externalities* are associated with ecosystem maintenance and public health and are caused by environmental degradation. Environmental externalities are difficult to determine economically, however the estimation may be done through determination of remediation costs that may show an estimation of the economic value of environmental damages.

This externality, which is an environmental quality change that results in economic losses (Pearce *et al.*, 2006; Tietenberg, 2000), is anticipated through transferring a compensation fund (Payment for Environmental Services - PES) from the downstream authority to the upstream area.

2.2.5. Economic Valuation

Implementation of natural resources management projects may raise costs and benefits. The visibility of these projects can be calculated through economic valuation. Economic valuations are the economic approaches to determine environmental changes based on individual preference for the change of

environmental services (Pearce & Seccombe-Hett, 2000). However, unlike other products, environmental services are non-market values and not explicitly priced, both of which mean that the services cannot be easily measured. Ecological economics therefore plays an important role in how environmental or ecology and economic systems can interact (Costanza *et al.*, 1997), where non-market values can be determined (Asafu-Adjaye, 2005). Ecological or "green" economics is a subset of natural resources economics, which predominately focuses on interaction between economic and ecological sectors (Asafu-Adjaye, 2005).

A general approach to economic valuations in natural resources management represents monetary transfer on investments and operations to produce environmental resources (Brouwer, 2000). Economic valuation can be calculated by the amount of money that is spent when the environment change due to production, which are the potential monetary losses from degradation of environmental qualities (Field, 1997; Pearce & Turner, 1997; Pearce & Seccombe-Hett, 2000). The monetary calculation, which may show a relationship between environmental assets as natural resources and as environmental constrain, can help decision makers in policy and regulation setting. Luken *et al.* (1992) state that the value transfer approach can be used in valuing water resources through regulation setting. An example is forests, as environmental assets and natural resources, forests can produce timbers, provide natural water purification, recreation areas and carbon stock areas, and as environmental constraints, forests can mitigate flood and drought.

However, every economic valuation approach has limitations in covering 'real' values in environmental values assessment (Straton, 2006). Turner *et al.* (1994) add that no specific method is superior in economic valuation of environmental resources, because every method has advantages and disadvantages, and no method has high validity, which means no method is very accurate in identification of all the values included in the environment. Researchers agree that approaches on economic valuation can be divided into two approaches; the demand curve approach and non-demand curve approach. The demand curve approach describes consumers' behaviour in term of how much they want to buy a quantity of product at a given market price (Turner *et al.*, 1994; Straton, 2006; Keohane & Olmstead, 2007). Non-demand curve approaches are used to estimate

environmental values based on cost-of-production (supply-side valuation), where the values converge to the assets from which the products are made (Turner *et al.*, 1994; Straton, 2006). Figure 2.3 shows a classification of economic valuation that is commonly used for environmental goods and services.

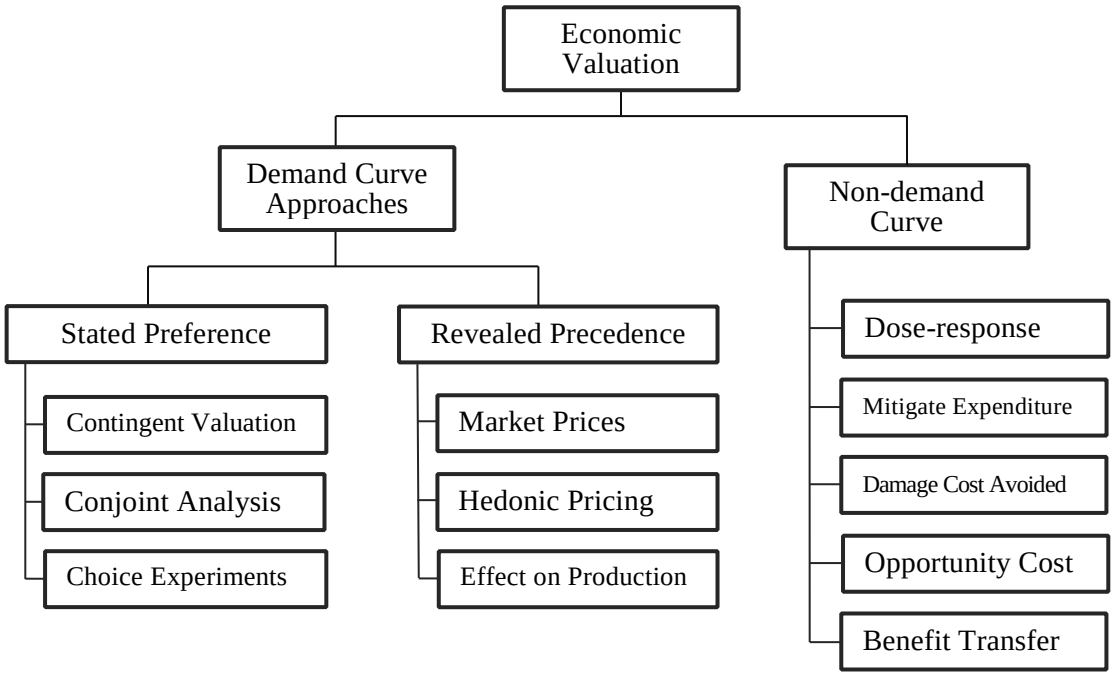

Figure 2.3 Economic valuation methods (Adopted from: Turner *et al.*, 1994; Emerton & Bos, 2004; Pearce *et al.*, 2006; Asafu-Adjaye, 2005)

a. Demand curve approach

Demand curve approaches are commonly used on economic valuation of environmental resources. This valuation calculates the benefits that individuals receive from environmental preservation or impacts of environmental changes. Demand curve valuation is utility-based and often refers to a stated preference model where the basic valuation is focussed on Willingness to Pay (WTP) or Willingness to Accept (WTA) (Pigram, 1997; Keohane & Olmstead, 2007). Demand curve methods commonly focus on individual preferences that rely on WTP to avoid a loss or WTP for a gain, or WTA by an individual to compensate in tolerating a loss, forego a benefit or for different environmental benefits (Pearce & Seccombe-Hett, 2000; Emerton & Bos, 2004; Keohane & Olmstead, 2007).

However, the environmental values that are based on WTP or WTA by individuals do not consider objective values of biophysical properties of

environmental resources (Patterson, 2002). Individuals always get benefits (directly and indirectly) from the environment, therefore environmental compensations should not be voluntary (willingness) based, but have to be mandatory based on values that are received from the environmental assets. The environmental values cannot be defined as how much would be paid (WTP or WTA), but it should be calculated as how much it costs to provide them using principles of sustainability of the environmental resources. Moreover, individuals may have different interpretations of WTP and WTA based on their economic and physiological perspectives. These are proposed by Kahneman *et al.* (1993) and state that individuals may identify an environmental goods and services as a purpose model on economic perspective, in which they determine benefit that they receive from the environment. However, individuals may also see the environmental goods and services as a contribution model on physiological perspective, which relates to their needs to support better environmental conditions. Therefore, there perspectives are an evidence that WTP and WTA do not always reflect on individual's ability to pay from the environmental resource values, and WTP and WTA are not simply a function of ability to pay (Guagnano *et al.*, 1994).

b. Non-demand curve approach

Non-demand curve (market-price or cost-based or production function) approaches for economic valuation methods are focused on estimation of actual costs of production processes (Emerton & Bos, 2004; Straton, 2006; Damigos, 2006). These approaches are based on replacement costs for environmental services, costs for avoiding damages, costs for providing substitute services and costs that are raised due to productivity changes through creating dose-response or biophysical relationship between production aspects and environmental goods and services (Turner *et al.*, 1994; Emerton & Bos, 2004; Damigos, 2006). These approaches theoretically assume that if individuals pay at least equal of the services that they receive from the environmental services, they can avoid the damages caused by environmental services changes.

Non-demand curve approaches are the most straightforward and simplest to model (Emerton & Bos, 2004). These approaches have advantages in

identification of environmental goods and services, such as for catchment protection that has many characteristics of goods and services. Also can be indentified environmental products that have been formally traded; price distortion through subsidies; regulation set for royalties and fees; and state control for pricing (Emerton & Bos, 2004). The approaches might be effective in a valuing land destruction through estimation of restoration costs and valuing water quality improvement through measuring of water treatment costs for filtering and chemicals used (Damigos, 2006). Moreover, Emerton and Bos (2004) offer three steps in non-demand curve approaches in collecting and analysing data required for water resources valuation: identify the quantity of the goods that are produced, used and exchanged; analyse the data that are related to market price; and, multiply quantity and price to determine the value. However, Emerton and Bos (2004) state that these approaches are not suitable for environmental values assessment that has limited consumers and temporal demand.

2.2.6. Application of Economic Valuation on Water Resources Management

Policies on water resources management have to include economic instruments in rules that will be implemented (Heinz *et al.*, 2007). The economic instrument can be prices, taxes such as for pollution and pumping, environmental compensation and incentive, and market based and policy approaches such as tradable water permits. An environmental services incentive and a compensation that derives from catchment management is a result of the catchment value as a part of an ecosystem value. In conjunction with those who receive benefits and who provide the service of benefits in a catchment, all costs that are incurred on catchment conservation process have to be taken into account by the beneficiaries, because this will motivate the providers to maintain the conservation processes (Salim, 2005). Salim also adds that the processes require a bottom-up approach in implementation of a reward system, in which Payment for Environmental Services (PES) may be applied. PES needs to consider the “user pays principle”, which is ability to pay by users, and equality among stakeholders in planning and implementing the goal, hence the parties will reach benefits based on their responsibilities (Field, 1997).

The United Nation Economic Commission for Europe (UNECE) describes the meaning of the Payments for Ecosystem Services (PES) as a relationship between buyers and sellers in a contractual transaction for an ecosystem service to secure the service (UNCEDE, 2007). However, application of PES depends on political and cultural contexts in the countries where the PES will be implemented, and the countries may apply different terminologies of PES, in which compensation, recompense or reward may be used in terms of PES application between environmental services beneficiaries and environmental service providers. One of the examples is RUPES (Rewards for Poor Farmer for Their Environment Service), where downstream authorities provide funds to secure the conservation processes in upstream areas. RUPES is an attractive reward for 'services' from beneficiaries to providers of environmental services to sustain the natural relationship between them, where the 'disservices' for environmental services may be avoided (Van Noordwijk, 2005). In more detail, Van Noordwijk (2005) offers a basic schematic for reward for environmental services related to land use applications (Figure 2.4).

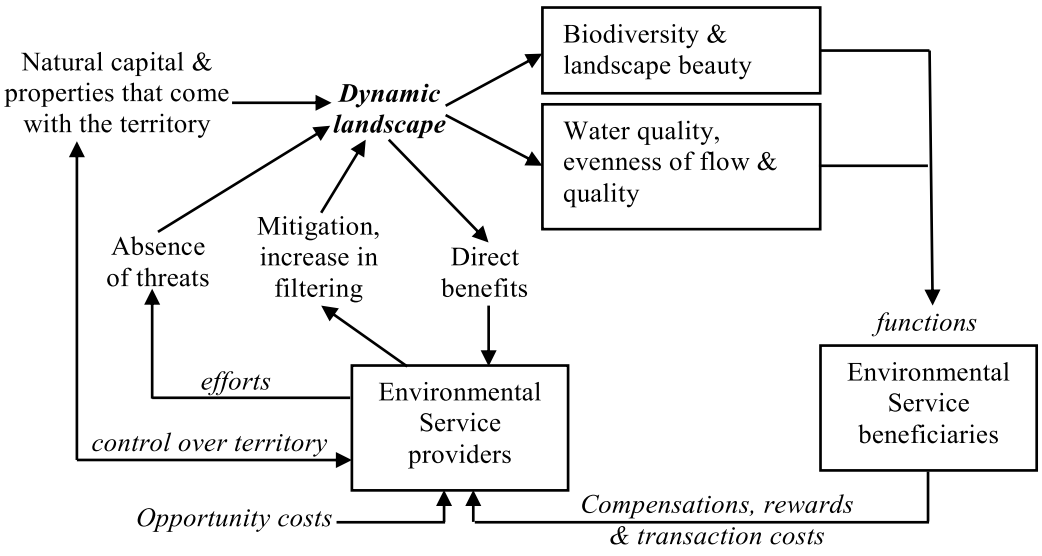

Figure 2.4 A basic schematic for recognition and reward for environmental services related to land use in relation to water resources (Van Noordwijk, 2005)

The successes of implementation of reward systems services on water resources management needs to identify a relationship between stakeholders in both the upstream and downstream area to know the capacity of their authorities

and responsibilities. The upstream and downstream areas can be represented by the authorities, and in implementation of reward and compensation systems, the authorities may work together to create their goals and policies. The key issue is identification of benefits that will be received by the downstream area related to the amount of resources that is available to produce those benefits.

2.3. Integrated Water Resources Management (IWRM)

The initiation of Integrated Water Resources Management (IWRM) incorporated competition and conflicts among water users at the UNESCO International Conference on Water in 1977 at Mar del Plata, Argentina. However, little progresses occurred after this event until the International Conference on Water and Environment in Dublin (1992). Significant progress on the international political agenda occurred in the 2000s during the Second World Water Forum (2000) in The Hague, the International Conference on Freshwater (2001) in Bonn, the World Summit on Sustainable Development (2002) and the Third World Water Forum (2003) in Kyoto that put IWRM on the global agenda (Rahaman & Varis, 2005).

The Dublin Principles

Principle No. 1 - Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.
Since water sustains life, effective management of water resources demands a holistic approach, linking social and economic development with protection of natural ecosystems. Effective management links land and water uses across the whole of a catchment area or groundwater aquifer.

Principle No. 2 - Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.
The participatory approach involves raising awareness of the importance of water among policy-makers and the general public. It means that decisions are taken at the lowest appropriate level, with full public consultation and involvement of users in the planning and implementation of water projects.

Principle No. 3 - Women play a central part in the provision, management and safeguarding of water.
This pivotal role of women as providers and users of water and guardians of the living environment has seldom been reflected in institutional arrangements for the development and management of water resources. Acceptance and implementation of this principle requires positive policies to address women's specific needs and to equip and empower women to participate at all levels in water resources programmes, including decision-making and implementation, in ways defined by them.

Principle No. 4 - Water has an economic value in all its competing uses and should be recognized as an economic good.
Within this principle, it is vital to recognize first the basic right of all human beings to have access to clean water and sanitation at an affordable price. Past failure to recognize the economic value of water has led to wasteful and environmentally damaging uses of the resource. Managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources.

Figure 2.5 Recommendation for action set out at the International Conference on Water and Environment in Dublin (*The Dublin Statement*, 1992)

Many authors have discussed an integration of WRM concerning aspects of social-culture, economic and environment (Dixon & Easter, 1991; The Dublin Statement, 1992; Biswas, 2004; TAC, 2000; Jønch-Clausen & Fugl, 2001; Rahaman & Varis, 2005; Jeffrey & Gearey, 2006; Heinz *et al.*, 2007). The original term of IWRM refers to the 'integration handle' of water resources on management and development (TAC, 2000; Jønch-Clausen & Fugl, 2001). However, catchment development, which includes development of water resources in a catchment, and catchment management are different both in physical application and conceptual meaning (Dixon, 1994), and there is no specific blueprint as principle that can be adopted into practice (TAC, 2000). Other terms

of IWRM may be used, such as Integrated River Basin Management (IRBM), Integrated Catchment Management (ICM), Integrated Basin Management (IBM) and Integrated Water Management (IWM) to describe water as a resource that is managed within a catchment scale, which regards to an importance of integrated management (White, 1997; Fenemor *et al.*, 2008). In "integrated management", it may be difficult to scale the levels of "integration" as it may involve every level of stakeholders in setting of policies, which may be intensive at the highest levels of government, and implementations, which may be acted upon by the lowest levels of government and various stakeholders. However, other authors state that those terms are parts of IWRM when IWRM is put in the context of national water policy (Hooper, 2006).

Biswas (2004) states that the concepts of IWRM always develop over the time with different interpretations and connotations. However, the basic concepts water resources are distinguished into two dimensions; the physical dimension and the non-physical dimension (Savenije & Van der Zaag, 2000). Savenije and Van der Zaag (2000) explain that:

1. *The physical dimension* of water resources consists of location, type and quality. Location refers to upstream-downstream interaction, catchment-wide and quantity of water available. Type refers to resource points in the hydrological cycle and physical behaviour of water. Quality of water resources refers to physical, chemical and biological characteristics.
2. *The non-physical dimension* relates to attributes and values of water resources for society and human beings, which refers to interests of sectoral users and national objectives for water resources that are regulated in a national framework.

More specific, integrated management at the catchment scale, which may illustrate the terminology of IWRM, is formulating and implementing processes that involve actions on natural and human resources, which includes social-politic, economic and operating factors in achieving specific objectives (Dixon, 2006). Similarly, the Global Water Partnership develops terminology for IWRM as a process that supports coordination in management and development of all related resources to optimise the outcome on economic and social welfare while retaining

the sustainability of ecosystem (TAC, 2000). Savenije and Van der Zaag (2008) add that water resources management concerns an integration of biological, social and physical aspects within a catchment, which have to be considered holistically and comprehensively as a bioregion unit. Moreover, catchment management should consider physical factors of the catchment, stakeholders, social and economic conditions, which involve specific purposes, and be carried out in response to problems of LULC degradation and water conservation (Dixon & Easter, 1991). IWRM therefore encompasses qualitative and quantitative ways to optimize water resource production for long-term production with a balancing between supply and demand.

Svendsen *et al.* (2005) add that general approaches on IWRM guarantees benefits on adjusting water allocation, reducing groundwater mining through conjunctive management with surface water, reusing water through users' planning, improving water quality through comprehensive monitoring and evaluation, integrating social and environmental values on water allocation and decision making, involving a wider range of catchment stakeholders and reducing conflicts among stakeholders. IWRM considers water production in several perspectives and dimensions (Savenije & Van der Zaag, 2008). The dimensions are:

1. *Water resources* or natural resources related to the hydrological cycle, including flows, distinguishing water quality and quantity;
2. *Water users* or human dimension, including all aspects including economics, stakeholders and interests;
3. *Spatial scale*, including water distribution and spatial scales of groups of users, catchments and institutional arrangements;
4. *Temporal scale,* including supply, demand and fluctuation of supply and demand on quality and quantity.

However, Calizaya *et al.* (2010) state that IWRM implementation may fail when it has a lack of systematic approaches, limited tools and techniques in addressing complex problems in water systems. Therefore, Calizaya *et al.* (2010) suggest that an improved decision-making process should inform and facilitate discussions of contentious issues on social justice, environmental concerns and

economic considerations. Moreover, Svendsen *et al.* (2005) add that there are a number reasons that make IWRM rare in practice, such as weaknesses in collaboration among sectoral units, bureaucratic and politic interventions, which may raise costs significantly and make decision-making processes more complex.

A concluding explanation of IWRM may be taken from Jønch-Clausen and Fugl (2001) who state that IWRM is not a goal, but a process that equilibrates and compromises different goals on social, economic and environmental perspectives, and IWRM is about coordination that leads fragmented stakeholders into a holistic institution. IWRM has been used for instance in the European Water Framework Directive (EU-WFD, 2000), has successfully implemented integrated links between ecological, social, and economic functions of the water cycle (Koch & Grünewald, 2009). Moreover, existing literature has explained that integrated management on water resources has concerned different issues depending on where they are implemented (Biswas, 2004), and problems and their solutions vary in different regions (Rahaman & Varis, 2005), which makes it difficult to formulate general lessons from the previous IWRM implementations.

Nowadays, IWRM has been adopted by 65 percent of countries around the world in their National water resources management plans, and 34 percent of them have moved to the stage of implementation (UNEP, 2012b). Moreover, IWRM has been applied in a wider range of water supply and demand opportunities where flood control, conservation of aquatic ecosystem, recreation, fisheries and shipping has been included in the scheme (Heinz *et al.*, 2007).

2.3.1. IWRM in Transboundary Water Resources

Transboundary water resources cause water conflicts due to political boundaries and failure in cooperation on IWRM. Cooperation may create better management; however, failure may result in tensions between states that generate costs and create loss in significant benefits (Sadoff & Grey, 2002). Transboundary river management is a complex problem, which requires skilful diplomacy rather than a technical approach (Rahaman & Varis, 2005; Shaw, 1994). The major difficulties in transboundary river management are gaps between policies, plans, orientations and target implementation (Savenije & Van der Zaag, 2000; Rahaman

& Varis, 2005). Therefore, transboundary water resources management needs to avoid these gaps through changing the way of thinking to be more focussed on policy approaches to transboundary resources, which require political arrangements and cooperation, or so-called hydro-political approaches (Kendie, 1999; Salman & Uprety, 1999; Salman, 2011; Goh, 2001; Waterbury, 1979; Elhance, 1999).

Many terminologies are used to describe the river system or catchment that is fragmented by administrative boundaries, such as international rivers, cross intra-national rivers, federalized rivers, transboundary rivers, watercourses and shared waters. The essential meaning of those terminologies refers to rivers or a catchment that is managed by different policies and goals on water resources management (Sadoff & Grey, 2002). Sadoff and Grey (2002) explain that some of those terminologies are:

a. *Transboundary rivers* refer to *international border rivers* and *cross intra-national rivers* (e.g. state, province) that shape the rivers into two different administrative areas or more where the rivers may not reflect as a system of a catchment area;
b. *Shared water* is used by others, which may be disputed by other authors that do not believe water can be "shared";
c. *Watercourse*, the term may not be acceptable because many authors believe that it does not include the full context of a river as the hydrological system;
d. *Federalized rivers* illustrates the rivers located within cross-state boundaries that have been managed by federal or central government (Seligman, 2011), however some parts of them are managed by lower government levels (e.g. states and provincial levels).
e. *Transboundary catchment, transboundary water resources* and *transboundary water basin* may be used to describe the perspective of integrated management within a catchment scale that is divided into two or more different administrative areas.

Savenije and Van der Zaag (2000) state that the pillars of transboundary water resources management based on IWRM principles are technical cooperation as a central pillar, a political pillar on dealing with the environment, and an

institutional pillar for laws and regulation implementations. The institutional pillar is focused on where the outcomes are collected, and which social-culture and political-economic influences are involved (Kemper *et al.*, 2007). Kemper *et al.* (2007) identify four variables that influence these headings; initial conditions and contextual factors, characters of decentralization, relationships between upper and lower levels of an institution and its capacities, and arrangement of catchment level institutions.

a. Decentralization

Catchment management has been implemented by government entities in major countries, in which federal or central government mandates catchment management to national agencies, ministries or decentralized government (state or provincial) levels, but the outcome of this policy is not clear in some developing countries (Kemper *et al.*, 2007). Kemper *et al.* (2007) argue that decisions are more equitable solutions when made by decentralized stakeholders at 'lowest appropriate levels', in which decentralization and 'lowest appropriate levels' mean that the decision is locally made as appropriate, and others are authorized at central, provincial or state levels. Moreover, Kemper *et al.* (2007) add that the essential meaning of decentralization is that public sector management may be better managed by regional government that make the services closer to those who are served, which is the basic element of good governance principles. Decentralization and stakeholder involvement mean that the decisions taken by these processes are more informed and involve more negotiation when appropriate, not including that all responsible have regard to decentralization issues on financing, regulating and legal framework (Kemper *et al.*, 2007).

However, decentralization may be unclear in meaning such as when regional governments are trying to apply decentralization budget management and decision-making processes (Gershberg, 1998). Moreover, regulation implementation may be inconsistent and create confusion (Suharyo, 2009). As a result, decentralization implementations do not promote good governance principles and efficient bureaucracy. Mis-interpretations and lack of clarity in implementation of decentralization policy has affected natural resources management with one consequence being increasing regional budget requirements.

Natural resources management under decentralization government may ignore excessive exploitation and improper management. These experiences occur especially in developing countries where decentralization in natural resources management has been applied.

Therefore, the success of transboundary catchment management under decentralization requires strong national institutions that can deal with preferences and state legislature on authority distribution (Sadoff & Grey, 2002), although it is not easy when the catchment involves multiple states with multiple purposes (Seligman, 2011). A better approach is a cooperative mechanisms system that allows lowest appropriate governments to manage their rivers through a single entity and promises a transaction tool of "payment for catchment services" where the beneficiaries' receive contribution for those services (Blomquist *et al.*, 2007a; Seligman, 2011).

b. Politics of cooperation

Transboundary catchments may be fragmented by different policies, plans and purposes, different stakeholders or districts. Every institution or district has their own legal framework, professional activities and organizational drivers, technical capacity, and historical and cultural background, which make transboundary catchment management more complex (Timmerman & Langaas, 2005). These differences can be overcome when those who are involved have a willingness to cooperate. The cooperation will be successful when every level is equal in taking responsibility and receiving benefits. Moreover, either level can achieve more net benefit, less risks and less cost of operation through cooperation rather than independent actions. Therefore, water resources management under developing political discussion among stakeholders can be a challenge to create better management and reduce costs of operation, which is one of the hydro-political challenges in transboundary catchment management (Berhanu *et al.*, 2014).

As a substitute to political cooperation, the concept of 'adaptive management' may handle problems of transboundary resources management, and allow the distribution of competency and authority among the levels of government (Rosa, 2007). Hypotheses on natural resources management are set

and tested based on experiences in political implementations under adaptive management concepts (Holling, 1996). The positive experiences from the consequence of actions (outcomes) will be considered and reversible in a resilient ecosystem that can absorb change and variation and by flexible institutions that can adopt the changes required (Holling, 1996). For instance, central government takes part in the arrangement of a national framework for water resources management and dispute resolution among districts on transboundary resource management through legislation. Middle government levels such as state or provincial levels focus on diplomacy and technical assistance to lower levels (districts) for operating and implementing cooperation among these levels.

An economic incentive can be an instrument of implementation of cooperation among levels of government (Sebastian, 2008). However, conflict may potentially happen when institutions have unclear understanding of the problems and share benefits, which may impact on authority and territorial integrity, annexation and competition (Sebastian, 2008). Raadgever *et al.* (2008) propose that the learning processes that may be involved in adaptive management should include: 1) integrated assessment of the problems and their solutions from stakeholder perspectives; 2) determining goals, 3) policy determination to reach the goals; 4) testing the hypotheses through implementation, and 5) monitoring and evaluation of policy outcomes. A schematic of the adaptive management process is shown in Figure 2.6.

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Figure 2.6 IWRM regime and criteria for adaptive management (Raadgever *et al.*, 2008).

2.3.2. Implementation of IWRM at Decentralized Government Levels

Centralized management of water resources has been successful in water allocation, managing conflicts among states and environmental concert (Molle, 2008). However, these successful examples are challenges of IWRM implementation under decentralized government where cooperation and coordination among government levels are more focussed. The cooperation and coordination may be both a success and a barrier to IWRM implementation in transboundary catchment under decentralized government (Sadoff & Grey, 2002).

In implementation of this, particular examples of IWRM may use different specific management tools that depend on local situations of social culture, institutional structures adapting to governance relationships and scope of knowledge on economic, ecologic and environmental concerns. This approach recognises the catchment as an appropriate organization unit to which will be applied a multidimensional partnership (Colaceci *et al.*, 2007; Rosa, 2007; Phillips *et al.*, 2010). Phillips *et al.* (2010) offer a schematic of multidimensional

relationship within integrated catchment management that can be applied under decentralized government (Figure 2.7).

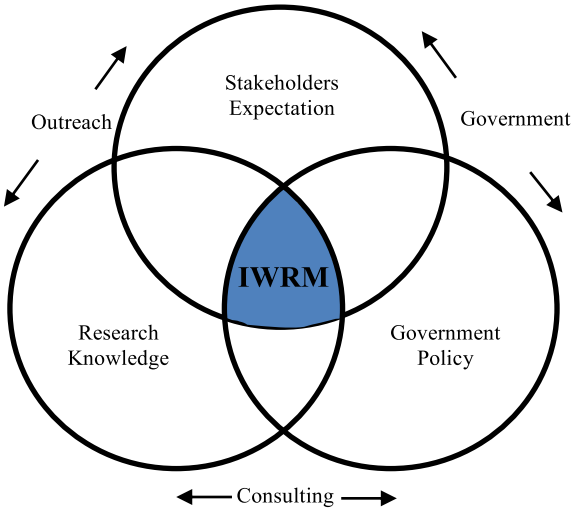

Figure 2.7 Multidimensional relationships within IWRM (Phillips *et al.*, 2010)

Many implementations of IWRM under decentralized governments have been successful, such as in Australia concerning on policy intervention, and the United States and the European Union that focus more on distribution of authority. However, some problems in implementation still occur. In many developing countries, implementation of IWRM requires improvement especially on cooperation among stakeholders to determine their goals, such as in India and Indonesia where the catchment involves many stakeholders and different levels of government.

a. The practice

1. Australia: experience from the Murray-Darling Basin

The Murray-Darling Basin is an example of the Australian experience of successful implementation of integrated water management, where policy intervention and stakeholder's involvement were used to address ecological degradation by over-allocation and competitive use (Docker & Robinson, 2013; Kemper *et al.*, 2007). The Murray-Darling Basin Authority (MDBA) manages the Murray-Darling Basin in an integrated way. The authority was established based on the national interest due to increasing water demand in South Australia and the

need for additional supplies to New South Wales and Victoria (Shaw, 1994; MDBA, 2013). The authority prepares and enforces regulation in the basin, and is accountable to the Commonwealth Minister. The Australian government also regulates via the River Murray Act 2003, which aims to protect the River Murray system from development, and activities that affect ecological sustainability, to promote a healthy basin system, sustain communities and measure unique values of the system. The act is integrated with the protection programme of the river and with other legislation that ensures the Murray-Darling River Basin gets environmental priority (MDBA, 2013).

Water resources management in the Murray-Darling basin has involved arrangements that focus on river management to be integrated, however the management is still driven by policy and audit groups in each state (Blomquist *et al.*, 2007b). There are several key participants and groups involved in institutional arrangements for governing the basin, which range from user groups such as irrigation and urban water providers, institutional structures, such as ministers and departments of the states, national government and the Murray-Darling Basin Commission. The participants have been successful in achieving goals of improved water resources management in practice and long-term vision and illustrate the economic framework of the resources (Lenton & Muller, 2009). Moreover, Lenton and Muller add that the Federal Government also plays important roles to achieve effective coordination among states.

2. The United States: PES implementation

The United States has the largest transboundary rivers in the world and has complex problems on water resources among states, some of which have occurred for years (Seligman, 2011). IWRM implementations have emphasized bottom-up approaches (Hooper, 2006), where transboundary (interstates) rivers are managed by the federal government in the United States through the federal agencies of the U.S Army Corps of Engineers and the U.S Bureau of Reclamation. However, rivers within states are managed by state governments under supervision and approved by the Federal Energy Regulation Commission (Seligman, 2011).

Application of a Payment for Environmental Services (PES) scheme at a local level has been successful in the New York City – Catskill catchment

management program where 90 per cent of water supply to the New York City is provided by the Catskill and Delaware catchment. The United States Environmental Services (EPA) required that surface water be filtered due to changes in water quality in the 1990s (UN, 2007). The budget for a filtration plant was estimated to be about US$ 7 billion and about US$ 400 million per year for its operation. However, the city authorities decided to invest US$ 1.5 billion over 10 years to improve the catchment that is administrated by a non-profit organization, the Catskill Watershed Corporation (UN, 2007). The program is based on improvements in forestry and farm practice in order to reduce land degradation. Now, the PES scheme is financed by the New York City water user by a tax that is included in their water bills.

3. The Rhine River Basin: cooperation and sharing responsibilities

Collaboration on catchments involving many countries can be seen in the implementation of IWRM in the Rhine River Basin, where the river rises in Switzerland, receives tributaries in France, Germany and Luxemburg and flows through the Netherlands to the North Sea. The problems of the Rhine River are mainly related to water quality and quantity. The Dutch area is mainly concerned with water quality, due to increasing industrial activities in Germany and France, and water quantity for ship transport (Shaw, 1994). German and French authorities collaborate on flow control in the middle reaches. In the upstream areas, Switzerland uses the river to develop power plants, while the authority has responsibility to monitor discharge due to snow melt that may cause flooding in the downstream area. The Rhine River Basin is an example of cooperation and sharing responsibilities.

4. India: "equitable apportionment" water issues

Transboundary water disputes are a concern in water resources management in India, and may arise from different interpretations of regulations by levels of government. Most issues in transboundary rivers relate to water allocation, sharing costs and benefits in projects that are funded by states, compensation in project implementation, and disputes relating to agreement interpretation (Jamil *et al.*, 2012). Moreover, India faces water scarcity where annual demand is more than

double the available water storages. This condition makes farmers very reliant on precipitation during the wet season (Seligman, 2011).

India has established procedures for adjudicating transboundary water rights, where the "equitable apportionment" is accepted as a reference for dividing transboundary waters and the states are permitted to make agreements with each other for water allocation (Seligman, 2011). The state has established a commission that manages the rivers under the agreement in an integrated and coordinated manner.

5. Indonesia: the decentralization in the Brantas catchment

The Brantas catchment, which is located in the province of East Java, may illustrate a good practice of IWRM implementation in Indonesia. The Brantas catchment faces land degradation and seasonal water scarcity, both of which may arise from lack of coordination between stakeholders on managing the catchment (Bhat *et al.*, 2007). The Brantas catchment is predicted to have a potential water resource of 12 million cubic meters, with 25% of that volume available as surface water. The catchment has over 400 deep wells for agriculture and over 27,000 shallow wells for rural water supply (Bhat *et al.*, 2007). The catchment's population is about 15 million, which has increased over 50% during the period 1975-2005, and the basin area is the centre of paddy production in eastern Java. 75% of paddy fields are irrigated from surface water.

The Brantas catchment management involves actors at national, provincial and regency levels that have responsibilities in planning, regulating and management of the catchment. Under national government initiatives, which are implementation of decentralization, the actors' collaboration has determined that water resources management is most sustainably undertaken under catchment level management. Establishing a semi-profit company (PERUM), owned by the government, this catchment authority illustrates objectives related to integrated management. The authority concentrates on balancing revenue and expenditure while providing an investment return for commercial infrastructure assets that are funded by the government (Bhat *et al.*, 2007). However, the application of decentralization policy that is focussed on distribution authority directly to district levels has caused problems. It has created confusion on relationships among

authorities at various levels of government (Bhat *et al.*, 2007). Brojonegoro (2009) states that Indonesia's decentralization reforms have ignored technical and economic problems and have been applied with a lack of guidance creating inconsistency with policies. He adds that the decentralization may cause mis-interpretations of policies when the decentralization is implemented without clear arrangements. As a result, natural resources management may fail due to excessive natural resources exploitation, when it is not concerned with environmental support and integrated approaches.

b. The challenge

Svendsen *et al.* (2005) state that there are a number reasons that make successes of IWRM rare in practice, because it needs a strong collaboration among units, may reduce authorities of units, creates more bureaucracy and politics in decision making, may raise costs significantly and makes decision-making processes more complex. In IWRM implementation in transboundary catchments, stakeholders' involvements and power distributions are commonly discussed as barriers in achieving accountability in decision-making. An imbalance of power distribution among stakeholders, different perspectives and dominance by lead agencies have created less stakeholder involvement (TAC, 2000; Biswas, 2004; Bouwen & Taillieu, 2004; Kemper *et al.*, 2007; Pahl-Wostl, 2007), which may arise from failure on cooperation and coordination processes. Achieving stakeholder involvement requires efforts to encourage them through advocacy, education and government interventions (Margerum, 1999).

Other challenges of IWRM implementation may arise from privatization of water resources that view water as economic assets and shift the perception away from common goods (Rahaman & Varis, 2005). Moreover, environmental concerns on degradation and health, aquaculture, issues around poverty reduction and spiritual aspects of water as a symbol of humanity, equity and justice are another aspect of IWRM implementation.

2.4. Water Resources Assessment

Human activities and their behaviours through LULC management may affect water resources both in term of quality and quantity. LULC modification especially on vegetation cover may change the energy balance through changing evaporation, soil moisture and water storage rates in the vegetation canopy, surface percolation and permeability, surface runoff and groundwater storage (Bultot *et al.*, 1990). Many studies have explained the correlation between LULC changes and their impact on regime flow changes within a catchment in regional studies, such as Himalayan deforestation impacts on river discharge and floods (Hofer, 1993), LULC change impacts the water balance in Belgium (Bultot *et al.*, 1990), future potential deforestation in the Amazon area impacts streamflow (Coe *et al.*, 2009) and deforestation impacts in Citarum catchment (Indonesia) the water demand (Tampubolon, 2007). More specifically the variation of crop types affects the water balance (Sellers & Lockwood, 1981; Zhao *et al.*, 2010) and potential water yields change through afforestation (Sahin & Hall, 1996). Long-term impacts of deforestation may be an increase in water yield based on evidence from 11 catchment studies in the north-eastern USA (Hornbeck *et al.*, 1993).

A catchment is illustrated as a hydrological unit that links physical-biological units, socioeconomic and socio-political units (Dixon, 1994; Asdak, 2010). Physical-biological units may be divided into the LULC system, topographical and geological condition of the catchment, which control water movement in complex relationships between them (Gerrard, 1981), such as precipitation, landscape systems, surface runoff, groundwater flow and vegetation. An adequate knowledge of catchment behaviour is required in assessment and management of hydraulic projects, in which suitable design, alternative decisions and operational procedures can be supported.

Water resources assessment may be carried out through modelling of water quantity and water quality. The water balance concept is often used in water quantity modelling, in which the data input is sourced from precipitation, LULC condition, soil types and discharge data records at outlets. Water quality modelling often examines catchments as non-point sources of pollutants, related to LULC, which are land and space dependent (Mimi, 2009), and models can be used to

improve the decision making in integrated management through various scientific approaches (Parson, 1995).

2.4.1. Water Balance Concept

An understanding of water balance conditions within catchments is necessary in developing effective water resources management. Water balance studies over longer time series use an assumption that a catchment is watertight and no subsurface movement across the catchment occurs (Shaw *et al.*, 2010; Shaw, 1994). The concept can be drawn as shown in Equation (2.1), where I is water inflow into a catchment, O is water outflow and ΔS is change in storage.

$$I = O \pm \Delta S \tag{2.1}$$

In terms of water accounting over a catchment, the water balance concept can be used to investigate water distribution within a catchment. Using runoff modelling, inflow *(I)* and outflow *(O)* can be calculated from precipitation. The I and O values from the modelling are being used to calculate the change in storage *(ΔS)* value, which is from water distribution for a variety of demand such as urban demands, agricultural demands and environmental flow demands.

2.4.2. Runoff Modelling

The linkage between forest cover, LULC and impacts on water resources in terms of both quality and quantity was initially described by Plato (427-347 B.C, cited in Avril & Barten, 2007). Onstad and Jamieson (1970) were the first authors to introduce hydrological modelling to determine LULC change affecting runoff by using sensitivity analysis of various LULC management practice. Several similar approaches on hydrological modelling have been developed around the world such as in the US (USACE-HEC, 2000), Zimbabwe (Lorup *et al.*, 1998), Australia (Nandakumar & Mein, 1997), China (Wang *et al.*, 2008), meso-scale catchment in Germany (Niehoff *et al.*, 2002), including in the Krueng Aceh catchment (Kartiwa & Sutrisno, 2006; Kasuri, 2006). Modelling approaches can be a major focus in determination of linkages between LULC and hydrological responses (DeFries & Eshleman, 2004). Most of the research highlights forest functions or deforestation

impacts on rate of infiltration, which change the runoff regime during the precipitation events.

The best available data sets estimating streamflow come from water level monitoring on gauging stations, however these data may be limited spatially and temporally. Hydrological modelling can be used to reduce these limitations (Lorup *et al.*, 1998). The hydrological models that have been developed generally apply a similar concept to the hydrological cycle. Specifically, these models focus on interpretation of the processes from a set of input parameters (i.e. precipitation and other climatological data) to generate a parameter output (runoff), in which the performance of a model may be evaluated.

There are several approaches that have been introduced in current water resources models for surface water and groundwater, based on principles of both physically-based distributed modelling and a simple conceptual water balance model. Physically-based models are focused on improving hydrological phenomena within a catchment and the changes that affect those phenomena (Beven, 1989). The simple conceptual water balance models are used for generating hydrological synthetic sequences for facility designs, water resources planning and management and forecasting the resources (Xu & Singh, 1998). However, as hydrological processes occur locally, which depends on other aspects such as geology and anthropological activities (i.e. modification of LULC, stream channels or storages), the performance of the model does not only depend on interpretation of the hydrological cycle into a mathematical relationship in a model. It also depends on the locality for which the model is developed and how the model is applicable in a specific storage. Therefore, the modelling that will be chosen may depend on the natural conditions of the application (Shaw *et al.*, 2010).

Modelling generates data on water resources and the modelled data can be used for analysis, planning, design, real time flood forecasting, especially when the observed data are not extensive enough for these purposes. Using models for water resources assessment depends on duration, data availability, purposes and accuracy that is expected. Rainfall measurement for estimating runoff or discharge depends on the timescale that will be considered, but for determining water yield from a catchment, relationships between the total of monthly rainfall data and

runoff or annual rainfall data and runoff can be used (Shaw, 1994). Moreover, models may be used to increase the quality of integrated catchment management through links to human activities and water utilization through environmental issues, socio-economic aspects and legal aspects (Mankin *et al.*, 1999; Heinz *et al.*, 2007). In LULC analysis, modelling may be used to analyse causes and effects of LULC changes that may support to spatial planning and policy. The models can assess socio-economic relationships, biophysical constraint rates and trends of LULC changes in supporting LULC-planning scenarios (Costanza & Ruth, 1998; Yu *et al.*, 2001).

Hydrological modelling approaches imply integrated hydrological processes within a catchment and transform precipitation into runoff. In small catchments, paired catchment approaches are often applied to compensate for climate variability (Lorup et al., 1998), where such approaches may be difficult to use in medium sized (100 – 2500 km2) catchments due to the difficulties in determination of LULC classification, distribution of climate variability, and adjusting topographic and geological conditions of the catchment (Lorup et al., 1998). Therefore, there are no general models that can be applied for data generating purposes for specific catchments, because the natural processes in every catchment can vary. Specific models may be applied that have been developed under similar conditions.

a. Rainfall Analysis

A regional study in Southeast Asia and the Pacific found that daily temperature and rainfall change has occurred in many parts of the region (Manton *et al.*, 2001). The change is also identified in many regions in Indonesia where annual precipitation has decreased, while temperature has increased compared with the early 20^{th} century (Boer & Faqih, 2004; Braak, 1921, cited in Aldrian & Djamil, 2008). Annual rainfall depth *(p)* has declined in southern regions and increased in northern regions of Indonesia. As a result, the change has resulted in a wet season that is more intensive in the northern regions and a more intensive dry season in the southern regions compared with the situation in the last decade. Moreover, Tsonis *et al.* (2005) state that the El Nino-Southern Oscillation (ENSO), which is a global scale climate phenomenon influences precipitation

patterns in Indonesia. Droughts happen more intensively during El Nino (the negative value of SOI or warm episode of ENSO) and intensive rainfall happens during La Nina (the positive phase of SOI or cold episode of ENSO). However, variability of rainfall pattern is very specific in every region of Indonesia with the pattern almost unrelated at two nearby stations that are located less than 100 km apart based on observed seasonal rainfall anomalies (Haylock & McBride, 2001).

The homogeneity for rainfall depths in the downstream, middle and upstream of the Krueng Aceh catchment can be analysed using double-mass curves, which plot the cumulative amount of rainfall depth in a station against the cumulative amount of rainfall depths at a neighbouring station (Searcy & Hardison, 1960; Buishand, 1982; Røhr & Killingtveit, 2003). The rainfall depth exhibits homogeneity when the graphical comparison between the cumulative rainfall totals at both stations trend along a straight line.

b. Conceptual rainfall-runoff models

Hydrological modelling, also termed rainfall-runoff modelling, can be used for analysing hydrological processes and generating data sets on streamflow that control water movement within a catchment. The rainfall-runoff models attempt to describe the relationship between precipitation, storage systems of catchments and runoff, which are determined by mathematical equations, that help to understand the dynamic relationship between the atmosphere and the LULC system in management of water quality and quantity (Arabi *et al.*, 2006).

The main principle of rainfall-runoff modelling is the use of a series of mathematical relationships that convert spatial rainfall patterns to runoff, evapotranspiration, water movement to and from groundwater systems and change of water volume (Dzhamalov *et al.*, 2010; Vaze *et al.*, 2012). The conceptual basis of these models represents water storage within a catchment using a concept that indicates water movement within vegetation, the soil moisture, groundwater condition and streamflow within a catchment (Vaze *et al.*, 2012). Rainfall-runoff modelling adopts a simple conceptual water balance concept that is shown in the equation below:

$$P = E + Q \tag{2.2}$$

Where *P* is long-term average annual precipitation, *E* is evapotranspiration and *Q* is streamflow. There are two parameters needed to use Equation (2.2). The annual *P* value in the long-term record is important where water demands are competitive, while *Q* can be calculated through generating the *E* value by using empirical methods (Xu, 1997). Many empirical methods are available to generate evapotranspiration within a catchment (Brutsaert & Sugita, 1992; Xiong & Guo, 1999), and depend on data availability on air temperature, solar radiation and wind velocity. In practice, pan evaporation data may be used in the field, and then actual evapotranspiration can be estimated through multiplying the data by a reduction factor that considers the soil water content function in a catchment (Xiong & Guo, 1999).

c. Option modelling

Models and methodologies used in hydrological modelling should be suited to a given purpose, which will be directly related to the problem definition and data availability. Moreover, models must be systematically adjusted via parameter values, such as using observed streamflow for calibration and validation, in which calibrated parameters are used to simulate runoff over a period outside the calibration period (Vaze *et al.*, 2012).

The WMO (2009) suggests the criteria and factors that need to be considered in selecting models in hydrological modelling: 1). the purposes of the analysis such as for hydrological forecasting, human influences on hydrological regime (i.e. LULC, water quality assessments); 2). types of systems to be modelled (i.e. small catchment, large catchment, reservoir); 3). hydrological elements that will be modelled (i.e. daily discharge, monthly discharge, floods; 4). physiographical and climatological conditions of a catchment; 5). data availability; 6). simplicity of the model that will be used; 7). possibility to transform the model parameter values from subbasins to overall catchment; 8). models are able to be updated based on current hydrological conditions. Moreover, Vaze *et al.* (2012) add that other considerations are 1). availability of modelling expertise; 2). whether models are used singly or in combination with other models; 3). possibility of uncertainty will be explicitly modelled (i.e. climatological uncertainty, climate changes

projections); 4). combination between simulation or optimization, or both is available.

d. Models review

Several models have been introduced for hydrological modelling in particular areas in Indonesia, such as HEC-HMS by the US Army Corps of Engineers-Hydrologic Engineering Centre (USACE-HEC, 2000), GR4J by CEMAGREFF (Perrin *et al.*, 2003), MOCK Method by FJ Mock (Nurrochmad *et al.*, 1998; Lano *et al.*, 2001; Setyono, 2012; BAPPENAS, 2006), NRECA Models by Crowford (Setyono, 2012) and the Tank Model by Sugawara (Madsen, 2000). Two of these models have been applied in the Krueng Aceh catchment, which are the MOCK Method on study of water availability (Kasuri, 2006), and the GR4J Model that has been used to simulate, based on LULC changes and their impact, the hydrological character changes (Kartiwa & Sutrisno, 2006).

1. MOCK Method

The MOCK Method is a model that applies a simple conceptual water balance. This model is often used for water resources assessment especially in large scale catchments in Indonesia where precipitation intensity is mostly high (BAPPENAS, 2006). Similar to other models, the input data on the MOCK Method is precipitation data, evapotranspiration, LULC unit, soil moisture, infiltration, base flow, direct runoff and storm runoff. Rainfall and land cover influence the evapotranspiration rate, which is adapted from the Penman equation. This model has to be adjusted with discharge data records for calibration to assess reliability of the modelled catchment. The MOCK Method schematic is simple as shown in Figure 2.8.

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Figure 2.8 The MOCK Method rainfall-runoff model (BAPPENAS, 2006)

The MOCK Method uses half-monthly precipitation data, and the model creates assumptions that accumulated water into the soil in a day is 12 mm in depth and 4 mm of that will be evaporated. Moreover, the model uses assumptions in running the simulation, such as: the Soil Moisture Capacity (SMC) is in the range of 50 mm – 200 mm, reflection coefficient is 40%, exposed surface is between 0% and 50%, the percentage of precipitation that will overflow is between 5% and 10% (Setyono, 2012; Nurrochmad *et al.*, 1998). Therefore, many authors state that successful application of the MOCK Method depends on choice of assumption parameters based on local experiments within a particular catchment (Lano *et al.*, 2001; BAPPENAS, 2006; Kasuri, 2006; Setyono, 2012). Moreover, the MOCK Method does not have a clear connection with GIS as the model is mathematically developed as lumped model for catchment behaviour, which is not associated with a physically-based distributed model.

2. GR4J Model

The GR4J Model is a conceptually lumped rainfall-runoff model that is developed based on four independent parameters driven from daily precipitation records (Edijatno *et al.*, 1999; Perrin *et al.*, 2003; Aubert *et al.*, 2003), which are maximum capacity of the production store (X_1), water exchange coefficient (X_2), maximum capacity of the routing store (X_3) and time base of unit hydrograph (X_4). A diagram of the GR4J Model is shown in Figure 2.9.

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Figure 2.9 the GRJ4 Model (Perrin *et al.*, 2003)

Based on Figure 2.9, precipitation *(P)* is sourced from daily accumulated rainfall records within the catchment and the evaporation *(E)* can be sourced from long-term average values, which mean that the potential evapotranspiration *(PE)* series is repeated annually. The rest of P after reduction by PE is stored in the production storage *(S)* and can be divided into percolation and runoff *(P_r)*. The potential *P** is divided into two parts, of which 90% is routed through percolation *(Q_9)* into routing storage *(R)* and 10% direct runoff *(Q_1)* which then accumulates as catchment outflow *(Q)*.

The GR4J Model is most effectively applied within large catchments and for floods event analysis (Edijatno *et al.*, 1999; Perrin *et al.*, 2003). The model can also be used in determinatioto show the effect of canopy change within a catchment (Kartiwa & Sutrisno, 2006), however this model cannot clearly show the event effects in LULC changes on infiltration rates of various soil types. Moreover, as the model is focussed on floods event analysis, the GR4J model uses short period data records (hourly or less than that) of discharge data for calibration, which may be scarce for some areas.

3. *HEC-HMS Model*

The US Army Corps of Engineers-Hydrologic Engineering Centre (USACE-HEC) developed the HEC-HMS Software, which is a mathematical numerical computer-based model to simulate the precipitation and runoff processes in the catchment system based on the concept of rainfall-runoff modelling. This model has been successfully applied for runoff prediction (Pistocchi & Mazzoli, 2002; Yusop & Katimon, 2007; Maskey *et al.*, 2004). While it has been used in combination with QUAL2K (water quality modelling) in the Keelung River catchment in Taiwan (Fan *et al.*, 2009), with NEXRAD rainfall and GIS for flood estimation in the San Antonio River Basin (Knebl *et al.*, 2005), and particular areas in Indonesia (Rahajeng, 2010; Hartanto, 2009; Tunas, 2012).

The structure of the HEC-HMS model is made up of six components that are used to develop the analysis; they are precipitation, runoff volume, direct runoff, baseflow, channel flow and water-control measure that includes diversions and storage facilities (USACE-HEC, 2010). Runoff volume is the rest of precipitation after the processes of interception, infiltration, surface storage and evaporation. Direct runoff is a part of storage water that is impacted by surface detention, surface storage, overland flow and surface runoff. Figure 2.10 shows the process of catchment runoff that is considered in HEC-HMS.

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Figure 2.10 A schematic of the runoff process at local scale that is adopted in HEC-HMS (USACE-HEC, 2000)

Based on Figure 2.10, the process begins with precipitation on a catchment's vegetation, land surface and water bodies that is assumed to evapotranspirate to the atmosphere. The rest will become streamflow and through flow across the land surface. Water that accumulates from the land surface will infiltrate in the soil and become overland flow through stream channels. Water in the soil may also flow to the stream channel and percolate into the aquifer. Moreover, water stored in the aquifer may seep to the stream channels, and on the other hand, water in the stream channels may also recharge the groundwater storage, cause floods and catchment discharge. With HEC-HMS modelling, the direct runoff is simulated based on an assumption that it is evenly distributed within the whole catchment with constant intensity in space and time (USACE-HEC, 2000). The reliability of this model may be demonstrated when the simulation result is calibrated with discharge records.

Lumped representation modelling, where the areas are interpreted at a homogeneous level, is commonly used in interpretation of hydrological modelling because of the limitations on dataset availability for applying a physically-based distributed model. Distributed modelling may consist of grids in sublevels of analysis that represent precipitation depth, topography, LULC or canopy and soil for the variability of those parameters (Vieux, 2005). Vieux (2005) describes applications of lumped representations and physically-based distributed modelling that can be used within the context of hydrological modelling in Figure 2.11.

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Figure 2.11 Lumped representation modelling and physical-based distributed modelling (Vieux, 2005)

The HEC-HMS model applies similar classifications to those shown in Figure 2.11. The HEC-HMS model represents schematically a lumped representation model in a subbasin approach in that each subbasin is assigned a set of hydrological parameters controlling rainfall input (USACE-HEC, 2000; Vieux, 2005), in which distributed hydrological modelling principles are applied to digital elevation model, grid of classes of soil and LULC gridded within subbasins. The HEC-HMS provides the following components (USACE-HEC, 2000):

1. a runoff distribution model for use with distributed precipitation data that may be collected from weather radar;
2. a continuous soil-moisture-accounting model is used in simulating long-term response of the catchment to wetting and drying;
3. an automatic calibration procedure can estimate model parameters and initial conditions based on hydro-meteorological conditions;
4. the model has links to a database management system that permits data storage, retrieval and connectivity with other data sources such as from GIS data.

Geographic Information Systems (GIS) are an important part of the hydrological model and allow considering variation in space and time, which make the interpretation more accurate. The important sources for hydrological modelling using GIS information are existing maps for infiltration simulation, such as a soil characteristics map that gives the soil information in the smallest units, vegetation and urbanization (Vieux, 2005), which have significant effect on runoff characteristics. The effectiveness of using GIS data requires understanding of the type, structure and scale of geospatial data used to represent catchment and runoff processes.

a. HEC-HMS application

The concept of HEC-HMS modelling considers LULC conditions and precipitation on streamflow performance that can be classified as direct-connection impervious or pervious surfaces (USACE-HEC, 2000). There are three specific methods that consider parameter inputs to the HEC-HMS, which are the loss method, transform method and baseflow method. In this research, the HEC-HMS uses the loss method of *SCS Curve Number*, the transform method of *Snyder Unit*

Hydrograph and the baseflow method of *Recession*. Figure 2.12 shows the flowchart of data required as the input for the HEC-HMS model for those methods.

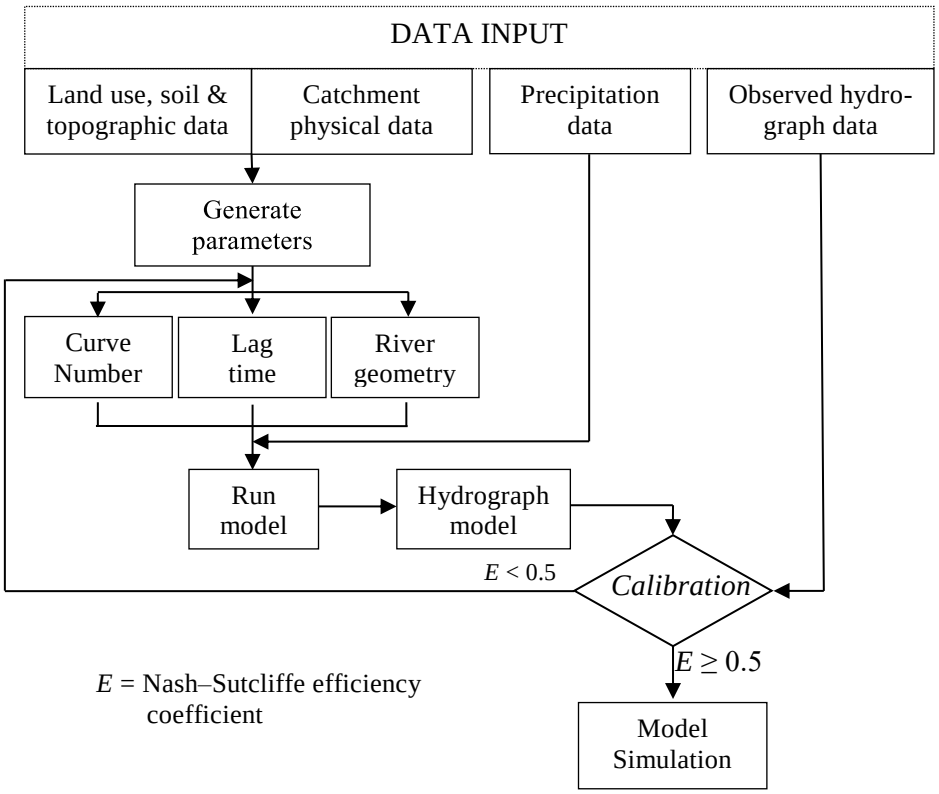

Figure 2.12 Flowchart data required for the HEC-HMS model

b. Loss method

The loss method involves using the Curve Number *(CN)* to calculate the accumulative losses where the number can be derived from LULC classification from the Landsat image analysis. The value of *CN* is in the range of 100 (water bodies) to 30 for soils with high infiltration rates. The SCS-CN classifies soil porosity and slope based on LULC classes (see Appendix 4.1). Soil porosity is grouped into Hydrological Soil Groups (HSG), which are marked as A, B, C and D in Table 2.1.

Table 2.1 Description of infiltration rates based on hydrologic group (Mishra & Singh, 2003)

Soil Group	***Description***	***Minimum loss rate***	
		(inch/hour)	***(mm/hour)***
A	Deep sand, high infiltration, low runoff potential	0.30 – 0.45	7.6 – 11.5
B	Shallow loess, moderate infiltration rate, fine to moderate texture.	0.15 – 0.30	3.8 –7.6
C	Clay loams, moderate texture, contained layers that impede downward water movement	0.05 – 0.15	1.3 – 3.8
D	Soils that have very low rate of infiltration, heavy plastic clays, and certain saline soils	0.00 – 0.05	0.00 –1.3

c. Curve Number

The Curve Number (*CN)* value was developed by Soil Conservation Service (SCS) in 1954 (Soil Conservation Service, 2005). The concept of the SCS-CN model is estimation of precipitation excess as a function of cumulative precipitation, LULC, soil types and slope (USACE-HEC, 2000).

Huang *et al.* (2006) suggest that the SCS-CN values produced from the *CN* Table (see Appendix 3.1) have to be corrected if land use slopes *(α)* are more than 5% (see Figure 3.5 the slope map of the study area in the Chapter 3) using Equation (4.2):

$$C_\alpha = \frac{322.79+15.63\alpha}{\alpha+323.52} \tag{2.3}$$

Where, (C_α) is a constant based on slope condition *(α)*. The composite *CN* in the catchment or subbasin can be calculated from the average *CN* value of LULC classes.

$$CN_{composite} = C_\alpha \frac{\sum A_i CN_i}{A} \tag{2.3a}$$

d. Transform method

The transform method relates to the direct runoff processing as the excess of rainfall in a catchment, which the HEC-HMS model refers to as a rainfall-runoff transformation (USACE-HEC, 2000). The transform method that is used to produce a streamflow hydrograph is the synthetic *Snyder Unit Hydrograph*. Snyder (1938, cited in USACE-HEC, 2000) developed this Unit Hydrograph (UH) by providing a relationship between UH parameters (lag time t_p and peaking coefficient C_p) and catchment characteristics in ungauged catchments in the

Appalachian Highland, the US (see Equation 4.1 on calculating the values of t_p and C_p).

e. Baseflow method

Baseflow is a component of streamflow, which comes from a delayed source of surface or groundwater storage, that closely relates to streamflow recession characteristic (Smakhtin, 2001). Chow *et al.* (1988) propose an initial baseflow recession in the components of the streamflow hydrograph during the precipitation event as shown in Figure 2.13.

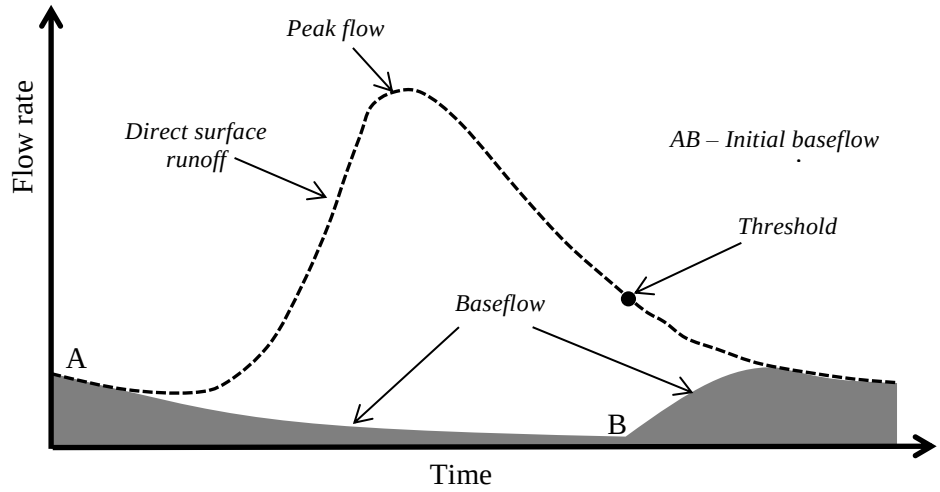

Figure 2.13 Initial baseflow recession of the streamflow hydrograph during the precipitation event (Chow *et al.*, 1988; USACE-HEC, 2000)

The relationship of baseflow *(q_t)* can be defined at any time of concentration *(t)* from the initial baseflow *(q_o)* corrected by an exponential decay constant *(k)* as shows in Equation (2.4). Baseflow model parameters as input of the HEC-HMS include initial *q*, a recession constant and threshold *q*, which defines the time when the recession model of Equation (2.4) defines the total *q*.

$$q_t = q_o k' \tag{2.4}$$

f. Routing method

Several routing methods have been developed, one of them is the Muskingum method of Cunge (1969, cited in Chow *et al.*, 1988). The Muskingum method is commonly used for analysis of a variable on a discharge-storage relationship. The

required parameters for this method are travel time (Muskingum *K*) and a weighting factor (Muskingum *X*). The Muskingum *X* has a range of $0 \leq X \leq 0.5$, which is around 0.2 in the natural stream flow and can be estimated using trial and error in the HEC-HMS calibration. The travel time *(K)* is the time of concentration for the flow from inlet to outlet of the catchment, which relates to the flood wave velocity *(V_w)* and the channel reach length *(L)*.

$$K = \frac{L}{V_w} \tag{2.5}$$

For estimating the flood wave velocity *(V_w)*, Seddon's law can be used, which is based on the top width of water surface *(B)* and slope of the *q* rating curve as a representative channel cross section *(dq/dy)* as shown in Equation (2.6).

$$V_w = \frac{1}{B}\frac{dq}{dy} \tag{2.6}$$

g. Calibration

Another input into the HEC-HMS modelling is the discharge data for calibration of the model. Calibration is the process to adjust the parameter values in the modelling to match simulated with observed values (García *et al.*, 2008) and thereby to create a reliable model catchment representation (Knebl *et al.*, 2005). The Nash-Sutcliffe efficiency coefficient can be used to calibrate the modelled value and to evaluate reliability of the optimization processes, which is a comparison between modelled and observed runoff values (Nash & Sutcliffe, 1970).

The USACE-HEC (2000) develops model calibration to estimate parameters used in the HEC-HMS, which is to match the values with the historical data. García *et al.* (2008) state the Nash-Sutcliffe model efficiency coefficient can be used to calibrate the modelled value and to evaluate reliability of the optimization processes:

$$E = 1 - \frac{\sum_{i=1}^{n}(EST_i - ESC_i)^2}{\sum_{i=1}^{n}(EST_i - \overline{ERC}_i)^2} \tag{2.7}$$

Where *n* is the series data that are used as the input of the model, which can be daily, monthly or some other series, *E* is Nash-Sutcliffe coefficient, ESC_i is discharge *q* estimated by model, EST_i is the observed *q*, and $\overline{ERC_i}$ is the average

observed *q*. García *et al.* (2008) define that the value of *E* should be unacceptable if it is less then 0.5, while the value more in range of 0.6 – 0.7 is considered good and the value more than 0.8 is considered excellent.

h. Simulation and optimization

The performance of the optimizing results can be adjusted by estimating the goodness-of-fit index (USACE-HEC, 2000). There are four objective functions that have been developed in the HEC-HMS, one of which is *Peak-Weighted Root Mean Square (RMS) Error* used in this application. The RMS Error considers a greater weight for large errors and near peak flow errors (USACE-HEC, 2000; Hammouri & El-Naqa, 2007).

2.4.3. Water Quality Modelling

Water quality is closely related to LULC as water drains from the land surface and carries accumulated contaminants. Water in natural storage may contain the contaminants that are sourced from natural processes and human intervention. Therefore, an understanding of the impact of LULC on non-point source pollution loading is important to predict water quality degradation associated with LULC changes (Tsegaye *et al.*, 2006). The contaminants have different impacts on water bodies, however natural processes may assimilate contaminants through dilution processes and self-purification. Problems may occur when contamination from anthropological activities exceed natural processes of dilution and self-purification.

Water quality is an indicator of healthy river conditions. A polluted river is one where the water quality has been changed in ways that are harmful for life. Water quality can be grouped into physical, chemical and biological features (Tebbutt, 1997). The physical features are solids, colour, taste and odour, turbidity or suspended sediment, electrical conductivity (EC), temperature and radioactivity. The chemical features are pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Nitrogen and Chlorides, while the biological features are the existence of plant and animal life in the rivers and other water bodies. The most important factor in assessing water quality in connection with LULC change

is increased sediment delivery transport, which may be identified as increasing the turbidity or Total Suspended Sediment (TSS) values, as an impact of vegetation loss.

Water resources management requires appropriate control on water quality to anticipate quality demand for particular purposes. There are many approaches that have been developed to assess water quality in streams. Nunes *et al.* (2003) used the Specific Pollution Index (SPI) to assess water quality in the Caima and Mau River Basin in Portugal. Tsegaye *et al.* (2006) determined water quality by using a Simple Index (WQC_{Index}) to predict water pollution in response to LULC changes downstream in the Wheeler Lake Basin (Northern Alabama and Southern Tennessee). The Water Pollution Index (IP) based on Indonesian Regulation No. 82 on Water Quality Management and Pollution Control was used to determine water quality degradation in the Brantas Basin Indonesia (Fulazzaky, 2009; Fulazzaky & Machbub, 2004) and to assess water quality within the Krueng Aceh Catchment (Zulfahmi, 2008). As this research is focussed on impacts of LULC change on hydrological responses in a catchment, further discussion on water quality is focussed on sediment delivery transport. Moreover, the analysis of sediment delivery connected with discharge analysis has not been carried out by other researchers in the Krueng Aceh catchment.

a. Sediment delivery, transport and deposition

Sediment delivery and transport may be closely related with LULC changes in terms of water quality, which can be caused by natural processes and anthropological processes. The natural processes are the impacts of weathering processes over the land that may happen more slowly than the anthropological processes, which relate to LULC management such as agriculture, settlements and other aspects. Sediment delivery and transport in a catchment can be defined by sediment yield by applying the sediment delivery ratio to predict daily, monthly and annual yields (Williams, 1977). The sediment transport sections can be divided into the lowland segment in the stream channels and upland segment where sediments are commonly transported and deposited over short distance (Parsons & Stromberg, 1998; Parsons *et al.*, 2006).

Universal Soil Loss Equation (USLE) was developed to determine long-term soil rate loss (*E [tonnes/km^2]*) with specific cropping and management conditions (Foster *et al.*, 1994; Morgan, 2005). The equation is developed on basis of the soil index (L_s), crop management factor (*C*), soil erodibility factor (*K*), erosivity (*R [mm/h]*) and erosional factor practice control (*P*).

$$E = L_s CKRP \tag{2.8}$$

The erosional factor practice control (*P*) is applied when control practices are applied, the *P*-factor = 1 when no erosion controls are applied such as no contour strip-cropping, terraces, deposition or cover contouring are practiced or are present as natural conditions (Morgan, 2005). With the *P*-factor = 1, the soil rate loss formula (*E*) reduces to:

$$E = L_s CKR \tag{2.8a}$$

The soil index (L_s) contains the factor of slope length (*L*) and slope gradient (*s*) that can be combined in one index determined on basis of a DEM or contour data using Equation (2.9) (Wischmeier & Smith, 1978, cited in Morgan, 2005; Mitasova *et al.*, 1996):

$$L_s = \left(\frac{L}{22.13}\right)^n (0.065 sin^2 s + 4.56 \sin s + 0.0654) \tag{2.9}$$

Where *L* is the slope length profile that has value higher than 122 m under natural conditions (Foster *et al.*, 1999), *s* is slope gradient (%), *n* is constant dependent on *s*, where n = 0.5 for *s* less than 4.5%, 0.4 for *s* of 3% - 4.5%, 0.3 for *s* of 1% - 3% and 0.2 for *s* of 0 – 1% (Foster *et al.*, 1994). This research develops the L_s value from a topographic map where the *L* values are transformed from the LULC class areas that are higher than 14,884 m^2 with an assumption that the area is larger than 122 m x 122 m.

Type of the crop management factor or land use factor *(C)* is specified from the land *C*-factor values that have been developed by USLE (Trahan & Ouyang, 2003; Poerbandono *et al.*, 2006) as shown in Table 2.2.

Table 2.2 *C*-factor of LULC type (modified from Poerbandono *et al.*, 2006)

No.	***LULC type***	***C-factor***
1.	Water body	0.0001
2.	Urban	0.0007
3.	Paddy Field	0.001
4.	Forest and Secondary Forest	0.002
5.	Grass	0.003
6.	Mixed Plantation	0.005
7.	Sparse Grass	0.4

The soil erodibility factor (*K*) represents the soil loss rate per erosion index unit detached by kinetic energy from rainfall and transformed by surface runoff (Morgan, 2005). Poerbandono *et al.* (2006) propose the soil erodibility factor (*K*) as shown in Table 2.3.

Table 2.3 *K*-factor of soil type based on PPT Bogor classification (Poerbandono *et al.*, 2006)

No.	***Soil type***	***K-factor***	***Code***
1	*Alluvial*	0.20	3
2	*Latorol*	0.23	1
3	*Mediteran*	0.24	2
4	*Andosol, grumosol, podsol, podsolik*	0.26	0
5	*Regosol, litosol, organosol, regina*	0.31	2

Moreover, Poerbandono *et al.* (2006) developed an erosion (*R*) index that is a representation of rainfall depth (*p*) to detach particles from the soil surface. The *R*-index is defined as:

$$R = 2.21\, p^{1.36} \tag{2.10}$$

As this equation is calculated based on the estimation of erosional gross rate at the plot-scale, the resulting sediment loss may be higher than calculated stream sediment at the outlet (Lu *et al.*, 2006). Therefore, Lu *et al.* (2006) state that the Sediment Delivery Ratio *(SDR)* can be used to reduce these effects. The *SDR* is the ratio of sediment delivered at the catchment outlet that involves various processes of onsite potential erosion loss *(E)* and downstream sediment yield *(Y)* where the

SDR is basically interpreted as an efficiency of the catchment to transport the sediment to the outlet (Van Rompaey *et al.*, 2001). The *SDR* equation is:

$$SDR = \frac{Y}{E} \; or \; E = \frac{Y}{SDR} \tag{2.11}$$

The *SDR* is influenced by geomorphological factors of the catchment including the environmental factors such as LULC and soil textures (Walling, 1983). A general method for interpretation of *SDR* values has been proposed by various researchers for certain sites, such as by Roehl (1962) for South-Eastern USA, Williams (1977) for Texas USA, and Lu *et al.* (2006) using spatially distributed *SDR* over the Murray Darling Basin Australia. Moreover, specific *SDR* values have also has developed for particular places in Indonesia, such as, the Upper Citarum catchment (Poerbandono *et al.*, 2006), a relationship between catchment areas and *SDR* values (Supirin, 1988) and the *SDR* value over the Wonogiri Dam catchment in Java (Supirin & Munir, 1997). Research shows that calculation of *SDR* values using empirical methods depends on catchment area:

$$SDR = \alpha A^{\beta} \tag{2.12}$$

Where α is an empirical constant, A is catchment area and β is the exponent that encompasses catchment sediment transportation processes and its links with rainfall-runoff processes (Lu *et al.*, 2005; Lu *et al.*, 2006). The USDA SCS (1972) has generalized a relationship between *SDR* and catchment area as shown in Figure 2.14.

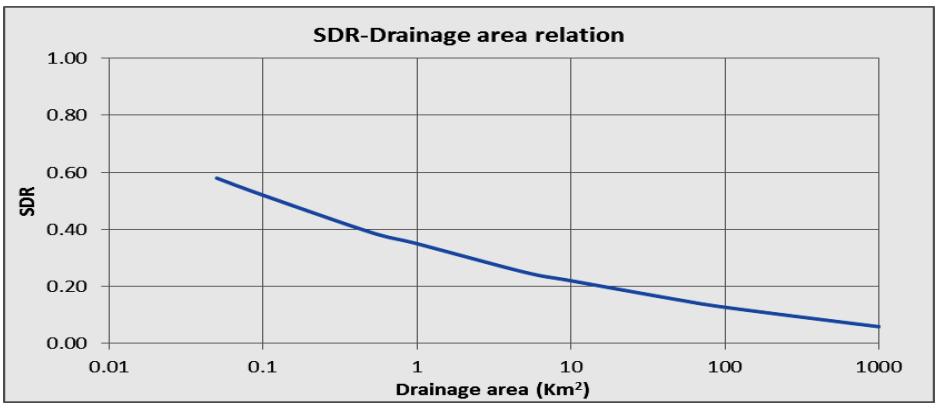

Figure 2.14 Relationship between catchment drainage area and *SDR* (USDA SCS, 1972)

Sediment delivery transport can be connected with rainfall-runoff models as a further application of discharge analysis (Williams, 1977; Tilrem, 1979). The

analysis may predict the sediment yield at certain time scales, which can be daily, monthly or during some events of sediment yield. The *Modified Universal Soil Loss Equation (MUSLE)* predicts sediment yield using the equation below (William and Berndt, 1976; Williams, 1975, cited in Williams, 1977):

$$Y = 11.8\ (Q\ x\ q_p)^{0.56} K\ C\ P\ L_s \tag{2.13}$$

Where *Y* is sediment yield for a time interval of rainfall (*ton/time)*, *Q* is the runoff volume (m^3), q_p is the peak flow (m^3/s), *K* is the soil erodibility factor, *C* is the crop management factor, P is erosional factor practice control, and L_s is the function of slope index. Procedures to calculate the parameters of K, C, P and L_s are similar to the methods discussed previously.

Similarly, Tilrem (1979) proposes an equation to calculate sediment discharge *(q_s)* at daily time scale depending on the values of mean daily discharge and mean concentration of suspended solid in the discharge, which is:

$$q_s = k\ q\ C_s \tag{2.14}$$

Where q_s is sediment discharge (*ton/day)*, q is the mean discharge (m^3/s), C_s daily mean concentration of suspended sediment (*mg/l*), k is a conversion factor, taken as 0.0864 (Tilrem, 1979).

b. Water quality approaches with GIS

Pollution transport within a catchment is a random process (Mimi, 2009), which is related to LULC condition and is land space dependent. Pollutant concentrations are measured at the outlet of a catchment and do not provide any information about spatial variation of the pollutant (Ghafouri & Swain, 2005). However, the pollutant concentration can be used to calculate the contaminated location using geostatistical methods that provide a methodology to quantify spatial uncertainty, in which probability distributions represent the range of possible values of particular parameters (Chilès & Delfiner, 1999; Poon *et al.*, 2000).

Geostatistical applications have been successful in transferring non-point source information into spatial information, such as non-point sources of nitrogen at the catchment level (Zhang & Huang, 2011), spatial variability of soil properties (Emadi *et al.*, 2010; Foroughifar *et al.*, 2013), and erosion vulnerability (Ogbonna,

2012) in particular areas. Therefore, the distribution maps of non-point source information over the catchment can be provided when they are successfully transferred into spatial information, in which case the information may support decision-making on pollution control and river management.

2.4.4. Assessment of Water Demand

Forecasting and managing water demand, which are essential subjects for improving decision making on water management (Baroudy, 2005), involve a complex relationship between human and natural systems that include micro-scale domestic and non-domestic demand, and macro-scale regional demands. The complexity includes uncertainty demand when it is connected with population growth and economic growth, both of which may be affected by changes in lifestyle, and improving technology in water usage. On the other hand, the complexity also includes supply uncertainty when connected with potential climate change, improving the LULC system and improving water supply infrastructures, which may change costs on investment, operations and maintenance.

a. Water demand standard

Water demand can be calculated based on demands for domestic, non-domestic and minimum environmental flow, which are required for a riverine ecosystem that is dictated by temporal flow fluctuation (Richter *et al.*, 1996; Lytle & Poff, 2004; Arthington *et al.*, 2006). Water demand consists of domestic demand and non-domestic demand that are calculated from current conditions and forecasted until the end of the projected year. Water supply to an area can be calculated annually based on rate of consumption and size of population, which can be divided into domestic and non-domestic demand (Shaw, 1994). The demand may relate to population, water price, household incomes, individual customs and daily activities, infrastructure facilities, rainfall, evaporation and air temperature (Wong, 1972; Linsley, 1992). The amount of water that is consumed in an area in terms of both domestic and non-domestic demand is an indicator of per capita consumption (Shaw, 1994), as mentioned in the UN Human Development Report 2006 (UNDP, 2006) on beyond scarcity of power, poverty

and the global water in selected countries (Figure 2.15). The per capita consumption is the average water usage and it can vary by location within a country, therefore the best way to know the real demand is using a demand survey in a project area.

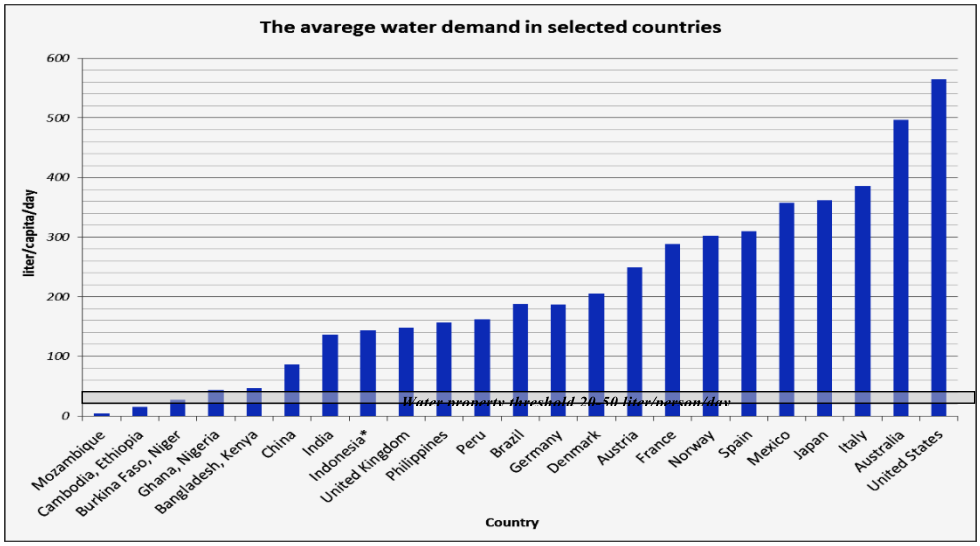

Figure 2.15 Average of water demand 1998-2002 in selected countries and the demand threshold (FAO, 2006, cited in UNDP, 2006) and Indonesia 2006 (Cipta Karya, 2006).

The Ministry of Public Works of Indonesia under the Directorate of Settlement (Dirjen Cipta Karya) has developed the standard demand for domestic and non-domestic demand based on population growth and urban categories in Indonesia, which is adopted from the Food and Agriculture Organisation of the United Nations (FAO) standards (Cipta Karya, 1998; 2007) as it shown in Table 2.4.

Table 2.4 FAO and Indonesia Water Demand Standard (Cipta Karya, 1998)

Population (in 1,000)	***Area Category***	***Water Demand (litre/day/person)***		
		Domestic	***Non-Domestic***	***Losses***
> 1,000	Metropolitan	150	60	50
500 –1,000	Big city	135	40	45
100 –500	Medium city	120	30	40
20 –100	Small city	105	20	30
< 20	Village	82.5	60	24

Moreover, the calculation of water demand should include water loss factors of 20 - 30%, peak hour factors of 15% - 25% (Cipta Karya, 1998; BAPPENAS, 1993; Prasetyo, 2000), and the minimum environmental flow of 300 litre/day per capita that has been developed by Nippon Koei (1993, cited in Hatmoko & Triweko, 2011). Specific demands may need to be accounted for in particular areas, and can be calculated separately. Specific demands are calculated based on real demand, such as paddy field water demand in the range of 0.76 - 1.04 l/s/ha based on the paddy varieties (Nurrochmad, 2007), or about 2,880 l/kg of paddy production (Nurrochmad, 2011). Agricultural demands generally may need to be calculated separately due to their significance in relation to water consumption.

b. Forecasting water demand

Substantial research has been undertaken on forecasting of water demand. An interactive integrated water allocation model was developed to assist decision makers on optimization of water allocation from a resource that has multi-sector users (Babel *et al.*, 2005), dependent on a complex function of social-economic, climate and water policies, in Kathmandu, Nepal (Babel *et al.*, 2007). The forecasting can be more powerful when it is connected with other instruments such as GIS (Armstrong & Fildes, 2006; Hillier & Lieberman, 2001),

Forecasting of water demand can be carried out based on the type of forecasting and method of forecasting. Demand forecasting can be divided into two types, short-term forecasts and long-term forecasts. The short-term forecast is required for operation and management, and the long-term forecast is used for planning and infrastructure design (Jain *et al.*, 2001; Zhou *et al.*, 2002; Bougadis *et al.*, 2005). The methods of demand forecasting are linear regression methods, time series analysis, artificial neural network (ANN) models and a combination of these methods (Jain *et al.*, 2001). Linear regression has been used to forecast daily water demand in Melbourne, Australia (Zhou *et al.*, 2002), and to determine daily water use in nine cities in the US (Maidment & Miaou, 1986). Danielson (1979) used the series analysis to identify residential water demand in seasonal conditions. Moreover, Bougadis *et al.* (2005) have tested the reliability of these three methods for water demand forecasting in the city of Ottawa, Canada. Projection of water demand can be calculated based on projection of annual

population growth (Cipta Karya, 2007). The annual population growth can be calculated by using an arithmetic mean, a geometric mean and a least square mean until the end of the projected year (Bartlett, 1993; Cipta Karya, 1998; Norman, 2011).

Water allocation scenarios can be used to increase the performance of forecasting water allocations based on users' behaviour (Lévite *et al.*, 2003). Lévite *et al.* (2003) found that limitations on data quality and availability are a crucial problem in achieving a good judgment when the scenarios were applied in Olifants River Basin, South Africa. Froukh (2001) developed a decision support system for water demand management that can provide the water resources management planner estimates of future domestic demand using various methods.

2.5. Creating Decision Alternatives

Decision situations are influenced by social cultural, economics, regulation and policy aspects that apply operating procedures in public, private and public-private organizations (Nyerges & Jankowski, 2010). Labadie (2006) adds that decision-making involves multiple criteria through combining various social, economic and environmental factors, which relate to spatial entities of water resources problems and make them available to the decision-making process. Moreover, decision alternatives can be combined with geographic information systems (GIS) to create spatial decision-making, which involves spatially referenced data integration in problem solving, where the information can be applied through planning and implementing the measures (Cowen, 1988; Nyerges & Jankowski, 2010). GIS may also be used for predicting LULC change through developing LULC scenarios (Malczewski, 2004; Miller *et al.*, 1998) such as for LULC planning for agricultural purposes (Campbell *et al.*, 1992) and for multi-criteria analysis for LULC suitability (Joerin *et al.*, 2001). The features of GIS technology are data management, graphic display, spatial analysis functions, modelling, simulation and optimization functions that are required for generating, testing and evaluating the solution sensitivity (Nyerges & Jankowski, 2010).

2.5.1. Predicting LULC Change

Intensive LULC changes in Indonesia began when the Indonesian Government introduced agricultural land intensification and targeted high economic development through the Five-Year Development Plan (PELITA) Program from the early 1970s. LULC changes as the impact of anthropological processes associated with the environment result in a complex interaction of economics, politics and human behaviours (Vesterby & Heimlich, 1991; Blomquist *et al.*, 2010; Matthews *et al.*, 2007; Lambin *et al.*, 2000). These impacts not only alter the hydrological regime (DeFries & Eshleman, 2004; Bhaduri *et al.*, 2000; Lorup *et al.*, 1998; Steiner & Osterman, 1988), but may also impact natural habitats and spatial diversity (Bouman *et al.*, 1999).

Developing LULC scenarios where spatial and anthropological information are involved are important inputs to predict future conditions, which can be developed through LULC modelling. The models should cover complexity of LULC system, possibilities to test LULC change sensitivity by changing its variables and by changing anthropological (social and economic) activities (Veldkamp & Lambin, 2001; Verburg *et al.*, 1999; Verburg *et al.*, 2004). Therefore, linking observations in temporal and spatial scales may increase the quality of LULC change analysis (Turner *et al.*, 1995), because direct measurements may not be sufficient to determine the sensitivity of its change (Parker *et al.*, 2003).

The complexity of the LULC system refers to multidisciplinary analysis that links selected variables in developed scenarios (Clayton & Radcliffe, 1996), which it fundamentally develops under process-based (structural) models and statistical-based models (Veldkamp & Lambin, 2001). Process-based models deal with time related change in system properties (biophysical or socio-economic), and statistical-based models rely on an assumption that LULC processes are static (Veldkamp & Lambin, 2001). Under these models, actors may be able to develop decision making that represents model scenarios where economics are commonly integrated in developed scenarios (Veldkamp & Lambin, 2001; Irwin & Geoghegan, 2001).

Parker *et al.* (2003) summarise several approaches to modelling in a wide range of LULC change analysis. They are system dynamic, mathematical equation-based, expert system, cellular and hybrid. Table 2.5 briefly shows the strengths and weakness of these models.

Table 2.5 Strengths and weakness of some selected LULC change models (Modified from Parker *et al.*, 2003)

No.	***Models***	***Strengths***	***Weakness***	***Publications***
1.	System dynamic	Models show clearly interaction between anthropological activities and ecology.	Models rely on explicit enumeration and lack spatial relationships.	Gilbert and Terna (2000), Veldkamp and Lambin (2001), He *et al.* (2006), Costanza and Ruth (1998)
2.	Mathematical equation-based	Models cover population growth, economic theories and potential links with GIS.	Models are limited in coverage of complexity at various levels of analysis.	Hales *et al.* (2003), Sklar and Costanza (1991), Chuvieco (1993)
3.	Statistical	Models are easy to use, widely acceptance and well-tailored with spatial statistics	Models may be limited on adopting decision making processes and stakeholders.	Lambin *et al.* (2001), Mertens and Lambin (1997), Veldkamp and Lambin (2001), Irwin and Geoghegan (2001), Chomitz and Gray (1996), Geoghegan *et al.* (1997)
4.	Expert system	Models may be able to combine expert judgment and express qualitative knowledge. Models deal with limited data source.	Models have difficulty covering the full problem domain. Models create inconstancies on analysis.	Stefanov *et al.* (2001), Rounsevell *et al.* (2006), Lambin and Meyfroidt (2011)
5.	Cellular (include cellular automata and Markov Models)	Models have proven an effective usage for modelling ecological aspects of LULC.	Models lack incorporation with decision making processes. Models rely on homogeneous processes on congruent cells that may not adopt neighbourhood relationships with other actual processes.	Verburg *et al.* (2004), Tobler (1979), Clarke *et al.* (2007), Stevens and Dragicevic (2007), Irwin and Geoghegan (2001)
6.	Hybrid	Models combine any other models, each of which is a discrete approach unto itself, which may be an advantage for decision making processes.	Models are complex in application and need a variety of data source.	Verburg *et al.* (2006), Alberti and Waddell (2000), Costanza *et al.* (1998)

2.5.2. Decision Alternatives under IWRM

An assessment of alternative actions for environmental solutions needs effective prediction methods that focus on those solutions as outcomes for decision-making processes. The prediction can be improved through modelling. Environmental modelling is a complex task, involving interrelatedness and dynamic behaviour that does not only involve technical parameters on ecology and economics but may also involve social and policy parameters (Wäger & Hilty, 2002). Accordingly, complexity, interrelatedness and dynamic behaviour in the modelling may become easier by improving modelling software.

Water resources management is interrelated with other considerations, such as conflict based management, complex problems and performance of water distribution and its allocation to anticipate demand. The process may involve alternative options and actions, which can be implemented and controlled by the decision-making process. Decision alternatives have been developed in a wide range of IWRM. In Brazil, a multi criteria group decision model under IWRM has been developed to support Watershed Committees due to conflicts in water allocation (Silva *et al.*, 2010). Decision-making under uncertainty conditions has also been applied in integrated catchment management of the Red River to address the problems, which are difficult to measure, in which the uncertainly model is developed using a methodology of ranking measures (de Kort & Booij, 2007). Developing decision alternatives has also been carried out for management of the Mekong River Basin, with cooperation between China, Vietnam, Myanmar, Lao PDR and Cambodia, which has created a model of mutual cooperation on river basin management and the complex relationship between authorities (MRC, 2011).

IWRM implementation in the context of a transboundary catchment requires different management approaches (Sadoff & Grey, 2002). Gaps exist between stakeholders in the application of policy, planning and implementation (Savenije & Van der Zaag, 2008), and this may be exacerbated when the resource change has to be managed, or there are increased demands on resources (Kliot *et al.*, 2001).

2.5.3. Multiple Criteria Decision Making (MCDM)

A multiple criteria decision making (MCDM) or a multiple criteria analysis (MCA) refers to methods and procedures that are formally used for deciding alternative procedures (Kou *et al.*, 2003), where multiple criteria are incorporated into management processes through scoring the overall decision options against objectives (Hajkowicz & Collins, 2007; Huang *et al.*, 2011). Figure 2.16 shows an interaction between databases (input criteria), scenario, model base and measures in achieving management objectives through MCDM on decision alternatives (de Kok *et al.*, 2001), in which a similar conceptual framework can be adopted in catchment management policy formulation based on local conditions of the catchment area.

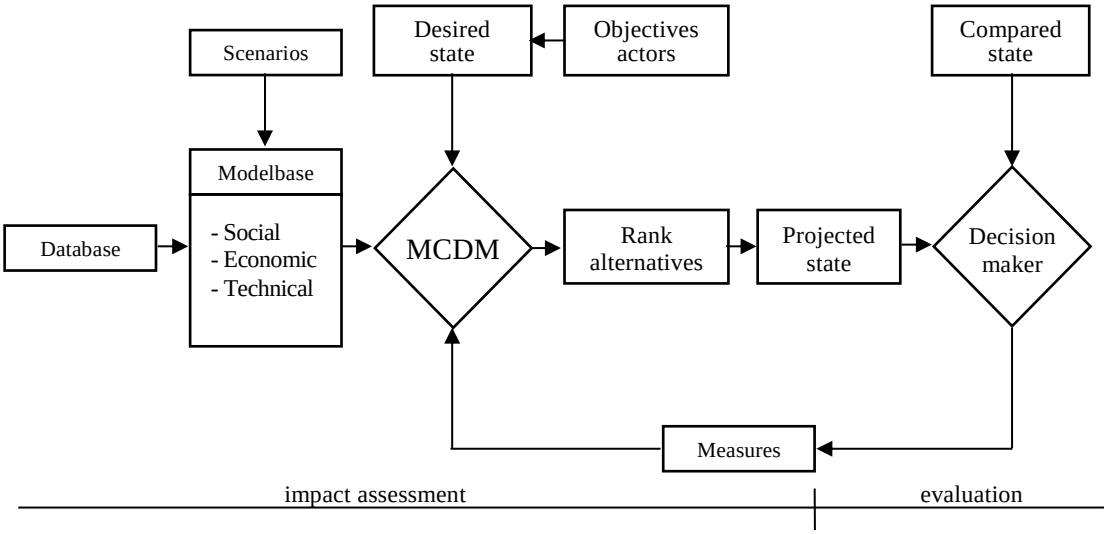

Figure 2.16 A conceptual framework for IWRM policy formulation on decision alternatives through MCDM (modified from Wind, 1988 cited in de Kok *et al.*, 2001).

The policy formulation of IWRM in Figure 2.16 starts from data collection for input on developing alternatives scenarios based on economic, social and technical aspects. Based on those scenarios, the MCDM is developed by controlling the desires of actors. The effect of the MCDM process is to rank alternatives that can be chosen in a projected state to compare with other strategies in the decision-making process. The Analytic Hierarchy Process (AHP) can be introduced to make the alternatives more powerful. The AHP is a structural technique that can be used to organize and analyse a complex decision that involves mathematical and physical techniques (Saaty, 1988). The AHP helps

decision makers to identify goals and understand the problems in a rational and comprehensive framework, therefore the goals and problems can be structured, represented and related for evaluating ranked solutions and measures.

Moreover, the solution and measures from the decision maker are recompiled in MCDM process to understand their reliability against the scenarios and objectives of actors. The measures recompiled in MCDM may also be evaluated and assessed against the measures that have been chosen. The application of decision alternatives in IWRM through MCDM can be implemented for planning and implementation processes. The processes are applied for developing short-term and long-term strategies. The short-term strategy might involve water allocation and distribution; while the long-term strategy can involve operational planning, water deregulation and resolving conflict between stakeholders. Planning may include identification of actors and their objectives, alternative scenarios and models based on social, economic and technical aspects. Implementation includes the processes for testing the measures to control the future state within the catchment area, which is expressed in management objectives and measurement objectives.

Decision alternatives for LULC management under Multi Criteria Decision Making (MCDM) in the Krueng Aceh catchment can be assessed by identifying steps and actors that contribute at various levels of MCDM. Figure 2.17 shows the steps and actors that contribute to MCDM formulation.

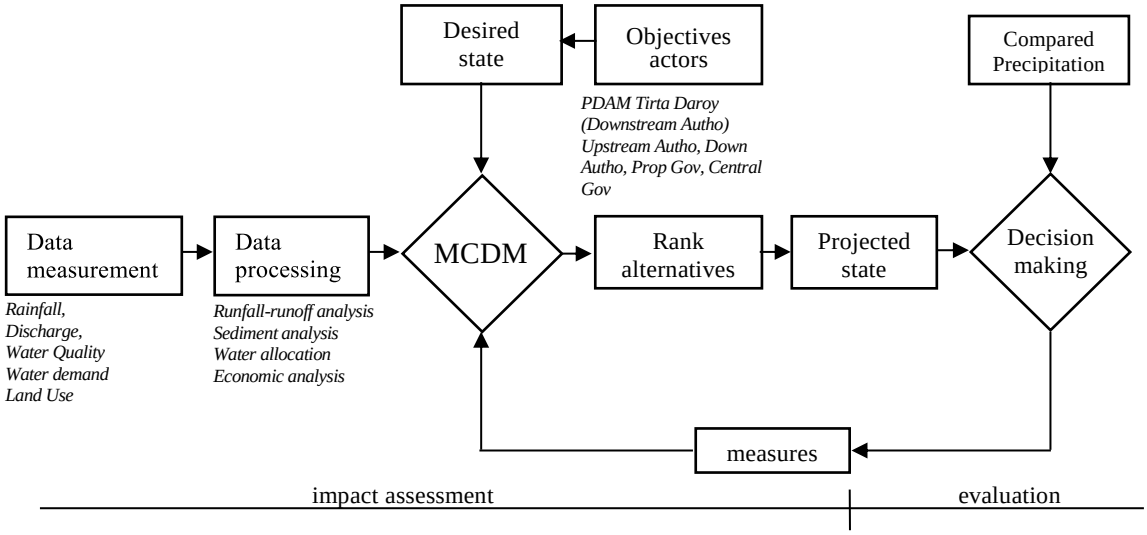

Figure 2.17 Framework of MCDM formulation for kinds of economic compensation for IWRM of Krueng Aceh catchment (modified: Wind, 1988 cited in de Kok *et al.*, 2001)

In more detail, Figure 2.17 can be explained as follows:

1. *Data measurement* is data inputs of the formulation which include rainfall, discharge, water quality, water demand and land use data where these data are used in previous analyses.
2. *Data processing* is the analyses that are carried out, which are runoff-rainfall analysis using HEC-HMS Modelling, sediment analysis using USLE method and sediment-discharge method, water balance analysis for water allocation and economic analysis for externalities due to LULC change.
3. *Desired state* is the state that is expected by PDAM Tirta Daroy (*objective actor*) due to compensation given, which can be stated as ensuring quantity of water demand and reducing sediment transport. Moreover, the desired state has to minimize cost impacts in terms of both social and capital costs.
4. *Objective actors* are stakeholders that contribute to the various steps of the MCDM formulation. They are government authorities, including PDAM Tirta Daroy, as a part of downstream authorities, and upstream communities (farmers) are the upstream authorities as compensation cannot be directly distributed to the community. Moreover, provincial and central government may also be included in terms of regulation setting and financial support.
5. *Rank of alternatives* is the potential alternatives that can be implemented in achieving the desired state. This analysis selects reforestation at selected areas based on slope conditions and soil types, land management practice for agricultural lands and plant management practice to agricultural products chosen as priority alternatives in terms of LULC management. This research found that reforestation of area based on slope conditions and soil types alone as shown in LULC Scenario II is not effective in increasing reliability of water supply and decreasing costs for water purification, therefore the combination of these alternatives is developed under MCDM and AHP methods.
6. *Projected state* is the best combination of alternatives that can be implemented after it is compared with model state (*Compared state*). As the results of the decision-making processes, *measures* to achieve the desired state can be assessed under *evaluation* and *impact assessment* when the projects are implemented, and these are not discussed n this research.

a. Level of importance

Comparisons of water quality, water quantity and social costs as shown in Figure 6.7 can be achieved using the Fundamental Scale of Absolute Numbers, using judgements as a predictive practice (Saaty & Vargas, 2006; Saaty, 2008). The scale is shown in Table 2.6.

Table 2.6 the Fundamental Scale of Absolute Numbers (Saaty & Vargas, 2006; Saaty, 2008)

Intensity of importance	***Definition***	***Explanation***
1	Equal Importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgement slightly favour one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgement strongly favour one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	Experience and judgement strongly favour one activity over another
8	Very, very strong	
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation

The decision-making is the link between an actual situation and a desired situation. Vreke (1994) illustrates the procedure on selecting the desired situation and strategy on decision-making processes in Figure 2.18. The desired situation arises when a higher level of management controls the decisions at other management levels. A desired situation that is selected should be related to an analysis of both physical and theoretical possibilities that can be applied within a region, behaviours and other management levels. However, behaviour cannot be controlled in reality and a strategy should be developed to induce desired behaviours, such as a strategy that is imposed by measures (i.e. legislative, regulations and subsidies) that needs more focus on negotiation to achieve its goals.

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Figure 2.18 Outline of procedures for supporting decision making processes (Vreke, 1994)

Howe *et al.* (1986) offer six criteria that can be used for optimization of decision-making in IWRM concerning economic aspects and stated social objectives, where water allocations operate over decentralized governance levels. They are:

1. Flexibility in allocation of existing water supply, in which water can be shifted between water users and places based on climate, economic and social-cultural conditions that may change over time. The flexibility needs to set both long-term (i.e. opening up possibilities for benefits among agricultural users and between agricultural demand and other demands), and short-term strategies (i.e. concerning population growth and economic growth);
2. Security for existing users that ensures their long-term supply. However, it needs flexibility so they can voluntarily respond to incentives for water reallocations;
3. Possibility to apply a competitive market that compares allocation mechanisms with opportunity costs of water availability for users. However, the competitive market has to guarantee the criteria of flexibility and security;
4. Predictability of the outcome, in which new roles of water allocation may increase the outcome over the existing allocation. However, new allocations may increase uncertainty and user rejection for the new proposal;
5. Equality on water allocation processes that can be perceived by users. These criteria should be added together with other previous criteria;

6. Capability to reflect on public values of social responsibility in water allocations that may not relate to the competitive market.

Trends in policy-making focussing on the goals rather than traditional democratic approaches may create problematic decisions. However, lack of representation may lead people to reject the decisions that are made by decision makers. For this reason, environmental decisions may better solve problems through technical approaches (Messner *et al.*, 2006), in which decision alternatives through economic compensation can be applied where the goals and public participation can be involved. Dixon and Sherman (1991) divide the alternative decision processes on the environmental decisions into political and economic dimensions. The politics often start with decision-making processes to determine the area that considers a potential area for environmental concerns. The political dimensions may be sourced from citizens, international organizations or any agencies, which consider expectations from the environmental services. In economic dimensions, decision making for selecting areas for environmental concerns is related to the objectives of the protection area. If the benefit of selected area is significant, it is necessary to determine the alternative value that may be used in the area that potentially loses the benefits associated with their protection. Pearce and Turner (1997) add that a decision on the environmental degradation that is caused by projects or human activities may be reached by comparing the costs of the project, benefits of the project and the TEV of the environment that may be forgone by the project or the activities.

Water allocation may involve economic principles in the demand curve where it directly affects supply and prices. The relationship between those associations and environmental quality is complex because it relates to several aspects such as preferences, economic structure and technology (Shafik, 1994). Shafik (1994) adds that the basic principle of demand theory is the "substitution" idea where customers compare and contrast the quality, quantity and price for a commodity with its alternatives based on the amount of their budget and the intensity of their desire. The principle of "the substitution effect" is the relationship between price against quantity and quality demanded where when one rises, the other goes down and vice versa (Prasch, 2008). The demand curve

principle can be used to assess decision alternatives for water allocation through quantity and quality approaches. The quality approaches, which relate to rights of water where the resources are located, are riparian water rights and a prior appropriation system (Haar & Gordon, 1958; Howe *et al.*, 1986; Chang & Griffin, 1992; Miller *et al.*, 1997; Zilberman & Lipper, 1999), and quantity approaches relate to human activities concerning to water quality within a catchment (Howe *et al.*, 1986; Turner *et al.*, 1994; Hussen, 2004; Pearce *et al.*, 2006).

b. Water quantity approach

Water quantity approaches are commonly applied in decision-making processes for water allocation and economic valuation. As stated before, there are two doctrines related to the rights on water allocation, which are a riparian water rights system and a prior appropriation system. The riparian water rights is a system for water allocation in which owners of the lands bordering on a water source have the right to make "reasonable use" of water and then return the water to the water body at "the same appropriate" quantity and quality without effects on lower owners (Haar & Gordon, 1958; Howe *et al.*, 1986; Miller *et al.*, 1997). These rights seem patently difficult in implementation due to difficulty in determination of the meaning of "reasonable use" and "the same appropriate" both in quality and quantity of water when it is returned to water bodies. With a prior appropriation system, the rights of users are queued and shared according to the time the water started to flow (Hildebrand, 1927; Zilberman & Lipper, 1999).

There are two types of ownership rights that have been developed under prior appropriation doctrines; priority rights, which is "first in time, first in rights" and proportional rights, which shares water among owners according to portions determined by the number of rights owners (Howe *et al.*, 1986). These systems are commonly used in the United States (Miller *et al.*, 1997; Chang & Griffin, 1992), the European countries and Australia (Apan *et al.*, 2002; Tisdell, 2003). However, the doctrines were not well known in developing countries where water availability relies on rainfall and groundwater such as in India and China (Ziegler *et al.*, 2006; Shah *et al.*, 2006), and the relationship between riparian and non-riparian users has not been established. Howe *et al.* (1986) offer a comparison

between characteristic of priority rights and proportional rights systems as shown in Table 2.17.

Table 2.7 A comparison of characteristic of priority and proportional rights systems (Howe *et al.*, 1986)

	Priority Rights	***Proportional Rights***
General advantage	Different Decrees of supply reliability can be proposed	Rights are homogeneous, easier to establish market
General disadvantage	Rights non-homogeneous, more difficult to organize the markets	Differing Decrees of reliability must be created by holding extra shares
When users are alike	Short-run inefficiencies during water shortages	Efficient allocation among users during shortages
When users are not alike	Prevents extreme loss to sensitive users during shortage but generates some short-term inefficiencies due to marginal products not being equal	Either excessive losses to water sensitive users during shortage or sensitive users must hold shares
When water supply is highly variable	Protects sensitive investments but results in some short-term inefficiencies	Makes protection of sensitive investments difficult but equates marginal values where users are alike

In the case of IWRM where an upstream area is identified as riparian users, water allocation under the prior appropriation doctrine implies water quantity availability where the relationship between upstream and downstream areas can follow that proposed by Zilberman and Lipper (1999). Figure 2.19 shows a water demand curve illustrating the relationship between upstream and downstream water users.

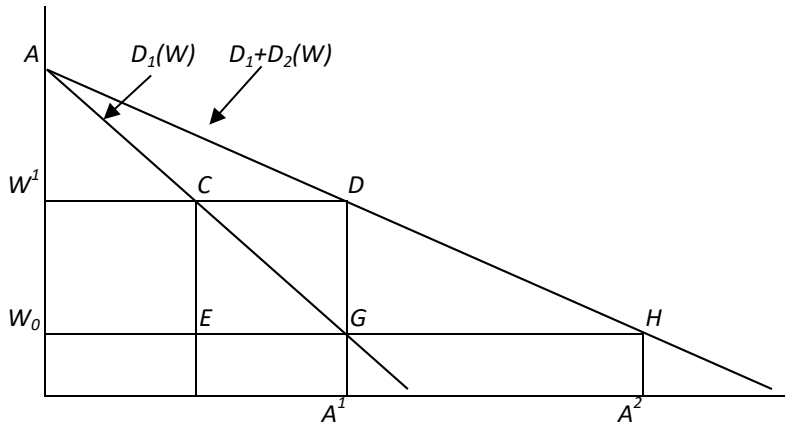

Figure 2.19 A demand curve for upstream and downstream water users (Zilberman & Lipper, 1999).

Identifying i as water users, with $i = 1$ for the most upstream user (X_1), and increasing for more downstream users (X_2). D_i is a user with i demand of water and assumes that the per unit value of water is W_0. In the case of demand for upstream users $D_1(W)$, the aggregate demand of both users is $D_1+D_2(W)$. Assuming that A^1 is a low state water supply and is constructed to equal demand by upstream users at $W = W_0$ then $D_1(W) = A^1$. X_i^j water is used by users i under state of nature j. When the state of water supply is low, upstream users will be able to use all available water $X_1^1 = A^1$, and downstream users will not be able to use water $X_2^2 = 0$. Therefore, when water is in a state of high availability, the demand for both upstream and downstream users can be satisfied, given the same version of value of W_0, which is $X_1^1 = X_2^2 = A^1 = A^2/2$. The surplus condition occurs when the state of low water supply is the area of AW_0G and when the state of high water supply is the area AW_0H.

Suppose compensation between the upstream and downstream area is applied, then the value of water at the state of low water supply will be W^1 and upstream and downstream users will be supplied $A_1/2$ unit of water, then the economic surplus in this state is shown in the area of AW_0GD. The transition market will not affect the outcome of the state of high water supply that will be W_0. Therefore, the gains of transition from a prior appropriation system in creating water compensation are especially evident at a state of low water supply. Moreover, an improvement on water distribution mechanism on IWRM can be done by creating decision alternatives based on the upstream community (riparian) and downstream community water users, ranks of priority and proportional alternatives. In connection with economic values, the alternatives can set a price of water that can be paid by the downstream community based on their demands. The value can be used for LULC improvements in the upstream area. Using economic valuation instruments, which are economic approaches to valuing environmental changes based on individual preferences for changes in the environmental services (Pearce & Seccombe-Hett, 2000), changing water allocations and cost for water production can be calculated through the unit price of its production.

c. Water quality approach

A demand curve describes a relationship between commodities and price compared and contrasted with budget availability and a rank of satisfaction. A demand curve can be applied to water when water as commodity and price are included in the demand. The demand of water in quantity, in terms of quality approaches, may increase when the quality changes to be worse to anticipate amount of quantity in maintaining the satisfaction. As a consequence, increasing demand may have an effect on budget availability. This can be reasoned through a water quality approach that users are willing to compensate for the losses of environmental services to reach at least the same quality in the future in maintaining a rank of satisfactorion (Unsworth & Bishop, 1994). As water quality includes environmental externalities (Howe *et al.*, 1986), the compensation is replacement costs that are estimated based on restoration and rehabilitation of the environmental services (Munasinghe, 1993b; Hussen, 2004), which are coupled with the operational and maintenance (O&M) costs (Rogers *et al.*, 1998).

An application of decision alternative through water quality approaches can be done by identifying the water quality changes during the years of data observed. If the condition of water quality becomes worse during these years, the externalities can be calculated through increasing O&M costs for downstream water users, such as increasing costs for chemical uses on water treatment. The decision therefore can set alternatives on replacement costs to maintain upstream areas and LULC management.

CHAPTER 3
DATASETS AND RESEARCH METHODS

3.1. Introduction

This chapter describes datasets and methodologies that have been applied in this research. The datasets relate to water resource conditions, in which surface water, groundwater and water quality conditions are included; spatial condition, which relates to Indonesia National Policy on spatial planning and its regulation, and actual LULC conditions of Krueng Aceh catchment. The research methods discuss analyses of LULC change on the hydrological regime, determination of economic valuation due to hydrological change, and the methods that are used in the analysis of decision making for the Krueng Aceh catchment utilising the concepts of IWRM and economic compensation.

3.2. Descriptions of the Study Area

The study area is the Krueng Aceh catchment, in the Province of Aceh, western Sumatra, Indonesia. The Krueng Aceh catchment is divided into two administrative areas. The upstream area is in Aceh Besar Regency (Indonesian: *Kabupaten Aceh Besar*) and the downstream area is in Banda Aceh City (Indonesian: *Kota Banda Aceh*). Banda Aceh, the capital city of the Aceh province, lies on the north coast of Sumatra. These districts are located in the northwestern part of the province.

The geographical position of the Aceh province is $02^{0}00'00"$ N – $06^{0}00'00"$ N and $95^{0}00'00"$ E – $98^{0}30'00"$ E. The area of the Aceh province is 56,758.85 km^2 and includes a part of the main land of the Sumatra Island and the archipelago in the south, west and north of the province (BAPPEDA Aceh, 2010; Decree No. 37 Year 2008, 2008). Sumatra is one of the sixth largest islands in the world that is currently divided into eight provinces in the main land and two provinces in the Sumatran archipelago. The Aceh province itself has 663 islands, of which 458 are unnamed (BAPPEDA Aceh, 2010). Aceh province is

surrounded by the Malacca Strait in the north-east between Sumatra and Malaysia, the Andaman Ocean in the northwest and the Indian Ocean in the south-west.

Based on the Indonesian Law *(Undang-Undang)* No: 32 Year 2004 on regional governance (article 18, item 4), the authority area of the province is twelve nautical miles from the territorial sea baseline. Therefore, the Aceh province has a marine authority area that is located between the Indian Ocean, the Andaman Sea and the southern Malacca strait. The Indonesia Government Regulation (*Peraturan Pemerintah*) No: 37 Year 2008 on the List of Geographical Coordinates as the Baseline the Indonesian Archipelago (*Daftar Koordinat Geografis Titik-Titik Garis Pangkal Kepulauan Indonesia)* states that the wide of the Aceh province authority area is 74,798.02 km^2 when it includes the marine area (BAPPEDA Aceh, 2010). Aceh is a special autonomous province in the Republic of Indonesia that has 23 districts, more precisely 18 regencies and five municipalities. Aceh has a special decentralization system that is applied in a different way than other provinces in Indonesia.

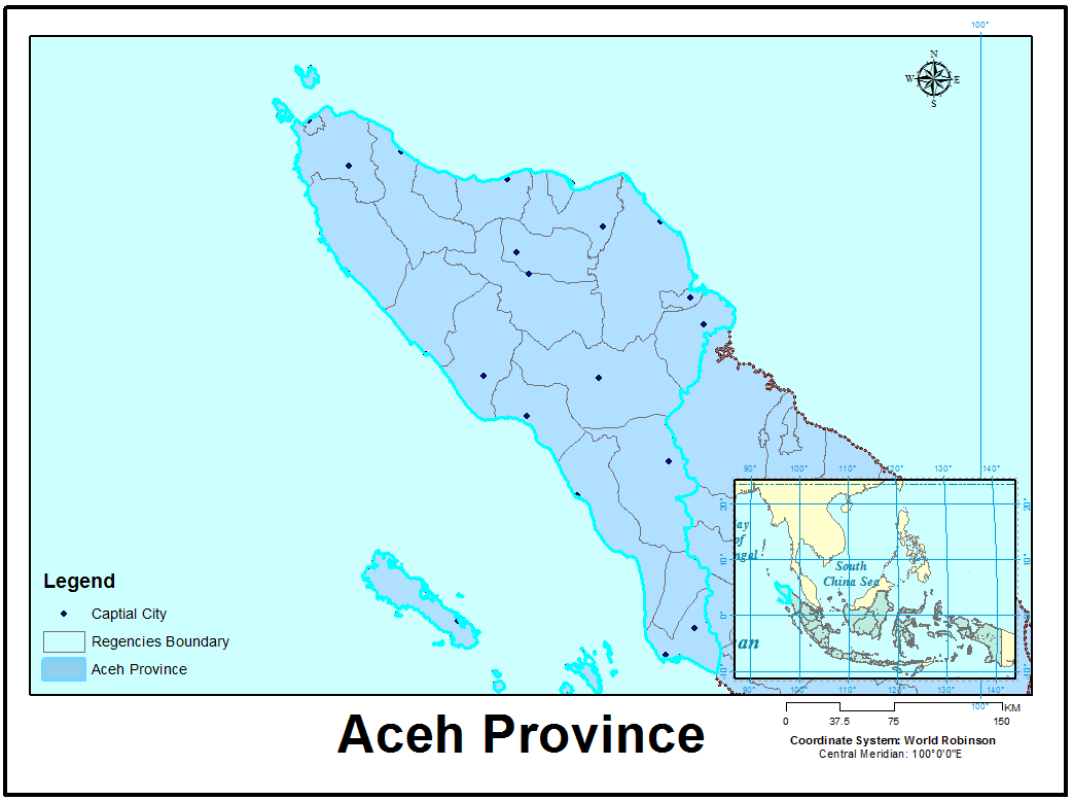

Figure 3.1 Administrative area of Aceh Province (BAPPEDA Aceh, 2010)

3.2.1. Location of the Study Area

The Krueng Aceh catchment is divided into two administrative areas, in the upstream area is the Aceh Besar Regency *[Kabupaten Aceh Besar]* with a small area in the Pidie Regency and in the downstream area is Banda Aceh City (Indonesian: *Kota Banda Aceh*). Banda Aceh City has nine sub-districts (BPS Banda Aceh, 2011), and all of the sub-districts are included in the Krueng Aceh catchment. The Aceh Besar Regency has 23 sub-districts, however, just 17 of the sub-districts are included in the Krueng Aceh catchment.

The Krueng Aceh catchment is geographically located between 05º00' N - 05º40' N and 95º15' E - 95º45' E. The catchment covers an area of 1,739.5 km^2 along the main river of the Krueng Aceh River *[*Acehnese: *Krueng,* abbreviated by *Kr.;* Indonesian: *Sungai,* abbreviated by *S.]*. Figure 3.2 shows the location of the Krueng Aceh catchment.

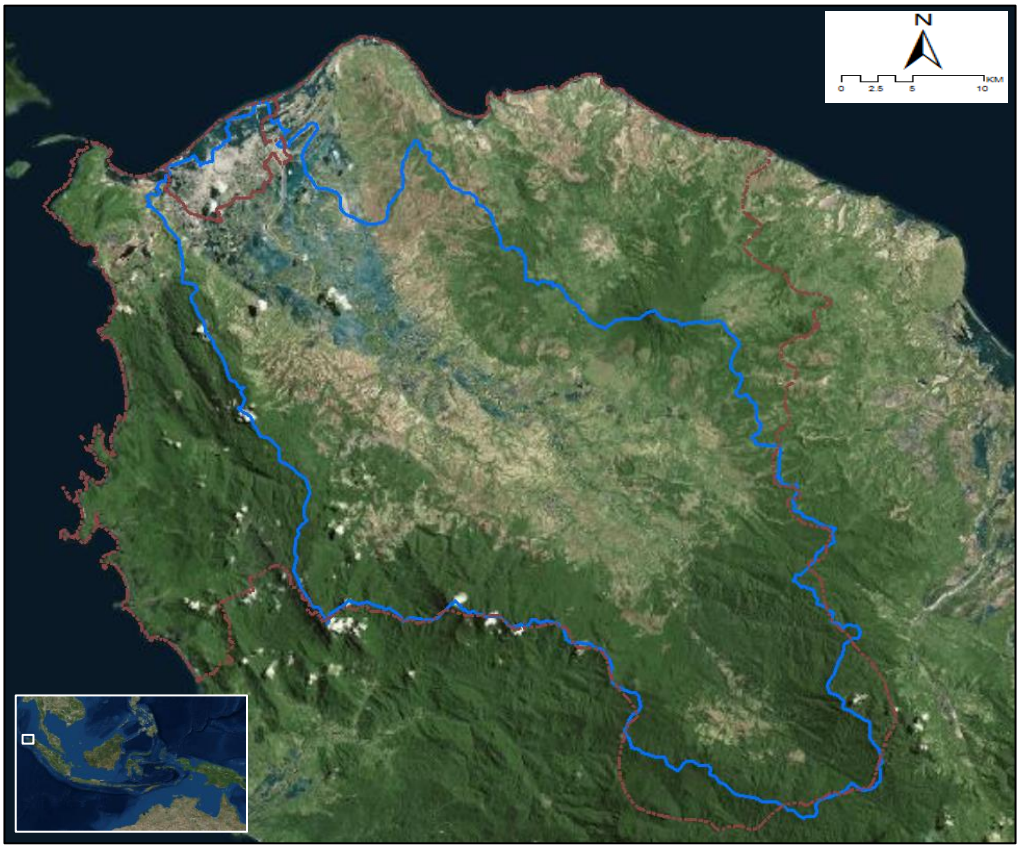

Figure 3.2 Map of the Krueng Aceh catchment *(blue line)* where the downstream area is located in Banda Aceh City *(upper left brown boundary)* and the upstream area is located in Aceh Besar Regency.

The rivers in Indonesia are divided into the groups of rivers *[Satuan Wilayah Sungai* or *SWS]*. The principle of group classification is based on rivers' location in the provincial levels, which aims to distribute river management to the provincial levels. The group classification is based on the Ministry of Public Work Decree No. 48/PRT/1990 on Water and Water Resource Management in Rivers' Areas *[Pengelolaan Atas Air dan/atau Sumber Air pada Wilayah Sungai]*. The groups of the river in the Aceh province are divided into seven groups, one of them is the SWS Krueng Aceh (river's code: 01.01) where one of 26 catchments *[Daerah Aliran Sungai*, abbreviated by *DAS]* is the Krueng Aceh catchment.

The Krueng Aceh catchment boundary and its subbasins were defined from the Shuttle Radar Topography Mission (STRM) data using the hydrological tools in ArcGIS v.10.2 software as shown in Figure 3.3. subbasins were defined based on four gauging stations on the Krueng Aceh main river, located at Boga, Lampisang, Darang, and Pasie. Based on the hydrological analysis of the STRM data, the Krueng Aceh catchment area is defined as 1,740 km^2 (see Figure 3.4).

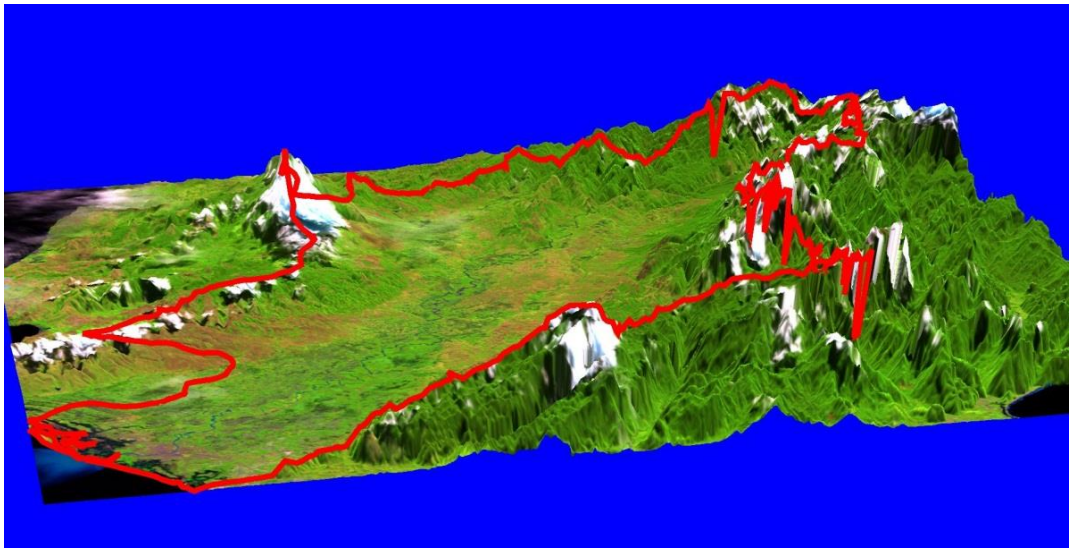

Figure 3.3 Boundary of the Krueng Aceh catchment interpreted using STRM data

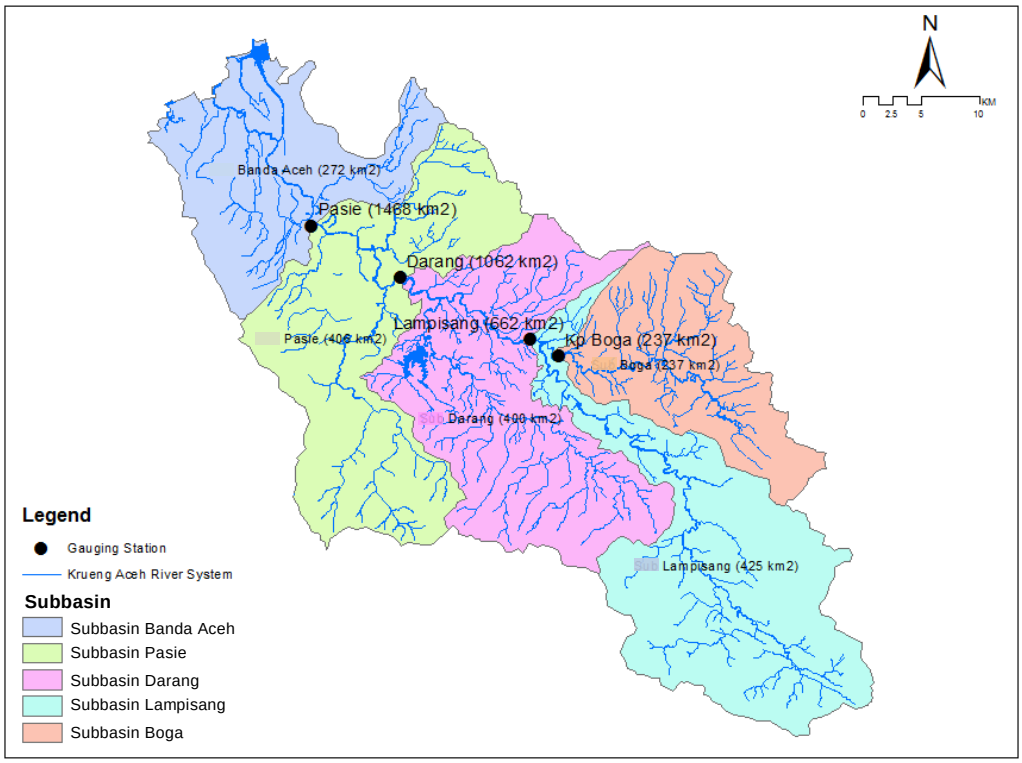

Figure 3.4 Subbasin within the Krueng Aceh catchment and their areas based on discharge stations (GIS Analysts, 2013)

Figure 3.4 shows four selected gauging stations located in the Krueng Aceh catchment that are located in the main river of the Krueng Aceh, as this analysis determines regime flow condition in the whole of the Krueng Aceh catchment. They are Boga station (237 km^2), Lampisang station (662 km^2), Darang station (1,062 km^2) and Pasie station (1,468 km^2). Moreover, those stations have longer data series compared with other stations on the tributaries of the Krueng Aceh main river.

3.2.2. Physical characteristics

Physical characteristics of the Krueng Aceh catchment can be divided into climate condition, physiographic (topographic) condition and geological condition. Generally, the study area is mainly in the northwestern part of the Barisan Mountain Range (Indonesian: Bukit Barisan). Gunung Batemeucica (Indonesian: *gunung* = mountain) constitutes the highest peak with an altitude of 2,125 m in the eastern part of the study area along the boundary of the Krueng Aceh catchment. In the southern and eastern part of the study area, the Barisan

Mountain Range acts as the main water divide. The Seulawah Volcano, which has an attitude of 1,726 m, forms the boundary of the catchment in the northern area (Jantop TNI, 1978c). Surface streams drain to the east into the Krueng Aceh main river that meanders in a northwestern direction through a wide coastal plain and discharges into the Andaman Sea.

a. Climate

As the Aceh Province lies close to the equator, the climate condition is tropical and has high humidity (75% - 90%) througout the year. The Barisan Mountain Range controls the predominant monsoons that result in sharp regional variations in rainfall (Bödecer, 2008). Meilianda (2009) states that dry and wet seasons over Aceh are mostly caused by wind direction. The dry season happens when the wind comes from the south and wet season normally occurs when wind flows from the north. Peak wet season in the Aceh Province normally happens from October to December, and peak dry season mostly happens from June to September. Table 3.1 below shows the average meteorological conditions at the Blangbintang stations (05°31'00" N/95°51'00" E, altitude: +21 m) between 2001 and 2010. The records may represent the general condition of the climate in the Krueng Aceh catchment, especially in the downstream area.

Table 3.1 Average meteorological conditions within the Krueng Aceh catchment based on the Blangbintang station in 2001-2010 (BMKG, 2010)

Items	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Average
Precipitation	mm	80.78	33.88	63.98	65.89	47.39	39.82	14.44	28.13	37.25	73.05	106.98	113.64	58.77
Humidity	%	80.22	79.33	80.53	80.31	78.75	73.09	72.09	71.81	76.47	79.83	82.22	82.54	78.10
Temperature	°C	25.85	25.89	26.19	26.66	26.86	27.12	26.75	26.92	26.46	26.11	25.81	25.52	26.35
Wind gusts	km/h	10.03	9.43	9.18	8.20	8.09	8.65	9.02	8.91	7.76	7.84	8.41	9.51	8.75
Sun shines	%	47.99	53.47	49.50	54.72	53.48	55.00	50.39	46.51	39.78	38.84	43.13	43.81	48.05

b. Physiographic condition

Based on interpretation of the Topographic Map of Indonesia scale 1:50,000 (Jantop TNI, 1978a; b; c), the topographic conditions of the Krueng Aceh catchment vary from lowland area to undulating hills that can be classified as lowland, plain, undulating hill, highland and mountain. The topographic condition is situated at zero to +2,125 m above sea level (*asl*). Terrain with

slopes of 0-5% dominates the central area extending to the downstream area, while hills and mountains flank and dominate the upstream area. The south of the catchment is dominated by the mountain ranges with an altitude of +125 m to +2,125 m *asl*. The slope of the mountain range area varies from 30% to 65%. The north of the catchment is dominated by undulating hills which range from +25 m to +1,276 m *asl*, and the slope of this area is 10%-15%. The study area's topographic condition is shown in Figure 3.5.

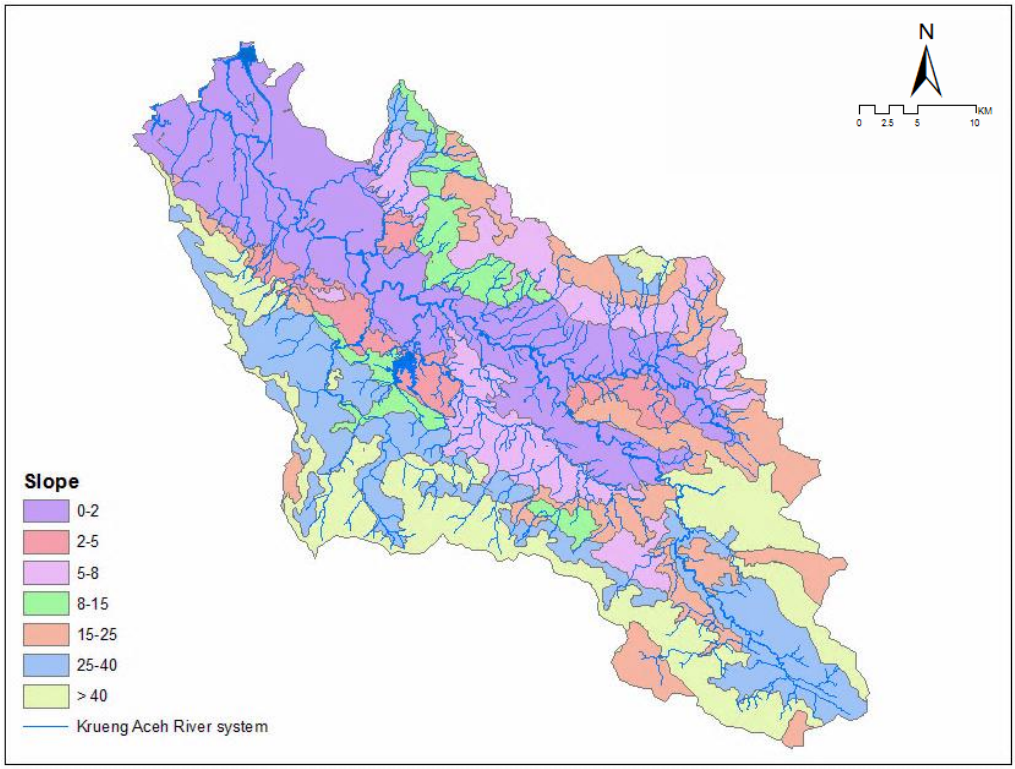

Figure 3.5 Land slopes (in %) in the Krueng Aceh catchment area (ESDM, 2005b; Jantop TNI, 1978a)

The drainage systems of the Krueng Aceh catchment mainly flow in a northwest-southeast direction and are controlled by geological structure and lithology. The drainage patterns are;

1). Radial patterns are present in the massive geological structures and volcano area (on the slopes of the Seulawah Volcano) in the north of the catchment,
2). Trellis patterns in areas that are controlled by folds and faults, such as in the south of the catchment,
3). Dendritic patterns occur in areas where horizontal layers are dominant, such as in the west of the catchment,

4). Meandering patterns occur in areas with a horizontal layer structure and especially in soft sedimentary rock in the lowland areas, such as from the centre of the catchment to the estuary area.

In the downstream area, the Krueng Aceh River was disembogued into the main rivers of Krueng Aceh River and the Krueng Aceh floodway channel, which was built in late of 1980's for flood control and mitigation. The Krueng Aceh main river has 1,300 m^3/s maximum capacity and the Krueng Aceh Floodway channel has 900 m^3/s maximum capacity (Meilianda, 2009).

c. Geological condition

The lithology in the Krueng Aceh catchment may be grouped into igneous rocks, metamorphic rocks, sedimentary rocks, old mountain rock groups, limestone, new mountain rock groups and alluvial (ESDM, 2005a). Figure 3.6 shows the lithology in the Krueng Aceh catchment in connection to water resources and soil fertility; they may be explained as follows:

1. Igneous and metamorphic rock groups consisting of granites, diorites, gabbro, schist, and slates are located in the Barisan Mountain Ranges. The rocks are mostly compact, impermeable and not suitable for aquifers. The weathered rocks have generally poor-medium fertility due to the high silica content.
2. Old mountain and sedimentary rock groups composed of breccia, conglomerate, and lava that are located generally in the slopes of 5%-10%. The rocks are not suitable for agriculture due to lack of porosity.
3. Limestone groups that are located in the south of the study area are compact and contain cavities and are intensively controlled by geological structures. The rock porosity depends on the intensity of the fractures. The soil from this group is generally of high fertility for agriculture.
4. Young volcanic rock groups consist of tuff, agglomerate, volcanic breccia, and lava from recent Seulawah volcano activities. In general, the rocks are compact, but the conditions are moderate to high porosity weathered, clay textured, silt to sand grain sizes and high fertility.

5. Alluvium deposit groups consist of clay to boulder size materials along the flood plain of the Krueng Aceh River and in the lowland of the Krueng Aceh catchment. The deposits are brittle, very porous and very good for agriculture.

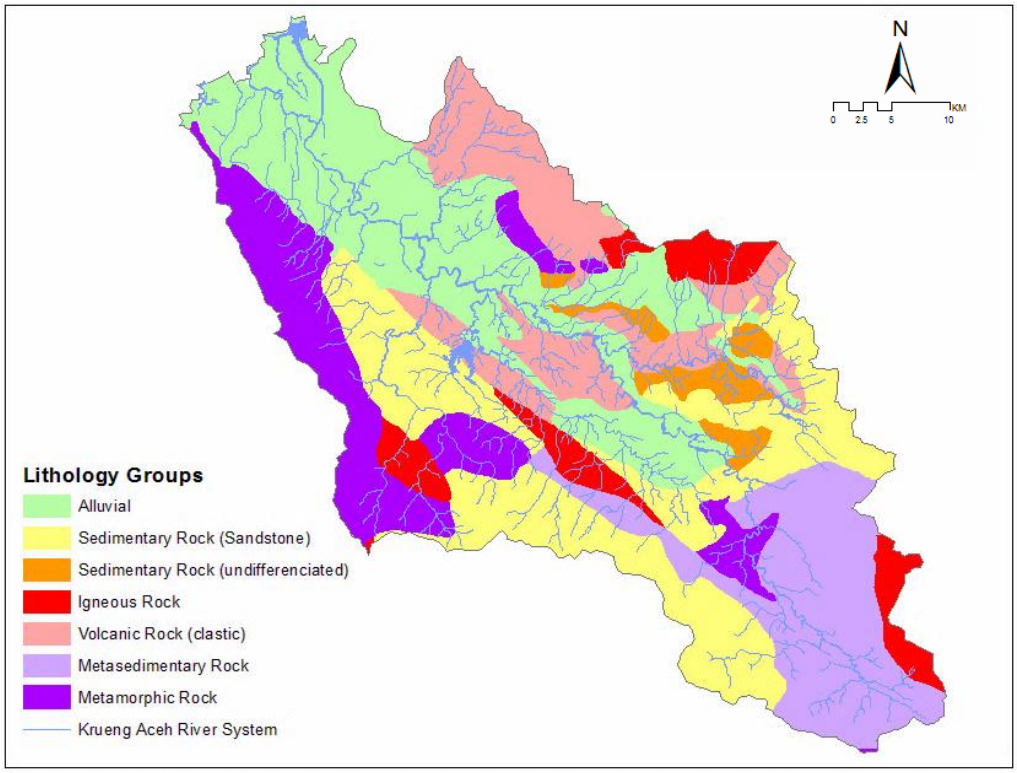

Figure 3.6 Geological map of Banda Aceh in the Krueng Aceh catchment area (ESDM, 2005a; Bennett *et al.*, 1981)

Tectonically, the Sumatran Mega Fault or the Semangko Fault (Sumatran Fault System), which runs from Lampung to Weh Island, controls the topographic condition in the study area (Figure 3.7). Bennet *et al.* (1981) state that the Sumatran Mega Fault system moves an average of eleven cm/year that involves the plates of Australia, Sunda and Eurasia, and the Sumatra Island itself is a part of Sunda continental plate. The plate acts as a *benioff zone* that creates the Sunda trench in the South-West of Sumatra (Bennet, et al., 1981; Curry, et al., 1979, cited in Bödecer, 2008). Moreover, they add that the tectonic system in Sumatra Island has been producing convergent interaction between the India-Australia plate and the Asia plate. The movement has given various subduction forms and dextral faults in the area that influence the topographic condition of the study area.

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Figure 3.7 General structure of the Sumatran Fault System. The red arrows show the direction of movement of the Indian Ocean Plate with the average movement per year (Natawijaya, 2000 & Crow et al., 2005, cited in Bödecer, 2008).

Bennet *et al.* (1981) state that stratigraphic conditions in the study area consist of the formations: Raba Limestone Formation (Mhurl), Coral Member (Murlr), Lhoknga Formation (Mul), Meucampli Formation (Tlm), Seulimuem Formation (QTps), Indrapuri Formation (Qpin), Lamteuba Formation (QTvt), Volcanic flow (Qvtl) and Alluvium Formation.

The relationship between the rock formations and geological age is shown in Figure 3.8 representing the regional stratigraphy of the study area.

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Figure 3.8 Regional stratigraphy of the study area (adopted from Bennett *et al.*, 1981)

d. Soil Types

Soil types in the Krueng Aceh catchment are grouped into *Alluvial, Andosol, Litosol, Mediteran, Padoslik* and *Regosol* based on the Centre of Soil Assessment Bogor (PPT Bogor) classification.

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Figure 3.9 Soil types map based on BPPT Bogor classification (PUSLITNAK Aceh, cited in ESDM, 2005a)

Figure 3.9 shows the soil types in the Krueng Aceh catchment. In connection with water resources and rates of erosion and infiltration, they may be explained as follows:

1. *Alluvial* is mostly located along the main river and low land area, containing organic components and sand material of about 60%, the composition may be variable depending on its location.
2. *Andosol* sourced from denudation of volcanic activities, some locations may contain volcanic deposits of more than 60%.
3. *Latosol* contains clay materials of more than 60% sourced from denudation of basaltic material and is relatively homogeneous.
4. *Mediteran* sourced from deposition of argillic clay material and basaltic materials, mostly sourced from denudation of meta-sedimentary rocks.
5. *Podsolik* is similar to *Mediteran*, however, this type is of less basaltic material than *Mediteran*.
6. *Regosol* is a soil that has a similar description to *Alluvial*, but with coarse texture compared to *Alluvial*.

3.2.3. Population

Population over the Krueng Aceh catchment province is mainly concentrated along the coastal plain area, alongside the rivers and main roads. The population whose water consumption relies on water resources allocation from the Krueng Aceh catchment are the population who live in the Banda Aceh City and Aceh Besar Regency. Based on calculations before the tsunami, the Bureau of Statistics of Banda Aceh City reports that the population of the Banda Aceh City was 230,828 at the end of 2003. It declined to 177,881 in 2005 because of mortality caused by the Tsunami (about 30.000) on 24 December 2004 and temporary evacuation to other cities (about 45.000) due to loss of their lands and homes (BRR NAS-Nias, 2005).

The population density of Banda Aceh city was 916 people/km^2 in 2005 (first calculation after the tsunami), and the population jumped to 3,642 people/km^2 in 2010 or increased almost fourfold over five years as shown in Table 3.2 (BPS Banda Aceh, 2005; 2011). The population of the Aceh Besar

Regency was 358.941 with the rate of population growth of 2.53% in 2010, however 284,776 people live within the Krueng Aceh catchment area (BPS Aceh Besar, 2011a).

Population and sub-regencies of the Aceh Besar Regency that are located within the Krueng Aceh catchment are shown Table 3.2, and population in sub-regencies of the Aceh Besar Regency within the Krueng Aceh catchment is given in Table 3.3.

Table 3.2 Population of Banda Aceh City 2001–2010 (BPS Banda Aceh 2005; 2011)

No.	Subdistricts	Area (km^2)	Population										Density 2010 (p/km^2)
			2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
1	Meuraxa	7.26	28,874	28,405	30,296	34,592	2,221	2,320	12,677	12,494	12,189	16,484	2,270.52
2	Jaya Baru	3.78	19,766	20,786	20,840	21,305	12,340	12,395	20,138	20,658	20,127	22,031	5,828.31
3	Banda Raya	4.79	17,504	16,985	18,503	23,995	24,257	24,272	21,376	20,907	20,352	20,891	4,361.38
4	Baiturrahman	4.54	30,986	33,442	32,752	37,715	33,582	33,657	35,980	36,124	35,135	30,377	6,690.97
5	Lueng Bata	5.34	15,801	13,447	16,699	19,232	19,284	19,339	22,562	22,025	21,437	23,592	4,417.98
6	Kuta Alam	10.05	44,957	53,386	47,516	54,718	35,033	35,088	43,940	43,792	42,664	42,217	4,200.70
7	Kuta Raja	5.21	17,773	18,283	18,790	21,632	2,978	3,013	8,068	8,076	7,890	10,433	2,002.50
8	Syiah Kuala	14.24	26,762	26,506	28,284	32,590	25,418	25,473	34,012	33,433	32,564	34,850	2,447.33
9	Ulee Kareng	6.15	15,873	13,753	16,781	19,319	22,768	22,823	20,906	20,409	19,865	22,571	3,670.08
Total		**61.36**	**218,296**	**224,993**	**230,461**	**265,098**	**177,881**	**178,380**	**219,659**	**217,918**	**212,223**	**223,446**	3,641.56

Table 3.3 Population growth rate in sub-regencies in the Aceh Besar Regency within the Krueng Aceh catchment, 2000 – 2010 (BPS Aceh Besar 2005; 2011a; BRR NAS-Nias 2005)

No.	Subdistricts	Area (km^2)	Population										Density 2010 (p/km^2)
			2001*	2002	2003	2004	2005	2006	2007	2008	2009	2010	
1	Indrapuri	285.25	13,500	14,445	15,294	16,742	17,463	18,214	18,595	19,067	19,231	19,975	70.03
2	Kuta Cot Glie	230.25	8,900	9,048	9,202	10,342	9,816	10,914	10,333	10,624	12,047	12,388	53.80
3	Seulimum	478.26	13,000	14,710	16,186	18,534	19,462	20,389	20,598	20,856	21,163	21,519	44.99
4	Kota Jantho	274.04	4,200	4,523	4,845	5,836	5,958	5,906	6,838	7,326	8,066	8,443	30.81
5	Lembah Seulawah	322.85	3,600	4,080	4,564	5,425	6,386	7,678	8,408	9,166	10,170	10,753	33.31
6	Darussalam	76.42	13,000	13,793	14,602	16,347	17,325	18,265	19,417	20,555	22,266	22,633	296.17
7	Baitussalam	37.76	13,700	14,128	14,489	14,860	6,194	9,659	12,710	14,883	16,176	16,590	439.35
8	Kuta Baro	83.81	19,400	20,104	20,662	21,454	22,223	22,585	22,718	22,804	23,018	23,541	280.89
9	Montasik	94.10	18,400	18,533	18,973	19,373	19,859	20,448	16,703	17,039	17,382	17,732	188.44
10	Blang Bintang	70.51							9,919	10,180	10,448	10,723	152.08
11	Ingin Jaya	73.68	17,700	20,246	21,847	23,730	23,827	24,295	25,143	26,053	27,027	28,064	380.89
12	Krueng Barona Jaya	9.06	6,400	6,570	6,653	8,871	10,632	12,174	12,632	13,105	13,593	14,096	1,555.85
13	Sukamakmur	106.00	8,900	9,054	9,168	12,225	12,010	12,746	12,874	13,949	13,569	13,905	131.18
14	Kuta Malaka	36.00	3,300	3,425	3,469	4,625	4,544	5,146	5,198	5,632	5,827	5,891	163.64
15	Simpang Tiga	55.00	3,500	3,576	3,621	4,828	4,743	5,105	5,156	5,587	5,241	5,360	97.45
16	Darul Imarah	32.95	24,000	24,340	24,648	32,865	32,287	35,614	35,972	38,974	45,723	46,397	1,408.10
17	Darul Kamal	16.90	4,300	4,381	4,436	5,915	5,811	6,128	6,190	6,706	6,586	6,766	400.36
Total		2,282.84	175,800	186,956	192,659	221,972	218,540	235,266	249,403	262,506	277,533	284,776	124.75

Population is related to economic condition and human resources development. Although this research does not intensively discuss these issues, it may be important to illustrate that the upstream area is less developed economically compared with the downstream area. In terms of income per capita, the Bureau of Statistics of Aceh Besar Regency (2011a) reports that Regional per Capita Income in 2010 is IDR 15,350,000 (equivalent with USD 1,587.38; USD 1 = IDR 9,670.00 based on mid-rate the Central Bank of Indonesia on 28 December 2012). However, the Bureau of Statistics of Banda Aceh City (BPS Banda Aceh, 2011) reports that Regional per Capita Income of Banda Aceh City is IDR 33,815,210 in 2010 based on market prices 2008-2010 (equivalent USD 3,496.92). The figures increased by 14.54% from 2009 (IDR 29,523,710 = USD 3,053.12) and 33.57% from 2008 (IDR 25,316,530 = USD 2,618.05). As an illustration and for comparison, Jakarta's Regional per Capita Income is IDR 40,269,000 or equal to USD 4,164.32 in 2010 (BPS DKI Jaya, 2011).

In addition to per capita income, the Bureau of Planning of the Aceh Besar Regency (BAPPEDA Aceh Besar, 2011b) reports that the percentage of the poverty headcount ratio in Aceh Besar Regency is 18.80% in 2010, which may have a correlation with the fact that 63% of family's activities are in agricultural lands (BRR NAS-Nias, 2005). The poverty headcount ratio in Aceh Besar Regency is higher than the National Poverty Headcount Ratio (12.5%) and almost similar to the Aceh Province poverty headcount ratio of 19.6% (BPS Aceh Besar, 2011b; BPS Indonesia, 2012b).

In human resources development, the BAPPEDA Aceh (2006) uses a Human Development Index (HDI) where the indexes on life expectancy, literacy, education, and income are combined. The overall HDI 2005 is 63.42% for Banda Aceh City, while the overall HDI 2005 in selected sub-regencies of the Aceh Besar Regency located in the Krueng Aceh catchment is 48.42%. As a comparison, the overall Indonesian National Index is 72.80% for the same year (BPS Indonesia, 2012a).

3.3. Datasets

Indonesian policy for water resources management, which began in 1984, was more focused on hydraulic infrastructure and development of new irrigation

systems (SDC, 2009a). The policy had proved to be non-sustainable due to lack of stakeholders' participation, especially their involvement in allocation of funds for operations and maintenance and relied heavily on government subsidies. The SDC (2009a) classifies Indonesia's policy for water resources reformation into four eras.

1. Water sector reforms (1990s)

   During this period, significant reform happened and the national reforms on water resources management were drafted, which formulated a policy on water sector reforms as part of the World Bank Programme (WATSAP). The programme was based on principles of transparency governance, accountability, public-sector partnership, and community participation.

2. Decentralization (2001)

   The implementation of the regional autonomy policy to the districts and provinces brought responsibility for managing water resources closer to users, however, this policy had created partial catchment management in the context of integrated approaches.

3. National Water Resources Law (2004)

   In 2004, districts and provinces can allocate revenue in relation to water resources by the implementation of Law No. 7 Year 2004 on Water Resources. Two specific issues were intensely debated upon introduction of the law; the issues related to water privatization, which put water closer to economic goods, and another is farmers' capacity to manage irrigation by themselves with minimum subsidies from the government. The debates are around the interpretations of Law No. 7 Year 2004 based on the Indonesian constitution (UUD 1945) that state that water resources management has to be managed by government and cannot be mandated to other parties. Moreover, farmers cannot be charged for water resources incentives as long as the resources are used for basic demands.

4. Water Resources and Catchment Management (2008)

   Water resources management as a part of catchment management was published in Government Regulation No. 41 Year 2007 on the Regional Organization and Presidential Decree No. 12 Year 2008 on Water Council Committees. The decrees set the legal base for establishing Water Resources Councils at national and provincial levels. The councils are under the

coordination of Ministry and Department at a national level and involve discussions and mediations of stakeholders for integrated catchment management manners.

Most recently, Indonesia published new guidelines in water resources management in the Government Regulation No. 33 Year 2011 on the National Policy for Water Resources Management as a further implementation of the Law No. 7 Year 2004. The decree states that water resources management has to consider improving the sustainability of water resources conservation, increasing justice in water distribution, protection from water hazards, improving community participation and developing national networking for water resources management (Article 1, point 3).

3.3.1. Water Resources Conditions

a. Surface water

The Office of Water Resources *[Dinas Sumberdaya Air]* of Aceh took responsibility for managing water resources in the Aceh province after decentralization began in 2001. The data on water resources, therefore may be sourced from this institution, however the availability of data is very limited, and some missing due to the civil war, the tsunami in 2004, floods and careless data storage by the owner. Unlike rainfall data, discharge data records are even worse and very limited. High reliability data is available between 1983-1987 in the inventory hydrological data report for the Aceh province (Bini, et al., 1989, cited in SDC, 2009c) and for 1972-1999 in the study of water supply within the Krueng Aceh catchment (Kasuri, 2006). All these data were collected by the former Regional Office of Irrigation *[Kanwil Pengairan]* that was the central government institution from the Ministry of Public Works. In this research, some discharge data covering 2000-2010 were received from the Office of Water Resources *[Dinas Sumberdaya Air or DSDA]* of Aceh. During 2008 to 2010, the Office of the Water Resources upgraded gauging stations instruments, and some of them were moved to other locations, such as Jrue gauging station in the Jrue River was removed due to mining activities and no longer operated. There are eight operational water gauging stations operating in the catchment and staff

gauge water levels at selected important locations (see Table 3.6). Detailed locations can be found in Figure 3.10 and Table 3.4.

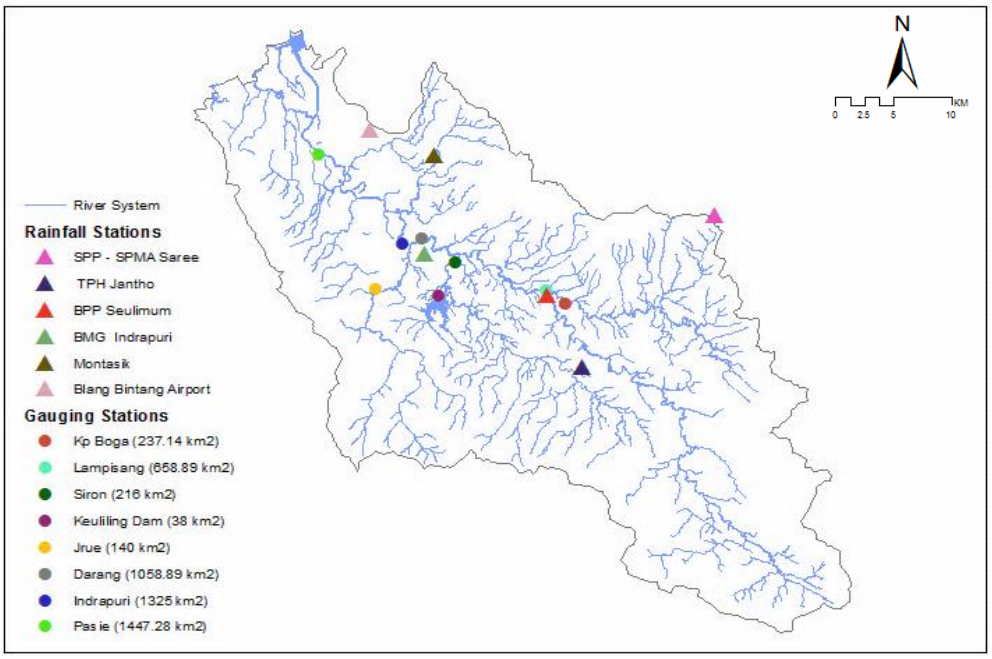

Figure 3.10 Rainfall stations and gauging stations within the Krueng Aceh catchment (SDA, 2011; BMKG, 2011; SDC, 2009c; Kasuri, 2006)

Table 3.4 Discharge records for the gauging stations within the Krueng Aceh catchment (Update November, 2011, modified from Kasuri, 2006; SDC, 2009e)

No.	*River and Location*	*Area (Km^2)*	*Years of Data Availability*)*	*Note*
AWLR Stations				
1.	Kr. Aceh at Pasie	1.566	1975-1977, 1981-1989, 2008-2010	
2.	Kr. Aceh at Indrapuri	1.325	n/a	Not operate
3.	Kr. Aceh at Darang	1.092	1975-1998, 2003-2006	
4.	Kr.Jrue at Jrue	140	1975, 1981-1987, 1989-1998, 2003-2006, 2010	Move location (2009)
5.	Kr. Keumireu at Siron	38	1972-1988, 1990-1999, 2003-2006, 2010	Move to Keuliling Dam
6.	Kr. Keumireu at Keuliling Dam	38	1998-2011	Operate (new)
7.	Kr. Aceh Lampisang	659	1981-1988, 1990-1997	
8.	Kr. Agam at Kp. Boga	237	1977-1990, 1992-1997, 2003-2006, 2010	
WLR Stations				
1.	Kr. Aceh weir at Seulimum	656	n/a	Not traceable
2.	Kr. Inong at Seulimum	412	n/a	Not traceable
3.	Kr. Jrue at weir	162	n/a	Not traceable

**) with same blank on monthly recapitulation*

This research uses four selected gauging stations, which are Kampong Boga, Lampisang, Kampong Darang and Kampong Pasie, to divide the Krueng Aceh catchment into subbasins as references for further analysis of water availability. The data that had been collected during field work covers 1981 to 2010, with some data available in daily data sets and others only available monthly, with some of them blank.

Surface water is closely related to precipitation. The precipitation data were collected from the Bureau of Meteorology, Climatology, and Geophysics *[Badan Meteorologi Klimatologi dan Geofisika/BMKG]*, the Office of Water Resources *[Dinas Sumberdaya Air Aceh/DSDA]* of Aceh, the Sultan Iskandar Muda Airport and the School of Agriculture of Saree. The precipitation data series are more complete and longer than the discharge data, however, there are some missing years in these data sets and the quality is difficult to check. The SDC (2009b) has received the precipitation data from Royal Netherlands' Meteorological Institute for 24 stations in Aceh including the Koetaradja station (05º35'00'' N/95 º19'00" E), which was the first rainfall station in the Krueng Aceh catchment. The station operated for the 80 years from 1879 to 1941 by Dutch Colonial offices and continued by the Indonesian Government between 1953-1972 and 1974-1978. There were 55 rainfall measuring stations and meteorological stations in the Krueng Aceh catchment. Currently, only 33 of them are available and are operated by BMKG (11 stations), by the Office of Agriculture *[Dinas Pertanian]* of Aceh (12 stations), by the Office of Water Resources *[Dinas Sumberdaya Air]* of Aceh (nine stations) and by the School of Agriculture of Saree (one station). However, just six of them are active in meteorological observations in term of continuity of data observation, they are the Blangbintang station at the Blangbintang, BMG Indrapuri, BPP Seulimum, TPH Jantho, and BMKG Montasik (see Figure 3.10).

For observation of precipitation depth in an area, climatology stations should be distributed properly to characterize the whole of the observation area. The Sea Defence Consultants (SDC, 2009b) state that three climatology stations represent climatological observation in the area, which are located in the upstream area (Jantho station), middle area (Indrapuri station) and the downstream area (Blangbintang station at the Sultan Iskandar Muda airport) as

those stations have a distance range of 10-12 km. Therefore, this research uses those rainfall stations as representative conditions of the Krueng Aceh catchment. Based on interpretation by the Sea Defence Consultants (SDC, 2009b), rainfall patterns in the study area are shown in Figure 3.11.

Figure 3.11 Rainfall (mm/year) pattern in the Krueng Aceh catchment. The red dots are the rainfall measuring stations (SDC, 2009b)

Overall rainfall and streamflow data in the Krueng Aceh catchment can be divided into three phases. The period before 1945 when the Royal Netherlands' Meteorological Institute was responsible for collecting the data, the period 1945-2000 when the central government of Indonesia focused on agriculture intensification, and the period 2000 to present when the local government of Aceh took over the responsibility of the data collection.

1. Period before 1945: Rainfall data are available in monthly record; the stations were limited and most of those stations did not continue observation after Indonesian independence. No discharge data are available for this period.
2. Period 1945-2000: Rainfall data and discharge data after Indonesian independence should be available with daily resolution especially after 1970 to

2000 when the Central government introduced an intensification program for agriculture where those data were used to develop irrigation infrastructure.

3. Period 2000 to present: Limited availability of rainfall data and discharge data during this decentralization period, data quality and its validation are also difficult to check. Moreover, the data that had been collected by the Central government is now taken over by the Aceh government and some years of data are missing due to the civil war, tsunami in 2004, floods and careless data storage by the owners.

b. Groundwater

Farr and Djaeni (1975), Lawrence and Djaeni (1977) and IWACO (1993) have researched the hydrogeological condition of the Krueng Aceh catchment (Siemon *et al.*, 2006b). The hydrogeological pattern in the Krueng Aceh catchment is depicted on the Hydrological Map of Indonesia scale 1:250,000 sheet 0421 Banda Aceh that was compiled by Soetrisno (1993). More recently, the Bundesantalt für Geowissenschaften und Rohstoffe (BGR) researched the groundwater resources within the Krueng Aceh catchment using a helicopter-borne geophysical system that includes five-frequency electromagnetic (HEM), magnetics and gamma-ray spectrometry (Siemon *et al.*, 2006b; Siemon *et al.*, 2006a).

Sandy-gravelly alluvial deposits are mostly deposited in the vicinity of the river courses in the Krueng Aceh catchment valley (Figure 3.12). IWACO (1993, cited in Siemon *et al.*, 2006b) predicts the thickness of the alluvial aquifer in the Krueng Aceh valley to be > 100 m between Indrapuri and Banda Aceh area, where potential groundwater yields might be available at 10 l/s. Moreover, Siemon *et al.* (2006a) state that shallow wells are generally available in the top 20 meters in the Banda Aceh area and are positioned in sandy clay to sand and gravel, considered to be the shallow aquifer system. This aquifer is directly recharged by rainfall. Farr & Djaeni (1975) and Lawrence & Djaeni (1977) predict that annual groundwater recharge in the 200 km^2 area of Banda Aceh City is about 200 mm (with an assumption of 12.5% of rainfall as recharge), which is equal to 4 x 10^9 m^3/annual or 1,270 l/s (Siemon *et al.*, 2006a). The deep aquifer in the Krueng Aceh catchment comprises a multi-layer system that

consists of sand-gravel layers below clay layers within the coastal belt. Farr & Djaeni (1975) and Lawrence & Djaeni (1977) add that groundwater potential yield may be estimated at 2.8 x 10^8 m^3/a or 90 l/s over the Krueng Aceh catchment (Siemon *et al.*, 2006a).

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Figure 3.12 Hydrogeological Map of Banda Aceh area (sheet 0421 Banda Aceh) by Soetrisno (1993, cited in Siemon *et al.*, 2006b). *Intergranular flow* (blue): extensive, very productive aquifer, (light blue): extensive medium productivity aquifer, (blue hatched): local aquifer with moderate productivity. *Flow through fissures and interstices* (blue green): extensive aquifer with moderate productivity, (light green): isolated aquifer with rare productivity. Flow through fissures, fractures, and channels (green): aquifers with moderate productivity. *Poorly productivity aquifers* (ochre): local aquifers, (orange): regions aquifers without groundwater.

c. Water quality

Water quality data within the Krueng Aceh catchment is sourced from the Environmental Protection Agency (BAPEDAL) of Aceh and other research over the catchment. The government of Indonesia introduced the PROKASIH

Program (Indonesian: *Program Kali Bersih*; English: Clean River Program) that was implemented in the provincial levels of the Environmental Protection Agency under coordination between the Ministry of the Environment of Indonesia *[Kementerian Lingkungan Hidup or KLH]* and the Ministry of Home Affair *[Kementerian Dalan Negeri* or *MENDAGRI]* from 1995 to 2007. The operational procedure of the PROKASIH was regulated in the Minister of the Environment Decree No. KEP-35/MENLH/7/1995, in which one of the procedures was an integrated team to carry out the PROKASIH program in provincial levels (KLH, 2012). The program monitored seven basic parameters and it may be possible for provincial levels to add other parameters based on regional issues in water resources. The basic parameters are DO (Dissolved Oxygen), COD (Chemical Oxygen Demand), pH, BOD (Biochemical Oxygen Demand), TSS (Total Suspended Solid), Ammonia and Facial Coliform.

Team members for the PROKASIH program were sourced from stakeholders, which were government officers at provincial and regency level, experts, journalists, NGOs, and private sectors. Therefore, the program had succeeded to encourage stakeholders' awareness through regional campaigns on the national promotion framework in water resources. In cooperation with the EPA of Aceh, the PROKASIH program monitored two main rivers in Aceh from 2005 - 2007, which were the Krueng Aceh river and the Tamiang river located within the Aceh Timur regency and the Tamiang regency. In addition, Zulfahmi (2008) continued to monitor the quality of Krueng Aceh river at the same locations with PROKASIH program observation points on 17 January 2008. Then, this research also observed the water quality at the former PROKASIH points on 2 March 2011. All the data that were collected by the PROKASIH program during 2005-2007, Zulfahmi on 17 January 2008 and this research on 2 March 2002 were analysed at the EPA laboratory in Banda Aceh. The water qualities of the Krueng Aceh catchment between 2005 and 2011 at selected points are shown and listed in Table 3.5.

Table 3.5 Water quality conditions of the Krueng Aceh catchment at selected locations1995-2012 (adopted from BAPEDAL Aceh 2007, Zulfahmi 2008)

No.	PARAMETER	UNIT	ACCEPTABLE LIMIT	LOCATION														
				JANTHO					INDRAPURI					LAMBARO				
				05° 19' 35.9" N / 095° 35' 48.3" E					05° 24' 51,8" N / 095° 26' 44,5" E					05° 30' 46,4" N / 095° 21' 29,0" E				
				2005	2006	2007	2008	2012	2005	2006	2007	2008*	2012**	2005	2006	2007	2008*	2012**
1	Temperatur	°C	Dev 3	31.80	29.50	23.20	27.00	25.50	na	31.40	27.80	27.80	26.80	35.00	31.50	26.00	28.30	28.40
2	pH	-	6-9	8.14	8.21	7.06	8.30	8.34	na	8.08	7.03	7.94	8.00	6.94	8.04	7.03	7.56	7.86
3	EC	µS/cm	-	217.00	178.20	190.50	34.10	75.30	na	230.00	323.00	172.30	144.10	212.00	231.00	300.00	449.00	133.00
4	TDS	mg/L	1000	642.0	83.0	88.0	163.0	35.0	na	105.0	155.0	82.0	67.0	767.0	109.0	141.0	214.0	66.0
5	TSS	mg/L	50	na	28.00	19.00	19.30	3.00	na	49.00	43.00	78.00	51.00	na	72.00	57.00	38.00	56.00
6	Salinitas	$^0/_{00}$	-	0.100	0.100	0.100	0.200	0.100	na	0.100	0.200	0.100	0.100	0.100	0.100	0.100	0.200	0.100
7	DO	mg/L	4 mg/L	8.280	6.540	7.210	6.000	6.170	na	6.13	6.37	6.08	5.74	6.80	5.87	5.63	7.64	5.68
8	COD	mg/L	25 mg/L	19.660	9.200	10.000	17.300	29.160	na	13.08	20.40	15.30	24.99	52.44	16.11	10.00	12.70	20.85
9	BOD	mg/L	2	1.73	0.80	1.14	5.00	0.25	na	1.20	3.24	4.00	0.39	1.57	1.52	2.68	3.00	0.55
10	Phospat	mg/L	0.2	0.240	0.290	0.150	0.060	0.158	na	0.200	0.180	0.047	0.152	0.450	0.240	0.210	0.073	0.646
11	Ammonia	mg/L	0.5	0.070	0.130	1.300	0.090	0.013	na	0.190	1.480	0.020	0.023	0.240	0.340	1.320	0.010	0.022
12	Faecal Coliform	MPN/100 ml	100	na	210	2,400	1,200	210	na	360	1,100	11,000	2,100	na	360	2,400	11,000	1,700

No.	PARAMETER	UNIT	ACCEPTABLE LIMIT	LOCATION														
				LUENGBATA					SP. SURABAYA					PEUNAYONG				
				05° 32' 26,3" N / 095° 20' 29.2" E					05° 33' 11,4" N / 95° 19' 50,8" E					05° 33' 38,7" N / 095° 19' 06,8" E				
				2005	2006	2007	2008*	2012**	2005	2006	2007	2008*	2012**	2005	2006	2007	2008*	2012**
1	Temperatur	°C	Dev 3	25.00	30.40	23.40	28.80	25.00	31.70	29.10	22.60	29.40	28.80	31.90	28.70	22.40	28.90	28.10
2	pH	-	6-9	6.94	7.90	7.13	7.61	7.64	7.43	7.93	7.22	7.80	7.73	7.41	7.83	7.00	7.64	7.60
3	EC	µS/cm	-	96.90	105.00	329.00	505.00	179.70	80.90	112.00	128.40	14.20	114.80	13.87	255.00	21.50	14.27	116.40
4	TDS	mg/L	1000	5,170.0	225.0	158.0	241.0	85.0	6,110.0	232.0	58.0	607.0	54.0	6,570.0	120.0	957.0	698.0	55.0
5	TSS	mg/L	50	na	57.00	55.00	21.00	75.00	na	55.00	30.00	35.00	49.00	na	47.00	20.00	29.00	54.00
6	Salinitas	$^0/_{00}$	-	2.500	0.100	0.200	0.200	0.100	4.900	0.100	0.100	0.500	0.100	16.700	0.200	0.100	0.700	0.100
7	DO	mg/L	4 mg/L	6.31	6.05	5.73	6.06	5.61	6.46	6.24	4.94	4.20	5.68	6.61	5.74	3.30	4.98	5.33
8	COD	mg/L	25 mg/L	26.22	7.67	10.00	10.70	24.99	32.78	15.35	10.00	12.00	20.85	13.11	16.87	10.00	12.00	29.16
9	BOD	mg/L	2	0.63	1.46	1.98	4.00	0.63	0.83	2.24	1.98	3.00	0.72	2.09	2.96	3.30	5.00	0.75
10	Phospat	mg/L	0.2	0.190	1.680	0.430	0.055	0.146	0.290	0.320	0.260	0.073	0.272	0.240	0.310	0.310	0.073	0.114
11	Ammonia	mg/L	0.5	0.090	0.250	1.240	0.030	0.014	0.100	0.540	1.630	0.020	0.020	0.170	0.250	1.310	0.020	0.021
12	Faecal Coliform	MPN/100 ml	100	na	360	2,400	11,000	1,400	na	2,900	4,600	11,000	2,800	na	2,100	11,000	11,000	280

Note : the Acceptable Limit is based on the Government Regulation No. 82 Year 2001 : Water quality class I (Drinking Water)
: The data 2005-2007 are taken on period of February - March (wet season)
*) : 2008; taken on 17 January 2008
**) : 2012; taken on 2 March 2012

The locations of sampling positions are shown in Figure 3.13:

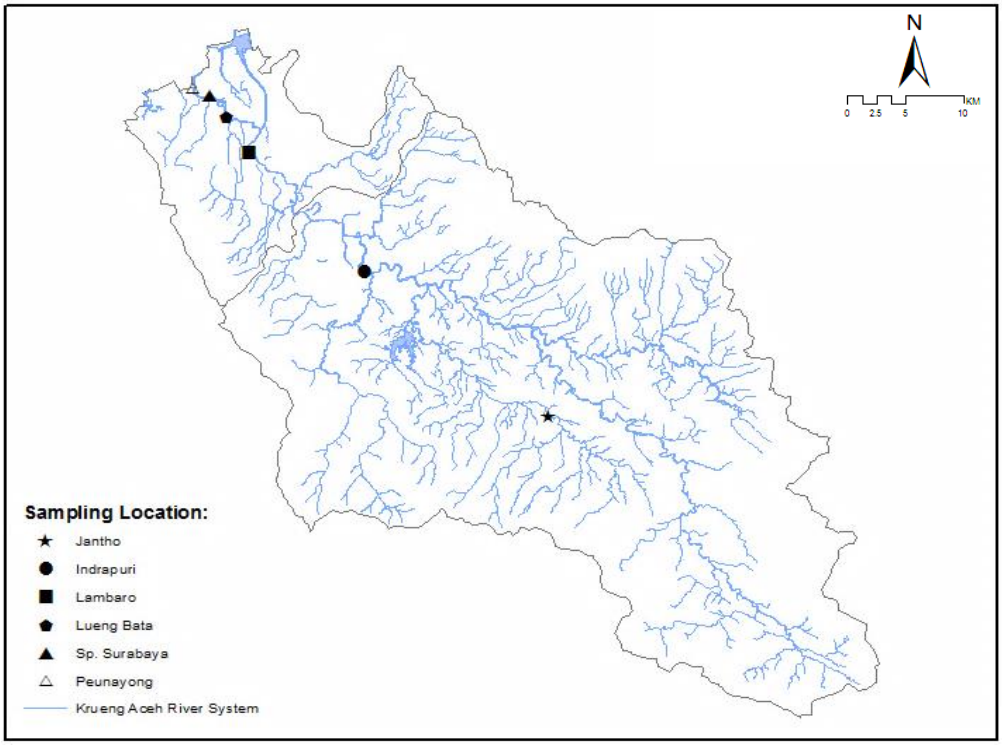

Figure 3.13 Locations of water quality sampling by the PROKASIH program (2005-2007), Zulfahmi (2008) and this research (2012)

Brown (2005, cited in Siemon *et al.*, 2006a) researched the electrical conductivity (EC) at the headwaters of the Krueng Aceh main river, which is 70 µS/cm in the Krueng Inong and 550 µS/cm in the Krueng Agam. In the middle of the Krueng Aceh main river, the EC value of the surface water shows around 300 µS/cm between the upstream Krueng Aceh catchment valley (Indrapuri area) and the town centre of Banda Aceh City. However, the EC range between the town centre of Banda Aceh City and the coastal area is between 1,500 µS/cm and > 50,000 µS/cm based on observation by BGR in September 2005 as well as the result from IWACO (1993, cited in Siemon *et al.*, 2006a).

The Environmental Service Program (ESP) team analysed for surface water and groundwater parameters of temperature, specific conductance (conductivity and electric conductance), pH, turbidity, dissolved oxygen, colour, odour, and Eh (oxidation-reduction potential) in the Krueng Aceh catchment on 22nd - 23rd of November 2005. Results show that overall, the quality of water in the Krueng Aceh River appears to be good. However, in some parts, high

concentrations of total dissolved solids from either natural or manmade sources require more detailed investigation (USAID, 2006).

Water intrusion through the rivers has been observed in Banda Aceh City especially through the Krueng Aceh main river. The government anticipated this problem together with flood mitigation by running the Krueng Aceh Urgent Flood Control Project (KAUFCP) in 1982. The project improved 43 km of the existing Krueng Aceh River from estuary to upstream, constructed a new floodway channel (9.7 km) to convey excess water and built a barrage (weir) to protect from saline intrusion for the PDAM intake that is located about 500 m upstream of the weir or about 10 km from the coastal area. Although the intrusion along the Krueng Aceh main River is contributed by topographic factors, existing condition shows that it occurs mainly due to low flow in the Krueng Aceh River since this problem happens mostly in the dry season.

3.3.2. Water resources infrastructure

a. Water distribution network

The water services provider is the company owned by the local government in Indonesia, which is named the Local Water Drinking Company *(Perusahaan Daerah Air Minum/PDAM).* As the company is owned by the government and was established based on the Law No. 5 Year 1962: Local Government Company *(Perusahaan Daerah)*, the company mostly does not apply full economic tariffs to consumers and gets subsidies for company expenditure. There are two PDAMs in the Krueng Aceh catchment that are owned by the Aceh Besar Regency and the Banda Aceh City.

Water distribution remains a problem for PDAMs throughout Indonesia. The Ministry of the Public Works argues that one of the problems is water price, which are the tariffs from PDAM, these are below the cost of water production and the company has to rely on subsidies. The average rate of tariffs from PDAMs throughout Indonesia is IDR 3,159 (USD 0.33) per cubic meter, while the cost of production is IDR 3,375 (equal with USD 0.35; based on mid-rate of the Central Bank of Indonesia on 28 December 2012, USD 1 = IDR 9,670.00) per cubic meter (Ministry of Public Works, 2012). On the other hand, PDAMs

have problems with water losses where the national average is 32.86%, and water pressure on the distribution networks is under the standard. The World Bank (Idelovitch & Ringskog, 1995) identifies three common factors that lead to low performance of water companies in developing countries. These are; (a) water losses between 40% and 50%, (b) the excess of labour, and (c) water quality is not stable and not standard.

The Ministry of Public Works (2012) reports that the average national water distribution network Indonesia has a coverage of 43.94% for urban area and 11.54% for a rural area. The proportion of people who get access to safe drinking water is 59.87% in urban areas and 46.61% in rural areas; therefore, the national average of safe drinking water access is only 53.26% (UNDP, 2012; Sedyaningsih & Segaf, 2011). On the other hand, Indonesia has to reach the implementation of Millennium Development Goals (MDGs) and one of those goals on water supply infrastructure is to ensure environmental sustainability and reduce by half the proportion of households without sustainable access to proper drinking water and basic sanitation by 2015 (UNDP, 2012). Although the Indonesian government has a target to reach the MDG target that 68.8% of the Indonesian population has access to safe water by 2015, the achievement of this goal was only 54% in 2012 (Cipta Karya, 2012).

Water pricing for PDAMs has been set by the Ministry of Home Affairs through the Ministry Decree No. 23 Year 2006 on Technical Guidelines and Procedures for Setting Water Rates for the Drinking Water Company *[Pedoman Teknis Dan Tata Cara Pengaturan Tarif Air Minum Pada Perusahaan Daerah Air Minum]*. The law mentions that the average of the PDAM tariff cannot be exceeded by 4% of the Regional Minimum Wage *[Upah Minimum Regional]* and the profit of PDAMs cannot be more than 10% annually. Initially, these restrictions provided an opportunity for the PDAMs to reach profit and cover all expenditure costs. As an illustration, the highest Indonesian Regional Minimum Wage in 2010 was for Aceh province and was IDR 1,300,000/month (equal with USD 134.44/month) enacted by the Aceh Governor on the Decree No. 132 Year 2009: The Minimum Wage of the Aceh Province *[Penetapan Upah Minimum Provinsi Aceh]*. It means that the maximum PDAM Tirta Daroy Banda Aceh tariff cannot exceed, for a person spending on water bills, more than IDR

52,000/person/month (equal with USD 5.38/person/month) for the people that are in a lowest class of economic income. If this amount of maximum water bills for the lowest income people is compared with minimum water usage of 120 litres/person/day (3.6 m^3/person/month), maximum water tariffs for people in the lowest class economic income can reach up to IDR 14.444/ m^3 (equal with USD 0.67/person/month). This tariff is an opportunity for water service providers in Indonesia to increase their income (compared with average PDAM Tirta Daroy tariff 2011: IDR 1,710/m^3 or USD 0.18/m^3). However, the maximum profit of 10% may be a challenge for the PDAM when compared with the average Indonesian inflation of the decade 2003-2012, which is 6.96% (inflation.eu, 2013; Bank of Indonesia, 2012), if the profit does not account for the rate of inflation.

The PDAM Tirta Daroy has been operating since 1974 based on the Minister of Home Affair Decree No. 14 Year 1974 on the establishment of the PDAM Tirta Daroy. The PDAM classifies the consumers by three categories, which are domestic, business and social. The domestic consumers are households or private users, business consumers are industries, stores and any other business activities and social consumers are the institutes, offices, and social activities that usually are government organisations. Table 3.6 is the result of the audit report that was published by the Government Auditor Board (BPKP) of Aceh.

Table 3.6 Performance, estimation and target of the PDAM Tirta Daroy in 2007-2012 (USD 1 = IDR 9,760 based on mid-rate of the Central Bank of Indonesia on 28 December 2012; PDAM Tirta Daroy, 2011; updated November 2011)

No	*Items*	*2007*	*2008*	*2009*	*2010*	*2011**	*2012***
1	Price (IDR/m^3)						
	Domestic	630	1,600	1,600	1,600	1,600	3,000
	Business	950	2,285	2,285	2,285	2,285	6,000
	Social	420	945	945	945	945	1,500
	Price average	687.61	1,727	1,719	1,712	1,710	3,161
2	Consumer						
	Domestic	11,263	17,522	22,806	27,560	30,659	
	Business	2,540	4,140	4,964	5,533	6,035	
	Social	66	103	127	126	127	
3	Water Production (m^3/year)	9,874,800	11,432,479	12,322,795	14,302,594	15,180,000	16,559,670
	Water Production (l/s)	439.97	584.49	612.72	656.47	700.00	
4	Losses (%)	68.91%	54.15%	44.15%	32.15%	26.15%	20.00%
5	Coverage (%)	41.00%	64.00%	76.00%	82.00%	85.00%	88.00%
7	Profit / Loss (in Million IDR)	-9,880	-1,039	-2,945	-3,481	-4,900	
8	Invests (in Million IRD)	97,447	3,030	19,476	4,116	10,821	10,760
9	Cash balance (in Million IDR)	350	762	1,540	4,239	6,270	10,950

*) Estimation by Noverber 2011, **) Prediction by PDAM at November 2011

The Agency of Urban and Infrastructures (KIMPRASWIL) of the Banda Aceh City reports on Regional Zoning Regulation of the Banda Aceh City 2009-2029 (KIMPRASWIL Banda Aceh, 2009) that water demand of the Banda Aceh City is projected to be 78,756 m^3/day or 912 litres/second in 2029. The projection was calculated based on initial demand in 2009, which was 44,889 m^3/day (520 l/s). The Banda city has a target to achieve water distribution to cover at least 90% of the entire population of Banda Aceh, which is distributed either through home connections or public hydrants.

Another water services provider in the Krueng Aceh catchment is the PDAM Tirta Montala that is owned by the Aceh Besar Regency. However, the Aceh Besar Regency water demand for domestic purposes does not depend on the PDAM's distribution systems. The domestic consumers of the PDAM Tirta Montala are only 15,082 (18.35%) households from 81,367 total households in the Aceh Besar Regency in 2010 (BPS Aceh Besar, 2011a). Currently, the PDAM Tirta Montala has three water treatment plants (WTP); Siron, Darul Imarah and Jantho. The PDAM Tirta Montala classifies the consumers by five classifications, which are social, domestic, business, industry and government organizations.

The water production by PDAM Tirta Montala in 2010 is 6.3 x 10^3 m^3 with a loss factor of 34.1%, which means the distributed water is 4.2 x 10^3 m^3 after reduction by the loss factor. If the distributed volume is compared with standard minimum water demands from the Indonesian Ministry of the Public Works of 100 litres/person/day for rural areas, the production only covers about 31.60% of the total population of the Aceh Besar Regency. However, the population of the Aceh Besar Regency may use less water than the standard from the Ministry of Public Works due to the resources limitation and habits. Table 3.7 shows the number of PDAM Tirta Montala consumers 2008-2010.

Table 3.7 Number of consumers of PDAM Tirta Montala in 2010 (BPS Aceh Besar, 2011a).

No.	*WTP*	*Social*	*Domestic*	*Business*	*Industry*	*Gov. Institution*
1	Jantho	27	1,836	222	14	77
2	Darul Imarah	72	7,190	581	34	48
3	Siron	61	6,056	748	3	41
T o t a l	**2010**	**159**	**15,082**	**1,551**	**51**	**166**
	2009	182	12,574	1,503	44	200
	2008	122	9,974	869	32	113

As the Aceh Besar Regency residents do not rely on the PDAM water distribution, they use shallow dug wells, shallow drilled wells or artesian wells. The artesian drilled wells are developed by the government in the public places (most of them in mosques and in village leader offices), and the communities develop pipeline systems to distribute water to their households or collect the water directly in the public hydrants. Another alternative is that the communities use rivers for water supply and this is common in the villages in the highland areas.

b. Irrigation systems

Irrigation systems were developed within the Krueng Aceh catchment since the beginning of the Indonesia First Five Year Development Scheme (PELITA I) in 1969-1970. The construction finished at the end of 1970s and irrigated 7,450 ha of paddy field area, and the next construction was developed in Krueng Jrue system to irrigate 2,350 ha (SDC, 2009a). Progress continued until the PELITA III to develop tertiary irrigation facilities. Furthermore, the government sent

agricultural instructors to teach farmers to more effectively manage water and agriculture. During the PELITA V, the improvement of operation and maintenance was emphasized where the focus was to involve the farmers in financing the irrigation system. However, the irrigation budget increased sharply as a consequence of the Indonesian economic crisis at the end of 1990's that required the government to re-evaluate irrigation system management in budget allocation. The SDC (2009a) states that the policy had been taken to handle the situation through alternatives:

1. Improvement of rehabilitation and upgrading was focused on rural areas that were less developed to promote rural economic stability;
2. Improvements in operations and maintenance have to be supported by farmers themselves;
3. Promotion of the private sectors in the water sector including in irrigation;
4. Development of schemes for tertiary irrigation systems that have to be initiated by farmers and local communities.

The SDC (2009a) investigation of water balance and allocation for the Krueng Aceh River found that irrigation systems have become worse due to political unrest in the Aceh province, which resulted in the irrigation systems not being managed properly. As a consequence, the development of irrigation systems often has to start from the beginning as data on existing irrigation infrastructure has been lost. With the Keuliling dam, for example, the dam design and irrigation systems were constructed since the 1970's, but due to political problems the construction was delayed until the year 2000 and not finished until 2008, and did not include operational and maintenance facilities, and the dam did not fill until the end of 2013 (SDC, 2009a; updated December 2011).

According to the irrigation classification system in Indonesia Law 7 Year 2004: the Water Resources *[Sumberdaya Air]*, the major irrigation system or cross province irrigation systems are managed by the central government, and the provincial governments manage medium irrigation systems or transboundary regencies irrigation systems. The regency governments are responsible for small irrigation systems, and the community manages the village irrigation systems. A

major irrigation system is one that covers 3,000 Ha or more of paddy field areas, medium irrigation system size is 1,000 Ha to 3,000 Ha, a small irrigation system is less than 1,000 Ha, and village irrigation is normally simple irrigation systems of less than 500 Ha. Based on that law, the Krueng Aceh irrigation system, which covers a paddy field area 7,450 Ha (see Table 3.8) is managed by the Central Government.

The data for village irrigation systems and semi-technical irrigation systems in the Krueng Aceh catchment are scarce, however SDC (2009a) tried to develop these data by an assumption that the weighted factor for village irrigation is 88% of the total technical irrigation area, and the weighted factor for semi-technical irrigation is 15% of total technical irrigation area. Based on this calculation, the potential of village irrigation and semi-technical irrigation is 10,301 Ha and 1,760 Ha as detailed on Table 3.8. Moreover, Table 3.8 also shows that the potential irrigated area within the Krueng Aceh catchment is 23,816 Ha of paddy field area.

Table 3.8 Technical irrigation systems in the Krueng Aceh catchment (modified from SDC, 2009a).

No	***Irrigation Scheme***	***Potential Area (Ha)***	***Functional Area (Ha)***	***Notes***
1.	Krueng Aceh	7,450	7,450	Water Source: the Krueng Aceh weir in Seulimum. 809 Ha is to cover rained paddy fields
2.	Krueng Jrue	2,350	2,350	Water Source: the Krueng Jrue weir in Indrapuri.
3.	Keuliling Dam	1,440	0	Reservoir filling in progress; gravity and pumping system
4.	Leubok Dam	515	0	Construction in progress; gravity system
Tech. Irrigation		***11,755***	***9,800***	
5.	Village	10,301	n/a	Prediction from 88% of the technical irrigation area)
6.	Semi-technical	1,760	n/a	Prediction from 15% of the technical irrigation area)
Village and Semi-Tech.		***12,061***	***n/a***	
Total		***23,816***	***9,800***	

The existing irrigated area (functional area) was 9,800 Ha in 2009 (SDC, 2009e). However, the current functional area is not available due to data insufficiency in the Branch Office of Sumatran River *[Balai Wilayah Sungai Sumatra]* – the Central Government organisation for irrigation in the regional area. Figure 3.14 below shows the schematic of technical irrigation systems in the Krueng Aceh catchment area illustrated by the SDC (2009a).

Figure 3.14 Schematic of irrigation systems within the Krueng Aceh catchment (Sea Defence Consultant, 2009e)

c. Water resources problems

Water resources problems within the Krueng Aceh catchment mainly relate to LULC management, however natural phenomena such as potential climate changes may also be contributing. The problems can include flooding, increased sediment transport, garbage dumping along the river, domestic waste and potential chemical contamination from agricultural lands. Several activities that relate to LULC management concerning water quantity and quality issues are legal and illegal sand mining along the rivers, illegal logging and farming, and agricultural activities.

Based on the research of River Infrastructure and Investigation in Krueng Aceh by the SDC (2009d), the infrastructure (i.e. riverbanks, bridges,

groundsills, gauging stations and outlet drainages) in the Krueng Aceh river were not maintained properly due to lack of concern by local government. Moreover, they add that sand exploitation along the river has contributed to poor infrastructure condition. Currently, about ten mining activities operate along the section Krueng Inong-Krueng Aceh and the number of mining activities may be double that in the Krueng Aceh main river. A few of them are legal activities, which are authorized by local governments (the Aceh Besar Regency and the Aceh province); nonetheless, most of them are unregistered or illegal activities. The exploitation seems likely to result in river degradation in the Krueng Aceh River, because the activities scrape the riverbed. As a result, the processes make the river become deeper, create erosion on the riverbanks and gauging stations no longer operate. Moreover, the USAID (2006) team reported that all of the subbasins in the Krueng Aceh catchment are in a critical condition especially in terms of the flow ratio between wet and dry seasons.

Furthermore, outside of the riverbanks, the critical issues in the catchment area are deforestation, forest burning, soil exploitation, garbage dumping and water contamination by agricultural activities. The deforestation has occurred for timber production, agricultural lands, settlements and infrastructure construction although a moratorium banning commercial logging had been signed by the Aceh governor in 2007 (redd-monitor.org, 2003). Forest burning is carried out for agriculture activities because farmers see it as an easy way to clear the lands. On the other hand, soil exploitation for hoarding in low land areas, especially in the Banda Aceh coastal area, became more intensive for reconstruction after the tsunami in 2004. Therefore, the reconstruction process after Tsunami 2004 that was led by the Reconstruction and Rehabilitation of the Nanggroe Aceh Darussalam-Nias (BRR NAD-Nias) created significant pressure on the catchment. Generally, garbage contamination is not a significant issue on the rivers of the Krueng Aceh catchment, however many garbage dumping activities are near to the rivers especially in traditional markets in the capital cities of sub-regencies *[Kecamatan]*, such as in the Saree sub-regency, the Seulimum sub-regency and the Indrapuri sub-regency. In some points along the rivers stock farms are close to the rivers and domestic waste outlets and domestic garbage

flow directly to the rivers. Figure 3.15 shows examples of the sand mining in the Krueng Aceh River and a broken bridge caused by riverbed erosion.

Figure 3.15 Mining activity in the Krueng Aceh river *(left)*, and a broken bridge caused by erosion of the riverbed *(right)* (BAPEDAL Aceh, 2010).

Other than contamination by soil particles from sand and soil exploitation, deforestation, garbage and stock farms, also potential water contamination sources are from the chemicals used by agriculture. In the area, it is easy to find outlets of paddy farms that directly flow to the streams. As a result, the chemical residues may directly flow to the rivers. Based on field observation, pesticides are used in the area, especially in paddy fields, chillies fields and tomato fields.

Moreover, the Krueng Aceh River floods annually between December and January due to increasing precipitation within those months. However, the impact had been reduced since the floodway channel construction finished in 1992. The construction was carried out by joining two secondary rivers of Krueng Cut and Krueng Lamnyong. The biggest flood after the construction was finished, happened on 20 December 2000. The flooding occurred after three days of peak precipitation recorded at the Blangbintang precipitation gauge, respectively 130 mm, 140 mm and 180 mm (SDC, 2009d). Based on the Sea Defence Consultants analysis of the peak precipitation, those events were unusual in the observation area.

3.3.3. Spatial Planning

a. LULC classification within Indonesian National Policy

Legal status for LULC classification within the Aceh province is regulated by the Minister of Forestry of Indonesia Decree No. 170/Kpts-II/2000 on the Forestry and Water Area in the Province of Nanggroe Aceh Darussalam *[Kawasan Hutan dan Perairan Provinsi Nanggroe Aceh Darussalam]* as detailed on the map in Figure 3.16. The classification is grouped into protected forests *[hutan lindung]*, production forests *[hutan produksi]*, limited production forests *[hutan produksi terbatas]*, national parks *[taman nasional]*, community park forests *[taman hutan rakyat]*, reserves *[suaka margasatwa]*, hunting parks *[taman buru]*, nature parks *[taman wisata alam]*, marine parks *[taman wisata alam laut]*, areas for other purposes *[area penggunaan lain]* and miscellaneous *[rupa-rupa]*. The provincial and regencies/municipalities governments use this legal status of the LULC system in regulating their spatial planning and zoning.

Image removed due to copyright restriction.

Figure 3.16 LULC map of the Aceh Province based on the Minister of Forestry of Indonesia Decree No. 170/Kpts-II/2000.

The principle of zoning regulation in Indonesia is managed based on the Law No. 26 Year 2007: Spatial Regulation *[Penataan Ruang]*. The law states that the national zoning plan *[RTRW Nasional]* is used as a reference for zoning regulation in provincial levels, and the provincial zoning plan *[RTRW Provinsi]* has to be harmonized with zoning plans of regencies *[RTRW Kabupaten]* and cities *[RTRW Kota]* level. Because the Aceh province zoning regulation *[RTRW Propinsi Aceh]* is not yet finalised, the regencies' zoning regulations also cannot be finished. The problem for the Aceh province zoning regulation is the extent of forest areas and their boundaries that are still being argued among regencies and provincial authorities. The government of Aceh Province has proposed to increase protected areas that were originally 3,549,813 ha (60.22% of the Aceh province area) to be 4,032,632 ha (63.28% of the Aceh province area) in the new Zoning Regulation 2010-2030 *[RTRW Provinsi Aceh 2010-2030]* to the Ministry of the Forestry of Indonesia on 22 October 2010 (BAPPEDA Aceh, 2010). However, the proposal was rejected by the House of Representatives *[Dewan Perwakilan Rakyat* or *DPR]* of Aceh with the reason that the proposal has to be agreed by regencies and city authorities where they expect to reduce the forest areas.

In finding a solution, the Directory of Planology of the Ministry of Forestry has prepared a technical team to review the Aceh government proposal by doing ground verification on actual forest area conditions. The team recommends that the extent of protected areas (forest areas) within the Aceh province is 3,894,758 ha. The recommendation has been accepted by the Government of Aceh; however, it still needs to approve from the authorities of regencies and municipalities. There are three indicators used by the Directory of Planology team, which are shown in Table 3.9.

Table 3.9 Aspects of LULC assessment for the Aceh Province's spatial planning regulation 2010-2030 by the Directory of Planology of the Ministry of Forestry (BAPPEDA Aceh, 2010).

No	*Aspect*	*Note*
1.	Judicial aspects	as legal aspects of the area that originally has proposed, such as the area has been regulated for industry should not be changed for other proposed.
2.	Biological and physical aspects	as engineering considerations that the areas have to propose for, such as soils and slopes factors for potential erosion or biodiversity aspects.
3.	Social, economic and cultural aspects	As anthropological aspects, such as existing statements that have been in the forest area before the law are regulated has to be remove from forest protected area.

b. Actual LULC condition of the Krueng Aceh catchment

The Leuser International Foundation *[LIF-Yayasan Leuser Internasional]*, which is a foundation established by the Indonesian Government supported by the European Union for the Leuser National Park conservation – part of the Tropical Rainforest Heritage of Sumatra (UNESCO, 2004), analysed forest cover between 2006 and 2010 within the Aceh Besar and Banda Aceh area based on LULC allocation status based on the Minister of Forestry of Indonesia Decree No. 170/Kpts-II/2000. They found that forest cover, as stated in the decree, has reduced from 118,701 Ha in 2007 to 108,129 Ha in 2010, which is a loss of 5,572 Ha or 3.26% per year.

More recently, the SDC (2009b) analysed LULC data of the Krueng Aceh catchment over the period 1990-2005 based on image records during those years. Because of poor image quality, Sea Defence Consultants used images only for analysis of forest cover change with an assumption that other land covers do not change between those years. Based on the analysis, they found that primary forest area had decreased by about 8.35%, while secondary forest area had increased by 209%. In connection with the hydrological condition, the SDC (2009b) has modelled the discharge using the Tank Model, but the validation was not satisfactory due to the limitations in observed discharge data. Although the model performs well for Darang gauging station with the rainfall data from the stations of Kuta Raja, Lhok Nga, Seulimum and Padang Tiji, because of inaccurate LULC data, the model does not show the real condition when the

result is adjusted with observed discharge data from other gauging station locations. Table 3.10 shows results from LULC analysis in 2005 by SDC team compared with the Draft of Regional Zoning Plan 2008 *[Rencana Tata Ruang Wilayah 2006 or RTRW 2006]* of the Aceh Besar Regency.

Table 3.10 LULC conditions 2005 from SDC compared with the draft Aceh Besar Regency's Regional Zoning Plan (RTRW Aceh Besar) 2006 - 2026 (modified from BRR NAD-Nias, 2006; SDC, 2009b)

LULC	***2005 (ha)***	***Draft RTRW 2006 (ha)***
Sparse grass	12,280.2	15,570.1
Grass	26,669.6	982.9
Primary Forest	72,050.9	94,673.5
Non-irrigated agriculture	51,892.6	32,587.3
Settlement	2,126.5	14,995.3
Paddy field	3,601.5	8,836.6
Secondary forest	1,390.4	2,366.2
Water body	564.8	564.8
Total	*170,576.6*	*170.576.6*

As the Banda Aceh City is stated as an urban area, the portion of green areas (*Kawasan lindung*) has to be at least 20% from total share area (Law 26 Year 2007, article 29, point 2 and 3). The green areas may be source from private areas (private gardens or yards) and public areas (riverbanks, public yards, cemeteries etc.). The detailed land allocation plan for Banda Aceh City is shown in Table 3.11.

Table 3.11 Land allocation plan in the Banda Aceh City Zoning Regulation (KIMPRASWIL Banda Aceh, 2009).

No.	*Items*	*Wide*	
		(ha)	*(%)*
A.	***Protection Area***	***1,258.80***	***20.52***
1.	River banks	163.70	2.67
2.	Mangrove forests	463.28	7.55
3.	Green open spaces	567.53	9.25
4.	Cultural heritage areas	64.29	1.05
B.	***Cultivation Area***	***4,877.20***	***79.48***
1.	Settlements	2,506.64	40.85
2.	Trades and services	989.04	16.12
3.	Offices	139.48	2.27
4.	Tourisms areas	103.00	1.68
5.	Open spaces (no green areas)	94.36	1.54
6.	Fisheries	120.19	1.96
7.	Public services	275.04	4.48
8.	Ports	14.49	0.24
9.	Blanks	169.59	2.76
10.	Water bodies	465.36	7.50
Total A and B		**6.136.00**	**100**

GIS Analysts of the School of the Environment, Flinders University, carried out a study on LULC cover in the Krueng Aceh catchment based on Landsat 7 imagery. There were only two images that were available for analysis due to high intensity of cloud cover. They are the images collected on the 9th February 1988 and 22nd March 2012. Moreover, the team also produced the catchment boundary using the Shuttle Radar Topography Mission (STRM) digital terrain data. The LULC classifications used in this research are therefore only based on the images that were acquired on 9th February 1988 and 22nd March 2012.

The LULC maps were produced by the GIS Team based on guidelines from the Directorate General of Land Use Rehabilitation (2004) on Decree No. S.296/V-SET/2004: the Guideline for LULC rehabilitation and conservation. The guideline states that LULC can be grouped into twelve classes, which are primary forest, secondary forest, restoration area, mono-agriculture plantation, mixed plantation, agroforestry, grass, sparse grass, swamp, water body, bare land and urban areas. However, this research produces eight LULC classes, which are primary forest, secondary forest, mixed plantation, paddy field, grass, sparse grass, water body and urban areas. Other LULC classes may not be significant for further

analysis or have some difficulties in interpretation from the image data. Swamp areas and bare land areas, for example, are not available for further analyses due to the fact that these areas are not clearly exposed as significant areas. Therefore, the swamp areas may be classified as a water body, and bare land areas may be classified as sparse grass areas. Other areas may be difficult to interpret due to image quality, and may be identified as unclassified areas when the areas are not associated with nearby areas. As an example, Figure 3.17 shows a suburban area in Aceh Province, where settlements, mixed plantation, grass and sparse grass mix together in an area.

Figure 3.17 Illustration of a suburban area in Aceh Province, Indonesia (www.leuserview.blogsport.com)

Based on the LULC classification carried out, some limitations can be identified in the results, as listed in Table 3.12 below:

Table 3.12 Limitations of image interpretation results over the Krueng Aceh catchment for images acquired on 9th February 1988 and 22nd March 2012.

No	*LULC Class*	*Limitations*
S01	Forest	may include cloud cover areas (formerly interpreted as S4 Cloud Cover) that cannot be interpreted in the imagery when the areas nearby are interpreted as forest areas.
S02	Water	may include swamp and mangrove areas, and may potentially include limited paddy fields when the paddy fields are in early stage of land preparation.
S03	Urban	may include limited crop areas, farms and mixed plantation areas especially in rural areas where they are mixed together
S05	Paddy Fields	paddy fields may potentially be interpreted as water areas in early stages of land preparation, or interpreted as sparse grass and grass areas at the middle stage of the cropping cycle and harvesting.
S06	Secondary Forest	may include hetero-agriculture and mono-agriculture areas where those areas are limited in the Krueng Aceh catchment, and may include cloud cover areas.
S07	Mixed Plantation	the areas where crop and farm areas are dominant, may potentially limit urban areas.
S08	Sparse Grass	may include other open spaces (bareland areas) or mining areas, and potentially may include paddy fields after harvesting.
S09	Grass	may potentially be interpreted as paddy field or may include paddy fields areas.
	Unclassified	where there is no reflectance in one more spectral bands in a pixel

Based on the limitations mentioned in Table 3.12, potential forest and secondary forest areas may be overestimated. However, urban area and paddy fields area may be underestimated as those areas are potentially associated with other classes such as grass and sparse grass areas. These limitations need to be considered, particularly for paddy fields as a focus of this research as high-water consumers, which may impact on water balances within the catchment. On the other hand, forest and secondary forest area are important for water reliability and its purification.

Interpretation of LULC condition for 1988 and 2012 showed that significant LULC changes occurred over the Krueng Aceh catchment, especially decrease of forest and secondary forest areas, and increasing urban and grass areas, as shown

in Figure 3.18. However, both LULC maps show that the Krueng Aceh catchment is still dominated by forest and secondary forest cover, which is 62.26% in 1988 and 51.70% in 2012.

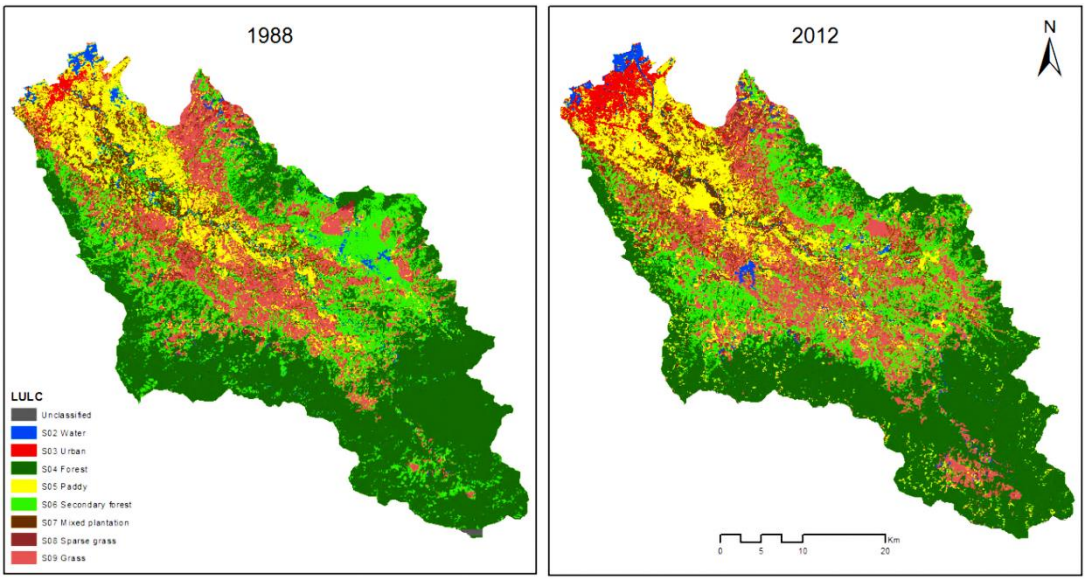

Figure 3.18 Land-use classification within the Krueng Aceh catchment on 9th February 1988 (*left*) and 22nd March 2012 (*right*)

Detailed rates of LULC change over the Krueng Aceh catchment between 1988 and 2012 are shown in Figure 3.19 and Table 3.13.

Table 3.13 Rate of LULC change over the Krueng Aceh catchment between 1988 and 2012.

No.	***LULC***	***1988***		***2012***		***∑ 1988 – 2012***
		Area (km^2)	***%***	***Area (km^2)***	***%***	***%***
	Unclassified	4.79	0.28	4.50	0.26	-0.02
S01	Forest	783.05	45.02	632.36	36.35	-8.66
S02	Water	32.94	1.89	37.98	2.18	0.29
S03	Urban	10.15	0.58	50.91	2.93	2.34
S05	Paddy body	183.19	10.53	192.89	11.09	0.56
S06	Secondary forest	287.70	16.54	253.72	14.59	-1.95
S07	Mixed plantation	113.30	6.51	143.12	8.23	1.71
S08	Sparse grass	31.29	1.80	49.90	2.87	1.07
S09	Grass	293.07	16.85	374.09	21.51	4.66
Total		***1739.49***		***1739.49***		***0***

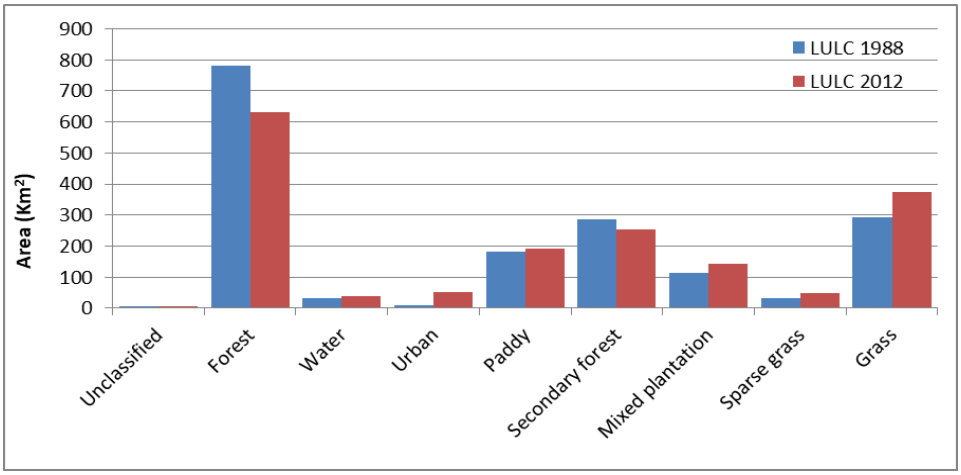

Figure 3.19 Difference in LULC conditions between 1988 and 2012

3.4. Research Methods

3.4.1. Analysis of LULC Change Impacts on Discharge

a. Analysis of LULC changes

Remote Sensing and Geographic Information System (GIS) procedures were used to examine LULC in the Krueng Aceh catchment. This includes image classification, determination of change matrices and GPS ground checking. The Landsat satellite remote sensing image processing involved selecting the images and downloading from United Stated Geological Survey (USGS) homepage: (http://earthexplorer.usgs.gov/) where the study area is located in the Path: 131 and Row: 56 of the Landsat 7 data set. The best available images were radiometrically corrected. Radiometric correction involved image processing to improve the brightness values of magnitude to reduce the "noise" in images, which can be associated with any undesirable spatial or temporal variation in brightness not associated with the image surface. Images were also cropped to catchment boundaries before further analysis on LULC classification.

In adopting LULC change trends to create decision alternatives for LULC management, this research considers that the forest, agricultural and urban LULCs undergo conversion to other LULC types following economic-hierarchical principles; where forest conversion is the highest, agricultural conversion is the second highest and urbanization conversion is the lowest ranked between these types (Niehoff *et al.*, 2002).

b. Simulation of hydrological response for LULC changes

1. Discharge analysis

The hydrological response influenced by LULC changes is simulated using HEC-HMS modelling software (USACE-HEC, 2000). The modelling is developed based on meteorological data and LULC conditions in 1988 and 2012 and the discharge data in these years are used to calibrate the model. Parameters from the calibrated model are used to generate various discharge conditions and to predict the future conditions.

There are two steps of analysis that can be done to determine water resources response for LULC changes, which are based on discharge data records and on modelling. However, the discharge data records are limited, not continuous and incomplete data series. In connection between discharge condition, water availability and LULC changes, the analysis approach uses three techniques:

1. If discharge data records and the meteorological data records within a catchment or a sub catchment are available between the years of LULC data (1988 and 2012), water availability is analysed using the discharge data, which shows the daily water availability curve in a year. The discharge data are compared with LULC conditions by using HEC-HMS Software where the *Soil Conservation Service-Curve Numbers (SCS-CN)*, which are generated from LULC classes, may be used to estimate discharge regime responses from the LULC conditions.
2. If the discharge data records in a sub catchment are not available in these years (1988 and 2012) but the rainfall data are available, calibrated parameters modelled from a subbasin will be used to simulate discharge in other subbasins using daily accumulated rainfall depth.
3. If discharge data and rainfall data within a subbasin are not available, water availability in this subbasin is compared with another subbasin where the hydrological characteristics of these subbasins are assumed to be similar.

2. Sediment transport analysis

Analysis of sediment transport uses two methods; the Universal Soil Loss Equation (USLE) method for analysis of annual sediment transport and Sediment-Runoff method for analysis of daily sediment transport using daily discharge data. Both methods apply in the Krueng Aceh catchment because no observed sediment transport data can be assessed for calibration of the calculation. Therefore, the USLE method will be used for model calibration using a different catchment where annual sediment transport field monitoring has been done. Calibration for application of the USLE method in the Krueng Aceh catchment was done using the Citarum catchment, as both catchments have a similar area, average slope condition, rainfall depth and both are located in tropical areas where it can be assumed that soil types and rates of denudation are similar. Whereas, the Sediment-Runoff method uses daily sediment discharge at the selected locations where further economic compensation was carried out.

The USLE method develops from the function of soil index *(L_s)*, crop management factor *(C)*, soil erodibility *(K)*, erosivity *(R [mm/h])* and erosional factor practice control *(P)* that are used to calculate soil sediment rate *(E [ton/km^2])*, sediment delivery ratio *(SDR)* and annual sediment yield *(Y [ton/year])*. The *SDR* value being used is the ratio that has been developed by USDA (USDA SCS, 1972), which is developed from the function of catchment drainage area. The functions of L_s value and *C* value can be developed from LULC condition that has been produced from images. Similarly, the sediment drainage areas for developing *SDR* value are sourced from the area of LULC classes. These areas are extracted through the GIS software (ArcMap version 10.1).

The Sediment-Runoff method is based on a function of average daily discharge *(q m^2/s)* and daily mean concentration of suspended sediment *(C_s [mg/l])* that are used to compute total sediment discharge *(q_s [ton/day])*. As total sediment discharge *(q_s)* is suspended sediment that does not reflect the total sediment yield *(Y [ton/year])* produced from the catchment, Tilrem (1979) and PUSLITBANG Pengairan (1989) propose the comparison between sediment discharge *(q_s)* and bedload sediment *(q_l)*, which is between 5% to 20% to

produce total sediment discharge *(Y).* The *Y* value through Sediment-Runoff method is being calibrated with *Y* values produced from the USLE method**.**

3.4.2. Determination of Environmental Costs

An analysis of the economic valuation in environmental services is applied using two approaches that relate to the resource ownership for water quantity and relate to water quality. A resources ownership approach relates to the individual or the organization that takes responsibility to produce and maintain the resources, which in this case is the upstream authority. Based on this approach, the resources allocation will be distributed maximally in upstream areas when the resources are limited, in which case that decision may affect resource scarcity in the downstream area. This calculation is carried out under the water balance concept.

Moreover, the water quality approach relates to changing costs for water production on water services providers (Drinking Water Company, *Indonesian: Perusahaan Daerah Air Minum/PDAM).* As the quality worsens, water services providers may spend more for chemical usage in purification processes, while the provider also needs more water storage to anticipate demand as some water may not be extracted due to high levels of sediments. However, this research is focussed on increasing costs for water purification and not increases of water quantity due to decreased quality as no available data is available. Moreover, although more water in quantity may be required to anticipate the demand in quality when water quality worsens, the increased water quantity may not be significant.

a. Analysis of water balance

Water balance analysis is based on water supply and water demands. Under the water balance concept, both quantity and quality are computed to know the reliability of water distribution. As the discussion is focussed on the impact of LULC changes, the reliability of water distribution is calculated under LULC conditions and these conditions run on the same input and water demand conditions. In the case of water reliability analysis between 1988 and 2012, the

inputs are daily accumulated rainfall depth for 2012 and water demands for 2012 for both LULC conditions of 1988 and 2012. In this simulation, water balance concepts are used to obtain simulated results for discharge from HEC-HMS modelling of LULC 1988 and LULC 2012 where rates of evapotranspiration and infiltration have been accounted for in the modelling.

b. Environmental externalities

Environmental externalities are sourced from changing economic costs associated with LULC change. This calculation is based on the reliability of water distribution under LULC 1988 compared with LULC 2012. The comparison includes both water quality and quantity.

3.4.3. Creating Decision Alternatives for IWRM

This research develops alternative decisions for LULC management as the impacts of discharge change, including changing water quality that affects environmental externalities. There are two conditions that are considered under the decision alternatives setting, which are water balance conditions related to water availability and scarcity, and economic externalities of water production related to increasing costs of water treatment.

The agents that are being considered in developing decision alternatives are represented by authorities, which in the upstream area is the authority of the Aceh Besar Regency and in the downstream area the authority is Banda Aceh City. Other agents action may contribute to LULC modifications within the Krueng Aceh catchment, such as agents who are involved in illegal logging, illegal mining and other activities. These agents may be difficult to include as the agents in the decisions due to difficulties in identifying them. Moreover, the illegal activities should be under the authorities' control and law enforcement.

As the decision alternatives are developed under water balance conditions and water quality changes, the decisions focus on introducing alternatives for LULC modification and trends in LULC modification until the predicted year. The aim of the developed decision alternatives is to anticipate increasing costs and to reduce environmental externalities under developing schemes of

compensation through Payment of Environmental Services (PES). The decision alternatives are created under the Multi Criteria Decision Making (MCDM) and the Analytic Hierarchy Process (AHP).

3.5. Data Quality and Limitations

As in much research in developing countries including Indonesia, data quality suffers from certain deficiencies. The deficiencies may be due to lack of human resources capacity in data collection and management; inaccuracy of data instruments and calibration; or natural factors. These issues can be barriers to data collection and their accuracy. All these problems may occur in this research. The major sources of data limitations in this research come from:

1. *Discharge Data:* the data availability for gauging stations is limited, missing some years and data reliability may be disputed. The reliability of discharge data is tested by comparing their consistency with other discharge data at nearby gauging stations, however precipitation distributions may vary locally, which creates different rainfall depths from one gauging station to another.
2. *Precipitation Data:* In general, data are available over long periods in the study area, however some locations have incomplete data series. Another difficulty is that many rainfall stations are no longer operated or have moved to another location. Moreover, current rainfall station locations are not evenly distributed in the area; therefore, connections between the impact of global climate change and rainfall intensity may not possible.
3. *Imagery Data:* Landsat image data that can be acquired are limited due to high cloud intensity in the area. This condition creates difficulties for LULC analysis. Only two selected years are available for the LULC change analysis using Landsat image data for the years 1988 and 2012.

CHAPTER 4
LONG-TERM HYDROLOGICAL RESPONSES DUE TO LAND USE/LAND COVER CHANGES

4.1. Introduction

This chapter discusses the impact of LULC changes in the Krueng Aceh catchment on a hydrological response from 1988 to 2012. The discussion examines how LULC change during these years has affected the flow regime and water quality. As the flow regime is closely related to rainfall events, this chapter also discusses rainfall change in the Krueng Aceh catchment as an impact of global climate conditions. The goal of this aspect of the study is to determine the intensity of LULC changes and their impact on water resources availability in the Krueng Aceh catchment.

4.2. LULC Changes Analysis

The LULC change analysis is based on catchment boundaries, and image availability in the study area. Preliminary field work found that LULC has changed significantly in the upstream area, due mainly to the conversion of forest covers (primary and secondary forests) to agricultural lands and grass areas.

This research classified the land cover at 30 m pixel resolution. Supervised classification of land cover (LC) was carried out in ENVI v.5.0 to produce GIS based maps and spread sheet tabulations. The results were ground checked at selected locations before producing final LC metrics. Only two images were suitable for classification, which were the images recorded on 9th February 1988 and 22nd March 2012, due to extensive and persistent cloud cover over the study area. The processing of these images to produce LULC classifications and tabulations were carried out by the GIS Analysts at the School of the Environment, Flinders University.

Figure 4.1 illustrates the LULC conditions in 1988 and 2012 resulting from the image classification. The LULC was classified into classes: water body, urban,

forest, paddy field, secondary forest, mixed plantation, sparse grass, and grass, including unclassified areas.

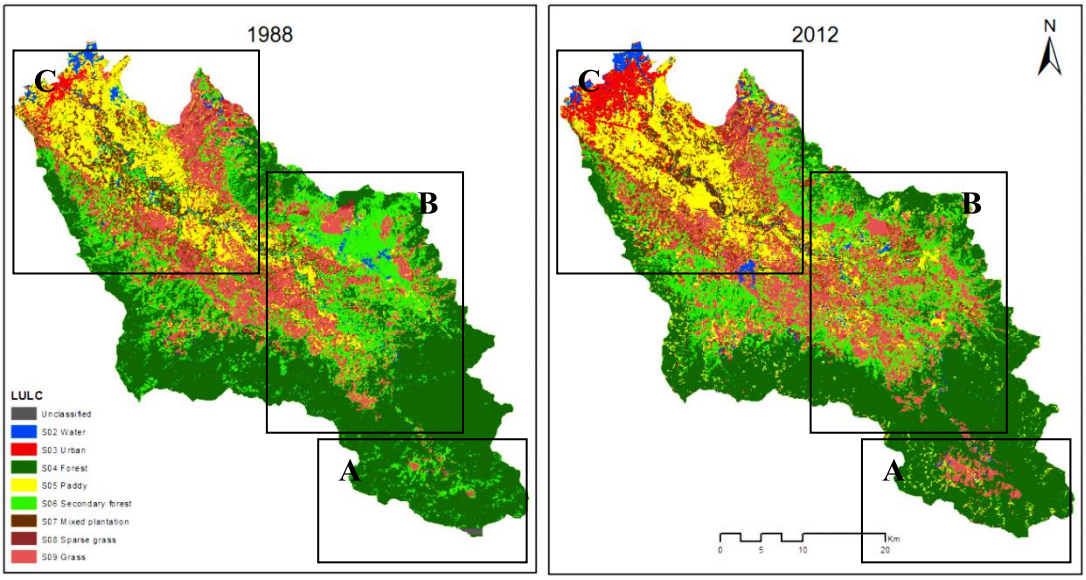

Figure 4.1 LULC classifications of 1988 (*left*) and 2012 (*right*) in the Krueng Aceh catchment based on interpretation of images on 9th February 1988 and 22nd March 2012.

The upstream area in the south west of the maps in Figure 4.1 was dominated by forests, and secondary forests in 1988 *(left)* and 2012 *(right)*. The changing of these areas to agricultural lands and bareland areas occurs over most of the catchment, especially in the upstream areas and low land areas along the Krueng Aceh main river. Box A in each of the maps indicates the area where most deforestation occurred between 1988 and 2012, while Box B indicates the change of secondary forest to cultivated lands (paddy fields and mixed plantation) and bareland areas (grass and sparse grass). Similarly, LULC changes also occurred in the middle of the catchment and riparian areas along the Krueng Aceh main river due to the conversion to paddy fields and urban areas (see Box C in the maps). Therefore, LULC changes occur over most of the catchment between 1988 and 2012, and cultivated lands and bareland areas increase notably in both of the maps. Table 4.1 shows the LULC change matrix over the Krueng Aceh catchment between 1988 and 2012.

Table 4.1 LULC change areas in the Krueng Aceh catchment between 1988 and 2012.

No.	*LULC*	*1988*		*2012*		*Rate of Change (%)*	
		Area (km^2)	*%*	*Area (km^2)*	*%*	*1988 -2012*	*Per year*
	Unclassified	4.79	0.28	4.50	0.26		
S01	Forest	783.05	45.02	632.36	36.35	-8.66	-0.36
S02	Water	32.94	1.89	37.98	2.18	0.29	0.01
S03	Urban	10.15	0.58	50.91	2.93	2.34	0.10
S05	Paddy	183.19	10.53	192.89	11.09	0.56	0.02
S06	Secondary forest	287.70	16.54	253.72	14.59	-1.95	-0.08
S07	Mixed plantation	113.30	6.51	143.12	8.23	1.71	0.07
S08	Sparse grass	31.29	1.80	49.90	2.87	1.07	0.04
S09	Grass	293.07	16.85	374.09	21.51	4.66	0.19
Total		**1739.49**		**1739.49**			

Table 4.1 indicates that forest, secondary forest and mixed plantation areas had decreased between 1988 and 2012, while urban and bareland areas (grass and sparse grass) have increased over the years. However, compared with other LULC classes, forest cover (forest and secondary forest) is still dominant in the Krueng Aceh catchment, covering 52% of the total area of the catchment in 2012, with grass and urban areas having the lowest percentage. Table 4.2 shows in detail how LULC classes in 1988 had converted to other LULC classes by 2012.

Table 4.2 Percentage LULC changes from 1988 to 2012.

		LULC 2012 (%)							
		F	*W*	*U*	*P*	*MP*	*SF*	*G&SG*	*Unc*
LULC 1988 (%)	*F*		4.24	0.16	12.21	6.24	56.80	19.34	1.00
	W	12.94		2.72	38.14	11.09	13.58	21.45	0.08
	U	6.51	17.16		18.34	5.33	13.61	38.46	0.59
	P	1.16	10.68	28.28		17.28	8.47	34.08	0.05
	MP	1.09	3.37	8.62	35.03		25.70	26.16	0.03
	SF	25.52	2.55	0.43	9.55	20.83		41.06	0.05
	G&SG	5.88	4.99	10.22	29.26	23.21	26.42		0.02

Note: F = forest, W = water body, U = urban, P = paddy field, MP = mixed plantation, SF = secondary forest, G&SG = grass and sparse grass, Unc = unclassified

Table 4.2 shows the forest area in LULC 1988 was converted primarily to secondary forest (SF=56.80%), grass and sparse grass (S&SG=19.34%), and paddy field (P=12.21%) in LULC 2012. Although the secondary forest (SF) areas in LULC 1988 had increased through conversion of primary forest (F) areas in LULC 2012, other secondary forest (SF) areas in LULC 1988 converted to grass and sparse grass (G&SG =41.06%), mixed plantation (MP=20.83%) and paddy field

(P=9.55%) in LULC 2012. Moreover, mixed plantation areas in LULC 1988 converted to paddy field (P=35.03%), grass and sparse grass (G&SG=26.16%), and urban area (U=8.62%) in LULC 2012. Thus, disappearing forest, secondary forest and mixed plantation areas resulted in significant increases of grass and sparse grass, paddy field and urban areas. Although the urban area was only 0.59% of total area of the catchment in LULC 1988, it had increased four-fold to 2.75% of the catchment in LULC 2012, which mostly comes from the conversion of paddy field (25.28%), sparse grass and grass (G&SG=18.37%) and mixed plantation (MP=8.62%).

Figure 4.2 shows the LULC metrics by subbasin where the subbasins in the upstream area (subbasins of Boga, Lampisang, Darang and Pasie) have experienced high intensity forest and secondary forest degradation. The Boga subbasin is the only catchment where forest remains stable, although secondary forest was reduced by 31.85% from LULC 1988 to LULC 2012.

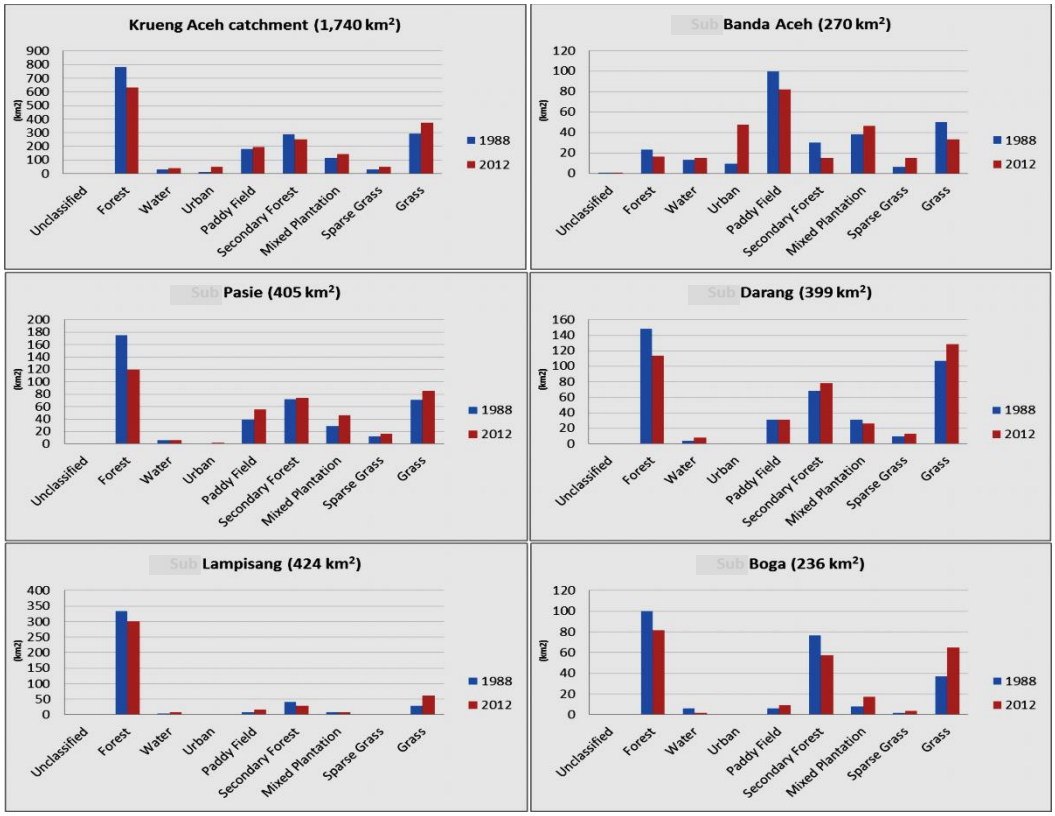

Figure 4.2 LULC in the subbasins of Krueng Aceh catchment between 1988 and 2012.

From Table 4.1, Table 4.2 and Figure 4.2, it can be concluded that deforestation of forest and secondary forest in the Krueng Aceh catchment from

1988 to 2012 occurred mainly through conversion to bareland areas. Increasing forest areas in Table 4.2 from a water body, urban, paddy fields, mixed plantations and grass areas may be attributed to misclassification because no evidence was found on reforestation programs run in the Krueng Aceh catchment during field work. However, there may be some errors present in the estimation of changes in cover between forest and secondary forest as vegetation in both areas may have a similar spectral response, and be classified into either class.

4.3. Rainfall Analysis in Krueng Aceh catchment

4.3.1. Rainfall condition

Sea Defence Consultants (SDC, 2009b) state that climate change has modified rainfall patterns in Banda Aceh, which is located in the Krueng Aceh catchment. SDC (2009b) found that average annual *P* has decreased in all seasons (wet and dry seasons). Moreover, the wet season in Banda Aceh area appears to be delayed and shortened based on observation of 30-year rainfall data in Banda Aceh area rainfall stations. However, no clear conclusion can be drawn on the intensity and frequency of the peak rainfall.

Boer and Suharnoto (2012) supported the findings from SDC (2009b) and found that the annual accumulated *P* in Banda Aceh area has decreased based on observation between 1983 - 2006 at the Blangbintang station. Boer and Suharnoto (2012) add that peak rainfall in January (representing the wet season period) tends to increase and peak rainfall in May (representing the dry season period) has decreased. Figure 4.3 shows the trend of peak rainfall in Blangbintang station.

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Figure 4.3 Trend of rainfall peaks in January and May at the Blangbintang station (Boer & Suharnoto, 2012)

For observation of rainfall depth over an area, meteorological stations should be evenly distributed over the whole catchment. A good distribution of rainfall stations in the Krueng Aceh catchment is available, however the data availability may be scarce. The SDC (2009b) states that three meteorological stations, covering an area less than 600 km^2 located in the upstream area (the Seulimum station), the middle area (the Indrapuri station) and the downstream area (Blangbintang station), represent the climatology of the catchment see Figure 3.11 in Chapter 3.

4.3.2. Rainfall depth

Figure 4.4 shows the annual rainfall depth *(P)* in the Koetaradja station between the period of 1879 and 1941, in which the annual rainfall in the Koetaradja station has decreased by about six percent between those years. No rainfall data are available after this period, therefore further analysis in downstream of the Krueng Aceh catchment can be referred to the Blangbintang station, as the stations are 12.8 km apart (see Figure 3.10 in Chapter 3).

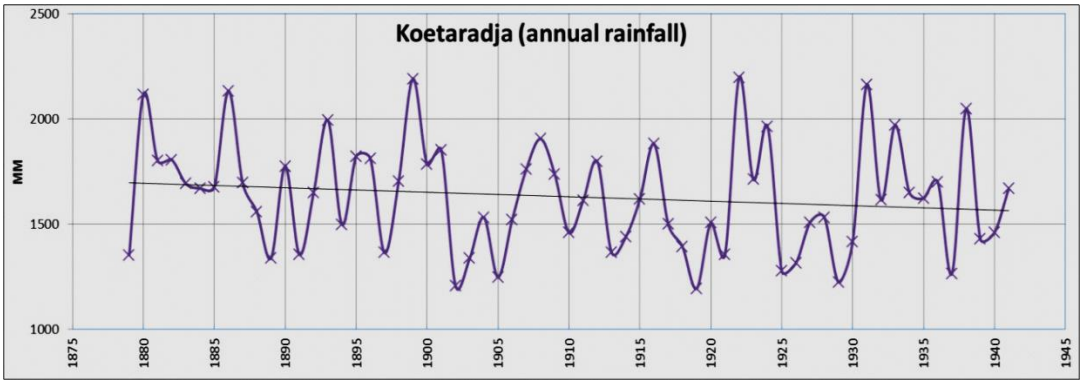

Figure 4.4 Trend of rainfall in the Koetaradja station 1879 – 1941

The trend of annual rainfall for the Blangbintang station 1960 – 2012 (Figure 4.5*a*) is similar with the trend recorded in Koetaradja station 1879 – 1941 (Figure 4.4). However, a trend of increasing annual rainfall in the Blangbintang station occurs over the last two decades (2000 to 2012) as shown in Figure 4.5*c*. Extremely low rainfall in 2001/2002 and 2005/2006, as shown in Figure 4.5*c*, may be influenced by El Nino, which occurred in the southern Asia and Pacific in those years, and the extreme high annual rainfall in 2010 may be caused by La Nina (Yulianti & Hayasaka, 2013; Safitri *et al.*, 2013).

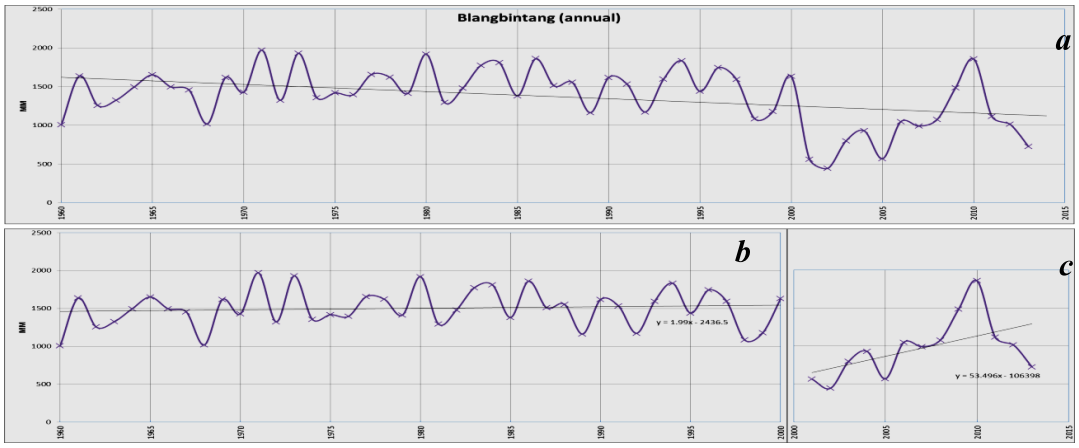

Figure 4.5 Annual rainfall at the Blangbintang station 1960-2012 (*a*) and trends of annual rainfall for 1960-2000 (*b*) and 2000-2012 (*c*)

Rainfall conditions in the middle of the Krueng Aceh catchment can be observed from the Indrapuri station for the period 1923-2013, however no clear trend line can be drawn between those years due to data limitations. The record in

the Indrapuri station can be grouped into two periods, which are the periods 1923 – 1961 (Figure 4.6*b*) and 1982 – 2012 (Figure 4.6*c*), where both periods show increasing trends. An anomaly occurs over the period 1960-1975 (dotted ellipse in Figure 4.6*a*) when the annual rainfall trends significantly down, which does not compare with regional climate conditions. Moreover, those observations are significantly different to rainfall records in the upstream part of the catchment. Low rainfall in 1983-1992 was influenced by La Nina that occurred in southern Asia and the Pacific (Safitri *et al.*, 2013).

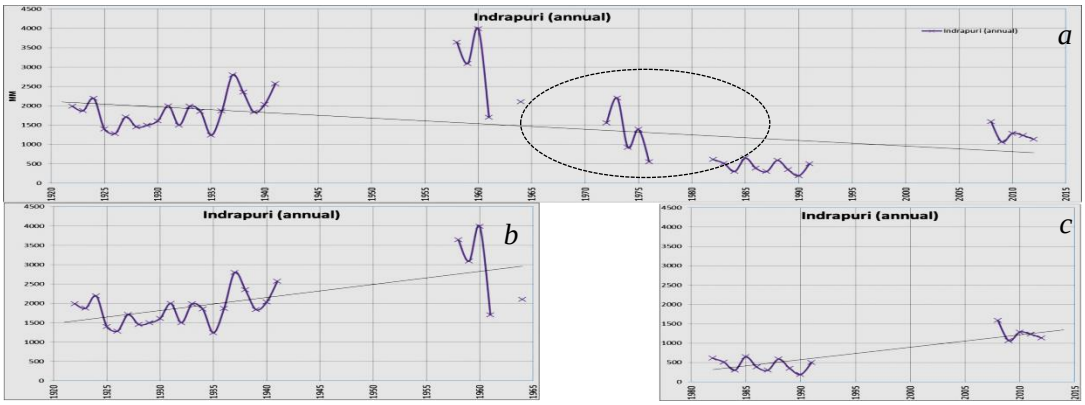

Figure 4.6 Annual rainfall for the BMG Indrapuri station (*a*) and trends of annual rainfall for 1920-1965 (*b*) and 1983-2012 (*c*)

The upstream catchment rainfall conditions can be represented by the BPP Seulimum station, however the data record is limited as shown in Figure 4.7. The trend over the period 1915-1941 (Figure 4.7*b*) shows that the annual rainfall decreased, which is similar to the trend in Koetaradja station in the same period (see Figure 4.4). However, the trend has increased after 1975 (Figure 4.7*c*), which is a similar trend with stations in the downstream and middle of the catchment (see Figure 4.4*c* and Figure 4.5*c*).

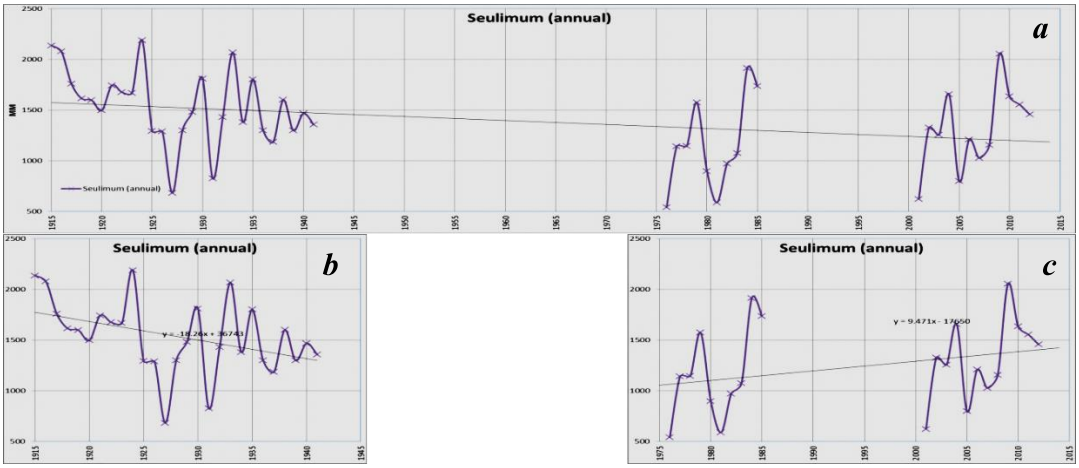

Figure 4.7 Annual rainfall value in the BPP Seulimum station (*a*) and trends of annual rainfall value in 1915-1942 (*b*) and 1976-2012 (*c*)

An interpretation of the homogeneity of these stations uses annual accumulated rainfall depth *(P)* data between 1989 and 2012 to illustrate the current condition of homogeneity. To test the homogeneity of the downstream station (Blangbintang Station) data between 1989 and 2012, the cumulative rainfall of this station is plot against the cumulative rainfall pattern of the middle station and upstream station. As the BPP Seulimum rainfall data is no longer available in recent decades, the upstream station is represented by the BPP Jantho station where both stations are located within 8.3 km distance. Figure 4.8 shows the homogeneity condition of these stations.

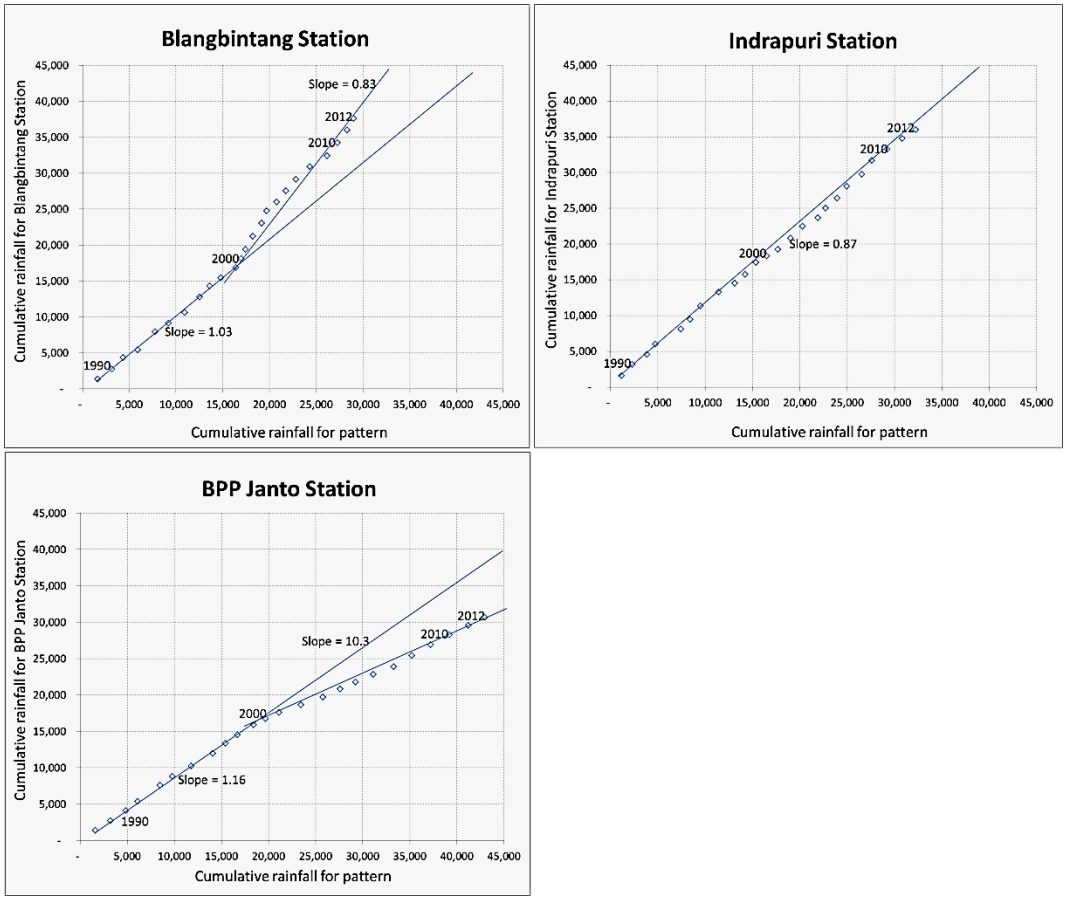

Figure 4.8 Homogeneity of Blangbintang (downstream), Indrapuri (middle) and BPP Jantho (upstream) stations based on annual accumulated *p* from 1989 to 2012.

There are two possible observations or explanations that can be drawn (referring to Figure 4.8) from the analysis of homogeneity of these stations. The first observation is that the downstream (Blangbintang) and upstream (BPP Jantho) stations data do not have homogenous patterns from the 2000s to 2012 where the trend breaks in slope, and the second explanation is that the rainfall patterns have changed during the years. Using these possibilities, the middle (Indrapuri) station shows a homogenous pattern from 1989 to 2012 (based on data availability as shown in Figure 4.6), and the pattern does not change during the years. In applying the second assumption that rainfall patterns have changed, the break in slopes in Figure 4.8 indicates that the downstream (Blangbintang) rainfall depth tends to decrease, and the upstream (BPP Jantho) rainfall depth tends to increase over the last decade (from 2000s). Moreover, the middle (Indrapuri) station remains stable in the last two decades (from 1989). However, annual accumulated rainfall may not be able to predict the intensity of these changes and

in what seasons they change as the difference of rainfall depths between wet and dry seasons are not considered.

Overall, based on the trend lines in Figures 4.4, Figure 4.5, Figure 4.6 and Figure 4.7, annual *p* decreased during the period 1870 – 1960 and increased over last three decades (1980s – 2012) in the downstream, middle and upstream parts of the catchment. However, the extent of these changes is difficult to determine and an open issue is the chaotic annual *p* between 1960 and 1980, due to limited data records and no relationship to regional climate conditions. Observations of two decades (1989-2012) from the stations in the catchment show that the lowest average annual *p* is in the downstream area (1029 mm), then the middle area (1262 mm or 22.6 percent higher than downstream part) and the upstream area (1375 mm or 9 percent higher than middle part) as shown in Table 4.3. This trend follows a similar pattern as the isohyet map produced by SDC (2009b; see Figure 3.11 in Chapter 3).

Table 4.3 Average annual rainfall and comparison of annual rainfall between downstream and middle rainfall stations, middle and upstream rainfall stations based on rainfall data 1989-2012

Rainfall Station	***Rainfall depth (p) (mm)***	***Percentage higher (%)***
Blangbintang (downstream)	1,029	-
BMG Indrapuri (middle)	1,262	22.6
BPP Jantho (upstream)	1,375	9

4.3.3. Discharge conditions

There are eight automatic water gauging stations operating in the catchment and gauging staff carry out water level gauging at selected locations (see Table 3.4 in Chapter 3). Unlike rainfall data, discharge data records are poor in quality and very limited. Figure 4.9 shows the discharge data at four selected stations at the Krueng Aceh main river. Discharge data are available between 1981 and 2010. The longer data series are the Darang station (1975-2006) compared with Boga (1990 – 2010), Lampisang (1981-1997) and Pasie (1981-1983) as shown in Figure 4.11.

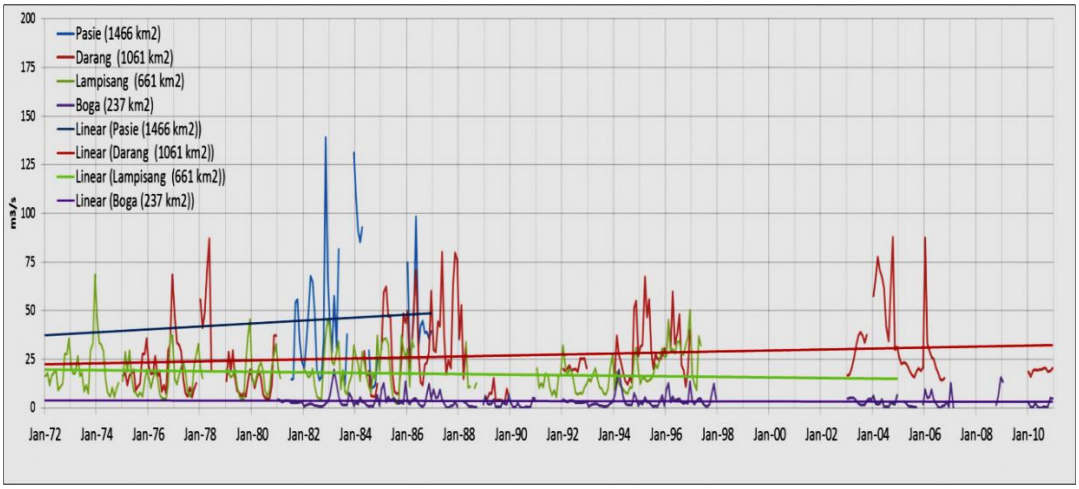

Figure 4.9 Daily average discharge records at four gauging stations in the Krueng Aceh catchment

Figure 4.9 shows that the average daily discharge *(q)* from 1981 to 2010 at four selected gauging stations in the Krueng Aceh catchment. The trend lines represent the trend in *q* at those stations, which average discharges are 3.46 m^3/s (Boga), 19.13 m^3/s (Lampisang), 29.53 m^3/s (Darang), and 46.43 m^3/s (Pasie). Table 4.4 shows that the Lampisang station area is 2.8 times larger than the Boga station area (area extrapolation factor: 2.8) and releases a *q* 5.5 times higher than the Boga station area (observed *q* extrapolation factor: 5.5). However, the Darang station area, which is 1.6 times larger than the Lampisang station area (area extrapolation factor: 1.6), releases a *q* value 1.5 times higher than the Lampisang station area (observed *q* extrapolation factor: 1.5). Moreover, the Pasie station area, which is 1.4 times larger than the Darang station area (area extrapolation factor: 1.4), releases a *q* value 1.6 times higher than the Darang station area (observed *q* extrapolation factor: 1.6).

Table 4.4 Extrapolation factors of areas and observed discharge (*q*) from the Boga and Lampisang stations for predicting *q* at Darang and Pasie stations

Gauging Station	***Area***		***Observed q***		***Predicted q***		***∑ q***	
	km²	***factor***	***m³/s***	***factor***	***factor***	***factor'***	***m³/s***	***m³/s***
Boga	237	-	3.5	-	-	-	-	-
Lampisang	662	2.8	19.1	5.5	-	-	-	
Darang	1,062	1.6	29.5	1.5	3.2	3.0	57.9	28.3
Pasie	1,468	1.4	46.4	1.6	2.7	1.8	101.6	55.2

factor = after correction using *p* values of the area covered by the gauging stations

A proxy-basin test, which is how the extrapolation corresponds to output variables between catchments that have similar parameters (Klemeš, 1986; Refsgaard & Knudsen, 1996; Refsgaard & Storm, 1996), can be used to predict the q released from catchments or test whether a catchment has similar reliability with its neighbours. As those stations have similar catchment parameters, input p of those stations can be corrected using Thiessen polygons of the area covered by the rainfall stations and percentage of rainfall depth in these areas. Using the proxy-basin test, the Darang station is predicted to release a q 3.0 times higher than the Lampisang, which is 57.9 m^3/s, using comparisons of q and area covered between the Lampisang and Boga stations. Similarly, the Pasie station should release a q 1.8 times higher than the Darang discharge, which is 101.6 m^3/s, using comparisons of q and area covered between the Darang and Lampisang stations. However, observed q at the Darang and Pasie stations are lower than predicted q due to water supplied to paddy fields, which is predicted on average at 28.3 m^3/s at the Darang station and 55.2 m^3/s at the Pasie station.

A relationship between q and p can be determined by comparing them on basis of short time records, however the shortest time data records of both q and p values are only available in daily records. Therefore, rainfall events in a catchment may not directly reflect the streamflow performance when lag time (t_p), which is the time from the centre of mass excess rainfall to the hydrograph peak (USACE-HEC, 2000), is shorter than the time interval of data records. USACE (1944, cited in USACE-HEC, 2000) has proposed alternative forms of the parameter predictive for lag time (t_p) as shown in Equation (4.1)

$$t_p = CC_t(LL_c)^n \tag{4.1}$$

Where C is conversion constant (0.75 for SI or 1.00 for US customary), C_t is catchment coefficient typically in the range of 1.8 - 2.2, although Bedient and Huber (1992, cited in USACE-HEC, 2000) found the C_t value 0.4 in extreme mountainous areas along the Gulf of Mexico. L is the length of the main river from the outlet to the divide, L_c is the length of the mainstream from the outlet to a point nearest of the catchment centroid, and n is an exponent, which is taken as 0.33. The parameters of C_t, L, and L_c can be generated by using SRTM DEM data or topographic maps. Table 4.5 shows the lag time (t_p) that is developed from the parameters of t_p, L, and L_c for subbasins based on interpretation from the

topographic map. The peaking coefficient (C_p) can be obtained by calculation of the model with measurements of the particular physical system, it typically ranges from 0.4 to 0.8 (USACE-HEC, 2010).

Table 4.5 Parameters of t_p developed from L, and L_c

No.	*Subbasin*	*L (km)*	*L_c (km)*	*t_p (hour)*
1	Boga	9.02	7.75	5.48
2	Lampisang	24.25	15.2	10.02
3	Darang	23.97	20.83	11.66
4	Pasie	22.57	19.49	11.74
5	Banda Aceh	36.59	15.52	13.38

Table 4.5 clearly shows that the t_p value of those subbasins are less than the daily period (24 hours), which means that storm duration cannot be directly observed as one event in discharge performance at the gauging stations. This is because daily data rainfall records are counted as accumulated rainfall, while discharges are recorded as discharge events. Therefore, the correlation between rainfall records and discharge records cannot be shown in a unit hydrograph (UH), which is a direct runoff hydrograph that is produced by one unit of excess rainfall over a specific rainfall event (USACE-HEC, 2000).

4.4. LULC Changes Impact on Water Resources

4.4.1. Runoff analysis

The best way to observe runoff change is to analyse observed runoff in the gauging stations with long-term data records, however these will be scarce. Another option is to simulate the change in hydrological characteristics by using a simulation model. This research uses the Hydrological Engineering Centre – Hydrological Modelling System (HEC-HMS) version 3.5 developed by the USACE-HEC (2000). The HEC-HMS modelling is developed to simulate the rainfall-runoff-routing relationship and has seven transforming methods to simulate excess precipitation into surface runoff, and for surface runoff itself, the model supports six hydrological routing methods.

a. Data input

HEC-HMS model runs with the data on rainfall, evapotranspiration, LULC and hydrological parameters of the catchment, and then the model is calibrated with discharge data records in the gauging stations. These data were from station networks that have passed from the data checking and processing before they were inputted to the model. Rainfall *(p)* data and discharge *(q)* data were selected from the most reliable stations, which were well distributed and had long time data distribution. The consistency of those data distributions between the stations was compiled using compilation curves.

There are three rainfall stations where the rainfall data were used for HEC-HMS inputs, which are Blangbintang station, BMG Indrapuri and TPH Jantho station. The *p* distribution was computed using the Thiessen Polygon method. The stations cover an area in the upstream area (the Seulimum station), the middle area (the Indrapuri station) and the downstream area (Blangbintang station). The Thiessen Polygon method is used to represent precipitation depth from unevenly distributed rainfall stations, which defines regions by a line midway between the rainfall station locations (Brassel & Reif, 1979). Table 4.6 shows the percentage of each area covered in the subbasins based on the Thiessen Polygon method. The Jantho station covers the subbasins of Boga (100%), Lampisang (100%), 61.66% of Darang and 9.73% of Pasie area. The BMG Indrapuri station influences the subbasins of Darang (61.71%), Pasie (77.34%) and Banda Aceh (5.68%). Moreover, the BMG Blangbintang station covers 13.33% of the Pasie subbasin and 95.32% of the Banda Aceh subbasins area.

Table 4.6 Areas covered by rainfall stations using the Thiessen Polygon method over subbasins.

Rainfall Station	***Boga***	***Lampisang***	***Darang***	***Pasie***	***Banda Aceh***
	237 km^2 (%)	425 km^2 (%)	400 km^2 (%)	406 km^2 (%)	272 km^2 (%)
Blangbintang	-	-	-	13.33	94.32
BMG Indrapuri	-	-	61.71	77.34	5.68
TPH Jantho	100	100	38.29	9.34	-

The evapotranspiration data used in the model is monthly accumulated data. The evapotranspiration rate in the Krueng Aceh catchment had been calculated by

Kasuri (2006), based on his observations between 1982 and 2005. The rainfall data and evaporation rates used as input into the HEC-HMS modelling are assumed to be spatially constant in the catchment. Table 4.7 shows the evapotranspiration rate in the Krueng Aceh catchment produced by Kasuri (2006).

Table 4.7 Evapotranspiration rate (in *mm/month*) within the Krueng Aceh catchment based on a calculation from meteorological data 1982-2005 (Kasuri, 2006)

Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
121.9	146.6	141.2	138.9	136.1	136.3	137.0	136.6	129.0	126.8	124.8	123.7

LULC used as input for the HEC-HMS modelling were the LULCs from 1988 and 2012, which were transformed into curve number *(CN)* values. As the *q* data availability for calibration is limited and can only be used in selected durations and locations due to the water supply for irrigation demand, the model calibration is done in January-February 1988 for LULC 1988. With an assumption that LULC in 1988 was not significantly changed from 1987, the calibrated modelling was simulated based on that year to observe the performance of the calibrated parameters that have been developed based on LULC 1988.

Soil maps, which indicate infiltration rates, are not available for the area, therefore the range of loss rates (Table 4.8) are developed from the Geological Map of Banda Aceh area based on lithological descriptions (Bennett *et al.*, 1981). Bennett *et al.* (1981) found that the study area has a soil cover between 30 cm and 200 cm, and with an assumption that the soils that cover the lithology are from weathering of rocks beneath, the infiltration rates of those soils can be predicted. An example is the alluvial group, which consists of unconsolidated materials that source from floodplain, estuary and marine, debris flow, alluvial fan and peat, which range in size from fine to boulders. These characteristics can be classified into deep sand, high infiltration and low runoff classification or soil group: A. Figure 4.10 shows the hydrological soil groups map that is interpreted from the geological map the study area.

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Figure 4.10 Hydrological soil group map *(right)* of the study area interpreted from the Geological Map of Banda Aceh Quadrangle *(left)* from Bennett *et al.* (1981)

Where CN_i is *CN* from the polygons of LULC classes, A_i is the area of the polygon and *A* is the total area of the catchment or subbasin. The SCS-CN map 1998 and 2012 can be shown in Figure 4.11, and Table 4.8 shows the *CN* composite for the subbasins in 1988 and 2012, and the rate of change between those years.

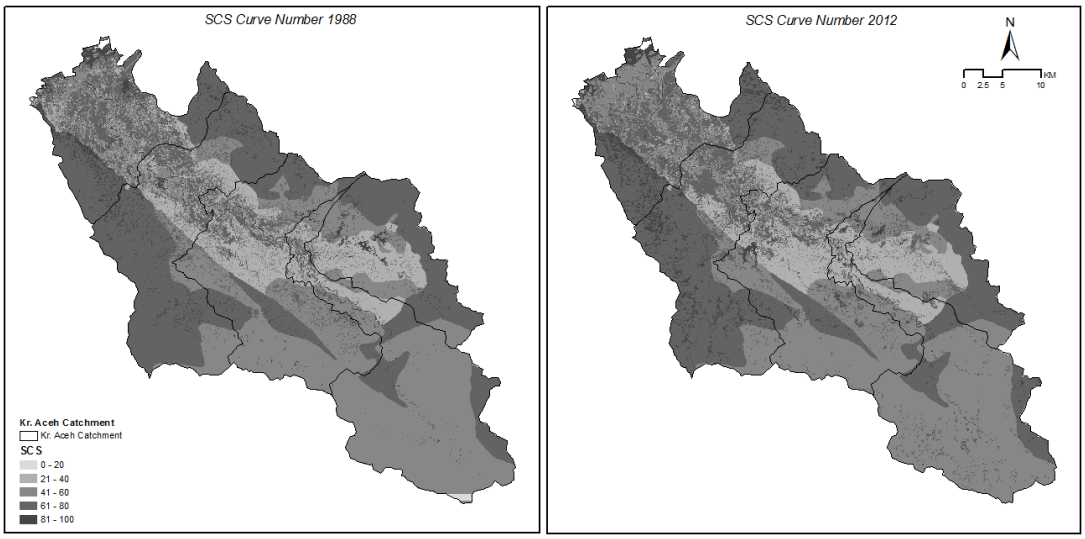


Figure 4.11 Spatial distribution of *CN* value of LULC 1998 *(left)* compared with and the *CN* value of LULC 2012 *(right)*

Table 4.8 Mean of *CN* value of subbasins in the Krueng Aceh catchment and their rate of change

No.	***Subbasin***	***LULC 1988***	***LULC 2012***	***∑ %***
1.	Boga	66.59	68.08	2.25
2.	Lampisang	68.94	70.93	2.88
3.	Darang	65.77	68.26	3.78
4.	Pasie	60.34	62.56	3.68
5.	Banda Aceh	63.41	63.71	0.47
Krueng Aceh Catchment		*65.01*	*66.74*	*2.61*

b. Running the HEC-HMS application

In this research, the Krueng Aceh catchment is divided into five subbasins, with four subbasins in the upstream area within the Aceh Besar Regency and another one is the Banda Aceh subbasin as a downstream area where Banda Aceh City is located. The schematic of the catchment model for the Krueng Aceh catchment in the HEC-HMS modelling can be explained as shown in Figure 4.12.

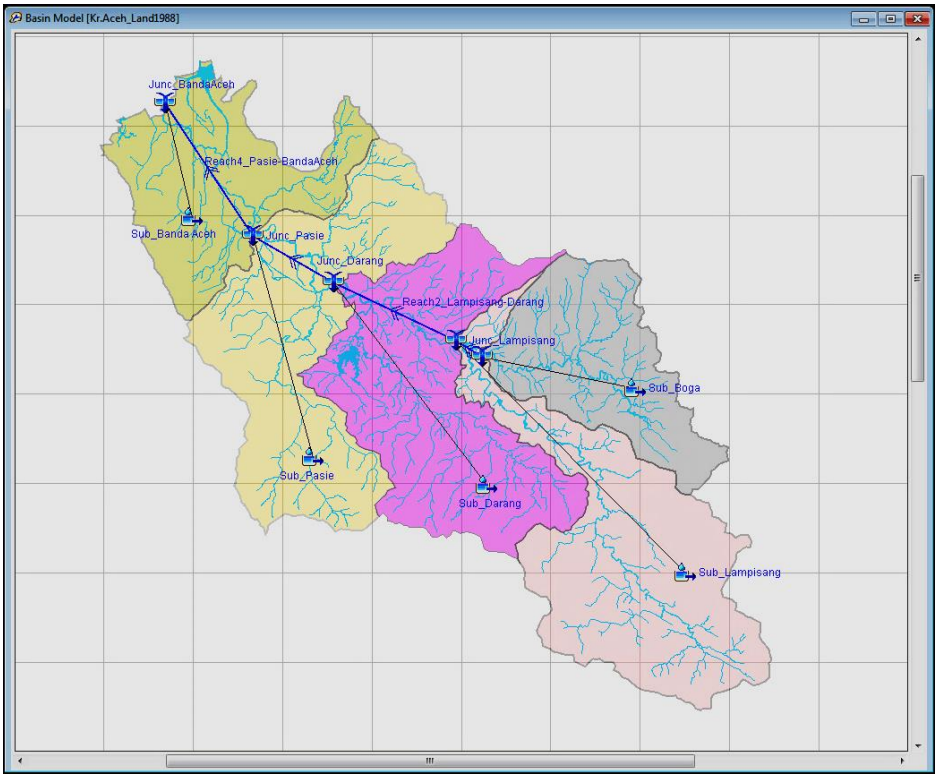


Figure 4.12 Schematic design of the Krueng Aceh catchment using hydrological elements in the HEC-HMS modelling

The HEC-HMS model simulates the hydrological parameters based on the schematic that has been developed in Figure 4.12 through the *Simulation Run* option, and then those results are optimized using the *Optimization Trial* option to fit the modelled runoff results with the observed runoff records for the selected locations. The model runs for the specific period when data is available for the Darang station between 1st January 1988 and 25th February 1988.

c. Simulation and optimization

The simulation begins by running the existing data to produce simulated output, and then an optimization is done to reach optimized results from the simulated parameters using selected observed *q* of the Darang station in 1988. Figure 4.13 shows the results of optimization parameter values that were developed from the simulated conditions.

Optimized Parameter Results for Trial "Trial_Darang88 (before)"

Project: Kr_Aceh17Feb14 Optimization Trial: Trial_Darang88 (before)

Start of Trial: 01Jan1988, 00:00 Basin Model: Kr.Aceh_Land1988
End of Trial: 25Feb1988, 00:00 Meteorologic Model: Thiessen
Compute Time: 17Feb2014, 12:34:37 Control Specifications: Con_Jan-Feb1988

Element	Parameter	Units	Initial Value	Optimized Value	Objective Function Sensitivity
Reach1_Bog...	Muskingum K	HR	11.675	13.148	-0.00
Reach1_Bog...	Muskingum X		0.24141	0.50000	-0.00
Reach2_Lam...	Muskingum K	HR	11.143	27.609	-0.01
Reach2_Lam...	Muskingum X		0.2298	0.50000	-0.02
Sub_Boga	Baseflow Initial Flow	M3/S	6.7961	4.8530	-0.00
Sub_Boga	Baseflow Threshold R...		0.10	0.1000000	0.00
Sub_Boga	Curve Number		59.56		
Sub_Boga	Initial Abstraction	MM	20.353	14.731	0.00
Sub_Boga	Recession Constant		0.2	0.0625569	0.00
Sub_Boga	Snyder Peaking Coef...		0.15887	0.1000000	0.00
Sub_Boga	Snyder Time to Peak	HR	3.0183	3.2323	-0.00
Sub_Darang	Baseflow Initial Flow	M3/S	2.4443	2.3887	-0.01
Sub_Darang	Baseflow Threshold R...		0.1	0.0723798	0.00
Sub_Darang	Curve Number		58.29		
Sub_Darang	Initial Abstraction	MM	48.259	46.797	-0.00
Sub_Darang	Recession Constant		0.75	0.98932	0.01
Sub_Darang	Snyder Peaking Coef...		0.7	0.70000	0.00
Sub_Darang	Snyder Time to Peak	HR	15	15.000	0.00
Sub_Lampisang	Baseflow Initial Flow	M3/S	2.3091	2.3123	-0.00
Sub_Lampisang	Baseflow Threshold R...		0.10	0.10048	0.00
Sub_Lampisang	Curve Number		58.90		
Sub_Lampisang	Initial Abstraction	MM	135.47	134.93	-0.00
Sub_Lampisang	Recession Constant		0.75	0.98763	0.01
Sub_Lampisang	Snyder Peaking Coef...		0.5996	0.59960	0.00
Sub_Lampisang	Snyder Time to Peak	HR	14.24	14.240	0.00
Reach1_Bog...	Number of Steps		1		
Reach2_Lam...	Number of Steps		1	6	

Figure 4.13 Initial values from the *Simulation run* option (simulated parameter value) input into the *Optimization trial* option to create the optimized values.

The result after simulation reflects the condition of the modelled result as shown in Figure 4.14 *(left)*, and the optimized parameters reflect conditions after the optimization run, which is the best fit with the observed runoff values, as shown in Figure 4.14 *(right)*.

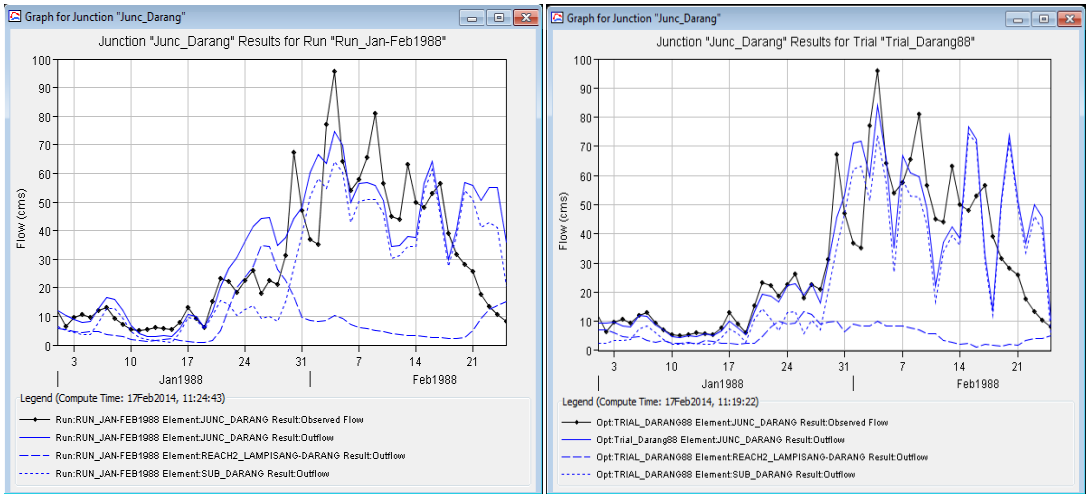


Figure 4.14 Result from developed parameters after simulation (*left*) and after optimization (*right*).

Figure 4.14 shows the model behaviour illustrated as a blue line, blue dashed line and blue dotted line compared with observed *q* condition at the Darang station (black line). The blue line is the modelled runoff simulated from the model as the model performance compared with the observed *q*, the blue dashed line the simulated runoff (outflow) from upstream subbasins, which in this modelling is from the subbasins of Boga and Lampisang, that flow though the stream channel (Reach2_Lampiang-Darang). The streamflow though the stream channels in this model assume no influent to or effluent from groundwater. Moreover, the blue dotted line is the total runoff (outflow) resulting from the Darang catchment, which is from direct runoff and baseflow. Therefore, the simulated runoff result at the Darang station (Darang Junction; Jucn_Darang) is sourced from the accumulative outflow from the upstream subbasin that is transported via the stream channel and outflow from the Darang subbasin (see detailed schematic in Figure 4.13).

d. Results

1. Model performance

Based on simulation and optimization processes, results do not show good performance during high flow, due to the observed *q* data being daily records. There are two methods by which the *q* data are collected in the Krueng Aceh catchment: using the automatic water level record (AWLR) instrument and by manual recording which may potentially result in inaccuracy in the modelled result performance in high flow conditions. The AWLR instrument records the average *q* in daily records where peakflow and lowflow events during a day have been averaged. The manually recorded values only observe streamflow events at specific times, and peakflow and lowflow events that occur before and after those times can be missed. Moreover, another inaccuracy may result from rainfall data that are only available in accumulated daily records, which capture the total rainfall during a day, and do not reflect rainfall distribution during a day. Therefore, overall the modelling results cannot satisfy the Nash-Sutcliffe coefficient, but it shows good performance in low flow conditions and reflects the behaviour of observed discharge. Figure 4.15 shows partial modelling results in low flow conditions compared with the overall results.

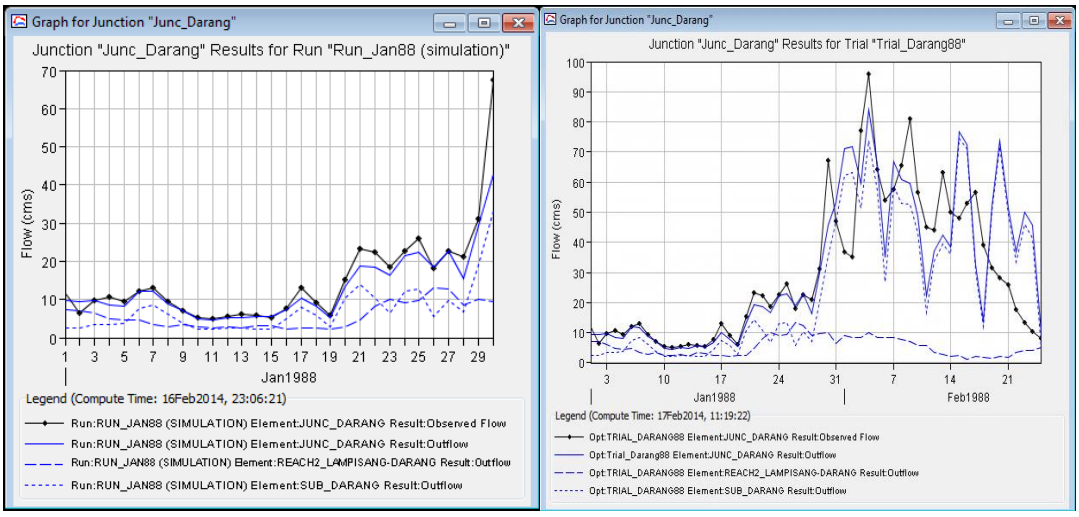


Figure 4.15 Modelling results after optimization from 1st January to 29th January 1988 (E = 0.68; low flow conditions, *left*) and from 1st January to 25th February 1988 (*right*).

Figure 4.15 (*right* – after optimization) shows a good fit of modelled *q* against observed *q* with the Nash–Sutcliffe efficiency (Nash & Sutcliffe, 1970; García *et al.* 2008) coefficient *(E)* is 0.68 from 1st to 29th January 1988 (low flow period) compared with the high flow period from 30th January to 25 February 1988. However, the model qualitatively has reflected the trend of observed runoff in the whole simulation period (*left* – after optimization).

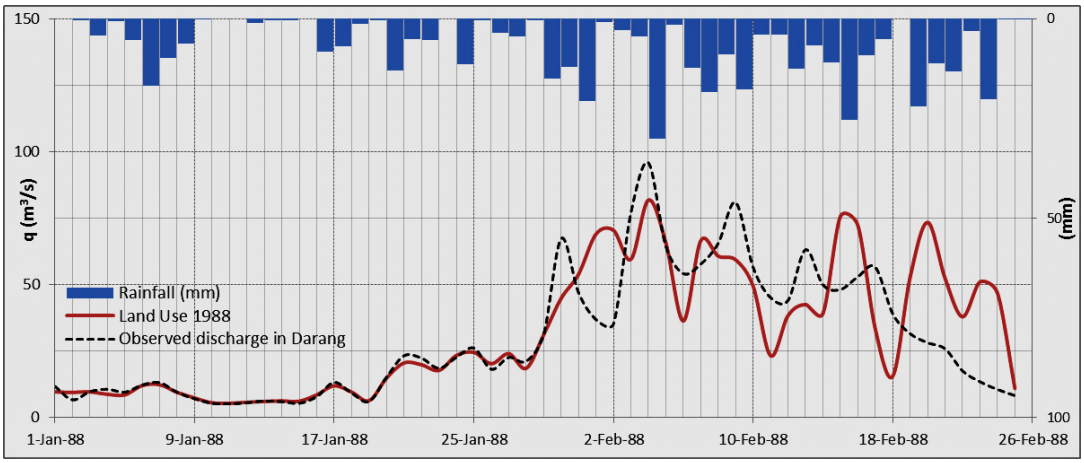


Figure 4.16 The magnitude of the *p* influences the performance of the model output for the 1st-29th January 1988 compared to observed *q* at the Darang station.

Moreover, Figure 4.16 shows the relationship between runoff and rainfall conditions at the Darang station (Darang junction). The Darang station covers 1062 km^2 of the Krueng Aceh catchment area (1740 km^2), and the Darang area is influenced by three rainfall stations, which are TPH Jantho, BMG Indrapuri and BMG Blangbintang. As has been stated previously, the daily data may not show the connection between average accumulated *p* and observed *q* especially under high rainfall conditions, however, Figure 4.17 qualitatively shows relationships between rainfall trend and both observed *q* and modelled runoff performance.

With an assumption that LULC 1988 was not significantly changed from LULC conditions in 1987, the performance of calibrated parameters for LULC 1988 is tested using *q* data from 1987 at Darang station.

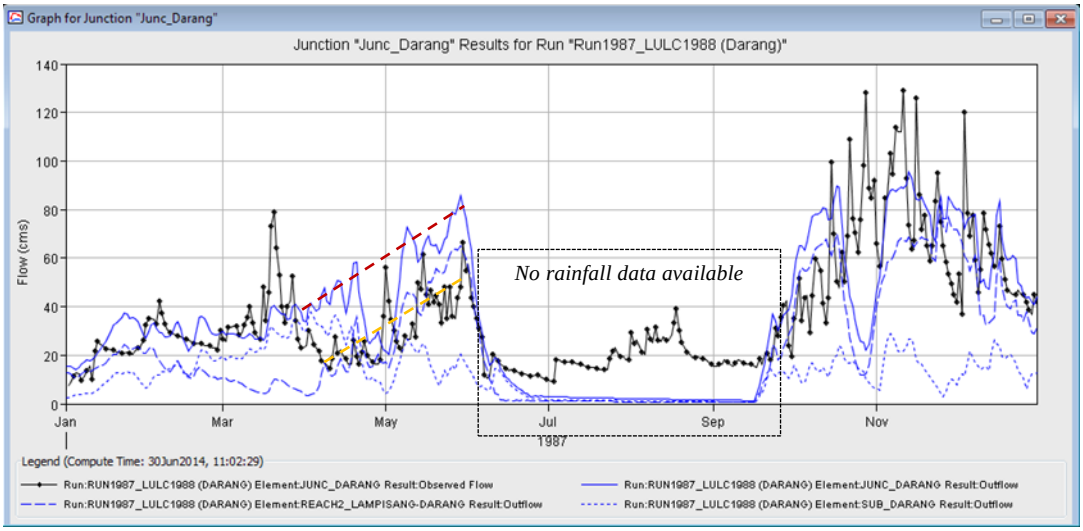


Figure 4.17 Observed *q (black line)* and modelled *q (blue line)* records at the Darang station for 1st January - 31st December 1987 (no rainfall data available for 13th June-15th September 1987) simulation of LULC 1988.

Figure 4.17 shows that the modelled *q* value demonstrates similar behaviour to the observed *q* value. It was found that the modelled *q* from March to June (dotted red line) is higher than the observed *q* (dotted yellow line), which may be because of water supply to paddy fields that starts in March (first three-month period) and September (second three-month period) for three months each period. However, the difference in the second period cannot be shown clearly because of the high intensity of *q* in that period (September-December). From Figure 4.17, the gap between the doted red line and the yellow line is computed as 24.4 m^3/s, which means paddy field demand in 1987 is about 24.4 m^3/s for the 155.24 km^2 of total paddy field in the subbasins of Darang, Pasie and Banda Aceh. From the proxy-basin test, the paddy field demand for the same area is predicted at 28.3 m^3/s (see Table 4.3).

2. Runoff change

Runoff change analysis based on LULC change between 1988 and 2012 was run using the same rainfall data from 2012. Figure 4.17 shows the modelled runoff in 1988 and 2012 where the regime flow in 2012 is higher than the regime flow 1998. Figure 4.18 clearly shows that the regime flow for LULC in 2012 results in

higher peak q values in high flow conditions and lower q values in low flow conditions than the LULC in 1988.

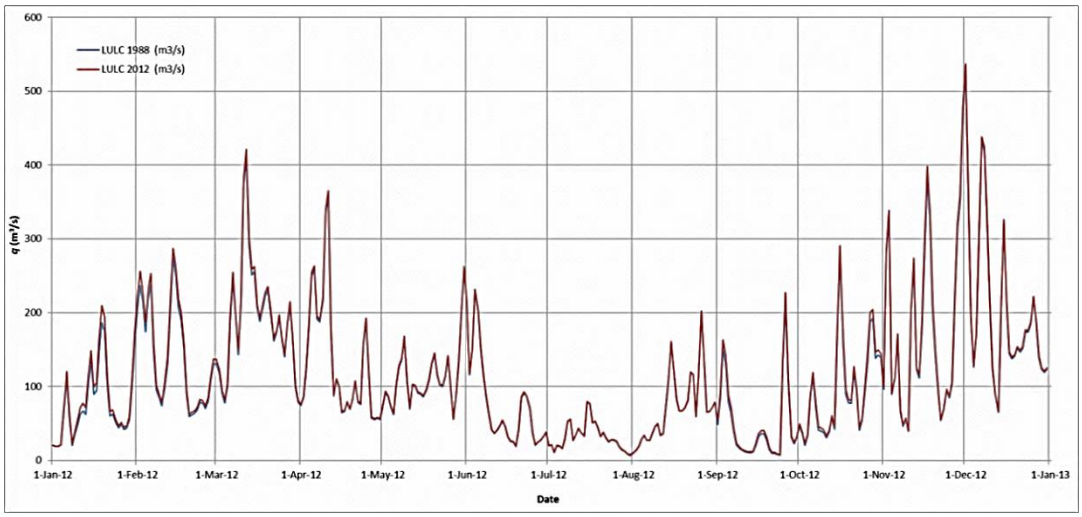


Figure 4.18 Modelled runoff based on LULC 1988 and LULC 2012 at the Banda Aceh outlet for 1st January to 31st December 2012 (Detail values can be found 1n Appendix 4.2)

Figure 4.18 shows that the highest peak q that occurred on 1st December 2012 had increased from q_{-1988} = 551.5 m^3/s to q_{-2012} = 553.5 m^3/s (increase by 0.36%), however the minimum q value on 31st July 2012 dropped from q_{-1988} = 8.3 m^3/s to q_{-2012} = 6.8 m^3/s (decrease by 18.07%). Detail values can be found in Appendix 4.2.

4.4.2. Sediment transport analysis

This research found that water quality conditions within the Krueng Aceh catchment between 2005 and 2012 were under the acceptable limit of the Government Regulation No. 62, Year 2001: Water quality standards for drinking water (see Table 3.4 in Chapter 4). However, there are two critical parameters, which are Faecal Coliform and Total Suspended Solids (TSS). The Faecal Coliform and TSS are non-point source contaminants where the Faecal Coliforms indicate that the aquatic environment has been contaminated by faecal material from humans and animals, and the TSS sources from soil erosion and agricultural activities, which closely relate to the LULC changes and seasons (Braskerud, 2001). This research therefore focuses on LULC changes that impact on TSS

variability in the Krueng Aceh catchment, which can be calculated as annual sediment transport and as sediment transport in specific runoff conditions.

The *R*-index in the Krueng Aceh catchment can be determined using annual *p* at the rainfall stations used in this research, and the subbasin area covered by each rainfall station can be determined by the Thiessen Polygons. Table 4.9 shows *R*-index in subbasins based on *p* values at TPH Jantho, BMG Indrapuri and BMG Blangbintang stations.

Table 4.9 Annual precipitation (*p)* and *R*-index per subbasin in 1988 and 2012 and average annual *p* for 1980-2012 after correction by Thiessen Polygons.

Station	Rainfall (MM)		Sub Boga		Sub Lampisang		Sub Darang		Sub Pasie		Sub Banda Aceh	
	1988	2012	1988	2012	1988	2012	1988	2012	1988	2012	1988	2012
TPH Jantho	1,366	2,366	1,366	2,366	1,366	2,366	522	905	175	317		
BMG Indrapuri	590	1,645					365	1,016	478	1,333	37	102
BMG Blangbintang	844	1,013							82	99	791	1,299
Total			1,366	2,366	1,366	2,366	887	1,921	736	1,749	828	1,401
R-index ($R = 2.21 * p^{1.36}$)			40,595	85,714	40,595	85,714	22,568	64,554	17,521	56,824	20,552	42,035

The SDR is the ratio of sediment delivered at the catchment outlet that involves various processes of onsite potential erosion loss (E) and downstream sediment yield (Y). The SDR is influenced by geomorphological factors of the catchment including the environmental factors such as LULC and soil textures (Walling, 1983).

The map produced in Figure 4.19 sources erosional gross rate *(E)* at plot-scale based functions of *E=LsCKR*, where the soil index *(Ls)* contains the factor of slope length *(L)* and the polygons area of LULC classes and slope gradient *(s)* that can be combined in one index determined on basis of a DEM or contour data, crop management factor *(C),* soil erodibility factor *(K),* erosivity *(R [mm/h]).* The detailed distribution of *E* in the Krueng Aceh catchment for LULC 1988 and LULC 2012 compares with *E* when both conditions run on the same *p,* as shown in Figure 4.19.

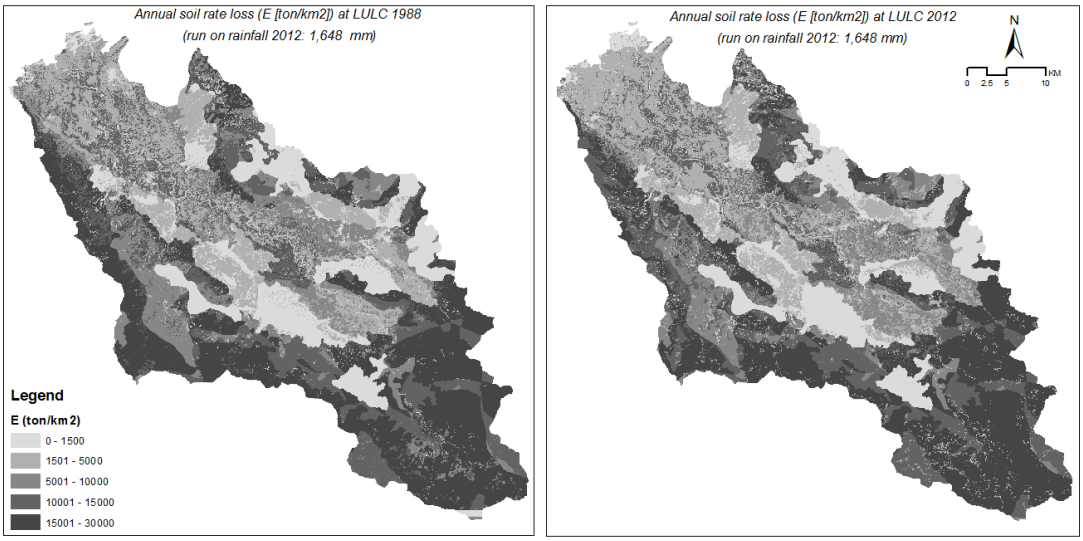


Figure 4.19 Annual soil loss *(E)* 1988 and *E* 2012 run on average *p* value 2012 (1,648 mm).

Table 4.10 shows the detailed comparison of *E* for the 1988 run for accumulated annual *p* of 1988 compared with *E* for 1988 run for accumulated annual *p* of 2012, and *E* for 2012 run for accumulated annual *p* of 2012.

Table 4.10 Detailed annual soil loss *(E)* value conditions

LULC	***Rainfall (MM)***	***E (tonnes/km^2)***				
		Min	***Max***	***Median***	***Std. Dev***	***Mean***
1988	941	0	13,235	13	1,981	1,119
1988 (in rainfall 2012)	1,648	0	27,380	28	4,246	2,399
2012	1,648	0	28,318	21	4,319	2,442

Based on calculations that are summarized in Table 4.10, the average annual soil loss *(E)* in 1988 (*p*: 941 mm) is 1,119 tons/km^2 and the number increased to 2,399 tons/km^2 when the annual *p* of 2012 is 1,648 mm, or the *E* value increased by about 118% between those years. However, calculations based on the same *p* value, which is *p* of 2012 (*p*: 1,648 mm), found that the average *E* value within the Krueng Aceh catchment based on LULC 1988 and 2012 increased from 2,399 tons/km^2 to 2,422 tons/km^2. The increasing soil loss based on the same *p* value may not be very significant; however, as the *E* depends on the intensity of *p*, potential annual soil loss (*E*) may rely on potential maximum rainfall events.

1. Annual Sediment Yield (Y)

An annual sediment yield *(Y)* can be calculated from the average of Sediment Delivery Ratio *(SDR)* and *E* using the equation (Walling 1983; Lu *et al.*, 2006):

$$SDR = \frac{Y}{E} \tag{4.2}$$

The *SDR* is the ratio of sediment delivered at the catchment outlet that involves various processes of onsite potential erosion loss *(E)* and downstream sediment yield *(Y)* (Van Rompaey *et al.*, 2001). The *SDR* value that is used on this calculation is based on the values that developed by USDA, which are based on the function of catchment drainage area (USDA SCS 1972) as shown in Figure 2.14 in Chapter 2. Figure 4.20 shows the spatial distribution of the *SDR* value for the Krueng Aceh catchment.

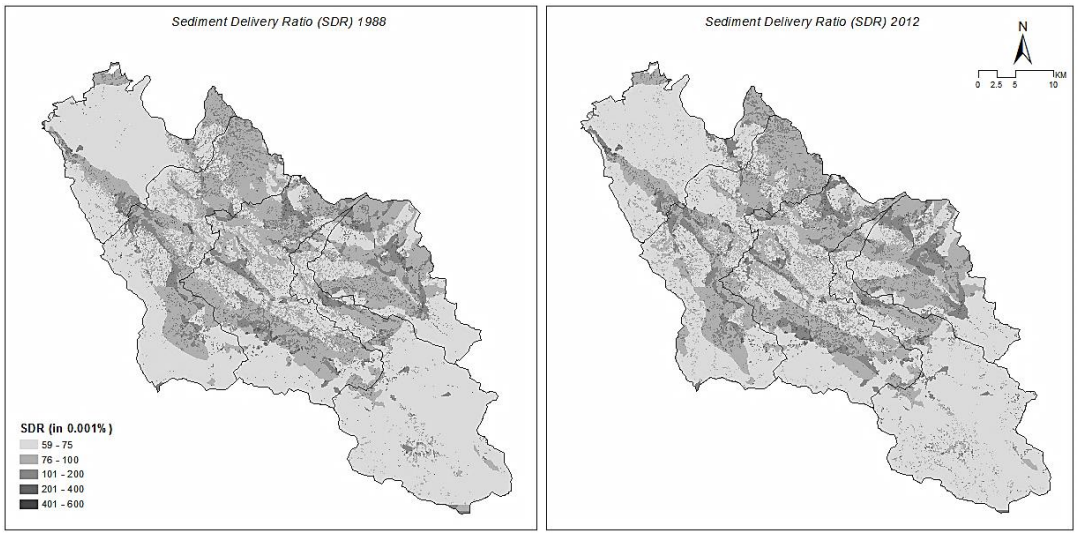


Figure 4.20 Spatial distribution of *SDR* for LULC 1988 and 2012

Table 4.11 below shows the minimum, maximum, median, standard deviation and mean values of the *SDR* 1988 and *SDR* 2012.

Table 4.11 Detailed *SDR* conditions

SDR	*Min*	*Max*	*Median*	*Std. Dev*	*Mean*
1988	0.059	0.580	0.250	0.164	0.297
2012	0.059	0.580	0.250	0.168	0.302

Based on Figure 4.20 and Table 4.11, the *SDR* values of LULC 1988 and 2012 do not show significant differences, which may be due to the lack of significant change in LULC areas over the period.

Lu *et al.* (2006) add that this equation can be used with an assumption that the *Y* values source from hillslope sheets, and the *SDR* is basically interpreted as an efficiency of the LULC classes to transport the sediment to the outlet. Therefore, the total sediment yield $(Y_{composite})$ can be stated as:

$$Y_{composte} = \sum_{i=1}^{n} (SDR_1 \; x \; E_1) \tag{4.3}$$

In connection with LULC changes, Equation 4.10b can be used to relate sediment availability and deposition at different spatial scales. The result of *Y* value for LULC conditions 1988 and 2012 is shown in Figure 4.21 and Table 4.12.

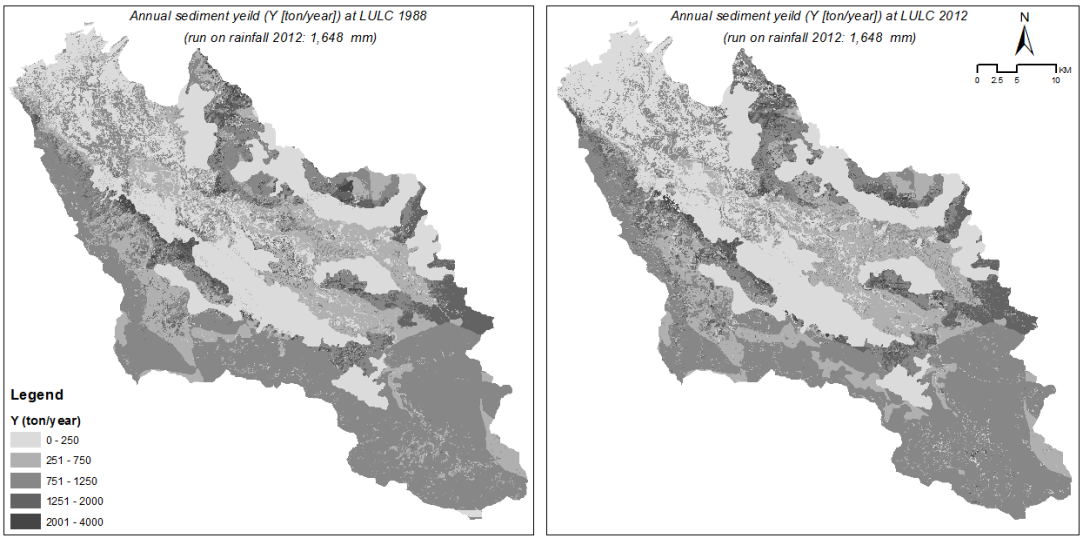


Figure 4.21 Annual sediment yield *(Y)* for LULC 1988 and LULC 2012, for those LULCs computed *Y* is for the *p* of 2012.

Detailed values from Figure 4.21 shown in Table 4.12 show the comparison of *Y* between LULC 1988 and LULC 2012, and those for LULCs run at the same rainfall depth of accumulated annual rainfall of 2012.

Table 4.12 Annual sediment yield (*Y)* calculated at different annual *p* values.

Y (tonnes/year)	*Rainfall depth (mm)*	*Y (tonnes/year)*					
		Min	*Max*	*Med*	*Std.Dev*	*Mean*	*Total*
1988	941	0	1,819	2	278	158	424,765
1988 (with rainfall 2012)	1.468	0	3,900	5	596	340	910,811
2012	1,648	0	4,031	4	614	348	972,225
2012 (run on rainfall depth 2200 mm)	2,200	0	5,970	6	909	516	1,439,876

Table 4.12 shows the increase in the *Y* value from 0.42 x 10^6 tonnes/year in LULC 1988 to 0.97 x 10^6 tonnes/year in LULC condition 2012 when the *p* value increased from 941 mm to 1,648 mm (75.1%), where the *Y* value has increased by 128.9%. However, when both LULC conditions run at the same *p* value (1,468 mm at the accumulated *p* of 2012), the increase in *Y* value is about 6.7% from *Y* = 0.91 x 10^6 tonnes/year (1988) to *Y* = 0.97 x 10^6 tonnes/year (2012).

However, the reliability of the sediment transport model has to be validated by using observed sediment transport data in the field. A comparison between observed and modelled sediment transport in the Krueng Aceh catchment cannot be done due to lack of data availability on sediment transport. The reliability of this application in the Krueng Aceh catchment is compared with observed sediment transport records and modelled results from the Citarum catchment (Java Island, Indonesia) based on findings by Poerbandono *et al.* (2006). As both catchments are located in the area where climate conditions are similar (tropical areas), and physiographical conditions and annual average p values of the catchments are similar, it can be predicted that the soil erodibility factor *(K)* and erosivity factor *(R)* are comparable. Table 4.13 shows the condition of both catchments.

Table 4.13 Characteristics of the Krueng Aceh catchment in 2012 and the Citarum catchment in 1994

Items	***Krueng Aceh catchment (2012)***	***Citarum catchment (1994)***
Area (Km^2)	1,740	1,771
Average slope (%)	10	11
Rainfall depth (mm)	1,648	2,200
Forest Cover (%)	51.7	46.3
Y (tonnes/year)	0.97×10^6	1.5×10^6

Table 4.13 shows that the significant difference is in the forest cover that may contribute to a *Y* value in the Citarum catchment that is higher than the Krueng Aceh catchment; the difference in the forest cover is 5.4% and the greater difference is in rainfall depth, which is around 25.10%. The LULC 2012 run on the accumulated annual *p* of the Citarum catchment (2,200 mm), results in a *Y* value of 1.44×10^6 tonnes/year (see Table 4.13). This value is similar with the observed trend line of *Y* values in the Citarum catchment, predicted as $Y = 1.50 \times 10^6$ tonnes/year in 1994 (see *blue triangle mark* compared with *Y* value in 1994, Figure 4.22) when at that time forest cover area of Citarum catchment was 46.3%. Thus, this comparison can be used for determining the reliability of parameters developed to describe sediment delivery transport in the Krueng Aceh catchment, and are likely to be similar to the actual conditions in the catchment.

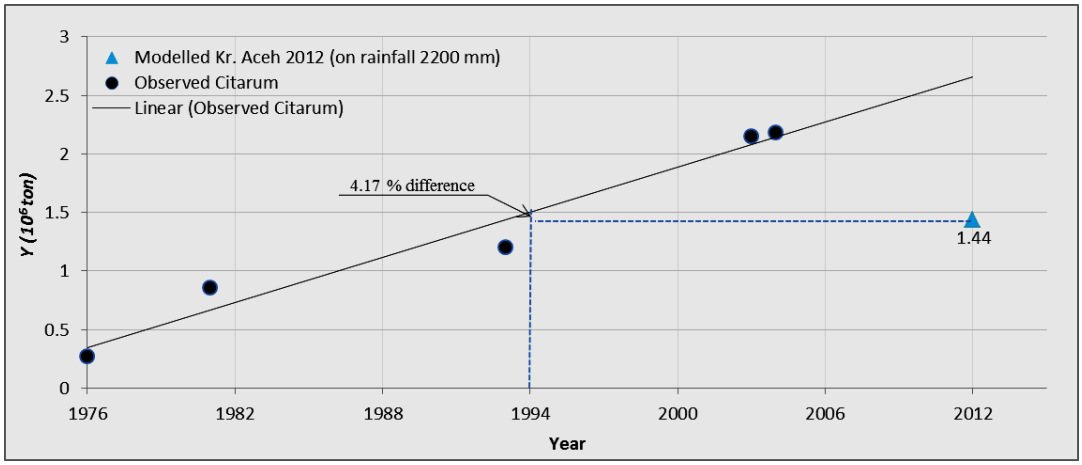


Figure 4.22 Comparison of modelled *Y* value 2012 in Krueng Aceh catchment and observed *Y* values in the Citarum catchment (modified from Poerbandono *et al.*, 2006)

Based on calculations using the USLE method in the annual sediment transport model, a summary of overall results per subbasin are shown in Table 4.14.

Table 4.14 Summary of overall modelling results per the subbasin

No.	***Subbasin***	***1988***			***2012***		
		E	***SDR***	***Y***	***E***	***SDR***	***Y***
1.	Boga (237 km^2)	4.85	0.26	2.32	5.32	0.26	2.43
2.	Lampisang (424 km^2)	5.81	0.24	1.86	5.98	0.25	2.04
3.	Darang (400 km^2)	3.69	0.25	2.79	3.82	0.25	2.91
4.	Pasie (405 km^2)	3.48	0.27	1.86	3.60	0.27	1.94
5.	Banda Aceh (273 km^2)	1.68	0.29	0.28	1.70	0.30	0.49

Note: *E* in 10^{-3} tonnes/km^2/year, *Y* in 10^{-5} tonnes/year

2. Sediment-Runoff Model

A sediment yield (*Y*) can be calculated using observed *q* data or modelled runoff data through runoff modelling. The analysis can predict the amount of *Y* for specific time resolutions, which can be daily, monthly or some events of sediment yield. Tilrem (1979) introduces an equation to calculate sediment discharge *(q_s)* from daily measurements, which is:

$$q_s = q\, C_s \tag{4.4}$$

$$q_{s\,total} = k \sum_{i=1}^{n} (q_1 C_{s\,1}) \tag{4.4a}$$

Where q_s is sediment discharge (*tonnes/day)*, *q* is discharge (m^3/s), C_s daily mean concentration of suspended sediment (*mg/l*), *k* is a conversion factor taken as 0.0864.

This research computes the q_s value in the Pasie station where the station is nearest to the intake of PDAM Tirta Daroy (the Banda Aceh City's public for water service), which is about 8.7 km downstream of Pasie station. This value is used for further environmental and economic analysis in Chapter 5. The *q* values are calculated in the HEC-HMS modelling from the daily *p* between 2nd January and 29th April 2012, which is matched with time series of observed turbidity data that was collected by the PDAM Tirta Daroy company. The relationship equation between turbidity values and Total Suspended Solid (TSS) values were created by the Laboratory of the Environmental Protection Agency (BAPEDAL) Aceh based

on water sampling at the PDAM Tirta Daroy intake for 29th January – 8th February 2014 for twenty samples. The samples were collected with no specific mention of rainfall events and runoff volume at the sampling point. The laboratory results are shown in Figure 4.23.

Figure 4.23 Relationships between observed turbidity and TSS at the PDAM Tirta Daroy intake tested by the Laboratory of the Environmental Protection Agency (BAPEDAL) Aceh (2014).

TSS values can be developed from the observed turbidity data from the PDAM Tirta Daroy Company using the equation in Figure 4.23. The resulting TSS values can be used to create a relationship between q_s *(tonnes/day)* and potential q *(m^3/s)* based on Equation (4.4). With an assumption that the PDAM Tirta Daroy intake is representative of the TSS values at the Pasie station and the Krueng Aceh catchment outlet, the relationship between q and q_s in Figure 4.26 can be used for long term daily simulation by simple determination of the q from observed runoff stations or from runoff modelling.

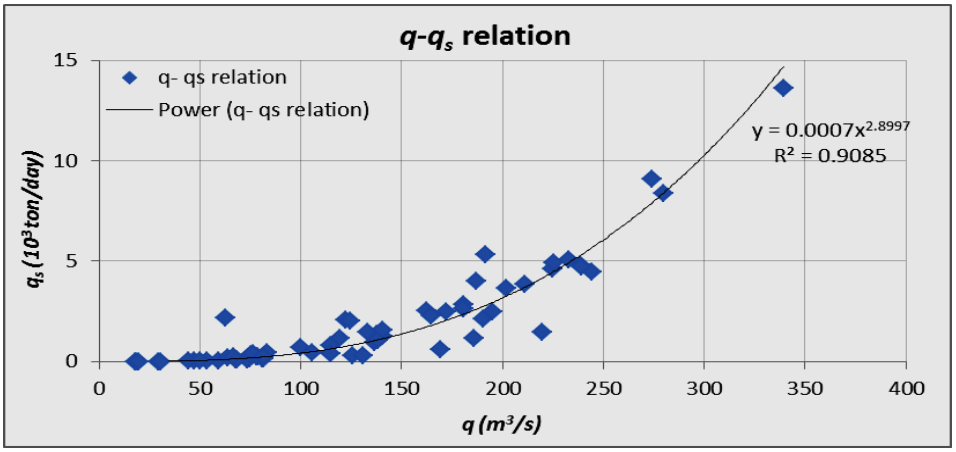


Figure 4.24 Relationship between q_s and q at the Krueng Aceh catchment outlet (Banda Aceh) based on simulation from 2nd January to 29th April 2012 using the equation in Figure 4.23.

However, q_s values are suspended sediments that do not reflect the total sediment yield *(Y)* produced in a catchment because the total *Y* value sources from the result of q_s and bedload sediments *(q_l)*. Although different locations may result in different comparison between q_s and q_l, the empirical formula for the q_l value is in the range of 10% - 15% of q_s and can be applied in tropical areas (Tilrem, 1979), and the PUSLITBANG Pengairan (1989) used the q_l = 20% of the q_s value in research on sediment transport within the Wonogiri Dam catchment in Java Island, Indonesia. Assuming that the *Y* value in the Krueng Aceh catchment produced using the USLE model has been calibrated with observed *Y* values in the Citarum catchment, which is Y_{2012} = 0.972 x 10^6 ton, this analysis uses the q_l value that is 24% of q_s value so that the Y_{2012} value produced through this sediment-runoff model is similar to that generated using the USLE model. The total *Y* value of the Krueng Aceh catchment is:

$$Y = q_s + q_l \tag{4.5}$$

$$Y = q_s + 0.101q_s \tag{4.5a}$$

$$Y = 1.101q_s \tag{4.5b}$$

Using Equation (4.5b), the Y_{2012} value based on modelled runoff 2012 (q_{2012}) produced from HEC-HMS substituted in the equation from Figure 4.24:

$$q_s = 0.0007(q)^{2.8997}$$

$$Y = 1.101\ x\ 0.0007(q)^{2.8997}$$

$$Y_{total} = 0.000771 \sum_{i=1}^{n}(q)^{2.8997}$$

Based on Equation (4.5b), total Y_{2012} in the Pasie station is 7.34 x 10^6 tonnes and has increased from 7.01 x 10^6 ton in 1988, or by 4.84% when both LULC conditions are run at the same *p* for 2012, as shown in Table 4.15. However, the sediment-runoff model cannot be used to calculate the *Y* values at other stations (Darang, Lampisang and Pasie) as there are no observed records for suspended sediment (C_s) at those locations.

Table 4.15 Summary of average values *Q*, *q* and *Y* changes on LULC 1988 and LULC 2012 based on the sediment-runoff model for daily *p* of 2012.

Gauging Station	*Q ($10^8 m^3$)*			*q (m^3/s)*			*∑ Y (10^5 ton)*		
	1988	**2012**	**∑ (%)**	**1988**	**2012**	**∑ (%)**	**1988**	**2012**	**∑ (%)**
Pasie (1466 km^2)	34.66	35.39	2.11	475.7	477.3	0.34	7.00	7.34	4.84
Outlet Banda Aceh (1739 km^2)	37.93	38.72	2.08	551.5	553.5	0.36	9.29	9.71	4.51

4.5. Discussion

The analysis presented here has found that LULC changes between 1988 and 2012 have impacted on hydrological conditions in the Krueng Aceh catchment. SDC (2009b) found that peak rainfall increases due to climate change also contribute to changing flow regime conditions. The conversion of LULC has altered the hydrological characteristics, which modify land surface condition and runoff condition. As a result, these changes have modified flow regime conditions and increased sediment delivery transport in the catchment. Table 4.19 shows the averages of Curve Number *(SCS-CN)* values, runoff (total runoff volume *Q* and runoff peak *q*) and potential sediment loss *E* changes in the subbasins for LULC 1988 and 2012 simulated using the same daily *p* value of January 1st – December 31st 2012.

Table 4.16 Average values of *CN*, *Q*, *q*, *E* by subbasin for LULC 1988 and 2012

Sub-Catchment	*SCS-CN*			*Q* (10^8 m^3)			*q* (m^3/s)			*E* (10^3 *ton/km*^{2})		
	1988	**2012**	**∑ (%)**	**1988**	**2012**	**∑ (%)**	**1988**	**2012**	**∑ (%)**	**1988**	**2012**	**∑ (%)**
Boga (237 km^2)	59.52	61.04	2.55	5.00	5.02	0.40	45.30	45.40	0.22	4.85	5.32	9.82
Lampisang (424 km^2)	53.01	62.16	17.26	1.12	1.16	3.57	293.60	295.20	0.54	5.81	5.98	2.95
Darang (400 km^2)	53.61	62.19	16.00	8.19	8.44	3.05	184.90	186.00	0.59	3.69	3.82	3.73
Pasie (405 km^2)	64.00	69.15	8.05	1.04	1.05	0.96	216.10	219.20	1.43	3.48	3.88	11.47
Banda Aceh (273 km^2)	61.91	66.27	7.04	3.31	3.36	1.51	139.60	140.40	0.57	1.68	1.70	1.53

Table 4.16 shows that the subbasins of Lampisang and Darang exhibit the highest change in average *CN* values, which can be defined that those areas have significant LULC changes compared with other subbasins. In the Lampisang subbasin, for example, 87.9 percent of the area was forest cover (forest and secondary forest) in 1988 and had reduced to 10.2 percent through conversion to bareland areas (especially water body, paddy field, mixed plantation, and grass) in 2012 (see Figure 4.2). Similarly, the Darang subbasin had 52.4 percent forest cover and 43.5 percent bareland areas (paddy field, mix plantation and grass) in 1988 and were changed to 48.7 percent forest cover and 45.6 percent bareland areas by 2012. The proportion of bareland area and forest cover in a catchment was originally used to develop the SCS Curve Number method (USDA SCS, 1972; Mishra & Singh, 2003). As a result, those subbasins contribute the highest change of *Q* values between 1988 and 2012 in the Krueng Aceh catchment.

There are three subbasins that have similar areas as shown in Table 4.16, which are the subbasins of Lampisang, Darang and Pasie. Although the subbasins of Lampisang and Darang have higher changes in *CN* values and *Q* values compared with the Pasie subbasin, the Pasie subbasin produces the highest change in *q* value. Therefore, it can be concluded that high changes in *CN* values and *Q* values are not correlated with the changing *q* values in those subbasins, as the SCS-CN value that contributes to increasing *Q* in the catchment is developed from the functions of LULC, slope and soil porosity. The proportion of forest covered and bareland areas in the Pasie subbasin is similar with the Darang subbasin (see Figure 4.2), therefore the higher *q* change in the Pasie subbasin is produced by porosity rate and slope condition. The Pasie subbasin is mostly dominated by metamorphic rocks, meta-sedimentary rocks and other consolidated rocks (see Figure 3.6 and 3.9

in Chapter 3) that have lower average porosity and have high average slopes compared with other subbasins, as shown Figure 4.25.

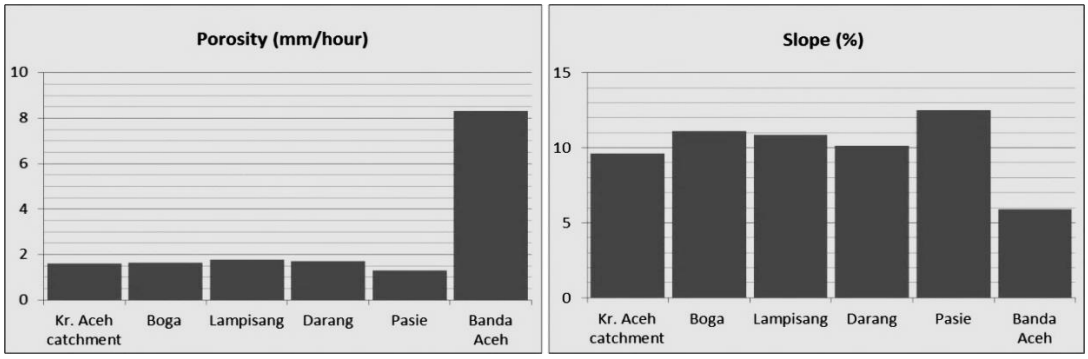


Figure 4.25 Average porosity *(left)* and slope *(right)* per subbasin.

In the Boga subbasin, high *E* value and change in *q* value are likely controlled by lithological aspects as the area is dominated by volcanic rocks and intrusive rocks. However, compared with the subbasins of Darang and Pasie, for example, the LULC of the Boga subbasin is similar, with 60.2% forest cover and 37% bareland areas (paddy field, mixed plantation and grass). Similarly, the Banda Aceh subbasin is dominated by alluvial soils that have a high porosity. These alluvial soils mostly contain organic components and sand material, about 60%, from denudation of volcanic materials, basaltic materials, argillic clay materials and denudation of meta-sedimentary rocks. They have very high rates of infiltration, and the area is mostly flat with an average slope of 6%. These conditions contribute to a low rate of *Q* and *q* change, although the rate of average *CN* value change is similar to the Pasie subbasin. This is because rock fragments contribute to soil properties and slope gradient in the area. The soil properties of rate of infiltration, permeability and erosion influence the hydrological response (Poesen & Lavee, 1994). The slope gradient potentially distributes the highest rate of runoff *(q)* fluctuation because it reduces the initial abstraction (Chaplot & Le Bissonnais, 2003; Fox *et al.*, 1997) and recession time (Evett & Dutt, 1985), decreases infiltration (Philip, 1991) and increases erosion (Fox & Bryan, 2000) during rainfall events.

The increasing *q* is correlated with increases in potential sediment yield *(Y)* as it was found that there is power function relationship between average *q* and sediment discharge *(q_s)*, as shown in Figure 4.24. Based on findings for the Pasie

station and the outlet of the Krueng Aceh catchment, it is possible to assume that an increased average *q* will increase the *Y* value by 12 - 14 times (see Table 4.16).

4.6. Conclusion

Overall, conditions over the Krueng Aceh catchment show decreasing trends in annual precipitation based on data observation between 1879 and 2010. However, there is an increasing trend in annual precipitation over the last three decades. Overall, a lack of rainfall stations with long-term data series limits more detailed assessment of changes in precipitation. Observations from rainfall stations in the downstream, middle and upstream areas of the Krueng Aceh catchment from 1989 to 2012 found that highest precipitation occurs in the upstream area, which is 11 percent higher than the middle area and the precipitation in the middle area is 22.6 percent higher than the downstream area. The rainfall depth records at these three locations indicate that the trend of increasing rainfall depth occurs in the upstream area and decreasing rainfall depth occurs in the downstream area, when these locations are compared. In more detail, increased rainfall peaks occur in wet seasons and a trend of decreasing low rainfall occurs in the dry seasons (Boer & Suharnoto, 2012; SDC, 2009b). From this evidence, it can be concluded that increased peak rainfall intensity is occurring in the upstream area, while decreased rainfall depth is occurring in the downstream area.

The long-term hydrological impacts of LULC change in the Krueng Aceh catchment are computed based on LULC 1988 and LULC 2012. Overall LULC changes show that the mean *CN* value increased over the Krueng Aceh catchment by 9.84 percent between those LULC conditions, which can be attributed to loss of forest cover, such as in the south west of the catchment, and an increase in bareland area concentrated in the centre of the catchment in low land areas. Forest cover is mostly converted to bareland areas (grass and sparse grass) and cultivated areas (paddy field and mix-plantation). Although the urban area was 0.59 percent of the Krueng Aceh catchment in 1988, this area has increased to 2.75 percent (an expansion of 363.27 percent) in 2012, reflecting increases in population and economic activity since the end of the Aceh civil war.

LULC change has impacted on the hydrological response between 1988 and 2012 in terms of both water quantity and quality. The highest peak q that occurred on 1st December 2012 increases from q_{-1988} = 551.5 m^3/s to q_{-2012} = 553.5 m^3/s (increase by 0.36%), however minimum q value on 31st July 2012 falls from q_{-1988} = 8.3 m^3/s to q_{-2012} = 6.8 m^3/s (decrease by 18.07%), based on HEC-HMS model runs for rainfall conditions of 2012. As a consequence, annual sediment yield *(Y)* increases from 9.11 x 10^5 ton for LULC 1988 to 9.72 x 10^5 ton for LULC 2012, or the *Y* value increases by 7.74 percent during the years when both LULC conditions run on the *p* of 2012. Moreover, average potential annual soil loss *(E)* increases from 2,399 tonnes/km^2 (1988) to 2,442 tonnes/km^2 (2012) when both LULC conditions are modelled for the same annual *p* of 2012.

CHAPTER 5
ECONOMIC VALUATION OF WATER RESOURCES ON LAND USE/LAND COVER CHANGE

5.1. Introduction

The hydrological response to land use/land cover (LULC) change in the Krueng Aceh catchment has been an alteration to the flow regime and sediment delivery transport. These alterations impact on water allocation schemes for domestic and non-domestic demands, and for environmental sustainability. In schematic terms, changing water allocation for domestic and non-domestic demands may result in changed costs for water production, and environmental protection of the river ecosystem. However, maintaining water flows for environmental sustainability may not be easy to quantify through economic valuation due to difficulties in determining costs and non-market benefits associated with water flows.

This chapter discusses changing economic costs based on the hydrological response to LULC change between 1988 and 2012 that affects externalities to agents, which are the impact to water service providers (PDAM Tirta Daroy) and water supply to paddy field area. The discussion examines potential economic losses related to drinking water production by the water service provider (PDAM Tirta Daroy) due to changes in water quantity and quality. It also examines the impacts of LULC change on paddy production.

5.2. Water Balance

Water availability and demands can be calculated based on the water balance concept. Water demands are quantified based on demand standards developed by the Ministry of Public Works of Indonesia. Water availability as water supply in the catchment is calculated based on the output of the HEC-HMS modelling that has been discussed in Chapter 4. The results are simulated based on water demands for 2012 for the Krueng Aceh catchment.

5.2.1. Water demand

Water demand will be divided into demand by locations and type. In terms of the upstream-downstream relationship within a catchment, the demand locations can be grouped into upstream demands and downstream demands. The types of demand include domestic, non-domestic, water losses and the minimum environmental flow. Paddy field water demand is one of the non-domestic demands that can be calculated separately due to the large extent of paddy field in the Krueng Aceh catchment and their high levels of water consumption. Therefore, in this research water demand is quantified into five categories, which are domestic demand, non-domestic demand, water losses, minimum environmental flow and paddy field demand.

The demand locations are Banda Aceh City (downstream area) and the Aceh Besar Regency (upstream area) where prior appropriate water rights can be applied, which is where water users are queued and shared by time according to the commencement of water flow. Water usage is allocated for upstream users first and the surplus is available to the downstream area. Therefore, upstream users may access and use water when water availability is low, while downstream users may only use surplus water from upstream users (see Figure 2.16 in Chapter 2).

Water demands for domestic, non-domestic, water losses and minimum environmental flow can be calculated based on population. The downstream area water demand for domestic use is based on a medium-sized city classification based on a population range between 100,000 and 500,000 (FAO and the Ministry of the Public Work of Indonesia Standard, see Table 2.2 in Chapter 2). Although the population of Aceh Besar Regency is also in the range 100,000 - 500,000, the upstream water demand will be based on village area because the population mostly live in village areas, and the water distribution systems in these areas are not integrated. Table 5.1 shows the upstream and downstream demands within the Krueng Aceh catchment, the demands are being converted in m^3/s unit to compare with water availability resulting from HEC-HMS modelling. Moreover, annual demand in Table 5.1 is being used for cost accounting calculation for the annual amount of water produced by water service provider (PDAM Tirta Daroy) in the downstream area.

Table 5.1 Water demands in the Krueng Aceh catchment in 1988 and 2012

No.	Location / Type of Demands	Consumtion factor (unit)	Daily Demand (10^6 litre/day)		Daily Demand (M^3/s)		Annual Demand (10^6 M^3/year)	
			1988	2012	1988	2012	1988	2012
Downstream Area Population		**2.40 % / year**	**135,147**	**238,784**	**135,147**	**238,784**	**135,147**	**238,784**
1	Domestic	120.00 litre/person/day	16.22	28.65	0.19	0.33	5.92	10.46
2	Non-domestic	30.00 litre/person/day	4.05	7.16	0.05	0.08	1.48	2.61
3	Water losses	40.00 litre/person/day	5.41	9.55	0.06	0.11	1.97	3.49
4	Min. environmental flow	300.00 litre/person/day	40.54	71.64	0.47	0.83	14.80	26.15
5	Paddy field area*	1.04 litre/s/ha	178.36	54.99	2.06	0.64	39.24	12.10
		Total Banda Aceh	*244.59*	*172.00*	*2.83*	*1.99*	*63.41*	*54.80*
Upstream Area Population		**2.28 % / year**	**182,798**	**322,976**	**182,798**	**322,976**	**182,798**	**322,976**
1	Domestic	82.50 litre/person/day	21.94	26.65	0.25	0.31	8.01	9.73
2	Non-domestic	60.00 litre/person/day	5.48	19.38	0.06	0.22	2.00	7.07
3	Water losses	24.00 litre/person/day	7.31	7.75	0.08	0.09	2.67	2.83
4	Min. environmental flow	300.00 litre/person/day	54.84	96.89	0.63	1.12	20.02	35.37
5	Paddy field**	1.04 litre/s/ha	1,310.37	1,688.93	15.17	19.55	288.28	371.57
		Total Aceh Besar	*1,399.94*	*1,839.60*	*16.20*	*21.29*	*320.97*	*426.56*
		Total Banda Aceh and Aceh Besar	***1,644.53***	***2,011.60***	***19.03***	***23.28***	***384.39***	***481.36***

* Downstream area: 1,985 ha (1988) and 612 ha (2012)

** Upstream area: 14,583 ha (1988) and 18,796 ha (2012)

From Table 5.1, it can be calculated that daily water demand in the downstream area was 224,798 x 10^6 litre/day in 1988 or equal to 2.83 m^3/s. This demand is the maximum demand, which includes paddy field demand in growing season, which is from March to September every year for 1,985 ha of paddy field area. However, the upstream water demand without paddy field demand is 0.77 m^3/s, which is the demand between October and February. This demand decreased to 1.99 m^3/s in 2012, when the paddy field area decreases to 612 ha. In fact, domestic and non-domestic water demands in downstream (without paddy field demands and minimum environmental flow) increases from 0.30 m^3/s (1988) to 0.52 m^3/s (2012) or increases from 10.6% to 26.1% of total share downstream demand.

In the upstream area, water demand is dominated by paddy field demand, which is 16.20 m^3/s (93.7% of total share of the upstream demand) in 1988 and increases to 21.29 m^3/s (91.8% of total share demand) in 2012 due to increasing paddy field area from 14,583 ha (1988) to 18,796 ha (2012). When the upstream water demand and the downstream water demand are compared, upstream water demand is 85.1% higher than the downstream demand in 1988 and the comparison increases to 91.5% higher in 2012. Therefore, it can be assumed that the upstream area is more dominant in water usage compared to the downstream area in the Krueng Aceh catchment.

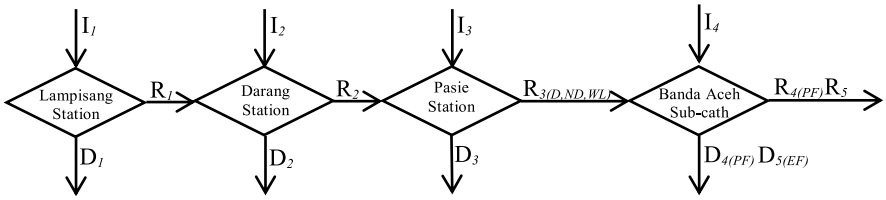
5.2.2. Water supply

There are three water stations that are used to calculate discharge in the upstream area, which are the Lampisang (I_1), the Darang (I_2) and the Pasie (I_3) stations. The discharge for upstream users is calculated in the Lampisang (I_1) and the Darang (I_2) stations as the offtake for upstream irrigation systems is located before these stations. Additional discharge for the Darang (I_2) station is also sourced from residual flow from the Lampisang (R_1) station, which is the result of water supply and demand. As water demand for irrigation (paddy fields) is counted based on available water at these stations, it is assumed both stations share 50% of total demand (D_1 and D_2). The demand for paddy fields at R_1 and R_2 is counted during the crop cycles, which are from March to June and September to

December. These conditions are created under a prior appropriate approach where priority rights, which is first in time, first in rights and proportional rights, which shares water among owners according to the number of rights owners (Howe *et al.*, 1986). Based on these principles, users at R_1 get first access to the water supply in the first step where it is fulfilled by I_1. In the case where R_1 has insufficient water supply, water supply at R_1 is stated to fail. Similarly, in conditions when R_2 has a deficit water supply from I_1 and I_2.

Moreover, water availability for downstream users is calculated based on inflow to the Pasie station (I_3), which sources from the Pasie subbasin and from the residual flows at the Darang (R_2) station. Under a prior appropriate approach, there are three types of demands that are split based on demand priorities. The first priority demand is for domestic, non-domestic and potential water losses ($D_{3(D,ND,WL)}$) that are managed by the Water Service Provider of PDAM Tirta Daroy as the first users. The paddy field demand ($D_{4(PF)}$) is the second priority managed by the farming community under supervision by the government as secondary users. The demands for $D_{3(D,ND,WL)}$ and $D_{3(PF)}$ are counted at the Pasie station (I_3), which is located 8.5 km upstream of the water intake of the PDAM Tirta Daroy. The third priority demand is for environmental flow ($D_{5(MEF)}$) that sources from residuals of $D_{3(D,ND,WL)}$ and $D_{4(PF)}$ and overflow from the Banda Aceh subbasin (I_5) before water flow to outlet of the Krueng Aceh catchment (R_5) with an assumption that this overflow is to the Krueng Aceh river before it flows to the ocean.

It should be noted that this calculation runs under daily water availability and may not consider water storages, which may impact on daily available water, and groundwater resources, as this research is focused on LULC impacts on the water regime directly via the rainfall-runoff relationship. A schematic of the water balance simulation for the upstream and downstream of the Krueng Aceh catchment is shown in Figure 5.1.



I_1 = Inflow to Lampisang station
D_1 = 50% of upstream demands (at Lampisang station)
R_1 = Residual from Lampisang station
I_2 = Inflow to Darang station
D_2 = 50% of upstream demands (at Darang station)
R_2 = Residual from Darang station
I_3 = Inflow to Pasie station
D_3 = Downstream demand for Domestic, Non Domestic and Water Losses
R_3 = Residual from D_3 at Pasie station
D_4 = Downstream demand for Paddy Field
R_4 = Residual from D_4 in Banda Aceh catchment
I_4 = Inflow from Banda Aceh catchment
D_5 = Downstream demand for Environmental Flow
R_5 = Residual from D_5 at the outlet of the Krueng Aceh catchment

Figure 5.1 Schematic of water balance in the Krueng Aceh catchment

Using the schematic in Figure 5.1 as the basis of water balance simulations using LULC 1988 and LULC 2012 results, show that the overall reliability of water supply, which is the ability of the water supply system to perform and anticipate the water demands, in the Krueng Aceh catchment was 93.44% (1988) and 88.54% (2012). For both conditions the HEC HMS simulation used rainfall of 2012 (see Appendix 5.1 and 5.2). In the upstream area, the reliability of water supply for 1988 at Lampisang station (R_1) is 94.54% and at Darang station (R_2) is 93.99%. In 2012, these conditions drop to 90.98% at R_1 and 92.35% at R_2 due to LULC change between these years due primarily to increasing paddy field area from 14,583 ha to 18,796 ha.

In the downstream area, reliabilities of water supply are almost similar, at 97.81% in 1988 and 97.54% in 2012, which means that increasing demand at the upstream area can still ensure water availability to Banda Aceh City (see detail in Appendix 5.1 and 5.2). With an assumption that all of the Banda Aceh population uses distributed water for domestic and non-domestic demands from the PDAM Tirta Daroy, the reliability of the PDAM Tirta Daroy at $R_{3(D,ND,WL)}$ is the same between 1988 and 2012, at 98.91%.

5.3. Economic Costs

Potential economic losses can be calculated based on a non-demand curve approach, which is related to the benefits that water users receive from environmental preservation or the impact of environmental damages. In the case of

Krueng Aceh's water users, this research calculates economic costs from environmental degradation due to LULC change that impacts surface water flow (inflow) to water users and on water quality through increasing sediment transport in surface runoff. The impacts can be a loss of opportunity to produce water to meet the demands and increasing costs for water productions based on chemicals used for water purification, operational and maintenance costs. Moreover, economic losses to paddy farmers can be calculated based on a loss of opportunity to produce rice caused by lack of water supply. However, environmental degradation that is caused by a lack of minimum environmental flow may be difficult to calculate.

Therefore, this analysis considers costs to two users, which are the water service provider of PDAM Tirta Daroy and the paddy farmers. Economic costs for the PDAM Tirta Daroy relate to costs of water production for consumers, which relates to the amount of water needed to meet demand and meeting minimum water drinking standards. Moreover, economic costs for paddy farmers relate to the amount of water used for paddy farming, which may impact their production when water is insufficient for paddy field demand. The upstream authority's water service provider (PDAM Tirta Montala) is not included in this calculation as domestic and non-domestic demand is only 2.85% of the total demand in the upstream area and only about 18% of the upstream population rely on the PDAM Tirta Montala water distribution network (see Table 3.7). The economic costs *(EC)* can be developed through Equation (5.1).

$$EC_{composite} = EC_{wp} + EC_{rp} \quad (5.1)$$

Where $EC_{composite}$ is total economic costs applied to all water users, which is derived from water production costs by the PDAM Tirta Daroy (EC_{wp}) and cost for paddy production by farmers (EC_{rp}).

5.3.1. Economic Costs for Water Production

The economic costs for water production (EC_{wp}) source from changing or losing the opportunity to produce water due to lack of water supply (ΔLP). The EC_{wp} value also sources from changing costs of operation and maintenance (ΔOM). These parameters have a relationship as shown in Equation (5.2):

$$EC_{wp} = \Delta LP + \Delta OM \quad (5.2)$$

Moreover, ΔOM is counted as the impact of changing quantities of chemicals used for water purification (ΔOM_{cu}) and changing water quantity due to quality change (ΔOM_{wi}). However, the ΔOM_{wi} can be eliminated because suspended solid volume in water is equivalent to zero as 1 ppm of sediment in water reduces water volume by 7.5 x 10^{-7} litres (PUSLITBANG Pengairan, 1989). This is based on the Directorate of Water Resource of Indonesia monitoring of sediment transport in the Wonogiri Dam, Central Jawa Province, where one ton of sediment has a volume equal to 0.75 m^3. Therefore, with an assumption that $\Delta OM_{wi} \approx 0$, the function of EC_{wp} can be written as shown in Equation (5.2b):

$$EC_{wp} = (\Delta LP_{ws} + \Delta LP_{wq}) + (\Delta OM_{cu} + \Delta OM_{wi}), \quad (5.2a)$$

Assuming that $\Delta OM_{wi} \approx 0$;

$$EC_{wp} = (\Delta LP_{ws} + \Delta LP_{wq}) + \Delta OM_{cu} \quad (5.2b)$$

a. Change of water production (ΔLP)

The ΔLP can arise when the PDAM Tirta Daroy loses the opportunity to produce water, which can occur when the PDAM Tirta Daroy has to reduce water production or cannot produce water. Shortage of water supply (ΔLP_{ws}) occurs when inflow to the water treatment plant (WTP) is less than the demand. The condition where water quality is below the threshold limit (ΔLP_{wq}) exists when the TSS value exceeds 2000 mg/l and the WTP cannot purify water.

Water production that has to be supplied by the PDAM Tirta Daroy for collective domestic, non-domestic and water loss demand is 16.6 x 10^6 m^3 from total share demand of 54.8 x 10^6 m^3 in 2012 (see Table 5.1). Cost of production in 2012 is USD 0.33/m^3 and a 20.0% loss factor is expected, which includes water losses at PTDAM Tirta Daroy related to water production, water meter inaccuracy and leaking from the distribution system, etc. (see Table 3.6 in Chapter 3). Based on the cost of production and the loss factor, an ideal average selling price is predicted to be at least USD 0.49 /m^3 to cover losses and to reach the 10% maximum profit as regulated by the Ministry of Home Affairs (Decree No. 26 Year 2006). This price can be higher if other company expenditures such as costs on investment recovery, depreciation, etc. are included, but these are not

considered in this research. Table 5.2 shows the calculation of potential profit of the PDAM Tirta Daroy in 2012 based on water value in 2012, with potential profit estimated at USD 5,954,460.18.

Table 5.2 Prediction potential profits in 2012 based on assumption 10% profit from water selling (PDAM Tirta Daroy, 2011)

No	*LULC*	*Unit*	*Price (USD)*	*Total Price (USD)*	
				DR	*CR*
1.	Cost for production (100%)	16,559,670.40 m^3	0.33	5,413,145.62	
2.	Profit (gain 10%)			541,314.56	
3.	Sold water (73.3% of production)	12,138,238.40 m^3	0.49		5,954,460.18
Total Income				5,954,460.18	5,954,460.18

Based on Appendix 5.1 and Appendix 5.2, PDAM Tirta Daroy reliability in relation to water quantity is similar between 1988 and 2012, which is 98.91%. This reliability includes reliability of inflow to the WTP (ΔLP_{ws}) that is 98.91% and loss of water production due to water quality change (ΔLP_{wq}) that is 0%. Therefore, it can be calculated that LULC change between 1988 and 2012 has no impact to PDAM Tirta Daroy quantity water production.

b. Operation and maintenance (ΔOM)

The *ΔOM* value arises when more chemicals are used for water purification (ΔOM_{cu}) and more frequent WTP maintenance is needed due to increasing TSS values. The maintenance can include changing filtration screens and removing residuals in the WTP. Based on quality standards from the Indonesia Ministry of Health (Decree No. 492/MENKES/PER/IV/2010), maximum turbidity threshold level for drinking water is below 5 NTU. Using the graphic relationship between a chemical used, which is alum ($[Al_2(SO_4)_3.18H_2O]$) as the main chemical used in the purification process, and turbidity value based on PDAM Tirta Daroy data in January to April 2013, the *ΔOM* can be estimated. Figure 5.2 shows the relationship between turbidity (in *NTU*) values and concentration of alum (in *ppm*) in WTP of the PDAM Tirta Daroy to produce water with turbidity below 5 NTU.

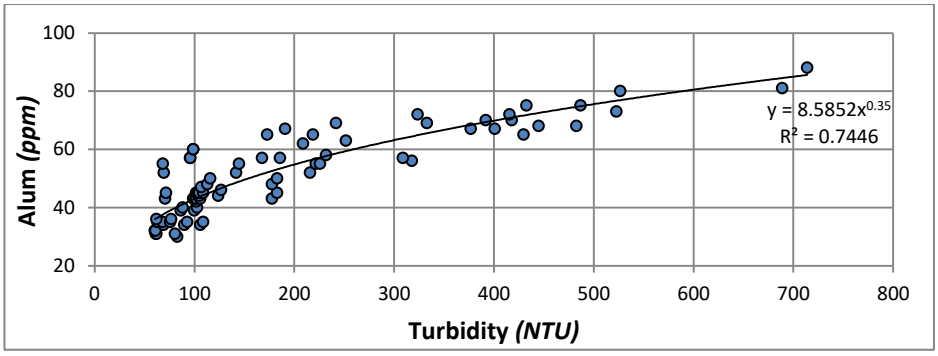


Figure 5.2 The relationship between turbidity value and chemical used (alum: $[Al_2(SO_4)_3.18H_2O]$) based on PDAM Tirta Daroy observations January to April 2013

Alum is available at concentrations of 80% and a price of USD 0.26/kg (2012). Using the relationship between discharge volume and turbidity that has been discussed in Chapter 4 (see Equation 5.13c), the amount of TSS (mg/l) can be estimated based on daily discharge. Then, the TSS value can be converted to turbidity values using the relationship between TSS and turbidity (see the equation in Figure 4.25 in Chapter 4) as the PDAM Tirta Daroy uses turbidity values to determine alum demand. Detailed calculations are provided in Appendix 5.1 and Appendix 5.2, and are summarised in Table 5.3.

Table 5.3 Reliability of water resource on LLULC 1988 and LULC 2012 run on rainfall depth 2012 and water demand 2012

No.	*LULC*	*Quantity Reliability (%)*			*Quality Reliability*		
		Upstream (%)	*Downstream (%)*	*DPAM Tirta Daroy (%)*	*TSS > 2000 g/l (%)*	*Turbidity < 5 NTU (%)*	*Purification Cost (USD)*
1	1988	93.44	97.81	98.91	0.00	14.48	205,269.36
2	2012	88.52	97.54	98.91	0.00	14.20	215,191.60

Table 5.3 shows that water quality reliability decreases from 93.44% in 1988 to 88.52% in 2012 in the upstream area, however the reliability at PDAM Tirta Daroy remains stable at 98.91%, except the reliability to the downstream area slightly decreases from 97.81% to 97.54%. In water quality, the frequency that TSS values are more than 2,000 mg/l never occurs based on the rainfall depth of 2012, while the percentage turbidity values less than 5 NTU increase slightly from

14.20% in 2012 to 14.48% in 1988, which results in increasing costs for water purification from USD 205,232.13 in 1988 to USD 215,191.60 in 2012.

5.3.2. Rice production (ΔEC_{rp})

Productivity loss due to water scarcity and erosion can have several effects on farming systems. Based on observations in the Krueng Aceh catchment, the effects can include loss of profits, farmers changing crop varieties and farmers changing land preparation that may lead to increased erosion. It can be seen in Krueng Aceh's upper subbasins where farmers use a cropping pattern of corn, upland rice and chilli when soils are relatively unaffected by erosion. When erosion becomes more severe, corn and rice are replaced by peanuts and cassava, and where soils are nutrient depleted cassava is grown, which has a lower value in the market than corn, rice and chilli. Moreover, cassava and peanuts require more soil preparation that leads to more erosion.

Figure 5.3 Images from the upper Pasie subbasin. Corn is planted along tributaries where the soil depth is relatively high *(left)*, and farmers change crops to cassava when soils are less fertile and the soil depth is low *(right)*.

In rice production, the Public Expenditure Analysis and Capacity Strengthening Program (PECAPP) reported that average rice production in Aceh Province was predicted at 4.6 tons/ha in 2012 with an average price of USD 0.57/kg (PECAPP, 2013). Using these values and the reliability of water supply in the upstream area as shown in Table 5.3, where about 91.81% water in the upstream is allocated to paddy fields, economic losses due to a shortage of water supply can be calculated. Based on Table 5.3, the reliability in 1988 is 93.44% and

in 2012 is 88.52%, the EC_{rp} based on 18,796 ha of paddy field in 2012 in the upstream area is:

EC_{rp} 1988 = *(100%-94.44%)* x *18,796 ha* x *4.6 tonnes/ha* x *USD 0.57/kg*
= *USD 2,734,244.85*

EC_{rp} 2012 = *(100%-88.52%)* x *18,796 ha* x *4.6 tonnes/ha* x *USD 0.57/kg*
= *USD 5,645,486.48*

ΔEC_{rp} = *USD 5,645,486.48 - USD 2,734,244.85*
= *USD 2,911,241.63*

The calculation found that the potential economic loss on rice production (ΔEC_{rp}) in the upstream area due to LULC change between 1988 and 2012 is USD 2,911,241.63. Similarly, using the value of Table 5.3, the reliability of 612 ha of paddy field based in 2012 in the downstream area is:

EC_{rp} 1988 = *(100%-97.81%)* x *612 ha* x *4.6 tonnes/ha* x *USD 0.57/kg*
= *USD 35,066.27*

EC_{rp} 2012 = *(100%-97.54%)* x *612 ha* x *4.6 tonnes/ha* x *USD 0.57/kg*
= *USD 39,389.51*

ΔEC_{rp} = *USD 39,389.51 - USD 35,066.27*
= *USD 4,323.24*

Therefore, the total economic loss for rice production (ΔEC_{rp}) over the Krueng Aceh catchment, which sources from the economic losses on paddy production in the upstream (USD 2,911,241.63) and downstream (USD 4,323.24) areas from 1988 to 2012, is USD 2,915,564.87.

5.4. Discussion

This analysis found that LULC change between 1988 and 2012 has changed costs for water production and distribution in the Krueng Aceh catchment, which is related to the supply of drinking water by the water service provider PDAM Tirta Daroy and to a portion of irrigation water to paddy fields in the upstream area. Although the LULC change does not have an impact on water quantity supply to the PDAM Tirta Daroy, the cost for water treatment (EC_{wp}) increases by USD 9,922.24 between LULC 1988 and LULC 2012 conditions run on the input

of precipitation in 2012. The value comes from increasing ΔOM values from USD 205,269.36 to USD 215,191.60 as a consequence of increasing alum demand from 793,838 kg in 1988 to 832,361 kg. Secondly, farmers have potential losses on paddy production (EC_{rp}) of USD 2,911,241.63 in the upstream area and USD 4,323.24 in the downstream area.

These conditions create externalities, which are both environmental quantity and quality change that create impacts in terms of economic losses to agents (Pearce *et al.*, 2006; Tietenberg, 2000), due to LULC change. The cost of these externalities is USD 2,925,487.11 derived from the sum of EC_{wp} and EC_{rp} values. However, the true ΔEC_{rp} values can be debated as paddy field water demand varies throughout the year and daily water shortage may not impact paddy crops especially in the early and end crop cycle stages where less water is needed. Therefore, the true ΔEC_{rp} values are most likely less than the amounts calculated for 1988 and 2012. Moreover, based on precipitation in 2012, the low rainfall depths that create paddy water shortages mostly happen from early September to the middle of October, which is the early stage of the crop cycle. However, the externality to the PDAM Tirta Daroy cannot be avoided as they produce water for domestic and non-domestic supply based on daily demand.

Water distribution under a prior appropriate approach puts upstream users as the first users, giving priority to the upstream area before water flows to the downstream area. This may create water shortages in the downstream area, especially when water usage in the upstream area is optimum such as when irrigation systems operate in the upstream area. In terms of water quality, LULC 2012 creates higher peak flows than LULC 1988, which would affect the intensity of soil erosion, increasing sediment transport to the intake of PDAM Tirta Daroy. However, water distribution to paddy field areas does not estimate the impact of water quality change for paddy water demand as no data is available on this subject associated with increasing sediment transport impacts to paddy plantations. Qualitatively, increased suspended sediments in irrigation for paddy fields may increase sedimentation to the irrigation system and stream channels, which may increase maintenance costs.

For the environmental flow demand, there are no significant impacts as the reliability of water supply remains similar at 97.81% in 1988 and 97.54% in 2012

in the downstream area. In the case of LULC change in the Krueng Aceh catchment, the externalities that are associated with ecosystem maintenance and public health caused by environmental degradation are difficult to determine economically. Moreover, lack of environmental flow may also affect potential sea water intrusion in the Banda Aceh coastal area in the future, which will also have significant economic and environmental costs.

5.6. Conclusion

The LULC change in the Krueng Aceh catchment between 1988 and 2012 has affected water availability in terms of both water quantity and quality. As water distribution is based on a prior appropriation system, impacts in the upstream area are less than those on the downstream area. The LULC change has created externalities in water resource management in the Krueng Aceh catchment to the water service provider in the downstream area and to paddy farmers in the upstream area. However, the environmental externalities for ecosystem and human health are difficult to calculate due to an uncertainty linked on those externalities.

The Natural Capital Project, which is a partnership between Stanford University, The Nature Conservancy, and World Wildlife Fund developed an integrated ecosystem services on decision making Invest Model. It helps decision makers to quantify environmental externalities from ecosystem and human health to effective policy and finance mechanisms (Heal, 2000; Mäler *et al.* 2008; Daily, *et al.* 2009, Tallis & Polasky, 2009). A challenge remains relative to other forms of capital because assets embodied in ecosystems are often rarely monitored, poorly understood and undergoing in rapid degradation, which is mostly recognized after they have been lost (Chambers *et al.* 2007).

CHAPTER 6
OPTIMIZATION OF LAND USE/LAND COVER SCENARIOS UNDER INTEGRATED WATER RESOURCES MANAGEMENT

6.1. Introduction

Depletion of both the quality and quantity of natural resources and LULC change are likely unavoidable in the Krueng Aceh catchment. However, some of the processes associated with this change may be able to be controlled so that the impacts can be anticipated. Developing scenarios of LULC change in relation to how and when such changes occur is one way in which management options can be explored. Many methods have been developed for predicting LULC change (Parker *et al.*, 2003), and these are reviewed in Chapter 2. The analysis presented in this chapter uses Expert Models as the availability of baseline LULC data is limited, with just two LULC datasets available: 1988 and 2012.

This chapter discusses scenarios of LULC change that could potentially occur within the Krueng Aceh catchment and their impact on the reliability of water resources in terms of both quality and quantity. These impacts focus on increased economic costs associated with water treatment by the water service provider PDAM Tirta Daroy.

As a conclusion to this discussion, this research assesses alternative decisions using multi criteria decision making (MCDM) and an analytic hierarchy process (AHP) to achieve the goal of PDAM Tirta Daroy in anticipating these externalities. However, technical implementation decisions associated with how PES can be distributed from PDAM Tirta Daroy to the upstream area are not discussed here as they would require additional research to collect primary data on stakeholders' perceptions through questionnaires and interviews, which is beyond the scope of this research.

6.2. Scenarios of LULC Change and their Impacts on Water Resources

The discussion in Chapters 4 showed that urban area, cultivation areas (paddy fields and mixed plantations) and open areas (grass and sparse grass) have increased from LULC 1988 to LULC 2012, together with a reduction in forest and secondary forest areas. It is predicted that these processes of LULC change will continue to occur in the future for the Krueng Aceh catchment. Conversion of land to be urban, paddy field and mixed plantation areas will continue as more lands is needed for these activities in line with increasing population growth and economic development. However, LULC allocations for these purposes can be controlled by authorities. For this research, scenarios of LULC changes will be created under two conditions where the first scenario is the "business as usual" where there is no control on LULC conversions and the second scenario is under controlled LULC conversions. This control can be achieved through forest protection, slope control for land management practices and crops management practices such as planting canopy plantations.

6.2.1. LULC Scenarios

a. Scenario I

Scenario I is the "business as usual" case, which assumes that there is no intervention or management for LULC in the Krueng Aceh catchment. Primary forest and secondary forest areas will be continued to be deforested over the catchment. The urban area will increase in the whole area of the Krueng Aceh catchment together with population growth and increasing domestic water demand, while paddy field, grass and sparse grass areas will increase in the upstream area. In reality, future "business as usual" LULC change would be more complex and spatially fragmented than is assumed under Scenario I, however the changes described here are a logical extension of the change already occurring in the catchment.

In the downstream area (Banda Aceh City), the Scenario I is developed under conditions that paddy field, mixed plantation and grass areas will be converted to an urban area. The sparse grass area is predicted to show no change as these areas are interpreted as community places such as yards, sporting fields and cemetery

areas. In the upstream area, lowland areas along Krueng Aceh main river and other flat areas will be converted to be paddy fields if the soil types are alluvial and slope conditions less than 5%. This condition will occur if existing LULC 2012 is forest and secondary forest areas. Forest and secondary forest areas will be converted to be a mixed plantation area if slope conditions are between 5% and 25%. Moreover, forest area will be logged for timber production if the forest is located on slopes of 25-40% and will convert to secondary forest. Only forest and secondary forest areas that are located on slopes more than 40% will remain stable from deforestation, due to the technical difficulties associated with timber extraction. As grass and sparse grass areas are sourced from agricultural lands after the lands are no longer productive due to soil fertility losses, these areas expand over the catchment, especially where the soil type is *Mediteran* based on PPT Bogor classification (see Figure 3.9 in Chapter 3). *Mediteran* is the type of soil that forms from the denudation of limestone formations and poor water infiltration. This soil is located in the south-west and northern part of the catchment (see Figure 3.9). Moreover, water bodies and urban areas will be projected to remain unchanged under this scenario in the upstream area as they indicated that their changing between 1988 and 2012 was not significant (see Figure 4.2 in Chapter 4). Figure 6.1 shows the change from LULC 1988 to LULC 2012 and predicted LULC under Scenario I.

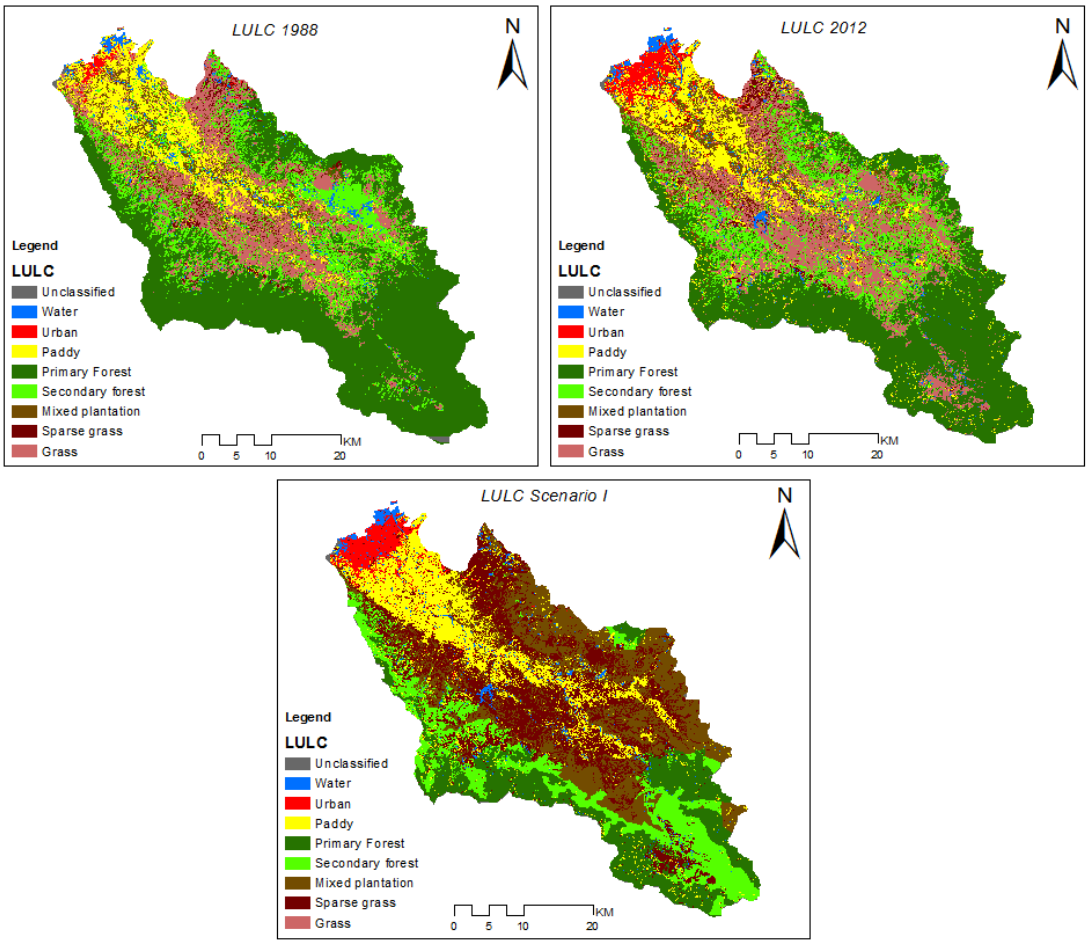


Figure 6.1 Maps of LULC 1988, LULC 2012 and predicted LULC Scenario I.

Based on the map of Scenario I, the lowland areas along the Krueng Aceh main river become dominated by paddy field. Deforestation occurs mainly in the northern part of the catchment where this area will be converted to be mixed plantation and grass areas. In western and southern parts of the catchment, deforestation is predicted for timber production, which is conversion of this area to be secondary forest, as this area has less soil fertility compared with northern parts of the catchment with soil types being predominantly *Litosol* and *Mediteran*, which source from denudation of metasedimentary rock (in the east and west), limestone, tuffaceous and other volcanic sandstones (see Figure 4.2 in Chapter 4). Moreover, the eastern part of the catchment will continue to experience urban expansion and become urban area as this is where the capital city of Banda Aceh is located. Table 6.1 shows the comparison of areas of LULC classes in 1998, 2012 and Scenario I in the Krueng Aceh catchment.

Table 6.1 Comparison areas of LULC classes in 1998, 2012 and Scenario I in the Krueng Aceh catchment.

No.	*LULC*	*1988*		*2012*		*Scenario I*	
		Area (km^2)	*%*	*Area (km^2)*	*%*	*Area (km^2)*	*%*
1	*Unclassified*	4.79	*0.28*	4.50	*0.26*	4.50	*0.26*
2	Forest	783.05	*45.02*	632.36	*36.35*	274.16	*15.76*
3	Water	32.94	*1.89*	37.98	*2.18*	37.98	*2.18*
4	Urban	10.15	*0.58*	50.91	*2.93*	58.57	*3.37*
5	Paddy Field	183.19	*10.53*	192.89	*11.09*	262.35	*15.08*
6	Secondary Forest	287.70	*16.54*	253.72	*14.59*	264.05	*15.18*
7	Mixed Plantation	113.30	*6.51*	143.12	*8.23*	405.96	*23.34*
8	Sparse Grass	31.29	*1.80*	49.90	*2.87*	112.10	*6.44*
9	Grass	293.07	*16.85*	374.10	*21.51*	319.82	*18.39*
Total		**1,739.49**		**1,739.49**		**1,739.49**	

A question that arises from Table 6.1 is the likely time period over which Scenario I may happen. This question cannot be answered from the trend of LULC change between 1998 and 2012 because the trend line between both LULCs creates a linear function. Natural resources depletion, which is included in LULC change, is seldom reflected as a linear function (Kaufmann, 2002), however, the limitations of having only two LULC maps in this research prohibits the development of a non-linear function to represent LULC trends over the Krueng Aceh catchment. Therefore, the trends of LULC change derived from other research are used to find a more reliable trend of LULC change over the Krueng Aceh catchment. There are two other research projects that have focused on deforestation over the Krueng Aceh catchment, which are that carried out by Sea Defence Consultants (SDC, 2009) and the Leuser International Foundation (LIF, 2012). SDC (2009b) found that the trend of deforestation between 1991 and 2004 was 0.56% per year, which is close to the finding from this research of 0.36% per year from 1988 to 2012. However, the LIF (2012) found that the rate of deforestation between 2007 and 2010 during the Aceh Tsunami 2004 reconstruction process was 3.83% per year (LIF, 2012). Although the trend of 3.83% per year may be too high to use as the current deforestation rate over the catchment, this value is more accepted compared with other values (0.56% or 0.36% per year) because no specific intervention was launched by authorities after the 2004 Tsunami to reduce deforestation. Moreover, as Scenario I is predicting

the “business as usual” case that will happen, the deforestation rate of 3.83% per year is used in this scenario.

Using the trend of deforestation rate of 3.83% per year and assuming the other LULC change trends, the reduction of forest area from 632.36 km^2 in 2012 to 274.16 km^2 is predicted to happen within 28 years, i.e. LULC Scenario I will occur by 2040.

b. Scenario II

In Scenario II, conditions in the downstream area (Banda Aceh capital city) are predicted to be similar to the conditions that occur in Scenario I where paddy fields, secondary forest and grass areas will be converted into urban area, as a consequence of population growth, and increasing domestic water demand. In the upstream area, the scenario is developed under conditions that forest area as determined in LULC 2012 will be preserved, and any LULC classes that are non-forested areas and have slopes of more than 40% will be converted to be secondary forest area except for water bodies. Although the expansion of paddy field area in the upstream area is predicted to continue, the expansion area is only accepted for converting non-forested areas in slopes of less than 5% and *Alluvial* soil types.

Moreover, expansion of mixed plantation area will be allocated for slope conditions between 8% and 40%. Under this scenario, sparse grass areas in LULC map 2012 will be re-forested, except LULC classes which are located in soil type of *Mediteran*, which has poor fertility, will still be exposed as sparse grass. In the upstream area, urban and water bodies are stated to remain stable as their change between 1988 and 2012 was not significant (see Figure 4.2 in Chapter 4). This scenario is assumed to occur by the same year as Scenario I, which is 2040. Figure 6.2 shows the change from LULC 1988 to LULC 2012 and the predicted LULC under Scenario II.

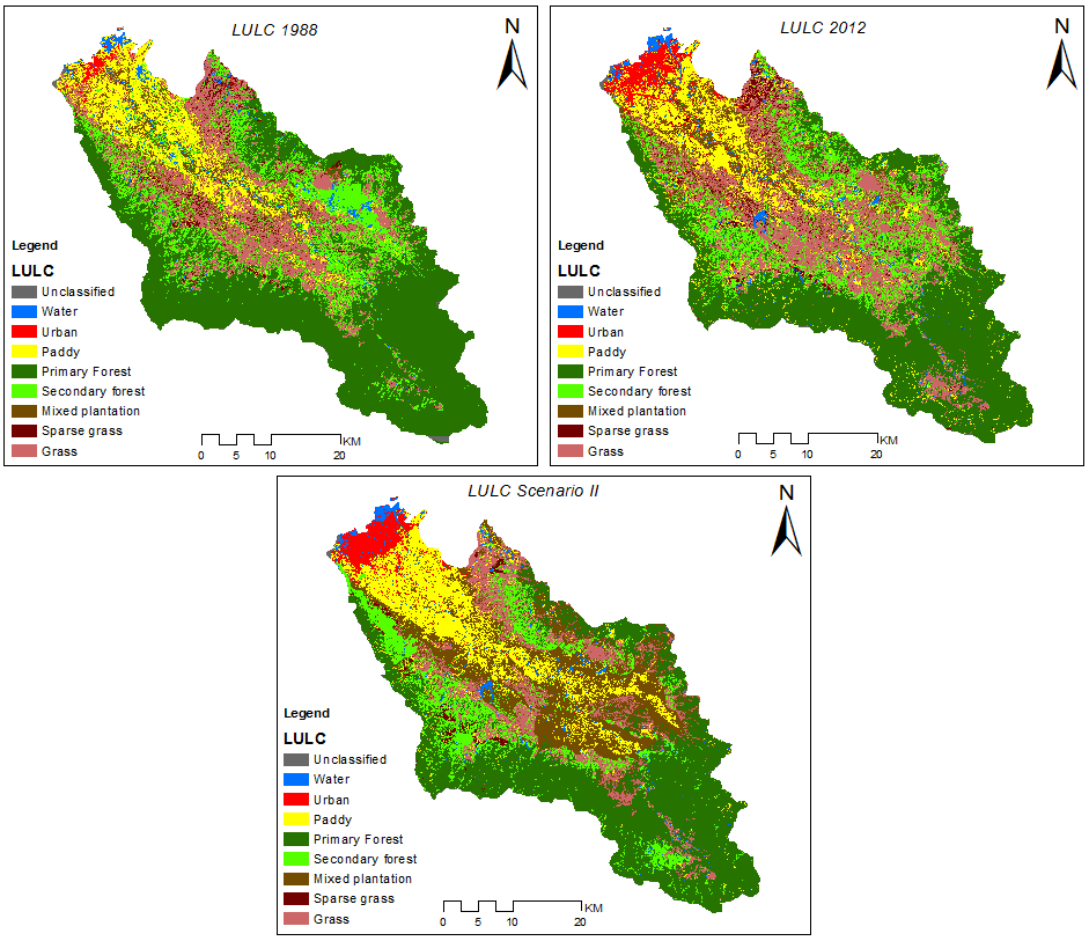


Figure 6.2 Maps of LULC 1988, LULC 2012 and predicted LULC Scenario II

Under Scenario II, lowland areas along the Krueng Aceh main river and its tributaries are dominated by paddy field. Urban area develops in the northern part of the catchment in the upstream area of the catchment. Forest area remains similar to the conditions in 2012. Re-forested lands that have land slope conditions more than 40% will recover sparse grass areas in the north and centre of the catchment. As a result, no sparse grass area will be exposed over the catchment under this scenario except limited areas in the southern and northern portions of the catchment. Urban areas and water bodies are stated as unchanged in the upstream area. Table 6.2 shows the comparison of areas of LULC in 1988, 2012 and Scenario II in the Krueng Aceh catchment.

Table 6.2 Comparison areas of LULC 1998, LULC 2012 and LULC Scenario II

No.	*LULC*	*1988*		*2012*		*Scenario II*	
		Area (km^2)	*%*	*Area (km^2)*	*%*	*Area (km^2)*	*%*
1	*Unclassified*	4.79	*0.28*	4.50	*0.26*	4.50	*0.26*
2	Forest	783.05	*45.02*	632.36	*36.35*	632.36	*36.35*
3	Water	32.94	*1.89*	37.98	*2.18*	37.98	*2.18*
4	Urban	10.15	*0.58*	50.91	*2.93*	58.57	*3.37*
5	Paddy Field	183.19	*10.53*	192.89	*11.09*	247.68	*14.24*
6	Secondary Forest	287.70	*16.54*	253.72	*14.59*	202.85	*11.66*
7	Mixed Plantation	113.30	*6.51*	143.12	*8.23*	349.85	*20.11*
8	Sparse Grass	31.29	*1.80*	49.90	*2.87*	13.38	*0.77*
9	Grass	293.07	*16.85*	374.10	*21.51*	192.30	*11.06*
Total		**1,739.49**		**1,739.49**		**1,739.49**	

6.2.2. Impact of LULC Scenarios on Hydrological Response

a. Hydrological response on discharge

The analysis of runoff change that is caused by LULC change from 1988 to 2012 has been discussed in Chapter 4. As the analysis was run under SCS Curve Number (*CN*) values for identification of hydrological responses, Table 6.3 shows the change in *CN* values between 1998, 2012, Scenario I and Scenario II in the subbasins.

Table 6.3 Mean *CN* values of subbasins in 1998, 2012, Scenario I and Scenario II

No.	*Subbasin*	*1998*	*2012*	*Scenario I*	*Scenario II*
1	Boga	66.59	68.08	69.00	67.53
2	Lampisang	68.94	70.93	71.91	70.30
3	Darang	65.77	68.26	68.99	67.11
4	Pasie	60.34	62.56	63.81	61.77
5	Banda Aceh	63.41	63.71	65.02	62.69
Krueng Aceh catchment		**58.41**	**64.16**	**67.74**	**65.88**

Based on Table 6.3, the highest change in *CN* values occurs in the Lampisang subbasin, which can be observed in the southern portion of the *CN* value map in Figure 6.3 (refer to Figure 3.4 in Chapter 3 for subbasin locations). Moreover, change is also shown in the northern part of the map (Pasie subbasin). Figure 6.4 shows the difference in CN values between LULC Scenario I and

LULC Scenario II (compared with the spatial distribution of CN values in LULC 1988 and LULC 2012 shown in Figure 4.12 Chapter 4).

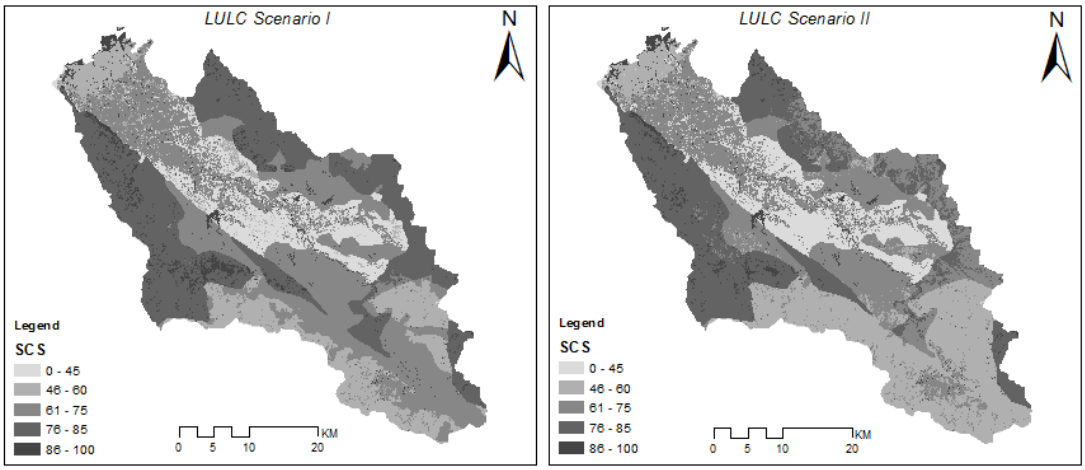


Figure 6.3 Spatial distribution of *CN* value of LULC Scenario I *(left)* and Scenario II *(right)*

Using a similar method to that described in Chapter 4, runoff change analysis on Scenario I and II were also run with the same rainfall data 2012 using the HEC-HMS model, in order to show the impact of LULC change on runoff. Under Scenario I and Scenario II, highest peak q increased from $q_{\text{-}1988}$ = 551.5 m^3/s and $q_{\text{-}2012}$ = 553.5 m^3/s to $q_{\text{-Scenario I}}$ = 556.3 m^3/s and $q_{\text{-Scenario II}}$ = 554.2 m^3/s. Moreover, LULC of these scenarios create a reduction in minimum q values from $q_{\text{-}1988}$ = 8.3 m^3/s and $q_{\text{-}2012}$ = 6.8 m^3/s to $q_{\text{-Scenario I}}$ = 6.3 m^3/s and $q_{\text{-Scenario II}}$ = 6.6 m^3/s (See Figure 4.20 in Chapter 4 for detailed descriptions of LULC 1988 and LULC 2012 responses). Table 6.4 shows the recalculation of peak q and minimum q results for LULC conditions for 1988, 2012, Scenario I and Scenario II.

Table 6.4 Peak q and minimum q results for LULC conditions for 1988, 2012, Scenario I and Scenario II.

No.	***LULC***	***Discharge q (m^3/s)***				
		Min	***Max***	***Median***	***Std.Dev***	***Mean***
1	1988	8.3	551.5	95.6	95.6	120.2
2	2012	6.8	553.5	99.2	99.2	122.6
3	Scenario I	6.3	556.3	99.6	100.0	124.0
4	Scenario II	6.6	554.2	99.5	99.4	123.4

b. Hydrological response on sediment transport

Sediment transport is calculated using similar methods to those described in Chapter 4 on sediment transport analysis, which involves use of the ULSE method for calculating annual soil loss *(E)*, so that the spatial distribution of soil loss rates can be shown over the catchment. In connection with the analysis of the impact of LULC changes under the scenarios, the same rainfall depth *p* of 2012 is used to see the differences between responses due to LULC change under these scenarios compared with the conditions in 1988 and 2012. Table 6.5 shows detailed *E* values for different LULC conditions in the Krueng Aceh catchment and Figure 6.4 shows the spatial distribution of *E* values under Scenario I and Scenario II (refer to the spatial distribution of *E* values for LULC 1988 and LULC 2012 shown in Figure 4.21, Chapter 4).

Table 6.5 Annual soil loss *E* results for precipitation of 2012 (1,648 mm)

No.	***LULC***	***Annual Soil Loss E (ton/km^2/year)***			
		Min	***Max***	***Std. Dev***	***Mean***
1	1988	0	27,631	2,680	1,299
2	2012	0	28,318	2,869	1,363
3	Scenario I	0	55,764	3,958	1,774
4	Scenario II	0	32,544	3,262	1,523

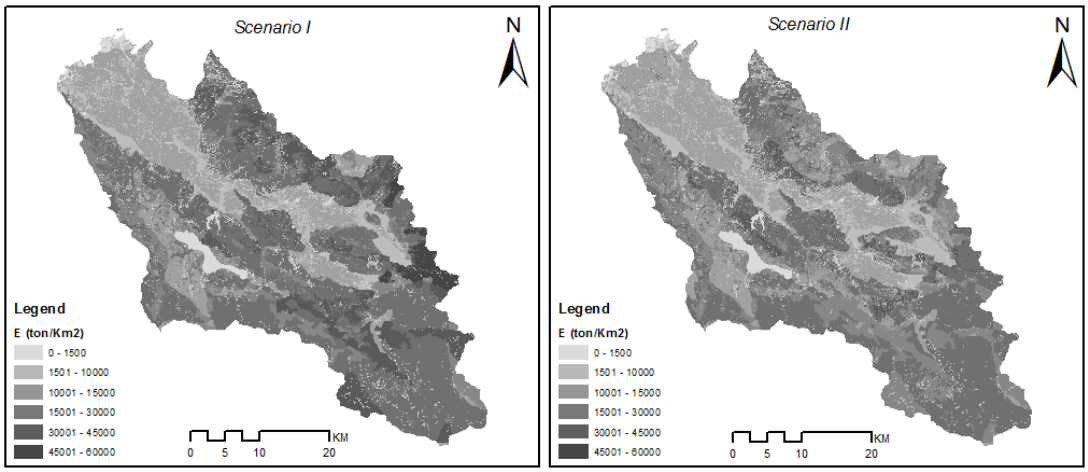


Figure 6.4 Spatial distribution of *E* for LULC Scenario I *(left)* and Scenario II *(right)*

Total sediment yield *(Y)* in the sediment transport analysis was calculated using the Sediment-Runoff Model described in Chapter 4, in order to analyse the impact of increasing discharge *q* on total sediment yield at selected locations in the Krueng Aceh catchment. Table 6.6 shows *Y* values produced under daily discharge *q* from HEC-HMS modelling when these conditions are run on accumulated daily rainfall depth 2012 at Pasie Station and Krueng Aceh catchment's outlet.

Table 6.6 Total sediment discharge *Y* results for daily discharge *q* produced from HEC-HMS modelling from accumulated daily rainfall depth 2012 at two selected locations

No.	***LULC***	***Total Sediment Discharge Y (ton/year)***	
		Pasie Station	***Catchment's Outlet***
1	1988	701,478.0	929,865.0
2	2012	735,422.7	971,719.5
3	Scenario I	755,117.7	992,766.0
4	Scenario II	748,230.1	981,842.3

6.2.3. Impact of LULC Scenarios on the reliability of water resources

The forecasting of hydrological responses under the scenarios as the consequence of LULC changes are computed using the HEC-HMS model. The scenarios are calculated under various conditions, which are under rainfall depth 2012 and water demands of 2012 to compare the response under the scenarios with LULC 2012. The scenarios are also computed under water demand 2040 and rainfall depth 2040 to analyse water reliability under LULC scenarios for 2040. Rainfall depth 2040 is predicted will increase 10% in wet season and decrease 10% in the dry season based on rainfall depth condition in 2012.

a. Impact of scenarios on water demand

Table 6.7 shows the different water quality and quantity conditions under LULC in 1988, 2012, Scenario I and Scenario II. These values are calculated using the schematic in Figure 5.1 (Chapter 5) using water balance simulations and water demands 2012. The inflow results from the HEC-HMS simulations run under rainfall depth 2012 (detail in Appendix 5.1, Appendix 5.2, Appendix 6.1 and Appendix 6.2).

Table 6.7 Reliability of water resources based on LULC conditions, run for water demand 2012 and rainfall depth 2012

No.	*LULC*	*Quantity Reliability (%)*			*Quality Reliability*		
		Upstream (%)	*Downstream (%)*	*DPAM Tirta Daroy (%)*	*TSS > 2000 g/l (%)*	*Turbidity < 5 NTU (%)*	*Purification Cost (USD)*
1	1988	93.44	97.81	98.91	0.00	14.48	205,232.13
2	2012	88.52	97.54	98.91	0.00	14.20	215,191.60
3	Scenario I	91.53	97.81	98.91	0.00	11.48	248,883.71
4	Scenario II	93.91	98.09	98.91	0.00	13.93	231,311.65

From Table 6.7, it can be seen that the water quantity reliability increases under Scenario I and Scenario II compared with conditions in 2012. This is because increases in runoff may increase water supply, resulting in better reliability in terms of water quantity. For water quality, however, the events where turbidity values are < 5 NTU (at the intake of PDAM Tirta Daroy) become less frequent as the increased open areas result in higher sediment transport.

These findings suggest that the LULC changes under both scenarios may be able to support the increased quantity of water demand. As the LULC scenario's result in increasing runoff over the catchment, the cost of water purification increases by 0.70% under Scenario I and 1.06% under Scenario II when both LULC scenarios are compared with LULC 2012. The costs for water purification reduces by 0.37% from Scenarios I to II, which is from USD 248,833.71 in Scenario I to USD 231,311.65 in Scenario II.

b. Impact of Scenarios on water demand in 2040

The economic costs under both LULC scenarios are calculated using a similar method as calculating water demand in 2012 (as described in Chapter 5). This calculation will be analysed based on water demand in 2040 and run based on LULC responses of rainfall for 2012 through HEC-HMS simulations. Water demand for 2040 in the upstream and downstream areas of the catchment is shown in Table 6.8.

Table 6.8 Water demand in the Krueng Aceh catchment in 1988, 2012 and 2040 (Scenario I and Scenario II)

No.	Location / Type of Demands	Consumption factor (unit)	Daily Demand (10^6 litre/day)				Daily Demand (M^3/s)				Annual Demand (10^6 M^3/year)			
			1988	2012	2040 (Sce I)	2040 (Sce II)	1988	2012	2040 (Sce I)	2040 (Sce II)	1988	2012	2040 (Sce I)	2040 (Sce II)
Downstream Area Population		**2.40 % / year**	**135,147**	**238,784**	**463,878**	**463,878**	**135,147**	**238,784**	**463,878**	**463,878**	**135,147**	**238,784**	**463,878**	**463,878**
1	Domestic	120.00 litre/person/day	16.22	28.65	55.67	55.67	0.19	0.33	0.64	0.64	5.92	10.46	20.32	20.32
2	Non-domestic	30.00 litre/person/day	4.05	7.16	13.92	13.92	0.05	0.08	0.16	0.16	1.48	2.61	5.08	5.08
3	Water losses	40.00 litre/person/day	5.41	9.55	18.56	18.56	0.06	0.11	0.21	0.21	1.97	3.49	6.77	6.77
4	Min. environmental flow	300.00 litre/person/day	40.54	71.64	139.16	139.16	0.47	0.83	1.61	1.61	14.80	26.15	50.79	50.79
5	Paddy field*	1.04 litre/s/ha	178.36	54.99	-	-	2.06	0.64	-	-	39.24	12.10	-	-
		Total Banda Aceh	*244.59*	*172.00*	*227.30*	*227.30*	*2.83*	*1.99*	*2.63*	*2.63*	*63.41*	*54.80*	*82.96*	*82.96*
Upstream Area Population		**2.28 % / year**	**182,798**	**322,976**	**627,435**	**627,435**	**182,798**	**322,976**	**627,435**	**627,435**	**182,798**	**322,976**	**627,435**	**627,435**
1	Domestic	82.50 litre/person/day	21.94	26.65	51.76	51.76	0.25	0.31	0.60	0.60	8.01	9.73	18.89	18.89
2	Non-domestic	60.00 litre/person/day	5.48	19.38	37.65	37.65	0.06	0.22	0.44	0.44	2.00	7.07	13.74	13.74
3	Water losses	24.00 litre/person/day	7.31	7.75	15.06	15.06	0.08	0.09	0.17	0.17	2.67	2.83	5.50	5.50
4	Min. environmental flow	300.00 litre/person/day	54.84	96.89	188.23	188.23	0.63	1.12	2.18	2.18	20.02	35.37	68.70	68.70
5	Paddy field**	1.04 litre/s/ha	1,310.37	1,688.93	2,357.37	2,225.55	15.17	19.55	27.28	25.76	288.28	371.57	518.62	489.62
		Total Aceh Besar	*1,399.94*	*1,839.60*	*2,650.07*	*2,518.25*	*16.20*	*21.29*	*30.67*	*29.15*	*320.97*	*426.56*	*625.46*	*596.46*
		Total Banda Aceh and Aceh Besar	***1,644.53***	***2,011.60***	***2,877.37***	***2,745.55***	***19.03***	***23.28***	***33.30***	***31.78***	***384.39***	***481.36***	***708.42***	***679.42***

* paddy fields area: 1,985 ha (1988, 612 ha (2012) and 0 ha (ScenarioI & II) in downstream area

** paddy fields area: 14,583 ha (1988), 18,796 ha (2012), 26,235 ha (Scenario I) and 24,768 ha (Scenario II) in upstream area

Table 6.8 shows that although no water demand is supplied for paddy field in the downstream area, the total demand in the downstream area increases by 32.15% from 1.99 m^3/s in 2012 to 2.63 m^3/s in 2040 due to population growth. The demands for domestic and non-domestic uses (including water losses) are predicted to increase from 0.52 m^3/s in 2012 to 1.01 m^3/s in 2040, or an increase of 94.23%. Similarly, increasing water demand in the upstream area in 2040 is predicted to result from increasing paddy field area, where more than 90% from total demand in the upstream area is proposed to supply paddy fields. The demand in the upstream area is 21.29 m^3/s in 2012 and increases to 29.15 m^3/s in 2040, or an increase of 36.92%. A summary of the reliability of water resources under LULC 2012, LULC Scenario I and LULC Scenario II is shows in Table 6.9 and detailed calculations are attached in Appendix 5.2, Appendix 6.3 and Appendix 6.4.

Table 6.9 Reliability of water resources for LULC 2012 based on water demand 2012, Scenario I and Scenario II based on water demand 2040 and run with rainfall 2012

No.	***LULC***	***Quantity Reliability***			***Quality Reliability***		
		Upstream (%)	***Downstream (%)***	***DPAM Tirta Daroy (%)***	***TSS > 2000 g/l (%)***	***Turbidity < 5 NTU (%)***	***Purification Cost (USD)***
1.	2012 (Demand 2012)	88.52	97.54	98.91	0.00	14.21	215,191.60
2.	Scenario I (Demand 2040)	87.43	96.17	97.81	0.00	13.93	416,908.06
3.	Scenario II (Demand 2040)	87.43	96.17	97.81	0.00	14.21	400,204.16

Table 6.9 shows that reliability of water supply for demand 2040 under these scenarios is similar, however, it was found that the scenarios cannot anticipate the demands of 2040 if the conditions are compared with 2012, which overall reduce the reliability in the upstream, downstream and at PDAM Tirta Daroy. Similarly, as demands for domestic and non-domestic increase at PDAM Tirta Daroy and more water has to be processed, costs for water purification increase by 96.33% from USD 215,191.60 in 2012 to USD 416,908.06 under Scenario I and by

95.60% to USD 400,204.16 under Scenario II (see Appendix 6.3 and Appendix 6.4).

c. Impact of Scenarios on water demand 2040 and rainfall depth 2040

It has been discussed in Chapter 4 that rainfall change over the Krueng Aceh catchment in terms of depth and duration cannot be clearly ascertained. However, from the rainfall depth records, the trend of increasing rainfall depth occurs in the upstream area and decreasing rainfall depth occurs in the downstream area when these locations are compared. In more detail, increased rainfall peaks occur in wet seasons and the trend of decreasing rainfall occurs in dry seasons (Boer & Suharnoto, 2012; SDC, 2009b).

Therefore, scenarios of rainfall depth change will be created under assumptions that peak rainfall depth is predicted to increase by 10% and low rainfall depth decreases by 10% in all periods over the catchment (upstream, middle and downstream) based on rainfall records for 2012 (see Appendix 3.1). A summary of calculation results is shown in Table 6.10 and detailed calculations are attached in Appendix 6.5 and Appendix 6.6.

Table 6.10 Reliability of water resources for LULC 2012 and water demand 2012, and Scenario I and Scenario II and water demand 2040 run with rainfall 2040

No.	***LULC***	***Quantity Reliability***			***Quality Reliability***		
		Upstream (%)	***Downstream (%)***	***DPAM Tirta Daroy (%)***	***TSS > 2000 g/l (%)***	***Turbidity < 5 NTU (%)***	***Purification Cost (USD)***
1	2012 (Demand & Rainfall 2012)	88.52	97.54	98.91	0.00	14.21	215,191.60
2	Scenario I (Demand & Rainfall 2040)	87.70	96.45	97.81	0.00	11.20	447,442.47
3	Scenario II (Demand & Rainfall 2040)	87.70	96.45	97.81	0.00	11.20	403.442.36

Table 6.10 indicates that reliability of water supply in quantity based on demand 2040 under rainfall depth scenario for both LULC scenarios is similar. However, costs for water purification increase by 110.71% from USD 215,191.60 in 2012 to USD 447,442.47 under Scenario I and by 110.19% to USD 403,442.36

under Scenario II. Moreover, increases of 10% in daily peak rainfall depths do result in TSS values exceeding 2000 mg/l such that PDAM Tirta Daroy's water treatment plan cannot be operated. However, the events where turbidity values are less than 5 NTU (equal to TSS = 1.6 mg/l at the intake of PDAM Tirta Daroy), where water does not need to be purified, happens less frequently when these conditions are compared with the results run under rainfall depth 2012. Detailed calculations are attached in Appendix 6.5 and Appendix 6.6.

6.3. Decision Alternatives for IWRM

The results presented here found that LULC changes, together with increasing water demands and climate change that impacts on changing rainfall depth, affect the reliability of water supply in the Krueng Aceh catchment, especially in terms of water quality. Therefore, controlling LULC change may maintain water reliability or at least prevent it from worsening. As LULC change in upstream of the Krueng Aceh catchment is closely related to economic activates, various kinds of compensation may contribute to the controlling of LULC change. As the upstream and downstream of the Krueng Aceh catchment is divided into different decentralized areas, compensation can be a link between those areas where the area that takes benefits compensates the area that gives the benefits from water resources in the catchment. The compensation funds can be spent on the reforestation costs, which can be optimized in selected locations that give significant positive impacts on water reliability compared with other areas that give less significant impacts. The significance can be related to slope conditions, soil types, and plant or canopy types. Moreover, the compensation can be addressed by farmers for paddy field water usage management and land use management practice for agricultural lands.

6.3.1. Multi Criteria Decision Making

Before the compensation is distributed under MCDM, it needs to identify drivers that contribute to target variables to ensure that the compensation can be effective to achieve the desired state. The Cognitive map (Figure 6.5) below

describes LULC management under the desired state of PDAM Tirta Daroy and shows the drivers that contribute to achieving the target.

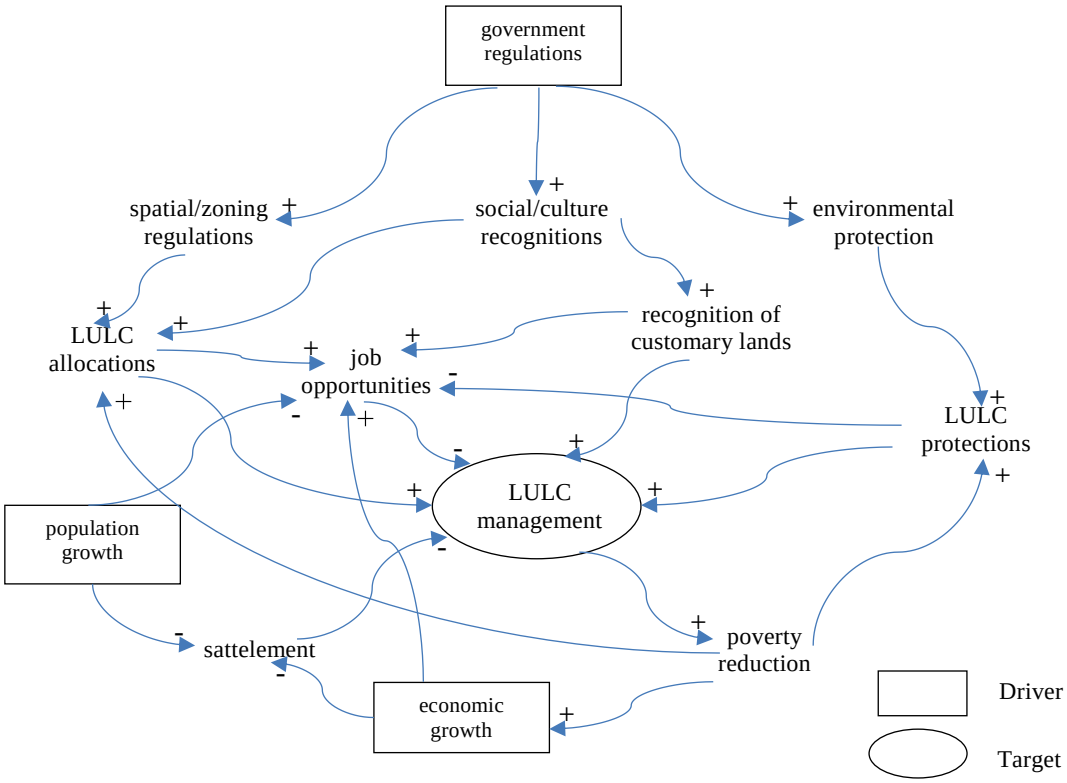


Figure 6.5 Cognitive map of LULC management under the desired state of PDAM Tirta Daroy.

There are three drivers that directly contribute to LULC management over the Krueng Aceh catchment, which are government regulation, population growth and economic growth as shown in the cognitive map in Figure 6.5. Under government regulations in Indonesia, there are three regulations that directly impact LULC management, they are spatial or zoning regulations, environmental protection and social and cultural recognition. These regulations positively impact LULC management. Moreover, population growth creates negative impacts on land due to increasing land demand for settlement and the need for more jobs, which in many cases means agriculture jobs. Economic growth also negatively impacts the land when it is connected with land allocation for settlements, however the economic growth positively impacts job opportunities, which may create certain jobs that do involve land usage.

Moreover, successful LULC management may reduce poverty, which may contribute to increasing economic growth, law enforcement for land protection and the role of land allocation. Therefore, economic compensation to the upstream area has to focus on poverty reduction through managing job opportunities as the rate of poverty in the upstream area is high, with less income per capita compared with the downstream and 63% of the upstream population rely on agricultural lands for their livelihoods, as discussed in Chapter 3. In other words, the desired state of PDAM Tirta Daroy can only be achieved when poverty in the upstream areas can be reduced through increasing job opportunities for upstream communities. The settlement does not contribute high impacts on LULC management in upstream areas as the average population density in the upstream area is 124.75/km^3 (see Table 3.3 in Chapter 3) compared with average population density in the downstream area 3,641.56/km^3 (see Table 3.2 in Chapter 3) based on data in 2010.

6.3.2. Decision Alternatives

Three ranks of alternatives contribute to the desired state of PDAM Tirta Daroy under MCDM assessment, which are reforestation, land management practice for agricultural lands and plant management practice for agricultural products. These alternatives will be chosen as potential actions that can be implemented to achieve the desired state of PDAM Tirta Daroy using the Analytic Hierarchy Process (AHP).

a. Goal

The goal has been set through MCDM, which is the desired state of PDAM Tirta Daroy that is to ensure the quantity of water demand and reduce sediment transport. This goal has to minimize impacts on social costs and capital costs in its implementation.

b. Potential factors

There are four factors which can be determined from the goal, they are related to the water quality, water quantity, social cost and capital cost factors. The water quality factor relates to ensuring the quality of water for the PDAM Tirta Daroy water distribution system to meet consumer demands. The Water quality

factor relates to the turbidity value of water that determines the cost of water purification. The social cost factor is the social impact of implementation of the goals to community or stakeholders that has to be minimized, which can result in loss of farmers' income, employment and food security, and the capital cost factor is the cost for goal implementation that has to be as low as possible.

c. Potential options

Potential actions in achieving the goal of PDAM Tirta Daroy can be summarised from the rank of alternatives, they are:

Under management practice for agricultural products:

1. Reduction of upstream paddy's water demand, which is expected to be 25% of the total paddy field share demand. This action may be achieved by substituting other crops for paddy plant that have similar market value, such as chili, peanuts, soybean etc.

Under management practice for agricultural lands:

2. Increasing infiltration rates over the catchment. This is expected to be achieved by 25% improvement of Curve Number (*CN*) values through planting canopies in agricultural lands together with reforestation.
3. Reducing sediment delivery transport. This is expected to be reduced by 25% through building sediment trap dams in tributary rivers in the upstream area.

Figure 6.6 summarises the goal, and factors that contribute to achieving the goal and their implementation options analysed under the Analytical Hierarchy Process (AHP).

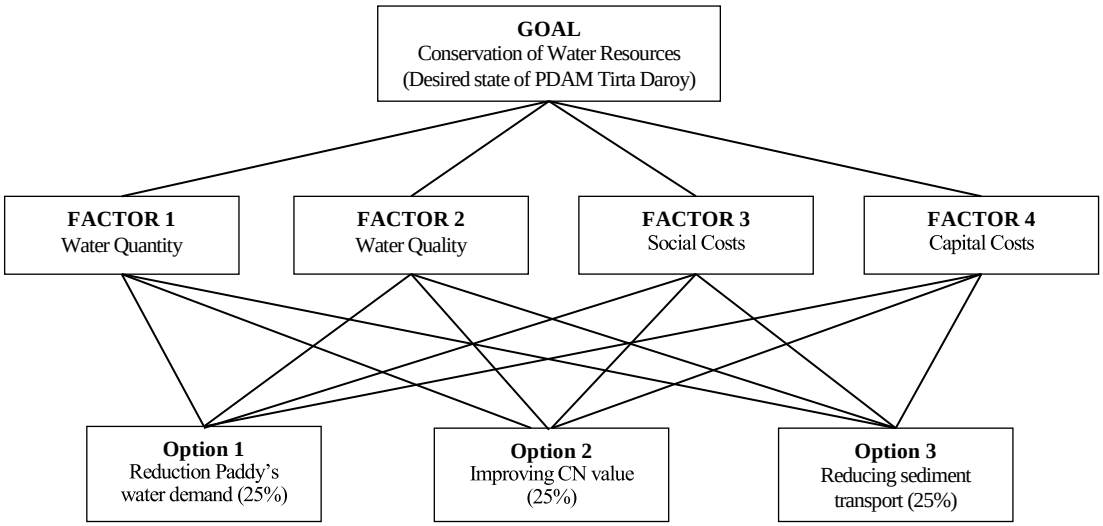


Figure 6.6 Goal, factors and options that contribute to implementation of the desired stated of PDAM Tirta Daroy under AHP

Under the Fundamental Scale of Absolute Numbers, water resources management in the Krueng Aceh catchment can be assumed as shown in Table 6.11.

Table 6.11 Predicted factor comparisons under the Fundamental Scale of Absolute Numbers

No	***Factor***	***Factor***	***Value (Intensity of importance)***
1.	Water quantity	Water quality	5
		Social Cost	2
		Capital Cost	7
2.	Water quality	Social Cost	2
		Capital Cost	3
3.	Social Cost	Capital Cost	3

Based on Table 6.11, water quantity is of stronger importance (5) than water quality because as long as the water is available, water with good quality could still be produced. Water quantity is of more importance (2) than social impact, because the impact of on social cost (i.e. farmers' income) can be avoided by providing compensation to farmers. Moreover, water quantity has a very strong demonstrated importance (7) relative to capital costs because people are willing to spend their money in order to get the necessary amount of water.

Water quality is more important (2) than social impact. An example is that to produce drinking water to meet a quality standard may require changing the way farmers use pesticide. This improvement may impact on reducing farmers' income (social costs), however, the social impact can be minimalized by giving compensation to the farmers. Moreover, the quality is also of moderate importance (3) compared to capital costs where as long as capital costs are available, it is still possible to produce water and to meet a quality standard.

Social costs are of moderate importance (3) compared to capital costs, because water providers and authorities responsible for water production may be more concerned about social impacts (social costs) compared with the capital issues.

Using the intensity of importance values in Table 6.11, the relative factors of competence can be illustrated as shown in Table 6.12.

Table 6.12 Pair-wise comparison matrix of criteria with respect to the desired state of PDAM Tirta Daroy

M1	***Water quantity***	***Water quality***	***Social Cost***	***Capital Cost***
Water quantity	1	5	2	7
Water quality	1/5	1	2	3
Social Cost	1/2	1/2	1	3
Capital Cost	1/7	1/3	1/3	1

Table 6.12 represents the pair-wise comparison between the different options to the rank of overall factors of the desired state of PDAM Tirta Daroy. The values of the respective options are entered in a *4 x 4* matrix where when an option is compared with itself is assigned a value 1, which makes the diagonal elements of the matrix 1. On the contrary, based on the Fundamental Scale of Absolute Numbers, a value is assigned if an option is compared with other criteria in the matrix.

Using the pair-wise comparison matrix (M1) in Table 6.12, computing the priority vector from the judgment (M2) can be set by normalizing the vector in each column of the matrix and summing over the row. This calculation was done

using matrix multiplication using the [=MMULT] function in Microsoft Excel software. Then its row sums can be divided by the column sums to calculate the vector priority values of the options. The results are shown in Table 6.13.

Table 6.13 Computing the priority vector from Table 6.12

M2	***Water quantity***	***Water quality***	***Social Cost***	***Capital Cost***	***Row Sum***	***Vector Priority***	***λ***	***λ max***
Water quantity	4.00	13.83	16.33	35.00	68.67	***0.563***	2.36	4.19
Water quality	1.85	4.00	5.40	13.40	24.62	***0.202***	0.85	4.20
Social Cost	1.53	4.50	4.00	11.00	21.03	***0.172***	0.74	4.31
Capital Cost	0.52	1.55	1.62	4.00	7.69	***0.063***	0.27	4.26
				Sum of row sum	122.01		Average	4.24

The results from Table 6.13 show that water quantity is of the highest priority above all other available options. Using the principal Eigen value (λ_{max}), the consistency of the vector priority value can be validated based on Table 6.13 to get λ value. Moreover, the λ_{max} values result from dividing the vector priority on each alteration level (M) and λ value until λ_{max} average results in a consistency ratio below 10% (Saaty, 1988).

The average of λ_{max} for M2 matrix is 4.166, and the consistency index (*CI*) is calculated using the given equation, where *n* is a number of options (4):

$$CI = \frac{\lambda_{max} - n}{n-1} = \frac{4.24 - 4}{4-1} = 0.08 \quad (6.1)$$

The consistency ratio (*CI*) can be calculated using the average random index (*RI*) developed by Saaty (1988) for the corresponding matrix size *(4x4)* as 0.89:

$$RI = \frac{CI}{RI} = \frac{0.08}{0.89} = 0.09 \quad (6.2)$$

As the *RI* value is less than 0.1 (10%), the judgments in Table 6.13 are considered consistent. Figure 6.7 shows the vector priorities of the desired state of PDAM Tirta Daroy.

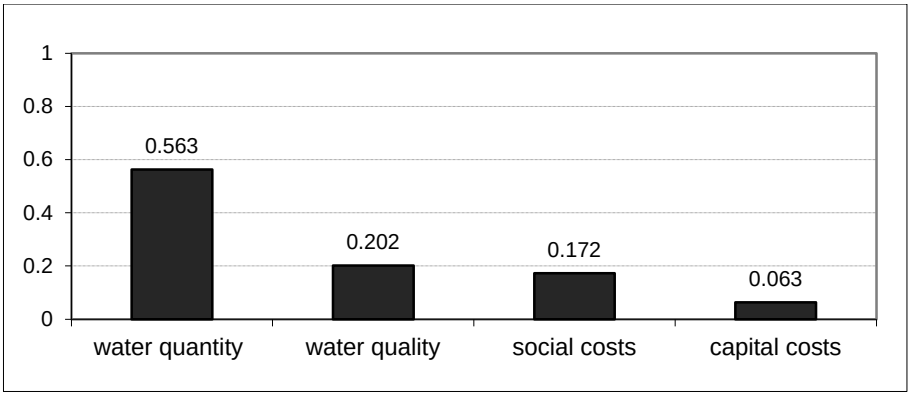


Figure 6.7 Vector priorities of the desired state of PDAM Tirta Daroy

Figure 6.7 shows that to ensure water quantity availability is 56.3% of total priority, which is almost three times higher than water quality priority (20.2%). The social consideration, which is stated as the social costs is 17.2%, and is two times higher than the priority of capital costs (6.2%).

d. Project implementation alternatives

Predicting project implementation alternatives in options importance can be computed using HEC-HMS modelling and water balance analysis. However, this research does not develop indicators to determine the impacts on social and capital costs, therefore these options are determined using the Fundamental Scale of Absolute Numbers (see Table 6.11). Table 6.14 shows the value of options when they are tested under the baseline of LULC Scenario II that runs on water demands and rainfall depth 2040 under the desired state or goal of the PDAM Tirta Daroy.

Table 6.14 Potential option values under the desired state of PDAM Tirta Daroy using baseline conditions of LULC Scenario II under demand and predicted rainfall depth 2040

No	*Options assessment to contributed factors*	*Result*	
		Indicator	*(%)*
1.	**Water quantity**		
	Reduction Paddy's water demand (25%)	PDAM reliability (R_3) : 99.18%	48.34
	Improving CN value (25%)	Overall reliability : 90.99%	44.35
	Reducing sediment transport (25%)	Prediction : 15.00%	7.31
	Total	***205.17%***	***100.00***
2.	**Water quality**		
	Reduction Paddy's water demand (25%)	Prediction : 2.00%	6.54
	Improving CN value (25%)	Turbidity < 5 NTU : 15.30%	50.03
	Reducing sediment transport (25%)	∑ Alum demand : 13.28%	43.43
	Total	***32.62%***	***100.00***
3.	**Social costs**		
	Reduction Paddy's water demand (25%)	Prediction : 9	60.00
	Improving CN value (25%)	Prediction : 3	20.00
	Reducing sediment transport (25%)	Prediction : 3	20.00
		15	***100.00***
4.	**Capital costs**		
	Reduction Paddy's water demand (25%)	Prediction : 3	16.67
	Improving CN value (25%)	Prediction : 6	30.33
	Reducing sediment transport (25%)	Prediction : 9	50.00
		18	***100.00***

Table 6.14 shows three potential options computed under the desired state of PDAM Tirta Daroy. The impact on water quantity shows that reduction in paddy field's water demand contributes to increase PDAM Tirta Daroy reliability by 99.18% (see Appendix 6.7 at R_3) and improving *CN* values increases overall (upstream and downstream) reliability to 80.99% (see Appendix 6.7). However, reduction of sediment transport is predicted as less significant in increasing water quantity value (assuming that is 15%). On water quality impacts, reduction in paddy field's water demand is predicted as having less impact on improving water quality value (assuming that is 2%) compared with other impact values. However, improving *CN* values in Scenario II increases events of TSS value less than 5 NTU by 15.30% (see Appendix 6.7) compared with not improving the *CN* value in Scenario II (see Appendix 6.6). Moreover, reducing sediment transport by 25% can reduce alum demand by 15.32% (see Appendix 6.7) compared with the alum consumption in Scenario II with no sediment reduction option (see Appendix 6.6).

Using the Fundamental Scale of Absolute Number, Table 6.14 shows that reducing the paddy field's water demands will affect paddy production, which

may have high impacts on farmers. The impact on the farmers is illustrated as the social cost of extreme importance (9) when this alternative is compared with other alternatives where the other two alternatives are predicted of moderate importance (3) impact on social costs. On the capital costs, reducing sediment transport, such as building sediment traps, is predicted to give extreme importance (9) impact on capital cost compared with impact on improving *CN* value through reforestation, which contributes strong plus importance (6), and reducing paddy field's water demand, which gives moderate importance (3).

The three option alternatives that have been developed are set in the implementation of the state purposes. Each action is apportioned in the program by 20%, 30% and 50%, respectively, as shown in Table 6.15.

Table 6.15 Alternative values based on potential portions in project implementation

Alternative I	**Portions in project**	**water quantity**	**water quality**	**social costs**	**capital costs**
Reduction Paddy's water demand (25%)	50%	48.34%	6.54%	60.00%	16.67%
Improving CN value (25%)	30%	44.35%	50.03%	20.00%	33.33%
Reducing sediment transport (25%)	20%	7.31%	43.43%	20.00%	50.00%
	Result	***0.389***	***0.270***	***0.400***	***0.283***
Alternative II	**Portions in project**	**water quantity**	**water quality**	**social costs**	**capital costs**
Reduction Paddy's water demand (25%)	30%	48.34%	6.54%	60.00%	16.67%
Improving CN value (25%)	50%	44.35%	50.03%	20.00%	33.33%
Reducing sediment transport (25%)	20%	7.31%	43.43%	20.00%	50.00%
	Result	***0.381***	***0.357***	***0.320***	***0.317***
Alternative III	**Portions in project**	**water quantity**	**water quality**	**social costs**	**capital costs**
Reduction Paddy's water demand (25%)	20%	48.34%	6.54%	60.00%	16.67%
Improving CN value (25%)	30%	44.35%	50.03%	20.00%	33.33%
Reducing sediment transport (25%)	50%	7.31%	43.43%	20.00%	50.00%
	Result	***0.266***	***0.380***	***0.320***	***0.367***

The project alternative value is calculated by summing of multiplication between the option value and its portion in the project. The Rank of Alternative Values can be derived as a result of multiplying the project alternative value and vector priority value, as shown in Table 6.16.

Table 6.16 Project implementation values based on action alternative values

Alternative	*water quantity 0.563*	*water quality 0.202*	*social costs 0.172*	*capital costs 0.063*	*Value*
Alternative I	*0.389*	*0.270*	*0.400*	*0.283*	
	0.219	**0.054**	**0.069**	**0.018**	**0.360**
Alternative II	*0.381*	*0.357*	*0.320*	*0.317*	
	0.215	**0.072**	**0.055**	**0.020**	**0.362**
Alternative III	*0.266*	*0.380*	*0.380*	*0.383*	
	0.150	**0.070**	**0.055**	**0.023**	**0.299**

Based on Table 6.16, it shows that alternative II is the best alternative compared with other alternatives, although it is almost similar with alternative I. The alternative II options composition in project implementation is reducing 30% of paddy field's water demand from 25% of total paddy field share demand (or 7.5%), improving 50% of *CN* value from total 25% of target *CN* value reduction (or 12.5%) and reducing 20% of sediment transport from total 25% of target reduction (or 5%).

6.4. Economic Costs of LULC Management under the Decision Alternative

Potential economic losses are calculated under the non-demand curve where the calculation is developed in relation to the benefit that users receive from environmental prevention or when project implementations can avoid environmental damage. In this calculation, the avoidance of environmental damage occurs when Scenario II is successfully implemented under introduction of Alternative II, which is reducing paddy field water demand, improving *CN* value and reducing sediment transport based on their portions. Using the schematic in Figure 5.1 (Chapter 5) for water balance simulation method, LULC Scenario II is simulated while applying Alternative II based on predicted demand 2040 and climate condition scenario 2040. Reducing paddy field water demand by 7.5% is calculated by reducing 7.5% of predicted paddy field demand 2040 in the upstream area using the water balance simulation. Improving the *CN* value by 12.5% is computed by reducing 12.5% of *CN* value from LULC Scenario II and simulated using HEC-HMS model. Moreover, reducing sediment transport by 5% assumes that the Total Suspended Solid (TSS) or Turbidity value delivered to the

intake of the PDAM Tirta Daroy water treatment plant is reduced by 5%, which is calculated in the water balance simulation. Table 6.17 shows the results of these calculations, and detailed calculations are provided in Appendix 6.7.

Table 6.17 Reliability of water resources for Scenario I, Scenario II and Scenario II for Alternative I run for water demand 2040 and rainfall depth 2040

No.	*LULC*	*Quantity Reliability*			*Quality Reliability*		
		Upstream (%)	*Downstream (%)*	*DPAM Tirta Daroy (%)*	*TSS > 2000 g/l (%)*	*Turbidity < 5 NTU (%)*	*Purification Cost (USD)*
1	Scenario I	87.70	96.45	97.81	0.00	11.20	447,442.47
2	Scenario II	87.70	96.45	97.81	0.00	11.20	403.442.36
3	Scenario II (under Alternative II)	90.98	96.99	99.18	0.00	15.30	349,846.94

Table 6.17 shows that water supply reliability to the upstream area increases from 87.70% in Scenario II to 90.98% in Scenario II under Alternative II, which can be achieved by reducing paddy field demands by 7.5% from total upstream paddy field demand 2040. Downstream demand is not significantly changed as the downstream demand is only calculated as the minimum environmental flow demand as there is no more paddy field in the downstream area in 2040. Surprisingly, water supply reliability to PDAM Tirta Daroy improves from 97.81% to 99.18%, which results from less frequent lowflow conditions. Moreover, events where the turbidity value is less than 5 NTU such that water does not need to be purified increase from 11.20% to 15.30%. This reduces the cost for water purification from USD 403,443.36 under Scenario II to USD 349,846.94 under Scenario II with the introduction of Alternative II.

6.5. Discussion

The two potentially realistic LULC scenarios assessed here for the Krueng Aceh catchment found that both scenarios have similar reliabilities of water quantity in the upstream and downstream areas. However, the reliability of water

quality, which relates to the cost for water purification, is 4.01% higher for Scenario I compared to Scenario II when both scenarios are run under the same conditions of water demand 2040 and climate scenario 2040. These conditions occur because there are no interventions in LULC management in Scenario I, as this is the business as usual case.

However, if LULC Scenario II is compared with Scenario II modified under decision Alternative II, where paddy field water demand, *CN* values and sediment transport are controlled, the cost for water purification is reduced by 13.28%. This means that improving the LULC conditions in LULC 2040 through decision alternatives can reduce externalities that would have to be covered by PDAM Tirta Daroy in water production. The reduction in costs for water production from Scenario II to Scenario II under Alternative II amount to USD 53,595.41. This amount could then be allocated for project implementation as listed in Alternative II.

Implementation of Alternative II needs to consider impacts to stakeholders, especially impacts which reduce upstream stakeholder's income. Further research would be required to assess the impacts for upstream farmers, and the reductions in income that may result from reduced paddy production. However, these impacts can be avoided through actions such as changing to crop varieties that have similar economic value to rice but consume less water. Moreover, it was found that LULC improvement is of highest importance under the Alternative II, which is 12.5% compared with the other options such as reducing paddy field demand (7.5%) and reducing sediment transport (5%).

Taking an example of rice crop substitution; soybean and chili are crop varieties that have high economic value. However, costs for their fertilizer and pesticide treatments may be higher than paddy. Moreover, the price stability of other crops is low compared with rice, which is associated with market price fluctuation and fluctuation in demand. These problems can be reduced by giving an incentive to farmers who are willing to plant alternative crops and assure them that their production will be bought and protected with suitable prices when the price is low. The fund for incentive and market protection can be sourced from PDAM compensation, which may be calculated through the level of water demand or associated with virtual water value for paddy production compared with

alternative crop production (such as soybean and chili). The virtual water value parameters may also be used in selecting locations based on water availability and crop varieties, where the areas where water availability is high may be able to plant paddy, and other crops that consume less water will be planted in the areas where water availability is low.

As the Krueng Aceh catchment is divided into different decentralization levels, the key issue of these possible implementations is how they will be successfully applied. This relates to who will implement what, and where it will be implemented. Table 6.18 illustrates authorities' responsibilities in terms of IWRM implementation through applying economic compensation, so-called Payment for Environmental services (PES), within the Krueng Aceh catchment.

Table 6.18 Authorities' responsibility under IWRM implementation for PES within the Krueng Aceh catchment

No.	***Decentralization Levels***	***Responsibility in term of IWRM implementation***
1.	City and Regency Levels	City and Regency levels are in project implementation and they have to set together the goal, including approaches and targets, which will be reached in terms of space and time. Space can be where the focus areas are located and time is how long for the steps of goal to be reached. In the case of the Krueng Aceh catchment where PES is being implemented as a goal of IWRM implementation, city and regency have responsibilities: **The Banda Aceh City** ensures water services provider PDAM Tirta Daroy, as the company owned by Banda Aceh City, shares the profit or applies additional cost or tax levy from water usage for PES to the upstream area. **The Aceh Besar Regency** guarantees project implementation under agreement with Banda Aceh City. The Aceh Besar Regency develops the regulations to implement these projects especially zoning regulation *(RTRW Kabupaten)*, which is spatial planning regulation at regency level. Other regulations can be further arrangements enacted by upper decentralization levels (provincial or national levels) as well as *RTRW Kabupaten* as a further agreement of the provincial spatial planning *(RTRW Provinsi)*.
2.	Provincial Level	**The Aceh Province** provides assistance and policies that ensure Banda Aceh City and Aceh Besar Regency can implement this goal. Policy can include regulating the provincial spatial planning *(RTRW Provinsi)* for land allocations in the Krueng Aceh catchment for goal implementation.

3.	National Level	**National level** can be represented by provincial levels as some of the national authority has granted to provincial levels. More focus on LULC policy at the national level, the national planning policy *(RTRW Nasional)* and other national policies related to water resources management have to accommodate PES implementation.

Table 6.18 clearly shows that although the Krueng Aceh catchment is under the jurisdiction of Banda Aceh City and Aceh Besar Regency, the upper decentralized level of Aceh Province may also contribute to IWRM implementation. The contribution would relate especially to regulation setting and assistance with potential disputes among the parties on project implementation.

LULC improvement would also require strong legislation and law enforcement by various authorities. This implementation may be directly addressed by the upstream authority (Aceh Besar Regency). Laws related to LULC management that have been regulated by National and Provincial authority levels that can be used by the Aceh Besar authority, include:

1. Decree No. 170/Kpts/-II/2000 on the land use allocation status regulated by the Ministry of Forestry of Indonesia. This Decree mentions the boundary of protected forest in the Krueng Aceh catchment (see Figure 3.16 in Chapter 3).
2. Decree No 26 Year 2008 on National Spatial Planning. This decree mentions that land with slope conditions more than 40% have to be allocated as protected forest (Article 55).
3. Aceh Province Spatial Planning *(RTRW Provinsi)*, which is currently under revision, that regulates forested and non-forested (cultivation) areas.

However, law enforcement may be difficult when it does not include social and economic considerations, as poverty and unemployment are high in the upstream area. Law enforcement can only involve “soft action” such as preparing other jobs for farmers to encourage them to leave forest protected areas. Most of the farmers’ disadvantage relates to job opportunity and income, which would be further impacted by stronger punitive law enforcement action. Potential alternative jobs can be craftsmen, animal husbandry and fish ponds that can reduce land allocation. Therefore, when the upstream authority focuses on law enforcement,

compensation funds can focus on social and economic aspects such as supporting farmer relocation, creating alternative jobs and reforestation projects. This implementation requires both upstream and downstream authorities to work together to achieve mutual benefits.

Similarly, in reducing sediment transport, programs can be implemented through funding by the downstream authority together with official support by the upstream authority, as the area of implementation is in the upstream area, while the benefit is received downstream. Projects can include building sediment traps in farming area outlets and tributaries, and improving stream channels, however these projects can be costly and less effective, as found in the AHP analysis presented in this chapter.

6.6. Conclusion

The economic costs of potential LULC change over the Krueng Aceh catchment can be reduced through application of decision alternatives in LULC management. The modelling presented in this chapter found that LULC change in 2040 under Scenario II may decrease externalities in water quality and quality production by 4.01% compared with business as usual (Scenario I). However, Scenario II may decrease the externality for PDAM Tirta Daroy by 13.28% when this scenario is modified by introducing decision alternatives. The decision alternatives involve farming management practice for paddy field water demand, improving *CN* value and sediment transport control under land management practice.

The success of implementing these actions needs to consider the issue of economic transferring or Payment for Environmental Services (PES) from downstream authority to upstream community where the downstream authority who receives benefits from water resources compensates the upstream area where the benefits are produced. This scheme would be most successful when both upstream and downstream authorities work together to formulate policy and goals for project implementation under supporting upper decentralization levels (provincial and national levels).

CHAPTER 7
CONCLUSION

7.1. Introduction

The Krueng Aceh catchment is experiencing an ongoing LULC change, which is impacting hydrological response across the catchment. LULC change has modified regime flows, which have impacts for water resources management of the Krueng Aceh catchment in terms of both quantity of water supply and demand and quality. In the downstream area of the catchment, the water service provider PDAM Tirta Daroy faces increasing water shortages and increasing costs for water purification. In the upstream area, the regime flow modification has created less water that can be distributed to paddy field areas. The changes will continue into the future as the Aceh economy develops and policy makers and natural resource managers work to deal effectively with a range of challenges. This research has identified the barriers to effective IWRM implementation that may occur in a catchment that lies in more than one jurisdiction or decentralization area. The analyses presented in this research highlight the differences between the upstream and downstream areas of the Krueng Aceh catchment, which include significant differences in population density, income per capita and human resources development. The downstream area is more urban and populous and more developed compared with the upstream area. A range of analyses shows that LULC change during the period 1988 to 2012 has altered water resources conditions, resulting in more intense highflow events and less intense in lowflow events across the catchment. These conditions create externalities, which include an environmental quality change that results in economic costs to water users. In addition, these conditions may create difficulties and tension in IWRM implementation when the upstream area produces water but the downstream area takes the major benefits from the resources. This concluding chapter summarises the findings from the research presented in this thesis and contributes a framework and pathways through which decision makers can set effective alternative decisions to support compensation funds for effective IWRM implementation.

7.2. Major Findings and Contributions of the Research

A major finding and contribution from this research is that IWRM implementation is more challenging when it is applied in transboundary catchments, particularly in the unique decentralised governance situation that exists in Aceh. There is a need to potentially shift away from the perception of "integrated" management to more "partial" management in policy setting, planning and implementation. This challenge can be addressed through an economic compensation process applied across decentralized areas to shift benefits to help achieve successful IWRM implementation. This research has:

1. Provided an extensive review of IWRM approaches in transboundary catchments including the guiding principles of IWRM, and the challenges and barriers to successful implementation in a range of international contexts.
2. Developed an argument that the economic value of water can be used to create a link between the downstream and upstream areas of a catchment and across different autonomous boundaries under the framework of economic compensation or Payment for Environmental Services applied in IWRM implementation.
3. Presented an analysis of LULC change between 1988 and 2012 and applied a range of hydrological modelling approaches, identified a trend towards declining forest area which has altered long term water regimes over the Krueng Aceh catchment, creating more intense highflow events and less intense lowflow conditions over the period. This regime change leads to increases in sediment transport over the catchment.
4. Presented economic modelling and analysis showing that water quantity and quality change over the Krueng Aceh catchment leads to externalities. The primary externality arises from the shortage of water supply to the PDAM Tirta Daroy consumers and increasing costs of water treatment in the downstream area as well as deficits in water availability to paddy fields in the upstream area. Economic losses are driven by LULC change, along with increasing water demands.
5. Argued that a Multi Criteria Decision Making (MCDM) approach under the framework of economic compensation (PES) may be the most effective way to achieve successful IWRM implementation in transboundary catchment

management. The MCDM can be used to make justifications related to law enforcement for LULC management, economic stimulus to upstream farmers and land management practice for agriculture. These approaches have to be developed under cooperation between the upstream and downstream authorities and under the framework of economic transfer from the downstream to the upstream areas. MCDM is also more powerful when it is applied in combination with another structured technique for analysing decisions, such as the Analytic Hierarchy Process (AHP).

7.3. Limitations and Opportunities for Future Research

A limitation of this research is that it does not address groundwater resources as an integral part of IWRM, as would be common in the majority of contexts. Groundwater resources data are limited in the Krueng Aceh catchment and the high availability of surface water means that there is limited exploitation of groundwater at present. However, it is predicted that groundwater use will become more intensive in the future as surface water resources become limited in quantity in the dry season and water quality become more of an issue in the wet season.

Another limitation of the research is that stakeholders' views on the application of MCDM are not considered as this project is focused on the impact of LULC change on water regime alteration. Therefore, future research should consider and include a range of social research approaches to aid effective IWRM implementation in the Krueng Aceh catchment, therefore an analysis of Willingness to Pay (WTP) and Willingness to Accept (WTA) as a part of the framework of economic transfer can be applied in MCMD that was beyond the scope of this research

A further limitation in this research relates to the quality of water resources data for the catchment, which is a typical problem in Indonesia especially on long-term availabity and its concistency. This has been exacerbated in Aceh due to a range of geopolitical issues and a catastrophic natural disaster in recent history. Incomplete data series and limited reliability of hydrological data across the catchment limit analysis and increase dependence on modelling approaches, therefore future research should consider data consistency and reliability tests.

Better data collection protocols, data coverage and improved automated systems are being implemented by the Aceh Government and will address these issues in the future.

APPENDIXES

Appendix 3.1 Daily Accumulated Rainfall Depth

Day	1987			1988			1989			2010			2012		
	Bl.Bintang	Indrapuri	Seulimum	Bl.Bintang	Indrapuri	Seulimum	Bl.Bintang	Indrapuri	Seulimum	Bl.Bintang	Indrapuri	Jantho	Bl.Bintang	Indrapuri	Jantho
1-Jan	-	0.6	10.0	-	-	-	-	-	-	-	-	-	-	4.5	20.7
2-Jan	8.9	7.9	9.4	-	-	1.0	-	-	-	3.1	-	-	5.1	6.0	23.3
3-Jan	-	5.5	7.0	-	-	11.2	5.1	9.4	11.1	4.1	9.4	3.3	-	3.0	11.6
4-Jan	13.0	2.1	20.4	-	-	1.4	1.0	11.9	9.9	-	11.9	6.2	4.6	5.5	0.3
5-Jan	1.0	1.4	31.4	34.0	7.2	2.6	-	2.0	1.5	-	2.0	8.7	49.2	37.2	13.0
6-Jan	19.1	17.7	32.1	-	26.1	2.1	-	16.0	12.3	10.9	16.0	24.4	2.0	3.1	4.2
7-Jan	9.9	0.2	10.5	-	15.3	1.1	1.0	34.8	27.6	9.9	34.8	21.3	-	-	1.5
8-Jan	6.1	19.9	10.2	-	9.7	0.7	1.0	1.4	1.9	-	1.4	4.5	-	1.9	33.7
9-Jan	1.0	-	0.6	13.0	-	0.6	-	-	-	-	-	2.0	1.0	2.2	5.2
10-Jan	-	1.0	1.5	-	-	-	-	-	-	-	-	-	3.1	6.2	0.6
11-Jan	-	-	-	-	-	-	-	-	-	-	-	-	-	2.1	33.7
12-Jan	-	20.2	-	-	-	2.7	-	5.0	3.9	-	5.0	-	2.0	3.8	2.2
13-Jan	-	4.0	15.7	-	-	1.0	3.1	-	2.3	-	-	-	-	1.2	4.9
14-Jan	46.0	-	45.6	-	0.2	0.5	0.5	-	0.4	-	-	2.5	17.0	20.6	0.3
15-Jan	-	47.3	24.3	-	-	-	-	-	-	-	-	1.5	-	2.2	0.7
16-Jan	-	12.7	5.4	25.9	13.5	-	4.1	-	3.1	-	-	15.8	1.0	1.3	109.0
17-Jan	-	13.4	11.2	-	11.1	-	13.0	-	10.0	-	-	12.5	-	-	6.6
18-Jan	-	1.2	2.2	-	2.1	-	4.1	-	3.1	-	-	3.8	-	2.1	0.5
19-Jan	-	12.3	15.8	-	-	1.2	-	1.0	0.8	-	1.0	6.6	0.5	1.0	7.9
20-Jan	-	13.3	24.7	-	13.5	12.3	-	39.0	30.0	-	39.0	15.1	-	4.2	0.6
21-Jan	-	14.2	29.3	4.1	-	13.3	-	12.0	9.2	-	12.0	3.4	-	-	-
22-Jan	-	-	6.5	1.5	-	14.2	24.9	3.0	21.5	-	3.0	2.1	-	-	-
23-Jan	-	29.9	3.8	1.0	-	-	21.3	-	16.4	118.9	-	1.2	-	-	-
24-Jan	-	0.9	-	-	-	29.9	6.0	-	4.6	99.1	-	-	-	-	-
25-Jan	-	9.1	-	-	-	0.9	-	14.0	10.8	-	14.0	-	-	-	-
26-Jan	-	5.8	-	-	-	9.1	-	-	-	-	-	1.5	-	-	-
27-Jan	-	-	-	4.1	3.7	5.8	-	-	-	-	-	4.5	-	-	-
28-Jan	-	-	-	13.0	0.7	-	-	-	-	-	-	9.1	-	-	5.8
29-Jan	-	-	-	-	24.4	-	-	-	-	-	-	25.2	-	2.1	41.7
30-Jan	-	-	-	-	19.5	-	-	-	-	-	-	18.3	8.9	2.5	26.1
31-Jan	-	-	-	-	33.5	0.1	-	0.5	0.4	-	0.5	30.6	-	3.0	41.2
1-Feb	-	-	4.3	-	0.8	0.8	-	0.5	0.4	-	0.5	1.9	3.1	6.5	13.0
2-Feb	0.5	-	7.4	-	2.0	4.0	-	-	-	-	-	3.1	1.0	2.9	10.7
3-Feb	-	6.7	3.4	1.0	7.2	-	-	-	-	-	-	5.0	-	-	3.9
4-Feb	-	0.8	-	3.1	48.8	-	-	-	-	-	-	50.2	-	11.3	8.7
5-Feb	-	9.5	4.7	-	2.4	-	-	-	-	-	-	9.5	25.2	22.6	2.9
6-Feb	1.0	20.8	2.6	2.0	20.0	-	-	-	-	-	-	20.8	-	2.3	4.6
7-Feb	-	17.8	8.2	-	30.0	-	-	-	-	-	-	17.8	-	6.1	4.0
8-Feb	-	21.0	10.6	-	14.5	-	-	-	-	-	-	21.0	-	-	1.2
9-Feb	-	0.8	32.2	-	28.7	-	-	-	-	-	-	1.1	-	-	1.2
10-Feb	-	0.6	12.0	-	6.3	-	-	-	-	-	-	0.8	-	2.8	1.2
11-Feb	-	40.9	-	-	6.3	-	2.0	-	1.6	-	-	54.2	7.1	10.1	5.6
12-Feb	-	4.0	2.6	-	20.4	-	-	-	-	-	-	5.3	3.1	12.3	12.5
13-Feb	-	0.2	3.7	-	10.8	-	-	-	-	1.0	-	0.3	20.1	27.8	1.2
14-Feb	-	0.7	-	-	17.6	-	-	-	-	-	-	1.0	-	22.3	58.3
15-Feb	-	1.2	2.4	-	41.3	-	-	-	-	-	-	1.6	-	3.4	0.5
16-Feb	-	-	-	-	14.7	-	-	-	-	-	-	-	-	2.1	1.8
17-Feb	-	-	32.2	-	8.4	-	-	-	-	-	-	-	-	1.9	0.8
18-Feb	-	-	1.6	-	-	-	-	-	-	-	-	-	-	-	3.0
19-Feb	-	13.1	17.0	-	35.5	-	-	-	-	-	-	17.4	-	-	0.2
20-Feb	-	18.5	-	-	14.9	5.1	2.0	-	1.6	-	-	24.5	-	-	2.8
21-Feb	-	4.3	6.6	-	19.2	3.3	-	-	-	-	-	5.7	-	1.3	0.3
22-Feb	5.1	7.8	-	-	3.5	2.6	-	-	-	-	-	10.7	2.0	2.9	6.1
23-Feb	-	-	10.1	-	28.0	7.8	-	-	-	27.9	-	12.3	-	2.1	2.8
24-Feb	5.1	0.6	-	-	0.3	-	0.5	17.5	13.9	-	17.5	0.8	3.1	3.5	1.3
25-Feb	-	-	6.4	-	-	0.6	-	-	-	4.1	-	-	-	-	4.6
26-Feb	-	8.8	-	-	22.2	-	19.1	24.0	33.1	-	24.0	11.7	-	2.4	0.4
27-Feb	-	0.8	10.4	-	9.0	8.8	12.3	-	9.5	20.1	-	8.2	2.0	6.0	20.7
28-Feb	2.0	8.3	2.6	-	10.4	0.8	2.0	-	1.5	21.1	-	11.0	2.0	4.8	14.1
29-Feb				-	9.5	12.3							0.5	7.2	0.4
1-Mar	1.0	3.6	3.6	-		-	-	0.4	0.3	-	0.4	0.3	-	0.4	-
2-Mar	2.1	4.6	5.2	-		-	2.0	6.2	6.3	-	6.2	4.8	-	6.2	-
3-Mar	1.4	6.3	5.9	-	-	-	2.3	1.0	2.5	3.1		2.3	-	-	4.0
4-Mar	0.3	8.9	7.0	-	3.6	2.8	76.0	3.6	61.3	0.5	3.6	3.2	2.0	3.6	37.5
5-Mar	-	2.3	1.8	7.9	10.0	13.8	78.0		60.0	8.1		6.3	-	-	25.0
6-Mar	-	-	-	4.0		3.1	-		-	-		-	22.1	-	12.0
7-Mar	-	-	-	5.1		3.9	-	3.0	2.3	-	3.0	2.3	-	3.0	-
8-Mar	-	-	-	4.1	5.8	7.6	5.6		4.3	-		-	-	-	15.0
9-Mar	-	-	-	-	-	-	1.0	8.8	7.6	-	8.8	6.8	-	8.8	-
10-Mar	-	-	-	17.0		13.1	-	70.6	54.4	4.1	70.6	57.5	-	70.6	22.0
11-Mar	-	-	-	-	5.2	4.0	42.9	32.6	58.2	-	32.6	25.1	7.9	32.6	27.0
12-Mar	-	-	-	-		-	12.0		9.2	1.0		0.8	15.0	-	-
13-Mar	-	-	-	0.5		0.4	-		-	27.9		21.5	-	-	35.0
14-Mar	-	-	-	1.0	20.0	16.2	-	10.2	7.9	-	10.2	7.9	13.2	10.2	-
15-Mar	-	-	-	-		-	-	6.0	4.6	1.0	6.0	5.4	-	6.0	16.0
16-Mar	-	-	-	-		-	6.0		4.6	-		-	-	-	40.0
17-Mar	20.1	10.9	23.8	-	2.0	1.5	2.0	5.8	6.0	-	5.8	4.5	-	5.8	13.0
18-Mar	-	15.9	12.2	31.0	20.0	39.3	1.0		0.8	-		-	0.5	-	26.0
19-Mar	-	6.7	5.2	10.9	6.0	13.0	-	9.6	7.4	-	9.6	7.4	-	9.6	6.5
20-Mar	-	3.3	2.5	3.1		2.3	-	-	-	-	-	-	-	-	11.0
21-Mar	2.0	6.8	6.8	2.0		1.6	-		-	-		-	-	-	10.0
22-Mar	-	-	-	-	2.0	1.5	-		-	-		-	-	-	9.0
23-Mar	-	-	-	-		-	-	23.0	17.7	9.9	23.0	25.3	-	23.0	1.0
24-Mar	-	-	-	-		-	-		-	4.1		3.1	3.1	-	1.5
25-Mar	-	-	-	-	35.6	27.4	-		-	-		-	-	-	1.0
26-Mar	-	-	-	-		-	-	26.6	20.5	-	26.6	20.5	-	26.6	-
27-Mar	-	-	-	-	4.0	3.1	6.1	3.0	7.0	-	3.0	2.3	7.9	3.0	-
28-Mar	-	-	-	-		-	46.0	5.4	39.6	14.0	5.4	14.9	14.0	5.4	-
29-Mar	-	-	-	-	10.4	8.0	0.5		0.4	-		-	-	-	2.0
30-Mar	-	-	-	-		-	-	6.0	4.6	9.9	6.0	12.3	-	-	4.5
31-Mar	-	-	-	-	3.0	2.3	-		-	-		-	-	-	-

1-Apr	-	-	-	-		-	na	na	na	3.1		2.3	-	-	-
2-Apr	1.0	1.0	1.6	-		-	na	na	na	3.1		2.3	-	-	66.0
3-Apr	-	-	-	-	40.8	31.4	na	na	na	-		-	-	-	20.0
4-Apr	-	-	-	-	31.4	24.2	na	na	na	11.9	4.0	12.3	-	4.0	22.0
5-Apr	-	12.9	9.9	-	3.0	2.3	na	na	na	1.0		0.8	4.1	-	12.0
6-Apr	2.0	3.6	4.3	47.0		36.2	na	na	na	2.0	0.4	1.9	0.5	0.4	2.0
7-Apr	-	-	-	18.0	2.0	15.4	na	na	na	-	6.0	4.6	-	6.0	11.0
8-Apr	-	-	-	-	1.8	1.4	na	na	na	14.0	30.4	34.2	-	30.4	12.0
9-Apr	-	-	-	-	2.2	1.7	na	na	na	43.9	1.0	34.6	-	1.0	7.0
10-Apr	-	-	-	-	17.0	13.1	na	na	na	-		-	55.1	-	8.0
11-Apr	5.1	5.1	7.8	-	-	-	na	na	na	-	2.0	1.5	-	-	-
12-Apr	2.3	2.3	3.5	-		-	na	na	na	-	0.2	0.2	-	0.2	-
13-Apr	-	-	-	-		-	na	na	na	-	1.0	0.8	1.0	1.0	-
14-Apr	-	-	-	-		-	na	na	na	-	4.0	3.1	6.1	4.0	-
15-Apr	-	-	-	-	1.0	0.8	na	na	na	-		-	-	-	-
16-Apr	-	-	-	39.1	20.0	45.5	na	na	na	-		-	-	-	-
17-Apr	18.0	18.0	27.8	3.1	19.0	17.0	na	na	na	-	0.2	0.2	4.1	0.2	5.0
18-Apr	0.5	0.5	0.8	3.1	15.0	13.9	na	na	na	-	0.2	0.2	2.0	0.2	-
19-Apr	-	-	-	3.1	6.0	7.0	na	na	na	-		-	-	-	-
20-Apr	-	-	-	-	2.0	1.5	na	na	na	-	19.6	15.1	-	19.6	-
21-Apr	-	-	-	3.1		2.3	na	na	na	-		-	-	-	-
22-Apr	-	-	-	-		-	na	na	na	-	2.0	1.5	-	2.0	-
23-Apr	-	-	-	-		-	na	na	na	20.1	23.0	33.2	-	23.0	-
24-Apr	-	-	-	-		-	na	na	na	-	42.4	32.6	-	42.4	-
25-Apr	6.1	6.1	9.4	-		-	na	na	na	-	1.0	0.8	-	1.0	-
26-Apr	-	-	-	-		-	na	na	na	8.9		6.8	-	-	-
27-Apr	1.3	1.3	2.0	-		-	na	na	na	77.0		59.3	-	-	-
28-Apr	1.0	1.0	1.6	-		-	na	na	na	19.1		14.7	5.1	-	-
29-Apr	0.3	0.3	0.4	-		-	na	na	na	2.0	0.8	2.2	-	0.8	23.0
30-Apr	-	-	-	-		-	na	na	na	-		-	-	-	13.0
1-May	-	-	-	7.1		5.5	na	na	na	-		-	1.0	-	-
2-May	3.1	3.1	4.7	64.0		49.3	na	na	na	-		-	-	-	2.0
3-May	41.9	41.9	64.5	-		-	na	na	na	-		-	-	-	2.0
4-May	122.9	122.9	189.3	-	4.8	3.7	na	na	na	8.9		6.8	4.1	-	1.0
5-May	52.3	52.3	80.5	-	0.2	0.2	na	na	na	-		-	-	-	27.0
6-May	156.0	156.0	240.2	-	34.4	26.5	na	na	na	-		-	12.2	-	-
7-May	7.9	7.9	12.1	-		-	na	na	na	-		-	-	-	-
8-May	8.1	8.1	12.5	-		-	na	na	na	-		-	-	35.6	-
9-May	25.9	25.9	39.9	-		-	na	na	na	-	35.6	27.4	-	-	-
10-May	-	-	-	-		-	na	na	na	-		-	-	-	8.0
11-May	3.1	3.1	4.7	-		-	na	na	na	-	-	-	-	13.0	4.0
12-May	-	-	-	0.5		0.4	na	na	na	-	13.0	10.0	-	3.2	14.0
13-May	4.1	4.1	6.3	1.0		0.8	na	na	na	-	3.2	2.5	-	-	8.0
14-May	9.4	9.4	14.5	27.9		21.5	na	na	na	10.9	3.6	11.2	-	-	2.0
15-May	2.3	2.3	3.5	7.4	2.8	7.8	na	na	na	2.0	3.0	3.9	-	-	-
16-May	-	-	-	-	1.0	0.8	na	na	na	-		-	2.0	-	13.0
17-May	-	-	-	5.6	4.4	7.7	na	na	na	1.0		0.8	2.0	-	39.0
18-May	-	-	-	-	30.0	23.1	na	na	na	-		-	-	-	7.0
19-May	-	-	-	-		-	na	na	na	-		-	-	-	-
20-May	-	-	-	-		-	na	na	na	-		-	-	-	-
21-May	-	-	-	-		-	na	na	na	3.1		2.3	-	-	-
22-May	10.9	10.9	16.8	-		-	na	na	na	-		-	10.9	-	2.0
23-May	-	-	-	-		-	na	na	na	-		-	3.1	-	-
24-May	-	-	-	-		-	na	na	na	-		-	12.2	6.4	-
25-May	9.9	9.9	15.3	-		-	na	na	na	-	6.4	4.9	9.9	-	-
26-May	-	-	-	-		-	na	na	na	-		-	-	-	-
27-May	-	-	-	-		-	na	na	na	-		-	4.1	2.0	-
28-May	-	-	-	-	-	-	na	na	na	-	2.0	1.5	5.1	0.6	80.0
29-May	-	-	-	-	1.4	1.1	na	na	na	-	0.6	0.5	-	-	-
30-May	-	-	-	-		-	na	na	na	2.0		1.6	10.9	-	20.0
31-May	0.3	0.3	0.4	-	10.6	8.2	na	na	na	-		-	2.0	-	-
1-Jun	-	-	-	-		-	-		-	-		-	-	-	-
2-Jun	-	-	-	-		-	-		-	-		-	-	-	-
3-Jun	-	-	-	-		-	1.0	60.0	47.0	-	60.0	46.2	-	60.0	-
4-Jun	-	-	-	-		-	1.0		0.8	3.1		2.3	-	-	-
5-Jun	-	-	-	-		-	-	26.5	20.4	25.9	26.5	40.4	17.8	-	-
6-Jun	3.1	3.1	4.7	-		-	-	31.2	24.0	36.1	31.2	51.8	4.1	-	-
7-Jun	-	-	-	-		-	-	7.0	5.4	-	7.0	5.4	7.1	7.0	-
8-Jun	-	-	-	-		-	-		-	2.0		1.6	1.0	-	-
9-Jun	3.6	3.6	5.5	-		-	-		-	-		-	-	-	-
10-Jun	10.9	10.9	16.8	-		-	-		-	-		-	-	-	-
11-Jun	4.5	4.5	6.9	-		-	-		-	-		-	-	-	9.0
12-Jun	-	-	-	-		-	-	0.4	0.3	-	0.4	0.3	-	0.4	-
13-Jun	-	-	-	-		-	-	1.8	1.4	-	1.8	1.4	-	1.8	-
14-Jun	9.9	9.9	15.3	-		-	-		-	31.0		23.9	-	-	-
15-Jun	-	-	-	-		-	-		-	-		-	-	-	-
16-Jun	-	-	-	-		-	-		-	3.1		2.3	-	-	-
17-Jun	-	-	-	-		-	-	2.8	2.2	-	2.8	2.2	-	2.8	-
18-Jun	-	-	-	-		-	-		-	-		-	-	-	-
19-Jun	-	-	-	-	0.2	0.2	-		-	-		-	-	-	2.0
20-Jun	18.0	18.0	27.8	-		-	-	14.6	11.2	-	14.6	11.2	-	14.6	30.0
21-Jun	-	-	-	-		-	-		-	-		-	-	-	1.0
22-Jun	-	-	-	-		-	-		-	25.9		20.0	-	-	-
23-Jun	-	-	-	-		-	-		-	0.5		0.4	-	-	-
24-Jun	-	-	-	-		-	-		-	4.1		3.1	-	-	-
25-Jun	-	-	-	-		-	-		-	-		-	-	-	-
26-Jun	-	-	-	-		-	-		-	-		-	-	-	-

27-Jun	2.0	2.0	3.1	-		-	-		-	-		-	-	-	10.0
28-Jun	-	-	-	-		-	-		-	-		-	-	-	-
29-Jun	-	-	-	-	27.0	20.8	-		-	-		-	-	-	-
30-Jun	-	-	-	-		-	-		-	-		-	-	-	-
1-Jul	-	-	-	-		-	-		-	-		-	6.1	-	-
2-Jul	-	-	-	-		-	-		-	-		-	-	-	-
3-Jul	-	-	-	1.0		0.8	-	1.4	1.1	-	1.4	1.1	-	1.4	-
4-Jul	-	-	-	-		-	-		-	-		-	-	-	-
5-Jul	-	-	-	-		-	-		-	-		-	-	-	-
6-Jul	-	-	-	-		-	-		-	-		-	-	-	-
7-Jul	-	-	-	-		-	-		-	-		-	4.1	-	-
8-Jul	-	-	-	-	2.0	1.5	1.0	-	0.8	-	-	-	6.1	-	1.0
9-Jul	-	-	-	-	6.0	4.6	-		-	10.9		8.4	-	-	37.0
10-Jul	-	-	-	-	9.0	6.9	-		-	-		-	0.3	-	-
11-Jul	-	-	-	0.5	15.0	11.9	-		-	-		-	-	-	-
12-Jul	-	-	-	8.9	2.0	8.4	1.0		0.8	-		-	-	-	-
13-Jul	-	-	-	6.1	2.0	6.2	-		-	13.0		10.0	-	-	-
14-Jul	-	-	-	-	1.0	0.8	0.3	10.0	7.9	-	10.0	7.7	2.0	10.0	-
15-Jul	-	-	-	7.1		5.5	0.5	5.0	4.2	4.1	5.0	7.0	-	5.0	-
16-Jul	-	-	-	-		-	-		-	-		-	-	-	-
17-Jul	-	-	-	-		-	18.3	12.2	23.5	-	12.2	9.4	-	12.2	1.0
18-Jul	-	-	-	-		-	-	0.2	0.2	-	0.2	0.2	-	0.2	-
19-Jul	-	-	-	-		-	3.1		2.3	2.0		1.6	-	-	-
20-Jul	-	-	-	-		-	2.0	5.6	5.9	-	5.6	4.3	-	5.6	-
21-Jul	-	-	-	-	1.5	1.2	-		-	-		-	-	-	1.0
22-Jul	-	-	-	-		-	-	-	-	-	-	-	-	-	5.0
23-Jul	-	-	-	-		-	-	-	-	-	-	-	-	-	-
24-Jul	-	-	-	-	3.0	2.3	-	-	-	1.0	-	0.8	-	-	-
25-Jul	-	-	-	-	1.8	1.4	-	0.4	0.3	16.0	0.4	12.6	-	0.4	-
26-Jul	-	-	-	-		-	-		-	-		-	-	-	-
27-Jul	-	-	-	-		-	-	16.2	12.5	20.1	16.2	27.9	-	-	-
28-Jul	-	-	-	-		-	-		-	-		-	-	-	-
29-Jul	4.1	4.1	6.3	-		-	0.5		0.4	-		-	-	-	-
30-Jul	-	-	-	-		-	-		-	-		-	-	-	-
31-Jul	-	-	-	-		-	-		-	-		-	-	-	-
1-Aug	-	-	-	-		-	na	na	na	-		-	-	-	7.0
2-Aug	-	-	-	-		-	na	na	na	1.0		0.8	-	-	-
3-Aug	3.1	3.1	4.7	-		-	na	na	na	2.0	0.2	1.7	-	0.2	-
4-Aug	-	-	-	-		-	na	na	na	-	4.2	3.2	-	4.2	3.0
5-Aug	-	-	-	-		-	na	na	na	-		-	-	-	-
6-Aug	-	-	-	-		-	na	na	na	-		-	-	-	12.0
7-Aug	-	-	-	-	0.4	0.3	na	na	na	-		-	-	-	1.0
8-Aug	-	-	-	-		-	na	na	na	-		-	-	-	1.0
9-Aug	4.6	4.6	7.0	-	21.8	16.8	na	na	na	3.1	6.0	7.0	-	6.0	-
10-Aug	-	-	-	-	2.6	2.0	na	na	na	-		-	-	-	-
11-Aug	-	-	-	-	0.4	0.3	na	na	na	1.0		0.8	-	-	12.0
12-Aug	-	-	-	-		-	na	na	na	-		-	-	-	41.0
13-Aug	-	-	-	-		-	na	na	na	-		-	-	-	3.0
14-Aug	-	-	-	-		-	na	na	na	-		-	-	-	17.0
15-Aug	-	-	-	-	0.5	0.4	na	na	na	-		-	7.1	-	13.0
16-Aug	na	na	na	1.0	5.0	4.6	na	na	na	-		-	-	-	3.0
17-Aug	na	na	na	1.0	3.7	3.6	na	na	na	-		-	-	-	2.0
18-Aug	na	na	na	-	2.0	1.5	na	na	na	-	3.0	2.3	-	3.0	1.0
19-Aug	na	na	na	-	34.0	26.2	na	na	na	27.9	7.2	27.1	-	7.2	2.0
20-Aug	na	na	na	-		-	na	na	na	-	0.8	0.6	7.1	0.8	1.0
21-Aug	na	na	na	-	25.3	19.5	na	na	na	212.1	14.0	174.1	-	14.0	3.0
22-Aug	na	na	na	1.0	0.9	1.5	na	na	na	-	1.4	1.1	18.8	1.4	-
23-Aug	na	na	na	-		-	na	na	na	-	2.3	1.8	-	-	-
24-Aug	na	na	na	-		-	na	na	na	-	8.4	6.5	-	8.4	-
25-Aug	na	na	na	-		-	na	na	na	-	66.0	50.8	0.5	66.0	-
26-Aug	na	na	na	-	4.1	3.2	na	na	na	-	0.6	0.5	-	0.6	1.0
27-Aug	na	na	na	9.9		7.6	na	na	na	-	-	-	2.0	-	7.0
28-Aug	na	na	na	23.9	16.0	30.7	na	na	na	-	1.6	1.2	0.5	1.6	11.0
29-Aug	na	na	na	-	23.0	17.7	na	na	na	-	2.0	1.5	0.5	-	12.0
30-Aug	na	na	na	4.1	25.0	22.4	na	na	na	-	4.4	3.4	-	4.4	1.0
31-Aug	na	na	na	6.1		4.7	na	na	na	21.1		16.2	-	-	1.0
1-Sep	na	na	na	-	26.4	20.3	na	na	na	-	0.4	0.3	-	0.4	-
2-Sep	na	na	na	-	0.4	0.3	na	na	na	3.1	52.0	42.4	-	52.0	-
3-Sep	na	na	na	-	-	-	na	na	na	-	23.4	18.0	-	23.4	2.8
4-Sep	na	na	na	-	16.0	12.3	na	na	na	1.0	1.6	2.0	-	1.6	-
5-Sep	na	na	na	4.1	9.0	10.1	na	na	na	-	3.6	2.8	8.9	3.6	-
6-Sep	na	na	na	3.1	7.0	7.7	na	na	na	-	2.0	1.5	-	2.0	-
7-Sep	na	na	na	3.1	1.2	3.3	na	na	na	-		-	-	-	-
8-Sep	na	na	na	-	9.0	6.9	na	na	na	-		-	-	-	-
9-Sep	na	na	na	0.5		0.4	na	na	na	2.0		1.5	-	-	-
10-Sep	na	na	na	0.5		0.4	na	na	na	-		-	-	-	-
11-Sep	na	na	na	-		-	na	na	na	-		-	-	-	-
12-Sep	-	-	-	-		-	na	na	na	-		-	-	-	-
13-Sep	-	-	-	-		-	na	na	na	-	0.2	0.2	-	0.2	-
14-Sep	-	-	-	-		-	na	na	na	-		-	-	-	7.0
15-Sep	-	-	-	34.3		26.4	na	na	na	-		-	2.0	-	15.0
16-Sep	-	-	-	10.9	15.6	20.4	na	na	na	-		-	-	-	1.0
17-Sep	5.1	5.1	7.8	17.0	17.3	26.4	na	na	na	-		-	-	-	-
18-Sep	-	-	-	-	15.8	12.2	na	na	na	-		-	-	-	-
19-Sep	-	-	-	-	1.0	0.8	na	na	na	10.2	0.2	8.0	-	0.2	-
20-Sep	8.4	8.4	12.9	-	0.2	0.2	na	na	na	8.9		6.8	-	-	-
21-Sep	23.9	23.9	36.8	4.1	9.8	10.7	na	na	na	-		-	-	-	-

22-Sep	-	-	-	5.1		3.9	na	na	na	-		-	-	-	-
23-Sep	-	-	-	-		-	na	na	na	4.1		3.1	-	-	-
24-Sep	1.0	1.0	1.6	-	5.0	3.9	na	na	na	11.9		9.2	-	-	-
25-Sep	4.1	4.1	6.3	-		-	na	na	na	19.1	1.0	15.4	53.1	1.0	-
26-Sep	3.1	3.1	4.7	-		-	na	na	na	8.9		6.8	10.9	-	-
27-Sep	-	-	-	-		-	na	na	na	-		-	6.1	-	-
28-Sep	-	-	-	0.6	0.2	0.6	na	na	na	1.0		0.8	1.0	-	-
29-Sep	-	-	-	4.0	5.0	6.9	na	na	na	2.0		1.6	-	-	-
30-Sep	10.9	10.9	16.8	-	2.0	1.5	na	na	na	-	14.2	10.9	-	14.2	-
1-Oct	-	-	-	-	4.6	3.5	na	na	na	-	0.6	0.5	-	0.6	-
2-Oct	-	-	-	-	0.6	0.5	na	na	na	-		-	-	-	-
3-Oct	-	-	-	-	0.2	0.2	na	na	na	6.1		4.7	-	-	-
4-Oct	1.0	1.0	1.6	-		-	na	na	na	-	16.0	12.3	-	16.0	-
5-Oct	1.0	1.0	1.6	-	2.1	1.6	na	na	na	37.1	31.0	52.4	-	31.0	-
6-Oct	-	-	-	-		-	na	na	na	-	1.0	0.8	-	1.0	18.0
7-Oct	-	-	-	-		-	na	na	na	-		-	-	-	-
8-Oct	-	-	-	-		-	na	na	na	-		-	-	-	-
9-Oct	-	-	-	-		-	na	na	na	-		-	0.3	-	-
10-Oct	-	-	-	1.0	2.3	2.6	na	na	na	-	6.2	4.8	-	6.2	-
11-Oct	-	-	-	22.1	4.0	20.1	na	na	na	-	0.2	0.2	-	0.2	-
12-Oct	1.0	1.0	1.6	2.0	5.0	5.4	na	na	na	-	18.0	13.9	-	18.0	-
13-Oct	-	-	-	-		-	na	na	na	-	1.4	1.1	-	1.4	-
14-Oct	-	-	-	-	-	-	na	na	na	-		-	-	-	20.0
15-Oct	13.0	13.0	19.9	-	0.3	0.2	na	na	na	-		-	50.0	-	11.0
16-Oct	0.3	0.3	0.4	-	2.2	1.7	na	na	na	-	7.4	5.7	9.9	7.4	-
17-Oct	-	-	-	-	0.5	0.4	na	na	na	-	-	-	0.8	-	-
18-Oct	-	-	-	-	36.8	28.3	na	na	na	-	-	-	8.9	-	10.0
19-Oct	-	-	-	-		-	na	na	na	-	0.2	0.2	-	0.2	-
20-Oct	-	-	-	-		-	na	na	na	-	31.0	23.9	0.5	31.0	-
21-Oct	-	-	-	-	0.4	0.3	na	na	na	-		-	3.6	-	-
22-Oct	-	-	-	-		-	na	na	na	-	0.5	0.4	-	0.5	-
23-Oct	0.5	0.5	0.8	-	-	-	na	na	na	-		-	-	-	25.0
24-Oct	-	-	-	-		-	na	na	na	-		-	2.0	-	27.0
25-Oct	2.0	2.0	3.1	1.0	0.6	1.2	na	na	na	-		-	2.0	-	26.0
26-Oct	1.0	1.0	1.6	3.1	13.9	13.1	na	na	na	-		-	1.5	-	28.0
27-Oct	1.0	1.0	1.6	-	0.8	0.6	na	na	na	9.1		7.0	11.2	-	-
28-Oct	-	-	-	-	1.0	0.8	na	na	na	-		-	0.5	-	-
29-Oct	-	-	-	-	10.0	7.7	na	na	na	12.2		9.4	-	-	21.0
30-Oct	2.0	2.0	3.1	-	3.2	2.5	na	na	na	-	0.3	0.2	15.0	0.3	-
31-Oct	1.2	1.2	1.8	-	8.0	6.2	na	na	na	1.0	1.0	1.6	-	1.0	-
1-Nov	-	-	-	na	na	na	na	na	na	20.1		15.5	1.5	-	-
2-Nov	-	-	-	na	na	na	na	na	na	34.0		26.2	68.1	-	-
3-Nov	34.0	34.0	52.4	na	na	na	na	na	na	2.0		1.6	-	-	-
4-Nov	13.0	13.0	19.9	na	na	na	na	na	na	-		-	-	-	-
5-Nov	-	-	-	na	na	na	na	na	na	5.1	0.4	4.2	31.0	0.4	-
6-Nov	-	-	-	na	na	na	na	na	na	-	4.0	3.1	-	4.0	-
7-Nov	-	-	-	na	na	na	na	na	na	-		-	-	-	-
8-Nov	-	-	-	na	na	na	na	na	na	-		-	7.1	-	-
9-Nov	-	-	-	na	na	na	na	na	na	17.0		13.1	-	-	-
10-Nov	-	-	-	na	na	na	na	na	na	1.0	6.2	5.6	-	6.2	-
11-Nov	-	-	-	na	na	na	na	na	na	11.9		9.2	52.8	-	-
12-Nov	-	-	-	na	na	na	na	na	na	10.9	8.6	15.0	-	8.6	-
13-Nov	-	-	-	na	na	na	na	na	na	-	8.2	6.3	3.1	8.2	50.0
14-Nov	-	-	-	na	na	na	na	na	na	1.0		0.8	1.0	-	70.0
15-Nov	-	-	-	na	na	na	na	na	na	1.0	-	0.8	-	-	42.0
16-Nov	-	-	-	na	na	na	na	na	na	-	27.5	21.2	-	27.5	39.0
17-Nov	-	-	-	na	na	na	na	na	na	94.0		72.4	-	-	-
18-Nov	-	-	-	na	na	na	na	na	na	-	-	-	-	-	-
19-Nov	-	-	-	na	na	na	na	na	na	13.0	0.6	10.4	-	0.6	-
20-Nov	-	-	-	na	na	na	na	na	na	11.9	0.2	9.3	6.1	0.2	-
21-Nov	-	-	-	na	na	na	na	na	na	53.1	1.8	42.3	-	1.8	-
22-Nov	-	-	-	na	na	na	na	na	na	3.1		2.3	-	-	-
23-Nov	-	-	-	na	na	na	na	na	na	66.8	19.6	66.5	-	19.6	-
24-Nov	-	-	-	na	na	na	na	na	na	-	3.3	2.5	-	3.3	-
25-Nov	-	-	-	na	na	na	na	na	na	2.0	7.4	7.3	-	7.4	-
26-Nov	1.0	1.0	1.6	na	na	na	na	na	na	-	25.2	19.4	-	25.2	19.0
27-Nov	5.1	5.1	7.8	na	na	na	na	na	na	-	58.4	45.0	-	58.4	23.0
28-Nov	3.6	3.6	5.5	na	na	na	na	na	na	-	13.6	10.5	-	13.6	20.0
29-Nov	3.6	3.6	5.5	na	na	na	na	na	na	52.8	52.0	80.7	3.1	52.0	23.0
30-Nov	-	-	-	na	na	na	na	na	na	-	25.4	19.6	22.1	25.4	-
1-Dec	-	-	-	na	na	na	na	na	na	3.1	13.8	13.0	23.1	13.8	-
2-Dec	7.9	7.9	12.1	na	na	na	na	na	na	1.0	3.0	3.1	-	3.0	9.0
3-Dec	-	-	-	na	na	na	na	na	na	6.1	11.6	13.6	-	11.6	10.0
4-Dec	1.3	1.3	2.0	na	na	na	na	na	na	7.9	2.2	7.8	-	2.2	6.0
5-Dec	16.0	16.0	24.6	na	na	na	na	na	na	-	47.0	36.2	-	47.0	30.0
6-Dec	-	-	-	na	na	na	na	na	na	-	44.0	33.9	0.5	44.0	32.0
7-Dec	-	-	-	na	na	na	na	na	na	-	0.8	0.6	27.9	0.8	11.0
8-Dec	-	-	-	na	na	na	na	na	na	30.0	33.4	48.8	-	33.4	-
9-Dec	2.3	2.3	3.5	na	na	na	na	na	na	1.0	7.2	6.3	2.3	7.2	-
10-Dec	0.6	0.6	0.9	na	na	na	na	na	na	2.0	0.4	1.9	-	0.4	-
11-Dec	6.9	6.9	10.6	na	na	na	na	na	na	3.1		2.3	6.1	-	-
12-Dec	0.4	0.4	0.6	na	na	na	na	na	na	-		-	-	-	-
13-Dec	-	-	-	na	na	na	na	na	na	-		-	-	-	16.0
14-Dec	21.3	21.3	32.8	na	na	na	na	na	na	-	45.0	34.7	25.2	45.0	12.0
15-Dec	-	-	-	na	na	na	na	na	na	-		-	0.5	-	-
16-Dec	4.5	4.5	6.9	na	na	na	na	na	na	1.0	5.4	4.9	2.8	5.4	-
17-Dec	-	-	-	na	na	na	na	na	na	7.9		6.1	5.1	-	-
18-Dec	3.1	3.1	4.7	na	na	na	na	na	na	-		-	6.1	-	30.0
19-Dec	1.0	1.0	1.6	na	na	na	na	na	na	112.0		86.2	10.2	-	12.0
20-Dec	6.3	6.3	9.7	na	na	na	na	na	na	5.1		3.9	-	-	20.0
21-Dec	2.2	2.2	3.4	na	na	na	na	na	na	-		-	-	-	-
22-Dec	1.0	1.0	1.6	na	na	na	na	na	na	-		-	2.0	-	-
23-Dec	-	-	-	na	na	na	na	na	na	-		-	12.2	-	40.0
24-Dec	-	-	-	na	na	na	na	na	na	32.0		24.6	-	-	8.0
25-Dec	-	-	-	na	na	na	na	na	na	-	12.0	9.2	9.9	12.0	13.0
26-Dec	-	-	-	na	na	na	na	na	na	-	0.2	0.2	-	0.2	12.0
27-Dec	-	-	-	na	na	na	na	na	na	-	-	-	-	-	2.0
28-Dec	48.0	48.0	73.9	na	na	na	na	na	na	-	2.1	1.6	0.3	2.1	19.0
29-Dec	-	-	-	na	na	na	na	na	na	-		-	-	-	1.0
30-Dec	3.2	3.2	4.9	na	na	na	na	na	na	-	1.2	0.9	-	1.2	-
31-Dec	2.6	2.6	4.0	na	na	na	na	na	na	7.1	9.0	12.4	3.1	9.0	-

Appendix 3.2 SCS Discharge Records at Darang Station

--1KR.ACEH-KAMPUNG DARANG

NO. POS DUGA AIR : 1-001-00-03
TAHUN : 1987

INDUK SUNGAI : KR.ACEH

--1DATA GEOGRAPHI--0 : 05 25 00 LU 095 28 00 BT
LOKASI : PROPINSI D.I ACEH, KAB.ACEH BESAR,KEC.INDRAPURI,KAMPUNG DARANG.DARI BANDA ACEH +/- 24 KM SAMPAI DI INDRAPURI MASUK JALAN KECAMATAN +/- 2 KM, SAMPAI DI KAMPUNG DARANG, DI SEBELAH KANAN ALIRAN KR.ACEH.
LUAS DAERAH PENGALIRAN: 1061.2 KM2 ; ELEVASI PDA :+ 22.043 M
--1KETERANGAN MENGENAI POS DUGA AIR--0
DIDIRIKAN : TANGGAL 13/03/1976 OLEH DPMA
PERIODE PENCATATAN : TANGGAL 13/03/1976 SAMPAI DENGAN 31/12/1987
JENIS ALAT : PESAWAT OTOMATIK MINGGUAN
--1RINGKASAN DATA ALIRAN EXTRIM--0
ALIRAN TERBESAR : M.A. = 6.00(+.00) M ; Q = 351.00 M3/DET ; TGL 4-12-1987
ALIRAN TERKECIL : M.A. = 1.06(+.00) M ; Q = 14.100 M3/DET ; TGL 23- 7-1987
ALIRAN EXTRIM YANG PERNAH TERJADI SAMPAI DENGAN TAHUN 1987 :
ALIRAN TERBESAR : M.A. = 8.39(+.00) M ; Q = 545.00 M3/DET ; TGL 12-12-1986
ALIRAN TERKECIL : M.A. = .24(+.00) M ; Q = 2.330 M3/DET ; TGL 20- 9-1977
--1PENENTUAN BESARNYA ALIRAN--0
BESARNYA ALIRAN DITENTUKAN BERDASARKAN LENGKUNG ALIRAN NO.29/12/83 YANG DIBUAT MENURUT DATA PENGUKURAN ALIRAN DARI TAHUN 1980 SAMPAI DENGAN TAHUN 1986.
TAHUN 1987 TIDAK ADA PENGUKURAN ALIRAN,SHIFTING DIANGGAP 0 (NOL)
--1CATATAN--0
PENGUKURAN ALIRAN MASIH KURANG TERUTAMA UNTUK MUKA AIR TINGGI, AIR TERTINGGI YANG PERNAH DIUKUR PADA 3.35 M DENGAN Q= 156. M3/DET TANGGAL 24/12/1983.
PELAKSANA : BALAI PENYELIDIKAN HIDROLOGI

TABEL BESARNYA ALIRAN HARIAN(M3/DET)

TANGGAL	JAN.	PEB.	MRT.	APL.	MEI	JUNI	JULI	AGST.	SEPT.	OKT.	NOP.	DES.
1	24.5K	35.2	26.7	48.1	112.	114.	19.5	29.5	15.5	35.2	66.1	41.8
2	26.0K	35.2	25.8	60.1	84.1	87.4	18.7	24.9	15.5	36.3	56.5	53.5
3	25.4	34.6	31.5	57.7	69.2	80.0	18.3	26.3	16.3	51.7	57.1	107.
4	23.1	33.0	31.5	48.7	60.7	70.5	17.9	23.6	16.3	34.1	84.8	237.
5	18.7	42.3	32.0	45.7	51.7	62.5	17.9	21.3	18.3	43.4	85.4	261.
6	40.1	37.4	32.0	43.4	46.3	54.7	17.1	20.4	17.1	44.5	103.	157.
7	39.0	33.0	28.5	35.7	42.3	24.0	17.1	30.5	16.3	29.5	94.5	117.
8	37.9	30.5	29.5	33.5	55.9	20.9	17.1	26.7	15.5	44.5	114.	110.
9	39.6	29.5	32.5	31.5	52.9	22.7	17.1	25.4	16.7	59.5	112.	92.6
10	37.4	29.0	35.7	29.5	52.9	41.0K	17.1	31.5	17.9	58.3	112.	88.7
11	35.7	28.5	40.1	37.4	65.5	39.0K	16.7	26.3	17.5	54.7	129.	78.3
12	33.5	28.1	33.5	54.7	54.7	35.0K	16.3	25.8	16.7	41.2	92.6	71.8
13	32.0	27.6	29.5	41.8	100.	33.0K	16.3	27.6	16.3	33.5	73.7	65.5
14	30.5	27.2	27.2	44.0	94.5	31.0K	15.9	26.3	16.3	43.4	63.7	61.9
15	30.0	26.7	26.7	40.1	123.	29.0K	15.5	26.3	16.3	99.7	67.3	56.5
16	28.5	26.3	48.1	36.8	90.0	27.0K	15.2	28.5	15.5	69.8	126.	56.5
17	28.1	25.8	34.1	32.5	81.5	28.5	14.8	33.5	14.8	50.5	86.1	73.1
18	27.6	24.9	45.7	32.5	93.9	27.2	14.8	39.0	18.7	48.1	71.8	59.5
19	27.6	24.9	73.1	52.3	83.5	26.7	14.5	30.0	16.3	62.5	77.6	51.1
20	26.7	24.9	78.9	39.0	89.3	25.8	14.1	25.4	20.4	50.5	64.9	46.9
21	26.7	24.9	64.3	32.5	82.2	24.9	14.1	23.1	20.9	69.2	58.9	45.7
22	26.3	24.0	52.9	42.3	66.7	24.9	14.1	21.3	17.9	109.	64.9	45.1
23	25.8	24.0	40.1	51.1	95.8	24.0	14.1	20.4	19.1	76.3	83.5	45.1
24	26.7	24.0	33.5	40.1	70.5	23.1	18.7	19.1	31.0	70.5	95.2	46.9
25	25.8	23.1	40.1	36.8	96.5	23.1	21.8	19.1	28.1	62.5	75.0	45.1
26	25.4	23.1	84.1	34.1	72.4	23.6	23.1	19.5	35.7	75.7	64.9	45.1
27	27.2	22.2	105.	32.5	69.8	23.6	20.4	18.7	40.7	98.4	58.3	41.8
28	29.0	30.0	68.5	32.5	87.4	22.2	19.5	18.7	42.3	128.	53.5	38.5
29	29.5		53.5	36.3	96.5	21.3	19.5	17.9	24.0	88.7	49.3	36.8
30	32.5		45.7	71.8	133.	20.0	17.9	17.1	19.5	84.8	45.1	45.1
31	40.7		45.7		110.		17.9	16.3		91.9		41.8
RATA-RATA	29.9	28.6	44.4	41.8	80.2	37.0	17.2	24.5	20.4	62.8	79.6	76.2
ALIRAN KM2 (L/DET.)	27.7	26.4	41.1	38.7	74.1	34.2	15.9	22.7	18.9	58.1	73.6	70.5
TINGGI ALIRAN (MM)	74.1	63.9	110.	100.	199.	88.7	42.6	60.7	49.0	155.	191.	189.
METER KUBIK (10**6)	80.1	69.1	119.	108.	215.	96.0	46.1	65.7	53.0	168.	206.	204.

DATA TAHUNAN
RATA-RATA : 45.2 ALIRAN KM2(L/DET): 41.8 TINGGI ALIRAN(MM):1323. METER KUBIK(10**6):1430.

--1DAFTAR PENGUKURAN TAHUN 1987--0

KR.ACEH-KR.ACEH-KAMPUNG DARANG

NO. PENGUKURAN	TANGGAL PENGUKURAN	M.A. (M)	Q (M3/DET)
0	0- 0	.00	.00

--1KR.ACEH-KAMPUNG DARANG

NO. POS DUGA AIR : 1-001-00-03
TAHUN : 1988

INDUK SUNGAI : KR.ACEH

--1DATA GEOGRAPHI--0 : 05 25 00 LU 095 28 00 BT
LOKASI : PROPINSI D.I ACEH, KAB.ACEH BESAR,KEC.INDRAPURI,KAMPUNG DARANG.DARI BANDA ACEH +/- 24 KM SAMPAI DI INDRAPURI MASUK JALAN KECAMATAN +/- 2 KM, SAMPAI DI KAMPUNG DARANG, DI SEBELAH KANAN ALIRAN KR.ACEH.
LUAS DAERAH PENGALIRAN: 1081.2 KM2 ; ELEVASI PDA :+ 22.043 M
--1KETERANGAN MENGENAI POS DUGA AIR--0
DIDIRIKAN : TANGGAL 13/03/1976 OLEH DPMA
PERIODE PENCATATAN : TANGGAL 13/03/1976 SAMPAI DENGAN 31/12/1988
JENIS ALAT : PESAWAT OTOMATIK MINGGUAN
--1RINGKASAN DATA ALIRAN EXTRIM--0
ALIRAN TERBESAR : M.A. = ( ) M ; Q = M3/DET ; TGL - -
ALIRAN TERKECIL : M.A. = ( ) M ; Q = M3/DET ; TGL - -
ALIRAN EXTRIM YANG PERNAH TERJADI SAMPAI DENGAN TAHUN 1988 :
ALIRAN TERBESAR : M.A. = 8.39(+.00) M ; Q = 545.00 M3/DET ; TGL 12-12-1986
ALIRAN TERKECIL : M.A. = .24(+.00) M ; Q = 2.33 M3/DET ; TGL 20- 9-1977
--1PENENTUAN BESARNYA ALIRAN--0
BESARNYA ALIRAN DITENTUKAN BERDASARKAN LENGKUNG ALIRAN NO.29/12/83 YANG DIBUAT MENURUT DATA PENGUKURAN ALIRAN DARI TAHUN 1980 SAMPAI DENGAN TAHUN 1983.
PENGUKURAN ALIRAN BARU SAMPAI TAHUN 1986.
--1CATATAN--0
PENGUKURAN ALIRAN MASIH KURANG TERUTAMA UNTUK MUKA AIR TINGGI, AIR TERTINGGI YANG PERNAH DIUKUR PADA 3.35 M DENGAN Q= 156. M3/DET TANGGAL 24/12/1983.

TABEL BESARNYA ALIRAN HARIAN(M3/DET)

TANGGAL	JAN.	PEB.	MRT.	APL.	MEI	JUNI	JULI	AGST.	SEPT.	OKT.	NOP.	DES.
1	11.7	36.8	17.5	---	---	---	---	---	---	---	---	---
2	6.60	35.2	13.4	---	---	---	---	---	---	---	---	---
3	9.70	77.0	10.5	---	---	---	---	---	---	---	---	---
4	10.6	95.8	8.25	---	---	---	---	---	---	---	---	---
5	9.50	64.3	7.50	---	---	---	---	---	---	---	---	---
6	12.2	54.1	9.30	---	---	---	---	---	---	---	---	---
7	13.1	57.7	10.5	---	---	---	---	---	---	---	---	---
8	9.41	65.5	13.8	---	---	---	---	---	---	---	---	---
9	7.02	80.9	49.3	---	---	---	---	---	---	---	---	---
10	5.33	56.5	24.5	---	---	---	---	---	---	---	---	---
11	5.11	45.1	18.3	---	---	---	---	---	---	---	---	---
12	5.48	44.0	14.1	---	---	---	---	---	---	---	---	---
13	6.23	63.1	13.4	---	---	---	---	---	---	---	---	---
14	5.88	49.9	37.4	---	---	---	---	---	---	---	---	---
15	5.32	48.1	---	---	---	---	---	---	---	---	---	---
16	7.84	52.9	---	---	---	---	---	---	---	---	---	---
17	13.2	56.5	---	---	---	---	---	---	---	---	---	---
18	9.13	39.0	---	---	---	---	---	---	---	---	---	---
19	6.03	31.5	9.90	---	---	---	---	---	---	---	---	---
20	15.2	28.1	25.4	---	---	---	---	---	---	---	---	---
21	23.2	25.8	9.90	---	---	---	---	---	---	---	---	---
22	22.3	17.5	6.30	---	---	---	---	---	---	---	---	---
23	18.5	13.4	4.30	---	---	---	---	---	---	---	---	---
24	22.6	10.5	3.90	---	---	---	---	---	---	---	---	---
25	26.1	8.24	3.10	---	---	---	---	---	---	---	---	---
26	18.1	7.78	2.00	43.4	---	---	---	---	---	---	---	---
27	22.6	8.83	---	34.1	---	---	---	---	---	---	---	---
28	17.1	9.20	---	29.5	---	---	---	---	---	---	---	---
29	31.2	8.83	---	25.8	---	---	---	---	---	---	---	---
30	67.3		---	35.2	---	---	---	---	---	---	---	---
31	46.9		---		---		---	---		---		---

ALIRAN KM2
TINGGI ALIRAN
METER KUBIK

DATA TAHUNAN
RATA-RATA : --- ALIRAN KM2(L/DET): --- TINGGI ALIRAN(MM): --- METER KUBIK(10**6): ---

--1DAFTAR PENGUKURAN TAHUN 1988--0

KR.ACEH-KR.ACEH-KAMPUNG DARANG

NO. PENGUKURAN	TANGGAL PENGUKURAN	M.A. (M)	Q (M3/DET)
0	0- 0	.00	.00

Appendix 4.1 SCS Curve Number

Cover description — Cover type and hydrologic condition	Average percent impervious area [2]	Curve numbers for hydrologic soil group — A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1] Average runoff condition, and $I_a = 0.2S$.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2]	Hydrologic condition [3]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

[1] Average runoff condition, and I_a=0.2S

[2] Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

[3] Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30[4]	48	65	73
Woods—grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30[4]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.

2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

3 *Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

4 Actual curve number is less than 30; use CN = 30 for runoff computations.

5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Appendix 4.2 Modelled runoff based on LULC 1988 and LULC 2012 at the Banda Aceh outlet

	Banda Aceh outlet (m^3/s)			
	LULC 1988	LULC 2012	Scenario I	Scenario II
1-Jan-12	21	21	21	21
2-Jan-12	19.2	19.2	19.2	19.2
3-Jan-12	19.2	19.2	19.2	19.2
4-Jan-12	21.5	21.6	21.7	21.7
5-Jan-12	70.2	75.6	77.5	77.2
6-Jan-12	109.7	120.3	123.7	123
7-Jan-12	56.4	61.9	63.7	63.1
8-Jan-12	20.9	23	24.2	23.6
9-Jan-12	35.4	39.9	42.2	41.3
10-Jan-12	48.3	55	58.7	57.4
11-Jan-12	62.4	71.7	76.5	74.6
12-Jan-12	67	77.1	82.7	80.5
13-Jan-12	62.4	71.5	77	75.1
14-Jan-12	102.9	115.4	122.4	120.4
15-Jan-12	133.1	147.9	155.5	153.3
16-Jan-12	90	99.7	105.7	104
17-Jan-12	94.2	105.4	113.2	111.2
18-Jan-12	149.2	168.2	179.5	176
19-Jan-12	186.7	209.5	221.1	216.6
20-Jan-12	175.1	194.9	204.1	200.1
21-Jan-12	103.3	114.5	119.9	117.6
22-Jan-12	60.2	66.1	69.4	68.1
23-Jan-12	63	68.5	72.1	70.6
24-Jan-12	50.6	54.4	57.3	56.2
25-Jan-12	44.4	47.3	49.9	49
26-Jan-12	48.5	51.9	54.7	53.6
27-Jan-12	42.1	44.8	47.2	46.3
28-Jan-12	44.5	47.5	49.9	49
29-Jan-12	55	59	61.8	60.8
30-Jan-12	102.2	110.3	115.5	114.2
31-Jan-12	162	175.5	183.1	181
1-Feb-12	205.6	222.4	231.2	228.4
2-Feb-12	237	255.5	264.7	261.6
3-Feb-12	213.8	229.2	236.9	234.2
4-Feb-12	174.7	186.3	192.2	190.1
5-Feb-12	219.7	233.2	240.2	238.7
6-Feb-12	238.8	252.8	259.9	258.6
7-Feb-12	150.7	159.9	164.7	163.4
8-Feb-12	95.8	102	105.6	104.5
9-Feb-12	85.2	90.4	93.3	92.3
10-Feb-12	74.5	78.9	81.3	80.4
11-Feb-12	96.1	101.4	104.3	103.5
12-Feb-12	132.9	139.8	143.5	142.7
13-Feb-12	205.6	215.9	221.5	220.5
14-Feb-12	273.7	286.6	293.3	292.1
15-Feb-12	251.6	264.1	270.6	269
16-Feb-12	207.1	218.7	224.9	223.2
17-Feb-12	190.8	200.9	205.9	204.3
18-Feb-12	154.1	161.7	165.3	164
19-Feb-12	91.4	96	98.4	97.5
20-Feb-12	59.4	62.6	64.4	63.7
21-Feb-12	62.3	65.7	67.4	66.7
22-Feb-12	63.9	67.3	69	68.4
23-Feb-12	68.6	72.1	73.9	73.3
24-Feb-12	78.6	82.6	84.7	84

25-Feb-12	77.1	81.1	83.1	82.5
26-Feb-12	71	74.7	76.5	75.9
27-Feb-12	80.6	84.6	86.6	86
28-Feb-12	108.9	113.9	116.4	115.8
29-Feb-12	130.8	136.9	139.8	139
1-Mar-12	131	137	139.8	138.9
2-Mar-12	117.6	122.9	125.4	124.5
3-Mar-12	91	95	96.9	96.2
4-Mar-12	78.5	81.8	83.6	83.1
5-Mar-12	100.4	104.6	106.7	106.2
6-Mar-12	189.6	197.4	201.5	201
7-Mar-12	244.9	254.2	258.6	257.8
8-Mar-12	193.7	200.6	203.3	202.4
9-Mar-12	143.5	148.7	151	150.2
10-Mar-12	211.9	218.1	220.8	220.1
11-Mar-12	374.1	384.3	388.9	388.1
12-Mar-12	409	421.3	427.5	426.6
13-Mar-12	292.9	302.5	307.4	306.5
14-Mar-12	251.1	258.7	262.5	261.7
15-Mar-12	255.7	262.8	266.2	265.5
16-Mar-12	205.9	211.4	214	213.3
17-Mar-12	188.9	194.1	196.6	195.9
18-Mar-12	204.8	210.2	212.8	212
19-Mar-12	222.4	228	230.5	229.7
20-Mar-12	229.9	235.4	237.9	237
21-Mar-12	193.6	198.1	200.3	199.6
22-Mar-12	162.4	166.1	167.9	167.3
23-Mar-12	172.5	176.2	178	177.4
24-Mar-12	192.7	196.7	198.6	198.1
25-Mar-12	162.7	166.4	168.2	167.7
26-Mar-12	140.6	143.6	145.2	144.7
27-Mar-12	182.4	186.1	188.1	187.7
28-Mar-12	210	214.5	217.1	216.8
29-Mar-12	162.6	165.9	167.8	167.6
30-Mar-12	99.7	101.6	102.7	102.4
31-Mar-12	79.1	80.8	81.8	81.5
1-Apr-12	74.6	76.2	77	76.8
2-Apr-12	84.7	86.5	87.4	87.1
3-Apr-12	122.9	125.5	126.7	126.4
4-Apr-12	181.6	185.4	187.2	186.7
5-Apr-12	250.2	255.2	257.3	256.8
6-Apr-12	257.9	262.9	264.9	264.3
7-Apr-12	191.6	195.2	196.7	196.2
8-Apr-12	188	191.2	192.5	192.2
9-Apr-12	216.5	220	221.6	221.2
10-Apr-12	334.4	340.7	344.3	344.1
11-Apr-12	358.4	364.6	368	367.9
12-Apr-12	174.9	177.6	178.8	178.6
13-Apr-12	88	89.7	90.5	90.3
14-Apr-12	109	110.8	111.7	111.6
15-Apr-12	99.3	101	101.8	101.7
16-Apr-12	64.9	66	66.7	66.5
17-Apr-12	66.3	67.5	68.3	68.1
18-Apr-12	78.5	79.8	80.6	80.5
19-Apr-12	69	70.2	70.9	70.7
20-Apr-12	82.1	83.4	84.1	83.9
21-Apr-12	106.1	107.7	108.5	108.3
22-Apr-12	79.1	80.6	81.3	81.2
23-Apr-12	75.9	77.4	78.1	77.9
24-Apr-12	156.5	158.7	159.6	159.4

25-Apr-12	189.5	192.3	193.5	193.3
26-Apr-12	118.2	120.5	121.6	121.4
27-Apr-12	57.5	59	59.7	59.5
28-Apr-12	55.5	56.8	57.5	57.4
29-Apr-12	57.3	58.6	59.2	59.1
30-Apr-12	55.6	56.8	57.3	57.2
1-May-12	72.9	74.5	75.2	75
2-May-12	91.7	93.6	94.3	94.1
3-May-12	86.2	87.8	88.5	88.2
4-May-12	72.2	73.7	74.3	74.2
5-May-12	62.9	64.1	64.7	64.6
6-May-12	101.7	103.5	104.4	104.3
7-May-12	126.4	128.5	129.5	129.4
8-May-12	135.6	137.6	138.3	138.1
9-May-12	165.7	167.9	168.8	168.6
10-May-12	107.5	109.3	110.1	109.9
11-May-12	70.4	71.8	72.4	72.3
12-May-12	101.9	103.4	104.1	103.9
13-May-12	100.1	101.8	102.5	102.3
14-May-12	91.6	93.2	93.9	93.7
15-May-12	90	91.5	92.1	91.9
16-May-12	86.3	87.7	88.3	88.2
17-May-12	94.8	96.3	97	96.8
18-May-12	109	110.7	111.4	111.3
19-May-12	130.8	132.8	133.6	133.4
20-May-12	143.1	145.2	146	145.7
21-May-12	115	116.6	117.3	117
22-May-12	101.4	102.9	103.6	103.5
23-May-12	100.5	101.9	102.7	102.6
24-May-12	112.7	114.1	114.9	114.9
25-May-12	140.2	141.9	142.9	142.8
26-May-12	98.3	99.6	100.2	100.1
27-May-12	55.7	56.6	57	56.9
28-May-12	88.2	89.4	90.1	90
29-May-12	133.7	135.4	136.2	136.1
30-May-12	200.7	203.4	204.6	204.4
31-May-12	259.2	262.3	263.6	263.3
1-Jun-12	211.2	213.6	214.6	214.3
2-Jun-12	116.3	117.8	118.4	118.2
3-Jun-12	149.1	150.5	151.1	151
4-Jun-12	229.1	231.2	232.1	231.9
5-Jun-12	201	203.3	204.5	204.4
6-Jun-12	149.3	151.2	152.2	152.1
7-Jun-12	113.7	115	115.6	115.5
8-Jun-12	85	86	86.5	86.4
9-Jun-12	62	62.8	63.2	63.2
10-Jun-12	41.4	42	42.3	42.3
11-Jun-12	36.6	37.1	37.4	37.3
12-Jun-12	40.8	41.4	41.7	41.6
13-Jun-12	46.6	47.3	47.7	47.6
14-Jun-12	53.6	54.3	54.6	54.5
15-Jun-12	45.5	46.2	46.5	46.4
16-Jun-12	31.9	32.5	32.8	32.7
17-Jun-12	25.9	26.4	26.7	26.6
18-Jun-12	25.2	25.7	26	25.9
19-Jun-12	19.5	20	20.3	20.2
20-Jun-12	41.1	41.7	42	41.9
21-Jun-12	85	86	86.5	86.4
22-Jun-12	91.6	92.8	93.4	93.3
23-Jun-12	86	87.2	87.7	87.6

24-Jun-12	70	70.9	71.2	71.1
25-Jun-12	36.7	37.2	37.4	37.3
26-Jun-12	21	21.3	21.4	21.4
27-Jun-12	24.7	25	25.2	25.1
28-Jun-12	27.5	27.8	28	28
29-Jun-12	32.3	32.7	32.9	32.9
30-Jun-12	37.8	38.3	38.5	38.4
1-Jul-12	51.1	51.7	52	51.9
2-Jul-12	48.7	49.3	49.5	49.5
3-Jul-12	25.1	25.5	25.6	25.6
4-Jul-12	20.2	20.5	20.7	20.6
5-Jul-12	19.5	19.8	20	19.9
6-Jul-12	15.9	16.1	16.3	16.2
7-Jul-12	29.7	30.1	30.3	30.3
8-Jul-12	52.8	53.3	53.7	53.7
9-Jul-12	55.4	56	56.3	56.2
10-Jul-12	54.7	55.4	55.7	55.6
11-Jul-12	73.1	74	74.4	74.3
12-Jul-12	88.8	89.8	90.1	90
13-Jul-12	75	75.8	76.1	76
14-Jul-12	60.4	61	61.2	61.1
15-Jul-12	78.7	79.3	79.6	79.5
16-Jul-12	76.5	77.2	77.5	77.4
17-Jul-12	50.9	51.4	51.6	51.6
18-Jul-12	52.8	53.3	53.6	53.5
19-Jul-12	44.3	44.8	45.1	45
20-Jul-12	32.3	32.7	32.9	32.9
21-Jul-12	37.8	38.1	38.3	38.3
22-Jul-12	30.3	30.7	30.9	30.8
23-Jul-12	25.2	25.5	25.7	25.7
24-Jul-12	27.7	28.1	28.2	28.2
25-Jul-12	27.5	27.8	28	27.9
26-Jul-12	25.2	25.5	25.7	25.6
27-Jul-12	18.1	18.4	18.5	18.5
28-Jul-12	14.2	14.4	14.5	14.5
29-Jul-12	12.2	12.4	12.5	12.5
30-Jul-12	9	9.2	8.6	8.9
31-Jul-12	8.3	6.8	6.2	6.6
1-Aug-12	10.1	9.8	9.4	9.7
2-Aug-12	14.3	14.5	14.7	14.6
3-Aug-12	19.2	19.5	19.6	19.6
4-Aug-12	28.7	29	29.2	29.1
5-Aug-12	34.1	34.5	34.7	34.6
6-Aug-12	27.4	27.8	28	27.9
7-Aug-12	27.6	28	28.2	28.1
8-Aug-12	36.1	36.6	36.8	36.7
9-Aug-12	45.5	46	46.2	46.2
10-Aug-12	49.5	50	50.1	50.1
11-Aug-12	34.2	34.6	34.8	34.7
12-Aug-12	36	36.4	36.6	36.6
13-Aug-12	71.3	72	72.4	72.3
14-Aug-12	108.3	109.4	109.8	109.7
15-Aug-12	159.1	160.5	161.1	161
16-Aug-12	164.7	166.1	166.6	166.5
17-Aug-12	109.6	110.5	110.9	110.8
18-Aug-12	88.5	89.3	89.6	89.5
19-Aug-12	88	88.6	88.9	88.8
20-Aug-12	95.1	95.8	96.2	96.1
21-Aug-12	106.1	106.9	107.3	107.2
22-Aug-12	154.1	155.3	155.9	155.8

23-Aug-12	149.4	150.5	151.1	151
24-Aug-12	76.4	76.9	77.2	77.1
25-Aug-12	142.7	143.5	143.9	143.8
26-Aug-12	235.5	236.8	237.4	237.3
27-Aug-12	161.4	162.6	163.3	163.2
28-Aug-12	84.2	85	85.4	85.4
29-Aug-12	81.8	82.4	82.8	82.7
30-Aug-12	87.4	88	88.4	88.3
31-Aug-12	95.4	96.1	96.4	96.3
1-Sep-12	83.6	84.2	84.5	84.4
2-Sep-12	126.7	127.4	127.7	127.6
3-Sep-12	217.5	218.6	219.1	219
4-Sep-12	192.2	193.4	194	193.9
5-Sep-12	129.5	130.5	131.1	131
6-Sep-12	103.7	104.5	104.9	104.8
7-Sep-12	62.5	62.9	63.1	63.1
8-Sep-12	36.2	36.5	36.6	36.6
9-Sep-12	27.1	27.3	27.3	27.3
10-Sep-12	23.3	23.5	23.5	23.5
11-Sep-12	20.5	20.6	20.7	20.7
12-Sep-12	19.1	19.2	19.3	19.2
13-Sep-12	18.6	18.7	18.8	18.8
14-Sep-12	19.7	19.8	19.9	19.9
15-Sep-12	33.8	34	34.1	34.1
16-Sep-12	50	50.3	50.5	50.5
17-Sep-12	55.3	55.7	55.9	55.9
18-Sep-12	55.8	56.2	56.4	56.3
19-Sep-12	43.4	43.7	43.8	43.8
20-Sep-12	24.2	24.4	24.4	24.4
21-Sep-12	16.5	16.6	16.7	16.7
22-Sep-12	16.3	16.5	16.5	16.5
23-Sep-12	13.9	14	14	14
24-Sep-12	13.2	13.3	13.4	13.3
25-Sep-12	185.2	186.5	187.2	187.3
26-Sep-12	287.2	288.9	289.8	289.9
27-Sep-12	132.8	133.4	133.7	133.7
28-Sep-12	41.5	41.8	41.9	41.9
29-Sep-12	30.9	31	31.1	31.1
30-Sep-12	39.7	39.9	40	40
1-Oct-12	59.1	59.4	59.6	59.5
2-Oct-12	48.6	48.9	49	49
3-Oct-12	30	30.3	30.4	30.3
4-Oct-12	42.6	42.8	42.9	42.9
5-Oct-12	102.1	102.6	102.8	102.7
6-Oct-12	135.9	136.6	136.9	136.9
7-Oct-12	93.4	94.1	94.4	94.3
8-Oct-12	58.7	59.3	59.5	59.5
9-Oct-12	56.6	57	57.2	57.2
10-Oct-12	52	52.4	52.5	52.5
11-Oct-12	40.4	40.6	40.7	40.7
12-Oct-12	47.3	47.6	47.7	47.7
13-Oct-12	70.1	70.5	70.6	70.6
14-Oct-12	54.2	54.6	54.7	54.7
15-Oct-12	203.5	204.7	205.4	205.4
16-Oct-12	324.4	326.1	327	327
17-Oct-12	185.1	186	186.4	186.3
18-Oct-12	112.8	113.5	113.8	113.7
19-Oct-12	95.9	96.4	96.6	96.6
20-Oct-12	91.6	92	92.2	92.1
21-Oct-12	140.8	141.5	141.8	141.7

22-Oct-12	110.4	111.1	111.3	111.3
23-Oct-12	53	53.3	53.5	53.5
24-Oct-12	65.4	65.8	66	65.9
25-Oct-12	110.8	111.4	111.7	111.7
26-Oct-12	159.7	160.7	161.1	161
27-Oct-12	224.9	226.3	226.8	226.7
28-Oct-12	228	229.3	229.8	229.7
29-Oct-12	164.7	165.6	165.9	165.8
30-Oct-12	165.9	166.7	167.1	167
31-Oct-12	158.9	159.6	159.9	159.9
1-Nov-12	112	112.5	112.8	112.7
2-Nov-12	306.2	307.5	308.2	308.2
3-Nov-12	356.9	358.2	358.9	358.9
4-Nov-12	98.5	98.7	98.9	98.8
5-Nov-12	121.5	122	122.3	122.3
6-Nov-12	180.2	180.8	181.1	181.1
7-Nov-12	74.8	75	75.1	75.1
8-Nov-12	53.9	54.1	54.3	54.2
9-Nov-12	63	63.2	63.4	63.4
10-Nov-12	46.1	46.2	46.3	46.3
11-Nov-12	215.2	216	216.4	216.4
12-Nov-12	284.2	285	285.5	285.5
13-Nov-12	132.2	132.6	132.8	132.7
14-Nov-12	124.7	125.3	125.6	125.6
15-Nov-12	198.4	199.5	199.9	199.8
16-Nov-12	314.6	316.4	317	316.9
17-Nov-12	421.2	423.4	424.1	423.9
18-Nov-12	357.6	359.5	360.2	360
19-Nov-12	224.8	226	226.4	226.3
20-Nov-12	157.2	157.9	158.1	158.1
21-Nov-12	104.7	105	105.2	105.2
22-Nov-12	60	60.2	60.3	60.3
23-Nov-12	73.6	73.8	73.9	73.9
24-Nov-12	101.8	102.1	102.3	102.2
25-Nov-12	92.3	92.6	92.8	92.7
26-Nov-12	112.3	112.7	112.9	112.8
27-Nov-12	227.6	228.3	228.6	228.5
28-Nov-12	330.8	331.9	332.4	332.3
29-Nov-12	372.4	373.9	374.5	374.4
30-Nov-12	493.7	495.5	496.3	496.2
1-Dec-12	551.5	553.5	554.3	554.2
2-Dec-12	381.3	382.6	383.2	383.1
3-Dec-12	202.8	203.6	203.9	203.9
4-Dec-12	134.5	135	135.3	135.2
5-Dec-12	178.6	179.2	179.5	179.4
6-Dec-12	313.8	314.7	315.1	315.1
7-Dec-12	447	448.5	449.1	449
8-Dec-12	433.8	435.3	435.9	435.8
9-Dec-12	334	335.2	335.6	335.5
10-Dec-12	221.7	222.5	222.9	222.8
11-Dec-12	129.2	129.6	129.9	129.8
12-Dec-12	92.8	93.1	93.2	93.2
13-Dec-12	68.7	68.9	69	69
14-Dec-12	211.8	212.3	212.6	212.6
15-Dec-12	330.9	331.7	332.1	332.1
16-Dec-12	221	221.7	222	221.9
17-Dec-12	150.9	151.5	151.7	151.7
18-Dec-12	143.1	143.5	143.8	143.7
19-Dec-12	145.9	146.3	146.5	146.5
20-Dec-12	157.6	158.1	158.3	158.2

21-Dec-12	152.7	153.2	153.4	153.4
22-Dec-12	158.4	159	159.2	159.1
23-Dec-12	180.2	180.7	181	180.9
24-Dec-12	179	179.5	179.8	179.7
25-Dec-12	190.5	191	191.3	191.2
26-Dec-12	225.4	226.1	226.3	226.3
27-Dec-12	192.9	193.5	193.7	193.7
28-Dec-12	144.1	144.6	144.8	144.7
29-Dec-12	128	128.3	128.5	128.5
30-Dec-12	123.5	123.9	124.1	124
31-Dec-12	128	128.4	128.5	128.5

Appendix 5.1

WATER BALANCE SIMULATION OF THE KRUENG ACEH CATCHMENT
LULC 1988 runs on inflow 2012 and water demand 2012 (in m^3/s)

DEMAND	Up	Down
Domestic	0.31	0.33
Non-Domestic	0.22	0.08
Water Losses	0.09	0.11
Min.Environmental Flow	1.12	0.83
Paddy Field	19.55	0.64

	Water Quantity														Water Quality at PDAM Tirta Daroy				
Date	Lampisang Sta			Darang Sta			Upstream	Pasie Sta			Sub Banda Aceh		Downstream	Upstream - Downstream	TSS (mg/l)	Turb (NTU)	Alum (kg/day)	Cost Alum (USD)	PDAM (Quantity & Quality)
	I_1	D_1	(I_1-D_1) R_1	I_2	D_2	$(R_1+I_2-D_2)$ R_2		I_3	$(R_2+I_3-D_{(D+ND+WL)})$ R_3	(R_3-D_{PP}) R_4	I_4	$(R_4+I_4-D_4)$ R_5			(R_2+I_3) = TSS (>2000) $0.000771*(R_2+I_3)^{2.899}$	Limit < 5 NTU $3.093*TSS^{1.017}$	5 NTU<Alum<2000 mg/l $1.2*(8.59*D_{(D+ND+WL)})^{0.35}$	(Alum*USD 0.259)	
RELIABILITY			**94.54%**			**93.99%**	**93.44%**		**98.91%**	**98.09%**		**97.81%**	**97.81%**	**93.44%**	**0.00%**	**14.48%**	**793,837.89**	**205,232.13**	**98.91%**
01-Jan-12	7.20	0.87	6.33	8.73	0.87	14.18	OK	23.28	22.76	22.76	2.30	24.23	OK	OK	1.0	3.2	-	-	OK
02-Jan-12	11.30	0.87	10.43	15.23	0.87	24.78	OK	32.88	32.36	32.36	0.70	32.23	OK	OK	1.5	4.8	-	-	OK
03-Jan-12	12.60	0.87	11.73	18.03	0.87	28.88	OK	36.18	35.66	35.66	0.30	35.13	OK	OK	1.8	5.6	888	229.64	OK
04-Jan-12	8.70	0.87	7.83	12.43	0.87	19.38	OK	26.18	25.66	25.66	0.80	25.63	OK	OK	1.0	3.2	-	-	OK
05-Jan-12	11.70	0.87	10.83	20.43	0.87	30.38	OK	100.08	99.56	99.56	12.30	111.03	OK	OK	29.9	98.2	2,425	626.82	OK
06-Jan-12	15.30	0.87	14.43	24.23	0.87	37.78	OK	111.48	110.96	110.96	12.60	122.73	OK	OK	33.8	111.0	2,531	654.26	OK
07-Jan-12	8.30	0.87	7.43	10.93	0.87	17.48	OK	26.08	25.56	25.56	1.20	25.93	OK	OK	1.1	3.5	-	-	OK
08-Jan-12	39.40	0.87	38.53	47.33	0.87	84.98	OK	93.38	92.86	92.86	0.40	92.43	OK	OK	10.7	34.3	1,651	426.91	OK
09-Jan-12	46.10	0.87	45.23	55.73	0.87	100.08	OK	112.78	112.26	112.26	0.70	112.13	OK	OK	14.8	48.0	1,857	480.09	OK
10-Jan-12	14.00	0.87	13.13	19.83	0.87	32.08	OK	49.68	49.16	49.16	2.30	50.63	OK	OK	3.7	11.9	1,139	294.35	OK
11-Jan-12	53.60	0.87	52.73	68.23	0.87	120.08	OK	140.48	139.96	139.96	1.80	140.93	OK	OK	21.6	70.4	2,123	548.88	OK
12-Jan-12	58.20	0.87	57.33	72.93	0.87	129.38	OK	145.88	145.36	145.36	1.30	145.83	OK	OK	23.6	77.1	2,192	566.67	OK
13-Jan-12	21.50	0.87	20.63	27.83	0.87	47.58	OK	58.58	58.06	58.06	1.20	58.43	OK	OK	4.3	13.5	1,192	308.14	OK
14-Jan-12	18.80	0.87	17.93	34.73	0.87	51.78	OK	110.78	110.26	110.26	11.50	120.93	OK	OK	24.9	81.4	2,234	577.54	OK
15-Jan-12	14.40	0.87	13.53	29.73	0.87	42.38	OK	102.28	101.76	101.76	11.60	112.53	OK	OK	24.4	79.8	2,219	573.73	OK
16-Jan-12	204.70	0.87	203.83	259.23	0.87	462.18	OK	488.48	487.96	487.96	1.20	488.33	OK	OK	242.1	822.8	5,021	1,297.99	OK
17-Jan-12	224.80	0.87	223.93	281.03	0.87	504.06	OK	528.28	527.76	527.76	0.90	527.83	OK	OK	285.3	972.1	5,322	1,376.03	OK
18-Jan-12	45.60	0.87	44.73	52.23	0.87	96.08	OK	103.18	102.66	102.66	0.30	102.13	OK	OK	13.4	43.5	1,794	463.69	OK
19-Jan-12	47.20	0.87	46.33	55.43	0.87	100.88	OK	109.88	109.36	109.36	0.50	109.03	OK	OK	14.7	47.6	1,851	478.60	OK
20-Jan-12	47.90	0.87	47.03	58.03	0.87	104.18	OK	115.88	115.36	115.36	0.60	115.13	OK	OK	15.7	50.9	1,896	490.12	OK
21-Jan-12	45.10	0.87	44.23	50.13	0.87	93.48	OK	100.98	100.46	100.46	0.20	99.83	OK	OK	13.1	42.2	1,776	459.08	OK
22-Jan-12	43.50	0.87	42.63	44.53	0.87	86.28	OK	87.08	86.56	86.56	-	85.73	OK	OK	11.6	37.4	1,703	440.16	OK
23-Jan-12	42.60	0.87	41.73	43.63	0.87	84.48	OK	85.08	84.56	84.56	-	83.73	OK	OK	11.2	36.0	1,679	433.97	OK
24-Jan-12	42.30	0.87	41.43	43.33	0.87	83.88	OK	84.38	83.86	83.86	-	83.03	OK	OK	11.0	35.5	1,671	431.89	OK
25-Jan-12	41.30	0.87	40.43	42.23	0.87	81.78	OK	82.18	81.66	81.66	-	80.83	OK	OK	10.5	33.9	1,644	424.93	OK
26-Jan-12	38.60	0.87	37.73	39.53	0.87	76.38	OK	76.68	76.16	76.16	-	75.33	OK	OK	9.2	29.7	1,570	405.98	OK
27-Jan-12	38.60	0.87	37.73	39.53	0.87	76.38	OK	76.58	76.06	76.06	-	75.23	OK	OK	9.2	29.7	1,570	405.97	OK
28-Jan-12	48.70	0.87	47.83	52.83	0.87	99.78	OK	100.98	100.46	100.46	-	99.63	OK	OK	14.5	47.1	1,845	476.94	OK
29-Jan-12	129.80	0.87	128.93	159.33	0.87	287.38	OK	299.28	298.76	298.76	0.10	298.03	OK	OK	99.2	331.9	3,654	944.64	OK
30-Jan-12	176.90	0.87	176.03	221.03	0.87	396.18	OK	432.08	431.56	431.56	6.90	437.63	OK	OK	186.6	631.3	4,576	1,183.07	OK
31-Jan-12	184.30	0.87	183.43	231.13	0.87	413.68	OK	451.18	450.66	450.66	7.00	456.83	OK	OK	202.2	685.0	4,709	1,217.37	OK
01-Feb-12	163.10	0.87	162.23	206.93	0.87	368.28	OK	399.18	398.66	398.66	2.80	400.63	OK	OK	160.7	542.2	4,339	1,121.75	OK
02-Feb-12	98.40	0.87	97.53	123.83	0.87	220.48	OK	247.48	246.96	246.96	3.60	249.73	OK	OK	63.7	211.5	3,121	806.83	OK
03-Feb-12	67.10	0.87	66.23	80.23	0.87	145.58	OK	154.98	154.46	154.46	0.90	154.53	OK	OK	28.3	92.8	2,339	604.76	OK
04-Feb-12	66.70	0.87	65.83	87.53	0.87	152.48	OK	172.98	172.46	172.46	0.40	172.03	OK	OK	31.9	104.8	2,441	630.99	OK
05-Feb-12	64.10	0.87	63.23	108.53	0.87	170.88	OK	277.58	277.06	277.06	23.80	300.03	OK	OK	100.3	335.7	3,669	948.43	OK
06-Feb-12	55.10	0.87	54.23	87.63	0.87	140.98	OK	232.68	232.16	232.16	23.50	254.83	OK	OK	72.9	242.5	3,274	846.41	OK
07-Feb-12	58.00	0.87	57.13	73.73	0.87	129.98	OK	145.68	145.16	145.16	2.10	146.43	OK	OK	23.5	76.8	2,189	565.90	OK
08-Feb-12	51.10	0.87	50.23	62.03	0.87	111.38	OK	122.58	122.06	122.06	0.80	122.03	OK	OK	17.6	57.1	1,973	510.07	OK
09-Feb-12	45.10	0.87	44.23	47.73	0.87	91.06	OK	99.18	98.66	98.66	0.20	98.03	OK	OK	13.0	41.9	1,771	457.83	OK
10-Feb-12	45.10	0.87	44.23	50.73	0.87	94.08	OK	104.98	104.46	104.46	0.20	103.83	OK	OK	13.5	43.8	1,799	464.97	OK
11-Feb-12	54.80	0.87	53.93	74.63	0.87	127.68	OK	169.38	168.86	168.86	7.50	175.53	OK	OK	31.4	103.2	2,428	627.61	OK
12-Feb-12	80.20	0.87	79.33	118.73	0.87	197.18	OK	262.58	262.06	262.06	11.00	272.23	OK	OK	71.7	238.6	3,255	841.57	OK
13-Feb-12	71.90	0.87	71.03	127.93	0.87	198.08	OK	319.58	319.06	319.06	25.80	344.03	OK	OK	130.8	439.7	4,032	1,042.38	OK
14-Feb-12	175.20	0.87	174.33	277.33	0.87	450.78	OK	593.18	592.66	592.66	23.30	615.13	OK	OK	332.8	1,137.1	5,623	1,453.63	OK

15-Feb-12	176.40	0.87	175.53	250.33	0.87	424.98	OK	483.48	482.96	482.96	2.40	484.53	OK	OK	218.1	739.7	4,837	1,250.52	OK
16-Feb-12	47.90	0.87	47.03	57.03	0.87	103.18	OK	117.18	116.66	116.66	0.70	116.53	OK	OK	15.9	51.7	1,906	492.86	OK
17-Feb-12	44.00	0.87	43.13	51.53	0.87	93.78	OK	104.28	103.76	103.76	0.30	103.23	OK	OK	13.1	42.4	1,778	459.68	OK
18-Feb-12	41.40	0.87	40.53	47.93	0.87	87.58	OK	95.48	94.96	94.96	0.10	94.23	OK	OK	11.4	36.7	1,691	437.16	OK
19-Feb-12	39.40	0.87	38.53	45.83	0.87	83.48	OK	89.38	88.86	88.86	-	88.03	OK	OK	10.2	33.0	1,628	420.92	OK
20-Feb-12	37.50	0.87	36.63	43.93	0.87	79.68	OK	84.18	83.66	83.66	-	82.83	OK	OK	9.3	29.8	1,572	406.36	OK
21-Feb-12	37.20	0.87	36.33	45.13	0.87	80.56	OK	86.48	85.96	85.96	0.10	85.23	OK	OK	9.4	30.3	1,580	408.51	OK
22-Feb-12	43.50	0.87	42.63	57.33	0.87	99.08	OK	114.28	113.76	113.76	2.40	115.33	OK	OK	14.6	47.3	1,848	477.78	OK
23-Feb-12	49.30	0.87	48.43	65.93	0.87	113.48	OK	130.08	129.56	129.56	2.40	131.13	OK	OK	18.6	60.4	2,013	520.46	OK
24-Feb-12	38.20	0.87	37.33	51.93	0.87	88.38	OK	106.78	106.26	106.26	3.60	109.03	OK	OK	12.8	41.2	1,760	455.14	OK
25-Feb-12	42.00	0.87	41.13	54.53	0.87	94.78	OK	109.58	109.06	109.06	3.50	111.73	OK	OK	13.6	43.8	1,799	465.13	OK
26-Feb-12	40.20	0.87	39.33	50.73	0.87	89.18	OK	100.08	99.56	99.56	0.30	99.03	OK	OK	11.7	37.8	1,708	441.47	OK
27-Feb-12	76.90	0.87	76.03	106.83	0.87	181.98	OK	209.78	209.26	209.26	3.60	212.03	OK	OK	45.1	148.9	2,760	713.60	OK
28-Feb-12	109.60	0.87	108.73	152.83	0.87	260.68	OK	298.88	298.36	298.36	6.70	304.23	OK	OK	87.9	293.4	3,500	904.82	OK
29-Feb-12	64.90	0.87	64.03	94.33	0.87	157.48	OK	189.58	189.06	189.06	4.60	192.83	OK	OK	37.1	122.0	2,574	665.42	OK
01-Mar-12	34.10	10.65	23.45	37.55	10.65	50.36	OK	66.76	66.24	65.41	1.30	65.88	OK	OK	10.5	33.7	1,641	424.17	OK
02-Mar-12	30.50	10.65	19.85	32.45	10.65	41.66	OK	54.66	54.14	53.31	0.50	52.98	OK	OK	8.2	26.2	1,502	388.28	OK
03-Mar-12	31.20	10.65	20.55	35.65	10.65	45.56	OK	58.36	57.84	57.01	0.40	56.58	OK	OK	8.8	28.4	1,545	399.45	OK
04-Mar-12	119.90	10.65	109.25	150.05	10.65	248.66	OK	269.06	268.54	267.71	3.30	270.18	OK	OK	92.4	308.8	3,563	921.16	OK
05-Mar-12	171.30	10.65	160.65	217.65	10.65	367.66	OK	392.36	391.84	391.01	3.30	393.48	OK	OK	179.7	607.4	4,515	1,167.21	OK
06-Mar-12	117.90	10.65	107.25	140.25	10.65	236.86	OK	292.56	292.04	291.21	34.30	324.68	OK	OK	102.3	342.4	3,694	955.03	OK
07-Mar-12	62.00	10.65	51.35	68.65	10.65	109.36	OK	164.96	164.44	163.61	34.50	197.28	OK	OK	43.1	142.3	2,717	702.37	OK
08-Mar-12	69.50	10.65	58.85	78.55	10.65	126.76	OK	140.56	140.04	139.21	3.10	141.48	OK	OK	32.1	105.2	2,444	631.93	OK
09-Mar-12	70.20	10.65	59.55	86.45	10.65	135.36	OK	158.26	157.74	156.91	1.50	157.58	OK	OK	36.8	121.0	2,567	663.66	OK
10-Mar-12	87.50	10.65	76.85	199.25	10.65	265.46	OK	415.86	415.34	414.51	5.90	419.58	OK	OK	248.4	844.3	5,066	1,309.80	OK
11-Mar-12	151.30	10.65	140.65	315.75	10.65	445.76	OK	661.86	661.34	660.51	20.20	679.88	OK	OK	529.8	1,824.3	6,634	1,715.18	OK
12-Mar-12	104.00	10.65	93.35	161.15	10.65	243.86	OK	360.26	359.74	358.91	40.00	398.08	OK	OK	162.6	548.6	4,357	1,126.33	OK
13-Mar-12	124.20	10.65	113.55	145.85	10.65	248.76	OK	290.36	289.84	289.01	24.80	312.98	OK	OK	102.1	341.9	3,692	954.52	OK
14-Mar-12	126.50	10.65	115.85	161.35	10.65	266.56	OK	322.66	322.14	321.31	23.10	343.58	OK	OK	119.3	400.4	3,902	1,008.82	OK
15-Mar-12	83.80	10.65	73.15	111.15	10.65	173.66	OK	236.26	235.74	234.91	23.60	257.68	OK	OK	72.3	240.5	3,265	843.98	OK
16-Mar-12	175.50	10.65	164.85	222.15	10.65	376.36	OK	400.16	399.64	398.81	3.30	401.28	OK	OK	187.0	632.5	4,579	1,183.85	OK
17-Mar-12	172.50	10.65	161.85	216.45	10.65	367.66	OK	390.36	389.84	389.01	1.30	389.48	OK	OK	179.7	607.4	4,515	1,167.17	OK
18-Mar-12	143.90	10.65	133.25	176.55	10.65	299.16	OK	319.76	319.24	318.41	1.60	319.18	OK	OK	126.6	425.3	3,985	1,030.36	OK
19-Mar-12	131.30	10.65	120.65	163.65	10.65	273.66	OK	299.66	299.14	298.31	1.70	299.18	OK	OK	110.0	368.9	3,792	980.26	OK
20-Mar-12	98.10	10.65	87.45	118.15	10.65	194.96	OK	216.56	216.04	215.21	0.80	215.18	OK	OK	63.3	210.1	3,114	804.97	OK
21-Mar-12	105.20	10.65	94.55	115.45	10.65	199.36	OK	215.56	215.04	214.21	-	213.38	OK	OK	66.6	221.3	3,171	819.75	OK
22-Mar-12	95.70	10.65	85.05	104.25	10.65	178.66	OK	191.56	191.04	190.21	-	189.38	OK	OK	55.3	183.4	2,969	767.52	OK
23-Mar-12	73.00	10.65	62.35	104.65	10.65	156.36	OK	207.16	206.64	205.81	1.80	206.78	OK	OK	57.5	190.5	3,008	777.78	OK
24-Mar-12	54.60	10.65	43.95	80.05	10.65	113.36	OK	167.56	167.04	166.21	7.00	172.38	OK	OK	43.5	143.6	2,725	704.53	OK
25-Mar-12	54.20	10.65	43.55	56.15	10.65	89.06	OK	109.16	108.64	107.81	5.20	112.18	OK	OK	21.3	69.6	2,115	546.72	OK
26-Mar-12	50.40	10.65	39.75	86.35	10.65	115.46	OK	174.06	173.54	172.71	2.00	173.88	OK	OK	48.9	161.6	2,840	734.30	OK
27-Mar-12	47.50	10.65	36.85	86.55	10.65	112.76	OK	191.66	191.14	190.31	15.90	205.38	OK	OK	64.4	214.1	3,134	810.25	OK
28-Mar-12	42.70	10.65	32.05	53.45	10.65	74.86	OK	143.96	143.44	142.61	38.70	180.48	OK	OK	42.1	138.7	2,692	696.03	OK
29-Mar-12	44.40	10.65	33.75	52.75	10.65	75.86	OK	121.16	120.64	119.81	24.90	143.88	OK	OK	26.9	88.1	2,297	593.89	OK
30-Mar-12	54.40	10.65	43.75	59.15	10.65	92.26	OK	111.36	110.84	110.01	-	109.18	OK	OK	21.7	70.8	2,128	550.23	OK
31-Mar-12	44.70	10.65	34.05	47.75	10.65	71.16	OK	85.56	85.04	84.21	-	83.38	OK	OK	14.9	48.2	1,860	480.98	OK
01-Apr-12	35.00	10.65	24.35	34.15	10.65	47.86	OK	57.86	57.34	56.51	-	55.68	OK	OK	9.0	29.1	1,558	402.79	OK
02-Apr-12	187.70	10.65	177.05	241.65	10.65	408.06	OK	430.26	429.74	428.91	-	428.08	OK	OK	213.8	725.0	4,803	1,241.76	OK
03-Apr-12	236.30	10.65	225.65	306.75	10.65	521.76	OK	546.46	545.94	545.11	-	544.28	OK	OK	329.9	1,126.8	5,605	1,449.04	OK
04-Apr-12	136.60	10.65	125.95	175.85	10.65	291.16	OK	312.06	311.54	310.71	0.30	310.18	OK	OK	119.6	401.6	3,906	1,009.85	OK
05-Apr-12	116.00	10.65	105.35	148.55	10.65	243.26	OK	270.36	269.84	269.01	7.50	275.68	OK	OK	90.7	303.1	3,540	915.10	OK
06-Apr-12	70.40	10.65	59.75	81.25	10.65	130.36	OK	146.66	146.14	145.31	8.10	152.58	OK	OK	33.7	110.7	2,488	643.31	OK
07-Apr-12	66.50	10.65	55.85	84.55	10.65	129.76	OK	147.36	146.84	146.01	1.40	146.58	OK	OK	33.2	109.2	2,476	640.14	OK
08-Apr-12	90.20	10.65	79.55	156.95	10.65	225.86	OK	299.36	298.84	298.01	2.90	300.08	OK	OK	112.2	376.1	3,818	986.96	OK
09-Apr-12	81.40	10.65	70.75	137.95	10.65	198.06	OK	261.16	260.64	259.81	2.50	261.48	OK	OK	87.9	293.7	3,501	905.08	OK
10-Apr-12	73.20	10.65	62.55	85.45	10.65	137.36	OK	265.56	265.04	264.21	99.80	363.18	OK	OK	124.7	418.9	3,964	1,024.89	OK
11-Apr-12	57.10	10.65	46.45	61.95	10.65	97.76	OK	222.36	221.84	221.01	99.70	319.88	OK	OK	106.5	356.7	3,747	968.79	OK
12-Apr-12	38.20	10.65	27.55	36.55	10.65	53.46	OK	65.96	65.44	64.61	8.90	72.68	OK	OK	10.7	34.5	1,654	427.64	OK
13-Apr-12	38.00	10.65	27.35	37.55	10.65	54.26	OK	67.86	67.34	66.51	4.60	70.28	OK	OK	11.0	35.3	1,668	431.23	OK
14-Apr-12	37.90	10.65	27.25	42.55	10.65	59.16	OK	91.06	90.54	89.71	14.30	103.18	OK	OK	16.9	54.9	1,947	503.30	OK
15-Apr-12	37.70	10.65	27.05	40.85	10.65	57.26	OK	83.36	82.84	82.01	11.80	92.98	OK	OK	14.5	47.0	1,843	476.54	OK
16-Apr-12	37.10	10.65	26.45	34.75	10.65	50.56	OK	54.36	53.84	53.01	0.10	52.28	OK	OK	9.2	29.4	1,565	404.62	OK
17-Apr-12	48.40	10.65	37.75	50.45	10.65	77.56	OK	90.96	90.44	89.61	7.60	96.38	OK	OK	16.5	53.6	1,931	499.13	OK
18-Apr-12	49.00	10.65	38.35	51.25	10.65	78.96	OK	96.56	96.04	95.21	11.30	105.68	OK	OK	17.7	57.6	1,980	511.82	OK
19-Apr-12	34.00	10.65	23.35	31.65	10.65	44.36	OK	50.86	50.34	49.51	3.80	52.48	OK	OK	8.1	25.8	1,495	386.50	OK

20-Apr-12	23.10	10.65	12.45	46.95	10.65	48.76	OK	86.26	85.74	84.91	1.60	85.68	OK	OK	19.7	64.0	2,054	530.93	OK
21-Apr-12	21.90	10.65	11.25	45.65	10.65	46.26	OK	83.46	82.94	82.11	1.60	82.88	OK	OK	19.1	62.3	2,035	526.01	OK
22-Apr-12	17.90	10.65	7.25	17.75	10.65	14.36	OK	18.76	18.24	17.41	0.50	17.08	OK	OK	3.1	9.7	1,060	274.10	OK
23-Apr-12	16.90	10.65	6.25	47.85	10.65	43.46	OK	90.26	89.74	88.91	2.20	90.28	OK	OK	25.8	84.5	2,264	585.29	OK
24-Apr-12	16.20	10.65	5.55	101.95	10.65	96.86	OK	218.46	217.94	217.11	5.40	221.68	OK	OK	135.8	456.9	4,087	1,056.49	OK
25-Apr-12	13.90	10.65	3.25	69.75	10.65	62.36	OK	143.16	142.64	141.81	3.60	144.58	OK	OK	64.8	215.1	3,140	811.67	OK
26-Apr-12	12.20	10.65	1.55	10.45	10.65	1.36	OK	13.06	12.54	11.71	0.80	11.68	OK	OK	2.6	8.0	994	256.87	OK
27-Apr-12	11.00	10.65	0.35	7.75	10.65	-	Fail	7.40	6.87	6.05	0.20	5.42	OK	Fail	1.6	5.1	850	219.75	OK
28-Apr-12	10.90	10.65	0.25	11.35	10.65	0.96	OK	17.86	17.34	16.51	9.50	25.18	OK	OK	3.6	11.4	1,124	290.69	OK
29-Apr-12	65.50	10.65	54.85	82.65	10.65	126.86	OK	148.96	148.44	147.61	9.50	156.28	OK	OK	33.3	109.4	2,478	640.68	OK
30-Apr-12	98.90	10.65	88.25	127.05	10.65	204.66	OK	217.36	216.84	216.01	0.90	216.08	OK	OK	65.5	217.7	3,152	815.01	OK
01-May-12	46.50	10.65	35.85	53.95	10.65	79.16	OK	86.66	86.14	85.31	2.10	86.58	OK	OK	15.7	51.0	1,897	490.48	OK
02-May-12	20.50	10.65	9.85	18.55	10.65	17.76	OK	22.26	21.74	20.91	2.00	22.08	OK	OK	3.5	11.0	1,108	286.39	OK
03-May-12	25.40	10.65	14.75	25.15	10.65	29.26	OK	31.46	30.94	30.11	-	29.28	OK	OK	5.0	15.8	1,259	325.38	OK
04-May-12	23.00	10.65	12.35	21.75	10.65	23.46	OK	34.16	33.64	32.81	7.60	39.58	OK	OK	4.9	15.5	1,251	323.44	OK
05-May-12	82.70	10.65	72.05	102.55	10.65	163.96	OK	180.06	179.54	178.71	7.60	185.48	OK	OK	46.9	154.8	2,798	723.37	OK
06-May-12	83.10	10.65	72.45	102.05	10.65	163.86	OK	197.66	197.14	196.31	22.80	218.28	OK	OK	52.3	173.1	2,910	752.26	OK
07-May-12	19.90	10.65	9.25	15.95	10.65	14.56	OK	42.16	41.64	40.81	22.80	62.78	OK	OK	7.8	25.1	1,480	382.54	OK
08-May-12	19.40	10.65	8.75	63.95	10.65	62.06	OK	128.56	128.04	127.21	3.00	129.38	OK	OK	46.6	154.0	2,793	721.97	OK
09-May-12	19.40	10.65	8.75	63.85	10.65	61.96	OK	128.36	127.84	127.01	3.00	129.18	OK	OK	46.5	153.5	2,790	721.21	OK
10-May-12	38.60	10.65	27.95	41.25	10.65	58.56	OK	65.06	64.54	63.71	-	62.88	OK	OK	10.8	34.6	1,657	428.33	OK
11-May-12	49.00	10.65	38.35	72.75	10.65	100.46	OK	130.86	130.34	129.51	1.10	129.78	OK	OK	27.8	90.9	2,323	600.49	OK
12-May-12	64.40	10.65	53.75	97.55	10.65	140.66	OK	177.46	176.94	176.11	1.30	176.58	OK	OK	44.5	147.0	2,748	710.35	OK
13-May-12	75.60	10.65	64.95	94.35	10.65	148.66	OK	161.56	161.04	160.21	0.30	159.68	OK	OK	39.7	130.8	2,638	681.99	OK
14-May-12	48.30	10.65	37.65	52.35	10.65	79.36	OK	85.46	84.94	84.11	-	83.28	OK	OK	15.9	51.5	1,903	491.98	OK
15-May-12	29.50	0.87	28.63	36.43	0.87	64.18	OK	68.68	68.16	68.16	-	67.33	OK	OK	6.1	19.6	1,356	350.69	OK
16-May-12	55.00	0.87	54.13	71.23	0.87	124.48	OK	134.98	134.46	134.46	3.80	137.43	OK	OK	20.8	67.8	2,096	541.83	OK
17-May-12	146.50	0.87	145.63	195.93	0.87	340.68	OK	363.78	363.26	363.26	7.60	370.03	OK	OK	134.9	453.9	4,077	1,054.04	OK
18-May-12	135.90	0.87	135.03	180.23	0.87	314.38	OK	330.98	330.46	330.46	3.80	333.43	OK	OK	115.1	386.0	3,852	995.92	OK
19-May-12	45.10	0.87	44.23	56.03	0.87	99.36	OK	105.48	104.96	104.96	-	104.13	OK	OK	13.6	44.1	1,803	466.20	OK
20-May-12	27.60	0.87	26.73	32.53	0.87	58.38	OK	61.78	61.26	61.26	-	60.43	OK	OK	5.2	16.6	1,281	331.15	OK
21-May-12	27.30	0.87	26.43	32.13	0.87	57.68	OK	60.28	59.76	59.76	-	58.93	OK	OK	5.1	16.1	1,268	327.85	OK
22-May-12	30.70	0.87	29.83	37.23	0.87	66.18	OK	92.98	92.46	92.46	20.50	112.13	OK	OK	11.0	35.4	1,669	431.53	OK
23-May-12	26.80	0.87	25.93	33.23	0.87	58.28	OK	91.38	90.86	90.86	26.30	116.33	OK	OK	11.9	38.4	1,717	443.90	OK
24-May-12	23.20	0.87	22.33	36.63	0.87	58.08	OK	105.18	104.66	104.66	29.30	133.13	OK	OK	18.4	59.7	2,004	518.22	OK
25-May-12	22.80	0.87	21.93	36.23	0.87	57.28	OK	119.48	118.96	118.96	42.40	160.53	OK	OK	27.6	90.4	2,318	599.25	OK
26-May-12	22.80	0.87	21.93	27.33	0.87	48.38	OK	71.18	70.66	70.66	18.80	88.63	OK	OK	7.0	22.4	1,422	367.70	OK
27-May-12	22.30	0.87	21.43	29.53	0.87	50.08	OK	63.38	62.86	62.86	7.90	69.93	OK	OK	4.9	15.7	1,257	324.86	OK
28-May-12	214.90	0.87	214.03	291.33	0.87	504.48	OK	548.08	547.56	547.56	17.60	564.33	OK	OK	286.7	977.0	5,332	1,378.47	OK
29-May-12	221.80	0.87	220.93	295.43	0.87	515.48	OK	546.18	545.66	545.66	9.70	554.53	OK	OK	293.6	1,001.0	5,377	1,390.19	OK
30-May-12	80.10	0.87	79.23	101.53	0.87	179.88	OK	208.98	208.46	208.46	20.80	228.43	OK	OK	45.5	150.4	2,770	716.10	OK
31-May-12	80.00	0.87	79.13	101.43	0.87	179.68	OK	213.38	212.86	212.86	24.70	236.73	OK	OK	47.2	155.9	2,805	725.20	OK
01-Jun-12	33.20	0.87	32.33	37.43	0.87	68.88	OK	74.98	74.46	74.46	4.20	77.83	OK	OK	7.4	23.7	1,450	374.98	OK
02-Jun-12	32.10	0.87	31.23	36.23	0.87	66.58	OK	67.78	67.26	67.26	0.10	66.53	OK	OK	6.7	21.4	1,400	361.93	OK
03-Jun-12	28.30	0.87	27.43	115.03	0.87	141.58	OK	254.38	253.86	253.86	5.10	258.13	OK	OK	119.6	401.4	3,905	1,009.69	OK
04-Jun-12	22.60	0.87	21.73	109.33	0.87	130.18	OK	242.78	242.26	242.26	5.10	246.53	OK	OK	117.6	394.5	3,882	1,003.60	OK
05-Jun-12	23.10	0.87	22.23	27.13	0.87	48.48	OK	88.78	88.26	88.26	34.10	121.53	OK	OK	13.7	44.2	1,905	466.52	OK
06-Jun-12	22.80	0.87	21.93	26.73	0.87	47.78	OK	97.08	96.56	96.56	41.90	137.63	OK	OK	18.2	59.3	2,000	517.05	OK
07-Jun-12	22.80	0.87	21.93	36.33	0.87	57.38	OK	95.78	95.26	95.26	22.10	116.53	OK	OK	13.9	45.1	1,817	469.80	OK
08-Jun-12	22.60	0.87	21.73	36.13	0.87	56.98	OK	88.48	87.96	87.96	16.20	103.33	OK	OK	11.0	35.5	1,671	432.09	OK
09-Jun-12	22.30	0.87	21.43	26.13	0.87	46.68	OK	57.18	56.66	56.66	4.10	59.93	OK	OK	4.2	13.3	1,185	306.47	OK
10-Jun-12	22.30	0.87	21.43	26.03	0.87	46.58	OK	54.48	53.96	53.96	2.00	55.13	OK	OK	3.9	12.2	1,151	297.62	OK
11-Jun-12	44.10	0.87	43.23	55.53	0.87	97.88	OK	104.08	103.56	103.56	-	102.73	OK	OK	13.2	42.7	1,783	460.93	OK
12-Jun-12	44.90	0.87	44.03	56.83	0.87	99.98	OK	105.88	105.36	105.36	-	104.53	OK	OK	13.7	44.3	1,805	466.69	OK
13-Jun-12	23.70	0.87	22.83	30.33	0.87	52.28	OK	58.78	58.26	58.26	0.20	57.63	OK	OK	4.4	13.9	1,203	310.96	OK
14-Jun-12	19.70	0.87	18.83	25.73	0.87	43.68	OK	48.78	48.26	48.26	0.20	47.63	OK	OK	3.1	9.8	1,066	275.64	OK
15-Jun-12	7.60	0.87	6.73	11.13	0.87	16.96	OK	18.28	17.76	17.76	-	16.93	OK	OK	0.6	1.8	-	-	OK
16-Jun-12	10.10	0.87	9.23	13.53	0.87	21.88	OK	22.88	22.36	22.36	-	21.53	OK	OK	0.9	2.7	-	-	OK
17-Jun-12	6.00	0.87	5.13	13.33	0.87	17.58	OK	23.58	23.06	23.06	0.20	22.43	OK	OK	1.0	3.2	-	-	OK
18-Jun-12	7.10	0.87	6.23	14.33	0.87	19.68	OK	25.48	24.96	24.96	0.20	24.33	OK	OK	1.1	3.4	-	-	OK
19-Jun-12	11.60	0.87	10.73	16.63	0.87	26.48	OK	27.38	26.86	26.86	-	26.03	OK	OK	1.2	3.7	-	-	OK
20-Jun-12	84.80	0.87	83.93	135.73	0.87	218.78	OK	253.58	253.06	253.06	1.20	253.43	OK	OK	64.8	215.4	3,141	811.95	OK
21-Jun-12	85.40	0.87	84.53	135.43	0.87	219.08	OK	253.58	253.06	253.06	1.20	253.43	OK	OK	64.7	215.0	3,139	811.52	OK
22-Jun-12	15.50	0.87	14.63	19.53	0.87	33.28	OK	36.68	36.16	36.16	-	35.33	OK	OK	1.9	6.0	894	231.26	OK
23-Jun-12	12.60	0.87	11.73	15.73	0.87	26.58	OK	28.98	28.46	28.46	-	27.63	OK	OK	1.3	3.9	-	-	OK

24-Jun-12	12.70	0.87	11.83	15.83	0.87	26.78	OK	28.58	28.06	28.06	-	27.23	OK	OK	1.3	3.9	-	-	OK
25-Jun-12	12.60	0.87	11.73	15.63	0.87	26.48	OK	27.78	27.26	27.26	-	26.43	OK	OK	1.2	3.8	-	-	OK
26-Jun-12	12.50	0.87	11.63	15.53	0.87	26.28	OK	27.28	26.76	26.76	-	25.93	OK	OK	1.2	3.8	-	-	OK
27-Jun-12	36.80	0.87	35.93	48.43	0.87	83.48	OK	86.48	85.96	85.96	-	85.13	OK	OK	9.6	30.8	1,590	411.03	OK
28-Jun-12	37.30	0.87	36.43	48.83	0.87	84.38	OK	87.18	86.66	86.66	-	85.83	OK	OK	9.8	31.4	1,601	413.97	OK
29-Jun-12	12.30	0.87	11.43	15.23	0.87	25.78	OK	26.18	25.66	25.66	-	24.83	OK	OK	1.2	3.6	-	-	OK
30-Jun-12	12.50	0.87	11.63	15.33	0.87	26.08	OK	26.38	25.86	25.86	-	25.03	OK	OK	1.2	3.7	-	-	OK
01-Jul-12	12.40	0.87	11.53	15.23	0.87	25.88	OK	39.78	39.26	39.26	11.80	50.23	OK	OK	2.5	7.9	985	254.77	OK
02-Jul-12	12.30	0.87	11.43	15.13	0.87	25.68	OK	39.58	39.06	39.06	11.80	50.03	OK	OK	2.5	7.8	983	254.17	OK
03-Jul-12	12.30	0.87	11.43	16.93	0.87	27.48	OK	30.28	29.76	29.76	1.10	30.03	OK	OK	1.3	4.2	-	-	OK
04-Jul-12	12.20	0.87	11.33	16.83	0.87	27.28	OK	29.98	29.46	29.46	0.40	29.03	OK	OK	1.3	4.1	-	-	OK
05-Jul-12	12.20	0.87	11.33	14.83	0.87	25.28	OK	25.38	24.86	24.86	0.10	24.13	OK	OK	1.1	3.5	-	-	OK
06-Jul-12	12.00	0.87	11.13	14.63	0.87	24.88	OK	24.98	24.46	24.46	-	23.63	OK	OK	1.1	3.4	-	-	OK
07-Jul-12	10.20	0.87	9.33	12.83	0.87	21.28	OK	30.48	29.96	29.96	7.80	36.93	OK	OK	1.4	4.5	-	-	OK
08-Jul-12	8.10	0.87	7.23	11.53	0.87	17.88	OK	40.98	40.46	40.46	19.60	59.23	OK	OK	4.1	13.0	1,175	303.75	OK
09-Jul-12	99.40	0.87	98.53	134.63	0.87	232.28	OK	254.58	254.06	254.06	11.80	265.03	OK	OK	67.0	222.7	3,178	821.49	OK
10-Jul-12	100.30	0.87	99.43	134.63	0.87	233.18	OK	242.08	241.56	241.56	1.70	242.43	OK	OK	64.9	215.6	3,142	812.21	OK
11-Jul-12	13.10	0.87	12.23	15.53	0.87	26.88	OK	29.08	28.56	28.56	0.80	28.53	OK	OK	1.3	4.1	-	-	OK
12-Jul-12	12.50	0.87	11.63	14.93	0.87	25.68	OK	26.88	26.36	26.36	0.10	25.63	OK	OK	1.2	3.7	-	-	OK
13-Jul-12	12.60	0.87	11.73	14.93	0.87	25.78	OK	26.68	26.16	26.16	-	25.33	OK	OK	1.2	3.7	-	-	OK
14-Jul-12	12.00	0.87	11.13	28.23	0.87	38.48	OK	62.38	61.86	61.86	4.80	65.83	OK	OK	6.7	21.3	1,398	361.47	OK
15-Jul-12	10.50	0.87	9.63	33.53	0.87	42.28	OK	89.28	88.76	88.76	9.60	97.53	OK	OK	17.9	58.1	1,986	513.45	OK
16-Jul-12	10.90	0.87	10.03	20.13	0.87	29.28	OK	52.88	52.36	52.36	4.80	56.33	OK	OK	5.2	16.5	1,277	330.23	OK
17-Jul-12	13.10	0.87	12.23	33.13	0.87	44.48	OK	67.78	67.26	67.26	1.00	67.43	OK	OK	7.6	24.3	1,464	378.44	OK
18-Jul-12	13.20	0.87	12.33	33.43	0.87	44.88	OK	68.48	67.96	67.96	1.10	68.23	OK	OK	7.7	24.8	1,474	381.20	OK
19-Jul-12	10.80	0.87	9.93	13.23	0.87	22.28	OK	26.78	26.26	26.26	0.30	25.73	OK	OK	1.1	3.3	-	-	OK
20-Jul-12	10.70	0.87	9.83	20.63	0.87	29.58	OK	43.08	42.56	42.56	0.60	42.33	OK	OK	2.9	9.1	1,037	267.97	OK
21-Jul-12	13.10	0.87	12.23	23.83	0.87	35.18	OK	48.18	47.66	47.66	0.50	47.33	OK	OK	3.3	10.4	1,087	280.98	OK
22-Jul-12	25.40	0.87	24.53	32.63	0.87	56.28	OK	60.78	60.26	60.26	-	59.43	OK	OK	4.8	15.2	1,243	321.30	OK
23-Jul-12	23.50	0.87	22.63	29.83	0.87	51.56	OK	55.08	54.56	54.56	-	53.73	OK	OK	4.1	12.9	1,172	303.06	OK
24-Jul-12	11.60	0.87	10.73	13.63	0.87	23.48	OK	25.28	24.76	24.76	-	23.93	OK	OK	1.0	3.2	-	-	OK
25-Jul-12	11.40	0.87	10.53	13.93	0.87	23.58	OK	25.68	25.16	25.16	-	24.33	OK	OK	1.0	3.2	-	-	OK
26-Jul-12	9.50	0.87	8.63	12.03	0.87	19.78	OK	21.48	20.96	20.96	-	20.13	OK	OK	0.8	2.3	-	-	OK
27-Jul-12	4.00	0.87	3.13	5.93	0.87	8.18	OK	8.88	8.36	8.36	-	7.53	OK	OK	0.2	0.6	-	-	OK
28-Jul-12	5.50	0.87	4.63	7.43	0.87	11.18	OK	11.78	11.26	11.26	-	10.43	OK	OK	0.3	0.9	-	-	OK
29-Jul-12	5.00	0.87	4.13	6.83	0.87	10.08	OK	10.48	9.96	9.96	-	9.13	OK	OK	0.3	0.8	-	-	OK
30-Jul-12	5.10	0.87	4.23	6.93	0.87	10.28	OK	10.58	10.06	10.06	-	9.23	OK	OK	0.3	0.8	-	-	OK
31-Jul-12	5.00	0.87	4.13	6.83	0.87	10.08	OK	10.28	9.76	9.76	-	8.93	OK	OK	0.2	0.8	-	-	OK
01-Aug-12	22.00	0.87	21.13	29.83	0.87	50.06	OK	51.88	51.36	51.36	-	50.53	OK	OK	3.7	11.8	1,138	294.13	OK
02-Aug-12	22.70	0.87	21.83	30.53	0.87	51.48	OK	53.18	52.66	52.66	-	51.83	OK	OK	3.9	12.5	1,158	299.40	OK
03-Aug-12	6.10	0.87	5.23	8.13	0.87	12.48	OK	12.98	12.46	12.46	-	11.63	OK	OK	0.3	1.1	-	-	OK
04-Aug-12	13.10	0.87	12.23	23.43	0.87	34.78	OK	43.78	43.26	43.26	0.40	42.83	OK	OK	2.6	8.3	1,005	259.91	OK
05-Aug-12	13.40	0.87	12.53	23.43	0.87	35.08	OK	43.68	43.16	43.16	0.40	42.73	OK	OK	2.6	8.2	1,000	258.50	OK
06-Aug-12	35.50	0.87	34.63	47.43	0.87	81.18	OK	83.98	83.46	83.46	-	82.63	OK	OK	9.1	29.1	1,559	403.02	OK
07-Aug-12	39.00	0.87	38.13	51.83	0.87	89.08	OK	92.08	91.56	91.56	-	90.73	OK	OK	10.8	34.7	1,657	428.50	OK
08-Aug-12	12.80	0.87	11.93	16.13	0.87	27.18	OK	28.08	27.56	27.56	-	26.73	OK	OK	1.3	4.0	-	-	OK
09-Aug-12	9.60	0.87	8.73	20.33	0.87	28.18	OK	39.98	39.46	39.46	0.50	39.13	OK	OK	2.6	8.1	995	257.19	OK
10-Aug-12	7.50	0.87	6.63	17.33	0.87	23.08	OK	34.58	34.06	34.06	0.50	33.73	OK	OK	2.1	6.7	933	241.12	OK
11-Aug-12	36.60	0.87	35.73	48.43	0.87	83.28	OK	86.18	85.66	85.66	-	84.83	OK	OK	9.5	30.6	1,586	410.14	OK
12-Aug-12	137.70	0.87	136.83	184.93	0.87	320.88	OK	332.98	332.46	332.46	-	331.63	OK	OK	118.3	397.1	3,891	1,005.91	OK
13-Aug-12	120.80	0.87	119.93	160.23	0.87	279.28	OK	289.28	288.76	288.76	-	287.93	OK	OK	91.3	305.0	3,547	917.10	OK
14-Aug-12	65.50	0.87	64.63	84.23	0.87	147.98	OK	152.58	152.06	152.06	-	151.23	OK	OK	27.9	91.3	2,326	601.35	OK
15-Aug-12	91.20	0.87	90.33	118.53	0.87	207.98	OK	230.78	230.26	230.26	13.80	243.23	OK	OK	55.7	184.5	2,975	769.24	OK
16-Aug-12	59.80	0.87	58.93	75.03	0.87	133.08	OK	152.68	152.16	152.16	13.80	165.13	OK	OK	25.5	83.3	2,252	582.30	OK
17-Aug-12	33.90	0.87	33.03	39.63	0.87	71.78	OK	73.98	73.46	73.46	-	72.63	OK	OK	7.6	24.2	1,462	377.98	OK
18-Aug-12	31.70	0.87	30.83	39.83	0.87	69.78	OK	76.88	76.36	76.36	0.30	75.83	OK	OK	7.3	23.3	1,443	373.05	OK
19-Aug-12	30.80	0.87	29.93	48.83	0.87	77.86	OK	98.28	97.76	97.76	0.90	97.83	OK	OK	11.1	35.9	1,677	433.57	OK
20-Aug-12	31.30	0.87	30.43	46.33	0.87	75.88	OK	107.98	107.46	107.46	14.50	121.13	OK	OK	14.4	46.6	1,838	475.25	OK
21-Aug-12	33.70	0.87	32.83	58.93	0.87	90.88	OK	135.78	135.26	135.26	15.00	149.43	OK	OK	23.8	77.7	2,198	568.35	OK
22-Aug-12	31.40	0.87	30.53	56.63	0.87	86.28	OK	158.28	157.76	157.76	37.80	194.73	OK	OK	40.8	134.3	2,662	688.29	OK
23-Aug-12	23.80	0.87	22.93	26.93	0.87	48.98	OK	94.08	93.56	93.56	36.60	129.33	OK	OK	16.2	52.5	1,917	495.60	OK
24-Aug-12	21.80	0.87	20.93	34.63	0.87	54.68	OK	70.58	70.06	70.06	3.40	72.63	OK	OK	6.1	19.5	1,355	350.34	OK
25-Aug-12	22.10	0.87	21.23	126.73	0.87	147.08	OK	287.68	287.16	287.16	8.20	294.53	OK	OK	172.9	584.3	4,454	1,151.43	OK
26-Aug-12	24.20	0.87	23.33	118.83	0.87	141.28	OK	267.38	266.86	266.86	7.00	273.03	OK	OK	142.7	480.6	4,160	1,075.38	OK
27-Aug-12	41.40	0.87	40.53	50.33	0.87	89.98	OK	103.78	103.26	103.26	4.10	106.53	OK	OK	12.5	40.4	1,749	452.21	OK

28-Aug-12	65.90	0.87	65.03	84.83	0.87	148.98	OK	166.48	165.96	165.96	5.10	170.23	OK	OK	30.1	98.8	2,391	618.06	OK
29-Aug-12	75.90	0.87	75.03	99.13	0.87	173.28	OK	187.28	186.76	186.76	2.10	188.03	OK	OK	38.4	126.5	2,607	674.04	OK
30-Aug-12	47.60	0.87	46.73	66.03	0.87	111.88	OK	126.88	126.36	126.36	1.40	126.93	OK	OK	17.7	57.6	1,980	511.84	OK
31-Aug-12	21.90	0.87	21.03	30.83	0.87	50.98	OK	62.18	61.66	61.66	0.40	61.23	OK	OK	4.7	14.9	1,234	319.10	OK
01-Sep-12	15.90	10.65	5.25	12.85	10.65	7.46	OK	15.86	15.34	14.51	0.10	13.78	OK	OK	2.6	8.3	1,005	259.81	OK
02-Sep-12	12.30	10.65	1.65	80.75	10.65	71.76	OK	175.56	175.04	174.21	4.50	177.88	OK	OK	97.5	326.1	3,631	938.83	OK
03-Sep-12	18.80	10.65	8.15	121.75	10.65	119.26	OK	265.36	264.84	264.01	6.50	269.68	OK	OK	189.6	641.6	4,602	1,189.79	OK
04-Sep-12	18.80	10.65	8.15	51.45	10.65	48.96	OK	99.56	99.04	98.21	2.40	99.78	OK	OK	29.2	95.8	2,366	611.59	OK
05-Sep-12	11.90	10.65	1.25	14.45	10.65	5.06	OK	37.16	36.64	35.81	17.80	52.78	OK	OK	8.7	27.9	1,535	396.95	OK
06-Sep-12	11.50	10.65	0.85	14.45	10.65	4.66	OK	36.96	36.44	35.61	17.80	52.58	OK	OK	8.8	28.2	1,541	398.33	OK
07-Sep-12	11.20	10.65	0.55	11.85	10.65	1.76	OK	14.96	14.44	13.61	3.00	15.78	OK	OK	3.0	9.4	1,048	271.06	OK
08-Sep-12	10.70	10.65	0.05	10.85	10.65	0.26	OK	7.36	6.84	6.01	0.80	5.98	OK	OK	2.0	6.2	910	235.19	OK
09-Sep-12	10.80	10.65	0.15	5.85	10.65	-	Fail	5.30	4.77	3.95	0.30	3.42	OK	Fail	1.3	4.0	-	-	OK
10-Sep-12	10.70	10.65	0.05	5.65	10.65	-	Fail	4.00	3.47	2.65	0.10	1.92	OK	Fail	1.2	3.6	-	-	OK
11-Sep-12	10.70	10.65	0.05	5.55	10.65	-	Fail	3.00	2.47	1.65	-	0.82	OK	Fail	1.1	3.4	-	-	OK
12-Sep-12	10.60	10.65	-	5.50	10.65	-	Fail	2.20	1.67	0.85	-	0.02	OK	Fail	1.1	3.3	-	-	OK
13-Sep-12	10.00	10.65	-	5.70	10.65	-	Fail	2.10	1.57	0.75	-	-	Fail	Fail	1.0	3.1	-	-	OK
14-Sep-12	25.50	10.65	14.85	26.55	10.65	30.76	OK	33.96	33.44	32.61	-	31.78	OK	OK	5.2	16.6	1,282	331.44	OK
15-Sep-12	60.90	10.65	50.25	74.65	10.65	114.26	OK	124.76	124.24	123.41	4.00	126.58	OK	OK	26.6	86.9	2,286	591.02	OK
16-Sep-12	46.80	10.65	36.15	55.25	10.65	80.76	OK	89.66	89.14	88.31	4.00	91.48	OK	OK	16.3	52.8	1,921	496.56	OK
17-Sep-12	11.40	10.65	0.75	11.55	10.65	1.66	OK	2.66	2.14	1.31	-	0.48	OK	OK	1.7	5.4	866	223.90	OK
18-Sep-12	8.60	10.65	-	5.10	10.65	-	Fail	0.60	0.07	-	-	-	Fail	Fail	0.7	2.3	-	-	OK
19-Sep-12	8.70	10.65	-	5.30	10.65	-	Fail	0.80	0.27	-	-	-	Fail	Fail	0.8	2.3	-	-	OK
20-Sep-12	8.40	10.65	-	5.30	10.65	-	Fail	0.70	0.17	-	-	-	Fail	Fail	0.7	2.2	-	-	OK
21-Sep-12	8.00	10.65	-	5.00	10.65	-	Fail	0.30	-	-	-	-	Fail	Fail	0.7	2.0	-	-	Fail
22-Sep-12	8.10	10.65	-	4.90	10.65	-	Fail	0.20	-	-	-	-	Fail	Fail	0.7	2.0	-	-	Fail
23-Sep-12	8.00	10.65	-	4.90	10.65	-	Fail	0.10	-	-	-	-	Fail	Fail	0.6	2.0	-	-	Fail
24-Sep-12	7.90	10.65	-	4.80	10.65	-	Fail	0.10	-	-	-	-	Fail	Fail	0.6	1.9	-	-	Fail
25-Sep-12	7.90	10.65	-	6.20	10.65	-	Fail	121.60	121.07	120.25	104.00	223.42	OK	Fail	82.3	274.5	3,419	883.97	OK
26-Sep-12	7.90	10.65	-	6.10	10.65	-	Fail	146.10	145.57	144.75	125.40	269.32	OK	Fail	116.3	390.3	3,867	999.84	OK
27-Sep-12	7.80	10.65	-	4.70	10.65	-	Fail	38.40	37.87	37.05	33.40	69.62	OK	Fail	9.7	31.3	1,600	413.54	OK
28-Sep-12	7.80	10.65	-	4.60	10.65	-	Fail	11.60	11.07	10.25	14.00	23.42	OK	Fail	1.5	4.8	-	-	OK
29-Sep-12	7.70	10.65	-	4.60	10.65	-	Fail	11.30	10.77	9.95	4.40	13.52	OK	Fail	1.5	4.6	-	-	OK
30-Sep-12	10.70	10.65	0.05	24.35	10.65	13.76	OK	47.16	46.64	45.81	1.90	46.88	OK	OK	11.6	37.5	1,704	440.59	OK
01-Oct-12	10.80	10.65	0.15	25.25	10.65	14.76	OK	47.56	47.04	46.21	1.50	46.88	OK	OK	11.7	37.6	1,705	440.86	OK
02-Oct-12	5.50	10.65	-	5.30	10.65	-	Fail	12.60	12.07	11.25	0.40	10.82	OK	Fail	1.5	4.8	-	-	OK
03-Oct-12	3.40	10.65	-	4.40	10.65	-	Fail	9.10	8.57	7.75	0.10	7.02	OK	Fail	0.8	2.6	-	-	OK
04-Oct-12	3.80	10.65	-	26.70	10.65	16.05	Fail	52.85	52.33	51.50	1.40	52.07	OK	Fail	13.1	42.4	1,778	459.68	OK
05-Oct-12	3.70	10.65	-	70.00	10.65	59.35	Fail	152.65	152.13	151.30	4.10	154.57	OK	Fail	78.0	259.9	3,354	867.18	OK
06-Oct-12	47.60	10.65	36.95	101.55	10.65	127.86	OK	195.86	195.34	194.51	2.80	196.48	OK	OK	65.3	216.9	3,149	814.05	OK
07-Oct-12	49.40	10.65	38.75	59.95	10.65	88.06	OK	97.36	96.84	96.01	0.40	95.58	OK	OK	18.3	59.5	2,002	517.65	OK
08-Oct-12	6.80	10.65	-	4.10	10.65	-	Fail	2.50	1.97	1.15	0.10	0.42	OK	Fail	0.5	1.6	-	-	OK
09-Oct-12	6.40	10.65	-	4.10	10.65	-	Fail	2.40	1.87	1.05	0.50	0.72	OK	Fail	0.5	1.5	-	-	OK
10-Oct-12	12.10	10.65	1.45	14.15	10.65	4.96	OK	18.56	18.04	17.21	1.00	17.38	OK	OK	3.4	4.9	-	-	OK
11-Oct-12	16.80	10.65	6.15	19.05	10.65	14.56	OK	27.66	27.14	26.31	0.60	26.08	OK	OK	4.2	13.4	1,189	307.34	OK
12-Oct-12	21.40	10.65	10.75	40.15	10.65	40.26	OK	75.26	74.74	73.91	1.60	74.68	OK	OK	16.2	52.4	1,915	495.19	OK
13-Oct-12	24.30	10.65	13.65	44.65	10.65	47.66	OK	84.66	84.14	83.31	1.70	84.18	OK	OK	18.4	59.9	2,007	518.77	OK
14-Oct-12	55.20	10.65	44.55	67.75	10.65	101.66	OK	109.26	108.74	107.91	0.20	107.28	OK	OK	22.1	72.1	2,142	553.74	OK
15-Oct-12	84.10	10.65	73.45	104.25	10.65	167.06	OK	287.26	286.74	285.91	98.60	383.68	OK	OK	126.3	424.3	3,982	1,029.49	OK
16-Oct-12	37.80	10.65	27.15	50.85	10.65	67.36	OK	139.96	139.44	138.61	118.80	256.58	OK	OK	43.1	142.3	2,717	702.32	OK
17-Oct-12	11.40	10.65	0.75	14.85	10.65	4.96	OK	43.16	42.64	41.81	21.70	62.68	OK	OK	11.3	36.5	1,687	436.12	OK
18-Oct-12	35.70	10.65	25.05	37.45	10.65	51.86	OK	76.06	75.54	74.71	19.10	92.98	OK	OK	12.8	41.4	1,764	455.94	OK
19-Oct-12	36.70	10.65	26.05	38.75	10.65	54.16	OK	76.96	76.44	75.61	17.60	92.38	OK	OK	12.9	41.6	1,767	456.84	OK
20-Oct-12	13.00	10.65	2.35	49.65	10.65	41.36	OK	101.16	100.64	99.81	5.90	104.88	OK	OK	35.9	118.1	2,545	658.01	OK
21-Oct-12	12.80	10.65	2.15	49.15	10.65	40.66	OK	108.16	107.64	106.81	11.40	117.38	OK	OK	41.2	135.8	2,673	690.96	OK
22-Oct-12	12.80	10.65	2.15	11.05	10.65	2.56	OK	17.26	16.74	15.91	7.30	22.38	OK	OK	3.2	10.0	1,073	277.42	OK
23-Oct-12	73.00	10.65	62.35	88.35	10.65	140.06	OK	151.06	150.54	149.71	2.20	151.08	OK	OK	36.1	118.9	2,551	659.49	OK
24-Oct-12	138.80	10.65	128.15	176.95	10.65	294.46	OK	314.16	313.64	312.81	4.70	316.68	OK	OK	121.8	409.1	3,932	1,016.45	OK
25-Oct-12	146.70	10.65	136.05	185.75	10.65	311.16	OK	334.86	334.34	333.51	8.20	340.88	OK	OK	135.1	454.3	4,078	1,054.41	OK
26-Oct-12	153.20	10.65	142.55	193.05	10.65	324.96	OK	347.06	346.54	345.71	7.10	351.98	OK	OK	145.1	488.6	4,184	1,081.58	OK
27-Oct-12	94.10	10.65	83.45	111.25	10.65	184.06	OK	220.46	219.94	219.11	25.10	243.38	OK	OK	63.3	210.2	3,114	805.14	OK
28-Oct-12	27.40	10.65	16.75	20.05	10.65	26.16	OK	53.56	53.04	52.21	23.10	74.48	OK	OK	9.7	31.2	1,597	412.97	OK
29-Oct-12	78.50	10.65	67.85	89.45	10.65	146.66	OK	160.16	159.64	158.81	6.60	164.58	OK	OK	39.8	131.2	2,641	682.71	OK
30-Oct-12	80.60	10.65	69.95	91.95	10.65	151.26	OK	196.06	195.54	194.71	31.40	225.28	OK	OK	52.8	174.6	2,918	754.51	OK
31-Oct-12	29.80	10.65	19.15	24.25	10.65	32.76	OK	73.26	72.74	71.91	30.30	101.38	OK	OK	15.9	51.7	1,906	492.78	OK

01-Nov-12	25.90	10.65	15.25	19.85	10.65	24.46	OK	38.76	38.24	37.41	8.10	44.68	OK	OK	5.9	18.8	1,337	345.54	OK
02-Nov-12	25.20	10.65	14.55	17.75	10.65	21.66	OK	185.46	184.94	184.11	139.60	322.88	OK	OK	147.8	498.1	4,212	1,088.88	OK
03-Nov-12	25.30	10.65	14.65	17.75	10.65	21.76	OK	180.46	179.94	179.11	135.60	313.88	OK	OK	139.5	469.5	4,125	1,066.57	OK
04-Nov-12	24.80	10.65	14.15	17.25	10.65	20.76	OK	24.56	24.04	23.21	0.10	22.48	OK	OK	4.2	13.2	1,182	305.69	OK
05-Nov-12	23.30	10.65	12.65	16.25	10.65	18.26	OK	91.86	91.34	90.51	61.70	151.38	OK	OK	35.1	115.3	2,523	652.40	OK
06-Nov-12	23.70	10.65	13.05	22.25	10.65	24.66	OK	105.06	104.54	103.71	62.10	164.98	OK	OK	41.4	136.6	2,678	692.30	OK
07-Nov-12	23.50	10.65	12.85	21.45	10.65	23.66	OK	32.76	32.24	31.41	5.50	36.08	OK	OK	4.7	15.0	1,236	319.44	OK
08-Nov-12	23.50	10.65	12.85	15.85	10.65	18.06	OK	35.26	34.74	33.91	15.70	48.78	OK	OK	5.6	18.0	1,318	340.64	OK
09-Nov-12	22.30	10.65	11.65	14.55	10.65	15.56	OK	32.46	31.94	31.11	14.60	44.88	OK	OK	5.2	16.7	1,283	331.62	OK
10-Nov-12	17.20	10.65	6.55	18.15	10.65	14.06	OK	26.36	25.84	25.01	3.90	28.08	OK	OK	4.0	12.6	1,163	300.57	OK
11-Nov-12	12.90	10.65	2.25	13.85	10.65	5.46	OK	136.96	136.44	135.61	106.80	241.58	OK	OK	96.7	323.6	3,622	936.29	OK
12-Nov-12	11.50	10.65	0.85	15.75	10.65	5.96	OK	141.86	141.34	140.51	106.40	246.08	OK	OK	103.2	345.5	3,706	958.06	OK
13-Nov-12	127.60	10.65	116.95	186.95	10.65	293.26	OK	343.36	342.84	342.01	10.30	351.48	OK	OK	133.1	447.6	4,057	1,048.90	OK
14-Nov-12	305.20	10.65	294.55	413.55	10.65	697.46	OK	749.56	749.04	748.21	9.70	757.08	OK	OK	563.1	1,941.1	6,780	1,752.85	OK
15-Nov-12	295.20	10.65	284.55	385.15	10.65	659.06	OK	686.96	686.44	685.61	2.90	687.68	OK	OK	501.7	1,725.9	6,507	1,682.22	OK
16-Nov-12	225.10	10.65	214.45	326.55	10.65	530.36	OK	600.56	600.04	599.21	2.70	601.08	OK	OK	361.4	1,236.3	5,790	1,496.83	OK
17-Nov-12	129.20	10.65	118.55	193.95	10.65	301.86	OK	362.56	362.04	361.21	2.50	362.88	OK	OK	146.2	492.5	4,195	1,084.63	OK
18-Nov-12	35.80	10.65	25.15	27.85	10.65	42.36	OK	42.46	41.94	41.11	-	40.28	OK	OK	8.1	25.8	1,495	386.41	OK
19-Nov-12	35.40	10.65	24.75	28.25	10.65	42.36	OK	43.56	43.04	42.21	0.10	41.48	OK	OK	7.9	25.4	1,487	384.38	OK
20-Nov-12	35.50	10.65	24.85	28.55	10.65	42.76	OK	58.06	57.54	56.71	12.20	68.08	OK	OK	9.6	30.7	1,589	410.81	OK
21-Nov-12	35.40	10.65	24.75	30.15	10.65	44.26	OK	61.86	61.34	60.51	12.30	71.98	OK	OK	10.1	32.6	1,621	419.15	OK
22-Nov-12	35.40	10.65	24.75	29.85	10.65	43.96	OK	47.36	46.84	46.01	1.10	46.28	OK	OK	8.1	26.0	1,499	387.45	OK
23-Nov-12	35.40	10.65	24.75	54.85	10.65	68.96	OK	105.86	105.34	104.51	2.00	105.68	OK	OK	22.0	71.9	2,139	553.00	OK
24-Nov-12	35.40	10.65	24.75	59.45	10.65	73.56	OK	116.66	116.14	115.31	2.10	116.58	OK	OK	26.7	87.5	2,291	592.31	OK
25-Nov-12	35.30	10.65	24.65	42.15	10.65	56.16	OK	76.26	75.74	74.91	1.00	75.08	OK	OK	12.5	40.4	1,748	451.96	OK
26-Nov-12	81.90	10.65	71.25	136.15	10.65	196.76	OK	262.36	261.84	261.01	2.90	263.08	OK	OK	88.5	295.6	3,509	907.09	OK
27-Nov-12	140.30	10.65	129.65	286.45	10.65	405.46	OK	572.26	571.74	570.91	7.40	577.48	OK	OK	387.9	1,328.8	5,938	1,535.09	OK
28-Nov-12	146.50	10.65	135.85	277.15	10.65	402.36	OK	547.56	547.04	546.21	6.40	551.78	OK	OK	338.9	1,158.3	5,659	1,463.06	OK
29-Nov-12	150.00	10.65	139.35	271.75	10.65	400.46	OK	540.56	540.04	539.21	11.90	550.28	OK	OK	324.2	1,106.9	5,570	1,440.01	OK
30-Nov-12	102.00	10.65	91.35	222.85	10.65	303.56	OK	455.96	455.44	454.61	57.10	510.88	OK	OK	278.3	947.9	5,276	1,363.92	OK
01-Dec-12	36.10	10.65	25.45	82.95	10.65	97.76	OK	273.76	273.24	272.41	93.80	365.38	OK	OK	192.4	651.3	4,626	1,196.04	OK
02-Dec-12	47.50	10.65	36.85	70.65	10.65	96.86	OK	182.76	182.24	181.41	47.70	228.28	OK	OK	63.0	209.2	3,109	803.69	OK
03-Dec-12	67.30	10.65	56.65	96.15	10.65	142.16	OK	173.96	173.44	172.61	7.60	179.38	OK	OK	42.5	140.3	2,703	698.81	OK
04-Dec-12	56.80	10.65	46.15	81.85	10.65	117.36	OK	146.96	146.44	145.61	3.10	147.88	OK	OK	32.7	107.5	2,462	636.60	OK
05-Dec-12	108.60	10.65	97.95	201.15	10.65	288.46	OK	389.26	388.74	387.91	4.90	391.98	OK	OK	182.6	617.6	4,541	1,174.00	OK
06-Dec-12	175.40	10.65	164.75	349.65	10.65	503.76	OK	625.36	624.84	624.01	9.20	632.38	OK	OK	426.0	1,461.4	6,139	1,587.08	OK
07-Dec-12	134.30	10.65	123.65	226.75	10.65	339.76	OK	498.26	497.74	496.91	60.90	556.98	OK	OK	293.1	999.0	5,374	1,389.25	OK
08-Dec-12	58.70	10.65	48.05	108.15	10.65	145.56	OK	275.66	275.14	274.31	58.90	332.38	OK	OK	134.6	452.7	4,073	1,053.05	OK
09-Dec-12	32.10	10.65	21.45	80.85	10.65	91.66	OK	173.26	172.74	171.91	9.10	180.18	OK	OK	65.6	218.1	3,155	815.57	OK
10-Dec-12	32.10	10.65	21.45	34.85	10.65	45.66	OK	66.36	65.84	65.01	5.50	69.68	OK	OK	10.6	34.0	1,646	425.51	OK
11-Dec-12	32.10	10.65	21.45	34.65	10.65	45.46	OK	60.96	60.44	59.61	12.30	71.08	OK	OK	9.3	30.0	1,575	407.18	OK
12-Dec-12	32.00	10.65	21.35	33.85	10.65	44.56	OK	59.06	58.54	57.71	12.20	69.08	OK	OK	9.0	28.8	1,554	401.67	OK
13-Dec-12	70.40	10.65	59.75	86.25	10.65	135.36	OK	146.26	145.74	144.91	-	144.08	OK	OK	34.2	112.5	2,502	646.84	OK
14-Dec-12	97.50	10.65	86.85	187.25	10.65	263.46	OK	389.66	389.14	388.31	54.30	441.78	OK	OK	197.8	669.8	4,672	1,207.86	OK
15-Dec-12	57.00	10.65	46.35	132.55	10.65	168.26	OK	266.46	265.94	265.11	55.40	319.68	OK	OK	116.1	389.6	3,865	999.18	OK
16-Dec-12	24.80	0.87	23.93	43.53	0.87	66.58	OK	87.38	86.86	86.86	7.10	93.13	OK	OK	9.4	30.1	1,578	407.90	OK
17-Dec-12	21.90	0.87	21.03	40.53	0.87	60.68	OK	90.98	90.46	90.46	16.20	105.83	OK	OK	11.5	37.0	1,696	438.48	OK
18-Dec-12	96.50	0.87	95.63	133.73	0.87	228.48	OK	262.38	261.86	261.86	22.40	283.43	OK	OK	68.6	228.7	3,260	842.71	OK
19-Dec-12	128.30	0.87	127.43	175.93	0.87	302.48	OK	350.18	349.66	349.66	32.60	381.43	OK	OK	118.3	397.2	3,954	1,022.29	OK
20-Dec-12	105.40	0.87	104.53	144.13	0.87	247.78	OK	279.08	278.56	278.56	20.40	298.13	OK	OK	78.0	260.1	3,410	881.49	OK
21-Dec-12	76.90	0.87	76.03	104.93	0.87	180.08	OK	197.58	197.06	197.06	-	196.23	OK	OK	41.5	136.9	2,724	704.19	OK
22-Dec-12	27.20	0.87	26.33	37.63	0.87	63.08	OK	77.38	76.86	76.86	4.10	80.13	OK	OK	7.0	22.5	1,448	374.27	OK
23-Dec-12	119.40	0.87	118.53	164.83	0.87	282.48	OK	331.08	330.56	330.56	28.50	358.23	OK	OK	106.1	355.4	3,804	983.34	OK
24-Dec-12	139.00	0.87	138.13	191.33	0.87	328.58	OK	372.58	372.06	372.06	24.40	395.63	OK	OK	133.9	450.5	4,133	1,068.41	OK
25-Dec-12	75.90	0.87	75.03	121.33	0.87	195.48	OK	249.38	248.86	248.86	20.90	268.93	OK	OK	63.7	211.7	3,172	820.18	OK
26-Dec-12	87.20	0.87	86.33	136.33	0.87	221.78	OK	275.98	275.46	275.46	20.90	295.53	OK	OK	76.0	253.2	3,378	873.29	OK
27-Dec-12	62.30	0.87	61.43	84.73	0.87	145.28	OK	164.28	163.76	163.76	2.40	165.33	OK	OK	28.8	94.5	2,392	618.39	OK
28-Dec-12	80.40	0.87	79.53	111.53	0.87	190.18	OK	211.08	210.56	210.56	1.40	211.13	OK	OK	46.5	153.6	2,836	733.12	OK
29-Dec-12	79.90	0.87	79.03	110.03	0.87	188.18	OK	205.98	205.46	205.46	0.90	205.53	OK	OK	44.9	148.3	2,801	724.20	OK
30-Dec-12	41.90	0.87	41.03	53.93	0.87	94.08	OK	107.38	106.86	106.86	0.30	106.33	OK	OK	13.1	42.5	1,809	467.56	OK
31-Dec-12	36.10	0.87	35.23	59.83	0.87	94.18	OK	128.48	127.96	127.96	7.10	134.23	OK	OK	19.4	63.2	2,078	537.18	OK

Appendix 5.2

WATER BALANCE SIMULATION OF THE KRUENG ACEH CATCHMENT

LULC 2012 runs on inflow 2012 and water demand 2012 (in m^3/s)

DEMAND	Up	Down
Domestic	0.31	0.33
Non-Domestic	0.22	0.08
Water Losses	0.09	0.11
Min.Environmental Flow	1.12	0.83
Paddy Field	19.55	0.64

	Water Quantity														Water Quality at PDAM Tirta Daroy				
Date	Lampisang Sta			Darang Sta			Upstream	Pasie Sta			Sub Banda Aceh			Downstream	Upstream - Downstream	TSS (mg/l)	Turb (NTU)	Alum (kg/day)	Cost Alum (USD)	PDAM (Quantity & Quality)
	I_1	D_1	(I_1-D_1) R_1	I_2	D_2	$(R_1+I_2-D_2)$ R_2		I_3	$(R_2+I_3-D_{(D+ND+WL)})$ R_3	(R_3-D_{PF}) R_4	I_4	$(R_4+I_4-D_4)$ R_5				(R_2+I_3) = TSS (>2000) $0.000771*(R_2+I_3)^{2.899}$	Limit < 5 NTU $3.093*TSS^{1.017}$	5 NTU<Alum<2000 mg/l $1.2*(8.59*D_{(D+ND+WL)})^{0.35}$	(Alum*USD 0.259)	
RELIABILITY			**90.98%**			**92.35%**	**88.52%**		**98.91%**	**97.81%**		**97.54%**	**97.54%**	**88.52%**	**0.00%**	**11.20%**	**832,361.12**	**215,191.60**	**98.91%**
01-Jan-12	7.20	0.87	6.33	8.73	0.87	14.18	OK	23.28	22.76	22.76	2.30	24.23	OK	OK	1.0	3.2	-	-	OK
02-Jan-12	11.40	0.87	10.53	15.33	0.87	24.98	OK	33.08	32.56	32.56	0.70	32.43	OK	OK	1.6	4.9	-	-	OK
03-Jan-12	13.80	0.87	12.93	19.23	0.87	31.28	OK	38.58	38.06	38.06	0.30	37.53	OK	OK	2.0	6.2	924	238.81	OK
04-Jan-12	9.70	0.87	8.83	13.43	0.87	21.38	OK	28.18	27.66	27.66	0.80	27.63	OK	OK	1.2	3.6	-	-	OK
05-Jan-12	13.70	0.87	12.83	22.43	0.87	34.38	OK	111.68	111.16	111.16	13.00	123.33	OK	OK	36.4	119.9	2,600	672.16	OK
06-Jan-12	18.00	0.87	17.13	27.03	0.87	43.28	OK	125.28	124.76	124.76	13.40	137.33	OK	OK	41.4	136.6	2,722	703.69	OK
07-Jan-12	9.40	0.87	8.53	12.13	0.87	19.78	OK	29.18	28.66	28.66	1.30	29.13	OK	OK	1.4	4.2	-	-	OK
08-Jan-12	47.20	0.87	46.33	56.33	0.87	101.78	OK	110.88	110.36	110.36	0.40	109.93	OK	OK	14.8	48.0	1,887	487.89	OK
09-Jan-12	54.90	0.87	54.03	66.13	0.87	119.28	OK	133.08	132.56	132.56	0.80	132.53	OK	OK	20.3	66.2	2,112	546.09	OK
10-Jan-12	15.60	0.87	14.73	22.43	0.87	36.28	OK	55.48	54.96	54.96	2.60	56.73	OK	OK	4.5	14.4	1,238	319.94	OK
11-Jan-12	62.10	0.87	61.23	79.63	0.87	139.98	OK	162.18	161.66	161.66	2.00	162.83	OK	OK	28.2	92.5	2,374	613.84	OK
12-Jan-12	67.20	0.87	66.33	84.83	0.87	150.28	OK	168.18	167.66	167.66	1.40	168.23	OK	OK	30.9	101.2	2,451	633.55	OK
13-Jan-12	23.50	0.87	22.63	30.83	0.87	52.58	OK	64.48	63.96	63.96	1.40	64.53	OK	OK	5.1	16.1	1,288	332.96	OK
14-Jan-12	20.30	0.87	19.43	39.33	0.87	57.88	OK	121.28	120.76	120.76	12.80	132.73	OK	OK	29.0	95.1	2,397	619.76	OK
15-Jan-12	15.60	0.87	14.73	33.73	0.87	47.58	OK	111.88	111.36	111.36	12.80	123.33	OK	OK	28.4	92.9	2,378	614.79	OK
16-Jan-12	229.10	0.87	228.23	293.13	0.87	520.48	OK	548.48	547.96	547.96	1.30	548.43	OK	OK	301.5	1,028.1	5,516	1,426.11	OK
17-Jan-12	250.50	0.87	249.63	316.43	0.87	565.18	OK	590.88	590.36	590.36	1.00	590.53	OK	OK	352.3	1,204.9	5,831	1,507.51	OK
18-Jan-12	48.70	0.87	47.83	56.23	0.87	103.18	OK	110.98	110.46	110.46	0.30	109.93	OK	OK	15.3	49.6	1,909	493.43	OK
19-Jan-12	50.50	0.87	49.63	59.83	0.87	108.58	OK	118.38	117.86	117.86	0.60	117.63	OK	OK	16.8	54.5	1,973	510.04	OK
20-Jan-12	51.20	0.87	50.33	62.73	0.87	112.18	OK	124.78	124.26	124.26	0.60	124.03	OK	OK	17.9	58.3	2,020	522.27	OK
21-Jan-12	48.10	0.87	47.23	53.73	0.87	100.08	OK	108.18	107.66	107.66	0.20	107.03	OK	OK	14.8	47.9	1,886	487.66	OK
22-Jan-12	46.40	0.87	45.53	47.43	0.87	92.08	OK	93.08	92.56	92.56	-	91.73	OK	OK	13.1	42.4	1,807	467.25	OK
23-Jan-12	45.50	0.87	44.63	46.53	0.87	90.28	OK	91.08	90.56	90.56	-	89.73	OK	OK	12.6	40.8	1,783	461.08	OK
24-Jan-12	45.20	0.87	44.33	46.23	0.87	89.68	OK	90.28	89.76	89.76	-	88.93	OK	OK	12.5	40.3	1,775	459.00	OK
25-Jan-12	44.10	0.87	43.23	45.03	0.87	87.38	OK	87.78	87.26	87.26	-	86.43	OK	OK	11.9	38.4	1,746	451.37	OK
26-Jan-12	41.20	0.87	40.33	42.13	0.87	81.58	OK	81.88	81.36	81.36	-	80.53	OK	OK	10.5	33.7	1,668	431.12	OK
27-Jan-12	41.30	0.87	40.43	42.23	0.87	81.78	OK	81.98	81.46	81.46	-	80.63	OK	OK	10.5	33.9	1,670	431.82	OK
28-Jan-12	52.30	0.87	51.43	56.83	0.87	107.38	OK	108.68	108.16	108.16	-	107.33	OK	OK	16.7	54.1	1,968	508.67	OK
29-Jan-12	140.20	0.87	139.33	173.83	0.87	312.28	OK	324.88	324.36	324.36	0.10	323.63	OK	OK	115.4	387.3	3,920	1,013.33	OK
30-Jan-12	190.20	0.87	189.33	240.33	0.87	428.78	OK	466.68	466.16	466.16	7.60	472.93	OK	OK	215.4	730.3	4,894	1,265.19	OK
31-Jan-12	196.40	0.87	195.53	249.13	0.87	443.78	OK	483.28	482.76	482.76	7.60	489.53	OK	OK	229.6	779.5	5,007	1,294.41	OK
01-Feb-12	173.00	0.87	172.13	222.03	0.87	393.28	OK	425.68	425.16	425.16	3.10	427.43	OK	OK	181.0	611.9	4,600	1,189.25	OK
02-Feb-12	103.90	0.87	103.03	132.23	0.87	234.38	OK	262.78	262.26	262.26	4.00	265.43	OK	OK	71.1	236.5	3,298	852.62	OK
03-Feb-12	71.20	0.87	70.33	85.73	0.87	155.18	OK	164.98	164.46	164.46	1.00	164.63	OK	OK	31.8	104.4	2,477	640.34	OK
04-Feb-12	70.50	0.87	69.63	93.53	0.87	162.28	OK	183.68	183.16	183.16	0.50	182.83	OK	OK	35.7	117.3	2,580	667.11	OK
05-Feb-12	67.70	0.87	66.83	116.73	0.87	182.68	OK	293.68	293.16	293.16	25.80	318.13	OK	OK	110.4	370.2	3,858	997.42	OK
06-Feb-12	58.20	0.87	57.33	93.93	0.87	150.38	OK	245.68	245.16	245.16	25.50	269.83	OK	OK	79.8	266.0	3,437	888.49	OK
07-Feb-12	61.20	0.87	60.33	78.43	0.87	137.88	OK	154.18	153.66	153.66	2.30	155.13	OK	OK	26.1	85.4	2,309	596.99	OK
08-Feb-12	53.90	0.87	53.03	65.83	0.87	117.98	OK	129.58	129.06	129.06	0.90	129.13	OK	OK	19.5	63.3	2,080	537.65	OK
09-Feb-12	47.60	0.87	46.73	50.63	0.87	96.48	OK	104.88	104.36	104.36	0.20	103.73	OK	OK	14.4	46.5	1,866	482.50	OK
10-Feb-12	47.50	0.87	46.63	53.83	0.87	99.58	OK	110.88	110.36	110.36	0.20	109.73	OK	OK	15.0	48.4	1,893	489.48	OK
11-Feb-12	57.70	0.87	56.83	79.63	0.87	135.58	OK	178.68	178.16	178.16	8.10	185.43	OK	OK	34.6	113.6	2,551	659.57	OK
12-Feb-12	84.30	0.87	83.43	126.43	0.87	208.98	OK	276.48	275.96	275.96	11.80	286.93	OK	OK	78.7	262.1	3,419	883.94	OK
13-Feb-12	75.50	0.87	74.63	136.43	0.87	210.18	OK	335.18	334.66	334.66	27.60	361.43	OK	OK	141.5	476.3	4,214	1,089.44	OK

14-Feb-12	183.20	0.87	182.33	293.43	0.87	474.88	OK	621.08	620.56	620.56	24.90	644.63	OK	OK	362.1	1,239.0	5,888	1,522.31	OK
15-Feb-12	184.30	0.87	183.43	263.93	0.87	446.48	OK	506.38	505.86	505.86	2.60	507.63	OK	OK	238.2	809.2	5,073	1,311.44	OK
16-Feb-12	50.20	0.87	49.33	60.13	0.87	108.58	OK	122.88	122.36	122.36	0.80	122.33	OK	OK	17.4	56.5	1,999	516.75	OK
17-Feb-12	46.20	0.87	45.33	54.43	0.87	98.88	OK	109.68	109.16	109.16	0.40	108.73	OK	OK	14.4	46.6	1,868	482.84	OK
18-Feb-12	43.70	0.87	42.83	50.83	0.87	92.78	OK	100.88	100.36	100.36	0.10	99.63	OK	OK	12.6	40.7	1,782	460.73	OK
19-Feb-12	41.50	0.87	40.63	48.53	0.87	88.28	OK	94.38	93.86	93.86	-	93.03	OK	OK	11.3	36.5	1,714	443.23	OK
20-Feb-12	39.60	0.87	38.73	46.53	0.87	84.38	OK	89.08	88.56	88.56	-	87.73	OK	OK	10.3	33.1	1,658	428.56	OK
21-Feb-12	39.40	0.87	38.53	48.03	0.87	85.68	OK	91.68	91.16	91.16	0.10	90.43	OK	OK	10.5	33.8	1,670	431.62	OK
22-Feb-12	45.90	0.87	45.03	60.83	0.87	104.98	OK	120.58	120.06	120.06	2.60	121.83	OK	OK	16.2	52.4	1,946	503.17	OK
23-Feb-12	51.90	0.87	51.03	69.83	0.87	119.98	OK	136.98	136.46	136.46	2.60	138.23	OK	OK	20.5	66.7	2,118	547.48	OK
24-Feb-12	40.40	0.87	39.53	56.23	0.87	93.88	OK	112.68	112.16	112.16	3.80	115.13	OK	OK	14.1	45.6	1,853	479.10	OK
25-Feb-12	44.30	0.87	43.43	57.83	0.87	100.38	OK	115.48	114.96	114.96	3.70	117.83	OK	OK	14.9	48.4	1,893	489.44	OK
26-Feb-12	42.40	0.87	41.53	53.73	0.87	94.38	OK	105.48	104.96	104.96	0.40	104.53	OK	OK	12.9	41.8	1,797	464.71	OK
27-Feb-12	80.40	0.87	79.53	112.33	0.87	190.98	OK	219.38	218.86	218.86	3.80	221.83	OK	OK	49.1	162.3	2,891	747.37	OK
28-Feb-12	114.30	0.87	113.43	160.43	0.87	272.98	OK	311.98	311.46	311.46	7.20	317.83	OK	OK	95.3	318.8	3,661	946.56	OK
29-Feb-12	67.80	0.87	66.93	99.13	0.87	165.18	OK	197.88	197.36	197.36	4.90	201.43	OK	OK	40.2	132.3	2,691	695.78	OK
01-Mar-12	35.30	10.65	24.65	39.75	10.65	53.76	OK	70.46	69.94	69.11	1.30	69.58	OK	OK	11.2	36.1	1,709	441.79	OK
02-Mar-12	31.80	10.65	21.15	34.55	10.65	45.06	OK	58.36	57.84	57.01	0.50	56.68	OK	OK	8.8	28.4	1,570	405.91	OK
03-Mar-12	32.70	10.65	22.05	38.15	10.65	49.56	OK	62.66	62.14	61.31	0.40	60.88	OK	OK	9.7	31.1	1,621	419.07	OK
04-Mar-12	124.30	10.65	113.65	156.85	10.65	259.86	OK	280.56	280.04	279.21	3.50	281.88	OK	OK	99.3	332.2	3,715	960.38	OK
05-Mar-12	177.20	10.65	166.55	226.85	10.65	382.76	OK	407.86	407.34	406.51	3.50	409.18	OK	OK	192.4	651.1	4,701	1,215.37	OK
06-Mar-12	121.70	10.65	111.05	145.95	10.65	246.36	OK	303.06	302.54	301.71	36.20	337.08	OK	OK	108.5	363.5	3,833	991.05	OK
07-Mar-12	64.00	10.65	53.35	71.75	10.65	114.46	OK	171.06	170.54	169.71	36.40	205.28	OK	OK	45.4	150.0	2,812	727.09	OK
08-Mar-12	71.70	10.65	61.05	81.85	10.65	132.26	OK	146.36	145.84	145.01	3.20	147.38	OK	OK	34.1	112.1	2,540	656.56	OK
09-Mar-12	72.40	10.65	61.75	90.25	10.65	141.36	OK	164.66	164.14	163.31	1.60	164.08	OK	OK	39.2	129.0	2,668	689.72	OK
10-Mar-12	90.00	10.65	79.35	207.75	10.65	276.46	OK	429.26	428.74	427.91	6.20	433.28	OK	OK	262.4	892.7	5,250	1,357.32	OK
11-Mar-12	155.50	10.65	144.85	327.95	10.65	462.16	OK	681.36	680.84	680.01	21.10	700.28	OK	OK	557.5	1,921.4	6,866	1,774.99	OK
12-Mar-12	106.80	10.65	96.15	166.95	10.65	252.46	OK	370.46	369.94	369.11	41.80	410.08	OK	OK	170.0	574.1	4,498	1,162.97	OK
13-Mar-12	127.40	10.65	116.75	150.45	10.65	256.56	OK	298.76	298.24	297.41	25.90	322.48	OK	OK	107.2	359.1	3,817	986.85	OK
14-Mar-12	129.70	10.65	119.05	166.55	10.65	274.96	OK	331.76	331.24	330.41	24.10	353.68	OK	OK	125.1	420.2	4,033	1,042.68	OK
15-Mar-12	85.80	10.65	75.15	114.75	10.65	179.26	OK	242.66	242.14	241.31	24.50	264.98	OK	OK	75.4	251.1	3,368	870.78	OK
16-Mar-12	179.60	10.65	168.95	228.55	10.65	386.86	OK	410.96	410.44	409.61	3.50	412.28	OK	OK	195.9	663.3	4,732	1,223.29	OK
17-Mar-12	176.40	10.65	165.75	222.55	10.65	377.66	OK	400.56	400.04	399.21	1.40	399.78	OK	OK	188.0	636.0	4,663	1,205.43	OK
18-Mar-12	146.90	10.65	136.25	181.25	10.65	306.86	OK	327.66	327.14	326.31	1.60	327.08	OK	OK	132.0	443.9	4,111	1,062.84	OK
19-Mar-12	134.00	10.65	123.35	168.05	10.65	280.76	OK	307.06	306.54	305.71	1.70	306.58	OK	OK	114.7	384.9	3,911	1,011.09	OK
20-Mar-12	100.00	10.65	89.35	121.25	10.65	199.96	OK	221.76	221.24	220.41	0.80	220.38	OK	OK	65.8	218.6	3,209	829.50	OK
21-Mar-12	107.20	10.65	96.55	118.35	10.65	204.26	OK	220.66	220.14	219.31	-	218.48	OK	OK	69.1	229.9	3,266	844.25	OK
22-Mar-12	97.60	10.65	86.95	107.05	10.65	183.36	OK	196.36	195.84	195.01	-	194.18	OK	OK	57.6	190.8	3,059	790.94	OK
23-Mar-12	74.50	10.65	63.85	107.65	10.65	160.86	OK	212.16	211.64	210.81	1.80	211.78	OK	OK	59.7	198.1	3,100	801.37	OK
24-Mar-12	55.70	10.65	45.05	82.45	10.65	116.86	OK	171.66	171.14	170.31	7.20	176.68	OK	OK	45.1	149.0	2,806	725.39	OK
25-Mar-12	55.30	10.65	44.65	57.85	10.65	91.86	OK	112.26	111.74	110.91	5.40	115.48	OK	OK	22.2	72.4	2,180	563.49	OK
26-Mar-12	51.10	10.65	40.45	88.75	10.65	118.56	OK	177.86	177.34	176.51	2.10	177.78	OK	OK	50.7	167.6	2,924	755.91	OK
27-Mar-12	48.20	10.65	37.55	88.95	10.65	115.86	OK	195.56	195.04	194.21	16.40	209.78	OK	OK	66.5	221.0	3,221	832.71	OK
28-Mar-12	43.30	10.65	32.65	54.95	10.65	76.96	OK	146.66	146.14	145.31	40.10	184.58	OK	OK	43.1	142.0	2,759	713.32	OK
29-Mar-12	45.10	10.65	34.45	54.15	10.65	77.96	OK	123.66	123.14	122.31	25.70	147.18	OK	OK	27.7	90.6	2,357	609.43	OK
30-Mar-12	55.30	10.65	44.65	60.75	10.65	94.76	OK	114.16	113.64	112.81	-	111.98	OK	OK	22.5	73.4	2,190	566.19	OK
31-Mar-12	45.50	10.65	34.85	49.05	10.65	73.26	OK	87.86	87.34	86.51	-	85.68	OK	OK	15.4	50.0	1,915	495.10	OK
01-Apr-12	35.60	10.65	24.95	35.25	10.65	49.56	OK	59.76	59.24	58.41	-	57.58	OK	OK	9.4	30.2	1,605	414.85	OK
02-Apr-12	191.00	10.65	180.35	246.95	10.65	416.66	OK	439.06	438.54	437.71	-	436.88	OK	OK	221.6	751.8	4,944	1,278.11	OK
03-Apr-12	240.30	10.65	229.65	313.25	10.65	532.26	OK	557.26	556.74	555.91	-	555.08	OK	OK	341.6	1,167.4	5,767	1,490.94	OK
04-Apr-12	138.80	10.65	128.15	179.65	10.65	297.16	OK	318.26	317.74	316.91	0.30	316.38	OK	OK	123.7	415.7	4,018	1,038.71	OK
05-Apr-12	117.80	10.65	107.15	151.65	10.65	248.16	OK	275.46	274.94	274.11	7.70	280.98	OK	OK	93.7	313.1	3,638	940.61	OK
06-Apr-12	71.50	10.65	60.85	83.15	10.65	133.36	OK	149.86	149.34	148.51	8.40	156.08	OK	OK	34.8	114.5	2,558	661.45	OK
07-Apr-12	67.50	10.65	56.85	86.45	10.65	132.66	OK	150.46	149.94	149.11	1.50	149.78	OK	OK	34.4	112.9	2,546	658.19	OK
08-Apr-12	91.50	10.65	80.85	160.45	10.65	230.66	OK	304.76	304.24	303.41	3.00	305.58	OK	OK	115.8	388.6	3,924	1,014.51	OK
09-Apr-12	82.60	10.65	71.95	141.05	10.65	202.36	OK	265.96	265.44	264.61	2.60	266.38	OK	OK	90.8	303.4	3,599	930.36	OK
10-Apr-12	74.20	10.65	63.55	87.15	10.65	140.06	OK	269.26	268.74	267.91	102.50	369.58	OK	OK	127.1	427.0	4,056	1,048.51	OK
11-Apr-12	57.90	10.65	47.25	63.35	10.65	99.96	OK	225.56	225.04	224.21	102.40	325.78	OK	OK	108.4	363.3	3,833	990.92	OK
12-Apr-12	38.70	10.65	28.05	37.45	10.65	54.86	OK	67.46	66.94	66.11	9.10	74.38	OK	OK	11.0	35.4	1,697	438.78	OK
13-Apr-12	38.50	10.65	27.85	38.55	10.65	55.76	OK	69.46	68.94	68.11	4.70	71.98	OK	OK	11.3	36.3	1,712	442.65	OK
14-Apr-12	38.40	10.65	27.75	43.65	10.65	60.76	OK	92.86	92.34	91.51	14.70	105.38	OK	OK	17.3	56.3	1,996	515.99	OK
15-Apr-12	38.20	10.65	27.55	41.95	10.65	58.86	OK	85.06	84.54	83.71	12.10	94.98	OK	OK	14.9	48.2	1,890	488.60	OK
16-Apr-12	37.60	10.65	26.95	35.75	10.65	52.06	OK	55.96	55.44	54.61	0.10	53.88	OK	OK	9.4	30.4	1,608	415.70	OK
17-Apr-12	49.10	10.65	38.45	51.65	10.65	79.46	OK	92.96	92.44	91.61	7.70	98.48	OK	OK	17.0	55.3	1,983	512.60	OK
18-Apr-12	49.60	10.65	38.95	52.35	10.65	80.66	OK	98.36	97.84	97.01	11.60	107.78	OK	OK	18.2	59.1	2,030	524.79	OK

19-Apr-12	34.50	10.65	23.85	32.55	10.65	45.76	OK	52.36	51.84	51.01	3.90	54.08	OK	OK	8.3	26.7	1,537	397.24	OK
20-Apr-12	23.60	10.65	12.95	48.45	10.65	50.76	OK	88.56	88.04	87.21	1.60	87.98	OK	OK	20.3	66.3	2,113	546.26	OK
21-Apr-12	22.30	10.65	11.65	47.05	10.65	48.06	OK	85.56	85.04	84.21	1.60	84.98	OK	OK	19.8	64.5	2,093	541.01	OK
22-Apr-12	18.40	10.65	7.75	18.75	10.65	15.86	OK	20.26	19.74	18.91	0.50	18.58	OK	OK	3.3	10.3	1,100	284.49	OK
23-Apr-12	17.30	10.65	6.65	49.45	10.65	45.46	OK	92.56	92.04	91.21	2.20	92.58	OK	OK	26.7	87.3	2,327	601.62	OK
24-Apr-12	16.60	10.65	5.95	104.65	10.65	99.96	OK	222.36	221.84	221.01	5.50	225.68	OK	OK	139.3	468.9	4,191	1,083.47	OK
25-Apr-12	10.30	10.65	-	68.20	10.65	57.55	Fail	138.85	138.33	137.50	3.70	140.37	OK	Fail	65.9	219.0	3,210	830.01	OK
26-Apr-12	12.60	10.65	1.95	8.15	10.65	-	Fail	11.80	11.27	10.45	0.80	10.42	OK	Fail	2.4	7.4	981	253.54	OK
27-Apr-12	11.40	10.65	0.75	8.55	10.65	-	Fail	7.40	6.87	6.05	0.20	5.42	OK	Fail	1.8	5.5	882	228.13	OK
28-Apr-12	10.30	10.65	-	7.70	10.65	-	Fail	17.00	16.47	15.65	9.70	24.52	OK	Fail	3.1	9.9	1,084	280.31	OK
29-Apr-12	66.60	10.65	55.95	94.55	10.65	129.86	OK	152.16	151.64	150.81	9.70	159.68	OK	OK	34.5	113.2	2,549	658.93	OK
30-Apr-12	100.50	10.65	89.85	129.65	10.65	208.86	OK	221.56	221.04	220.21	0.90	220.28	OK	OK	67.7	225.0	3,241	837.91	OK
01-May-12	47.30	10.65	36.65	55.35	10.65	81.36	OK	88.96	88.44	87.61	2.20	88.98	OK	OK	16.3	52.9	1,953	504.95	OK
02-May-12	21.00	10.65	10.35	19.45	10.65	19.16	OK	23.66	23.14	22.31	2.00	23.48	OK	OK	3.6	11.5	1,146	296.29	OK
03-May-12	25.90	10.65	15.25	26.05	10.65	30.66	OK	32.86	32.34	31.51	-	30.68	OK	OK	5.2	16.5	1,298	335.67	OK
04-May-12	23.50	10.65	12.85	22.65	10.65	24.86	OK	35.66	35.14	34.31	7.70	41.18	OK	OK	5.1	16.2	1,291	333.66	OK
05-May-12	83.90	10.65	73.25	104.65	10.65	167.26	OK	183.46	182.94	182.11	7.70	188.98	OK	OK	48.3	159.7	2,874	743.12	OK
06-May-12	84.30	10.65	73.65	104.05	10.65	167.06	OK	201.06	200.54	199.71	23.20	222.08	OK	OK	53.8	178.1	2,986	772.03	OK
07-May-12	20.30	10.65	9.65	16.65	10.65	15.66	OK	43.46	42.94	42.11	23.20	64.48	OK	OK	8.0	25.7	1,517	392.21	OK
08-May-12	19.80	10.65	9.15	65.65	10.65	64.16	OK	130.96	130.44	129.61	3.00	131.78	OK	OK	47.8	157.6	2,863	740.07	OK
09-May-12	19.80	10.65	9.15	65.55	10.65	64.06	OK	130.86	130.34	129.51	3.00	131.68	OK	OK	47.7	157.6	2,861	739.71	OK
10-May-12	39.20	10.65	28.55	42.25	10.65	60.16	OK	66.66	66.14	65.31	-	64.48	OK	OK	11.1	35.8	1,703	440.21	OK
11-May-12	49.70	10.65	39.05	74.25	10.65	102.66	OK	133.26	132.74	131.91	1.10	132.18	OK	OK	28.6	93.6	2,384	616.45	OK
12-May-12	65.30	10.65	54.65	99.45	10.65	143.46	OK	180.46	179.94	179.11	1.40	179.68	OK	OK	45.8	151.2	2,820	729.06	OK
13-May-12	76.60	10.65	65.95	96.05	10.65	151.36	OK	164.26	163.74	162.91	0.30	162.38	OK	OK	40.8	134.5	2,707	699.77	OK
14-May-12	49.00	10.65	38.35	53.55	10.65	81.26	OK	87.36	86.84	86.01	-	85.18	OK	OK	16.4	53.1	1,955	505.40	OK
15-May-12	29.90	0.87	29.03	37.23	0.87	65.38	OK	69.98	69.46	69.46	-	68.63	OK	OK	6.3	20.2	1,394	360.37	OK
16-May-12	55.80	0.87	54.93	72.53	0.87	126.58	OK	137.18	136.66	136.66	3.90	139.73	OK	OK	21.4	69.9	2,153	556.49	OK
17-May-12	148.30	0.87	147.43	198.83	0.87	345.38	OK	368.58	368.06	368.06	7.80	375.03	OK	OK	138.3	465.5	4,180	1,080.70	OK
18-May-12	137.50	0.87	136.63	182.83	0.87	318.58	OK	335.28	334.76	334.76	3.90	337.83	OK	OK	117.9	395.6	3,949	1,020.86	OK
19-May-12	45.60	0.87	44.73	56.93	0.87	100.78	OK	106.98	106.46	106.46	-	105.63	OK	OK	14.0	45.2	1,848	477.88	OK
20-May-12	27.90	0.87	27.03	33.13	0.87	59.28	OK	62.68	62.16	62.16	-	61.33	OK	OK	5.3	17.0	1,313	339.42	OK
21-May-12	27.70	0.87	26.83	32.83	0.87	58.78	OK	61.38	60.86	60.86	-	60.03	OK	OK	5.2	16.7	1,303	336.86	OK
22-May-12	31.10	0.87	30.23	37.93	0.87	67.28	OK	94.18	93.66	93.66	20.90	113.73	OK	OK	11.2	36.1	1,708	441.55	OK
23-May-12	27.20	0.87	26.33	33.93	0.87	59.38	OK	92.68	92.16	92.16	26.80	118.13	OK	OK	12.1	39.2	1,757	454.36	OK
24-May-12	23.50	0.87	22.63	37.43	0.87	59.18	OK	106.48	105.96	105.96	29.90	135.03	OK	OK	18.7	60.7	2,048	529.59	OK
25-May-12	23.10	0.87	22.23	36.93	0.87	58.28	OK	120.78	120.26	120.26	43.10	162.53	OK	OK	28.0	91.6	2,367	611.89	OK
26-May-12	23.10	0.87	22.23	27.93	0.87	49.28	OK	72.18	71.66	71.66	19.10	89.93	OK	OK	7.1	22.8	1,455	376.27	OK
27-May-12	22.60	0.87	21.73	30.13	0.87	50.98	OK	64.28	63.76	63.76	8.00	70.93	OK	OK	5.1	16.1	1,288	332.91	OK
28-May-12	217.20	0.87	216.33	295.13	0.87	510.58	OK	554.38	553.86	553.86	17.90	570.93	OK	OK	293.0	998.9	5,461	1,411.77	OK
29-May-12	224.10	0.87	223.23	299.13	0.87	521.48	OK	552.38	551.86	551.86	9.90	560.93	OK	OK	299.9	1,022.8	5,506	1,423.49	OK
30-May-12	80.80	0.87	79.93	102.83	0.87	181.88	OK	211.18	210.66	210.66	21.20	231.03	OK	OK	46.4	153.3	2,834	732.57	OK
31-May-12	80.80	0.87	79.93	102.73	0.87	181.78	OK	215.58	215.06	215.06	25.10	239.33	OK	OK	48.1	158.9	2,870	741.87	OK
01-Jun-12	33.50	0.87	32.63	37.93	0.87	69.68	OK	75.88	75.36	75.36	4.20	78.73	OK	OK	7.5	24.2	1,484	383.69	OK
02-Jun-12	32.40	0.87	31.53	36.83	0.87	67.48	OK	68.68	68.16	68.16	0.10	67.43	OK	OK	6.8	21.9	1,433	370.49	OK
03-Jun-12	28.60	0.87	27.73	116.93	0.87	143.78	OK	257.08	256.56	256.56	5.20	260.93	OK	OK	121.8	409.0	3,995	1,032.88	OK
04-Jun-12	22.90	0.87	22.03	111.23	0.87	132.38	OK	245.38	244.86	244.86	5.20	249.23	OK	OK	119.7	401.7	3,970	1,026.34	OK
05-Jun-12	23.30	0.87	22.43	27.53	0.87	49.08	OK	89.58	89.06	89.06	34.60	122.83	OK	OK	13.8	44.8	1,842	476.16	OK
06-Jun-12	23.10	0.87	22.23	27.33	0.87	48.68	OK	98.18	97.66	97.66	42.50	139.33	OK	OK	18.5	60.0	2,041	527.70	OK
07-Jun-12	23.10	0.87	22.23	37.03	0.87	58.38	OK	96.88	96.36	96.36	22.40	117.93	OK	OK	14.1	45.8	1,856	479.94	OK
08-Jun-12	22.90	0.87	22.03	36.83	0.87	57.98	OK	89.58	89.06	89.06	16.50	104.73	OK	OK	11.2	36.2	1,709	441.91	OK
09-Jun-12	22.60	0.87	21.73	26.63	0.87	47.48	OK	58.08	57.56	57.56	4.10	60.83	OK	OK	4.3	13.7	1,216	314.37	OK
10-Jun-12	22.60	0.87	21.73	26.63	0.87	47.48	OK	55.38	54.86	54.86	2.00	56.03	OK	OK	4.0	12.6	1,181	305.34	OK
11-Jun-12	44.60	0.87	43.73	56.33	0.87	99.18	OK	105.48	104.96	104.96	-	104.13	OK	OK	13.5	43.8	1,827	472.37	OK
12-Jun-12	45.40	0.87	44.53	57.73	0.87	101.38	OK	107.28	106.76	106.76	-	105.93	OK	OK	14.0	45.3	1,850	478.32	OK
13-Jun-12	23.90	0.87	23.03	30.83	0.87	52.98	OK	59.48	58.96	58.96	0.20	58.33	OK	OK	4.5	14.2	1,231	318.33	OK
14-Jun-12	19.90	0.87	19.03	26.23	0.87	44.38	OK	49.48	48.96	48.96	0.20	48.33	OK	OK	3.2	10.1	1,093	282.64	OK
15-Jun-12	7.90	0.87	7.03	11.63	0.87	17.78	OK	19.08	18.56	18.56	-	17.73	OK	OK	0.6	1.9	-	-	OK
16-Jun-12	10.30	0.87	9.43	13.93	0.87	22.48	OK	23.48	22.96	22.96	-	22.13	OK	OK	0.9	2.8	-	-	OK
17-Jun-12	6.30	0.87	5.43	13.83	0.87	18.38	OK	24.38	23.86	23.86	0.20	23.23	OK	OK	1.1	3.3	-	-	OK
18-Jun-12	7.40	0.87	6.53	14.93	0.87	20.58	OK	26.38	25.86	25.86	0.20	25.23	OK	OK	1.2	3.6	-	-	OK
19-Jun-12	11.90	0.87	11.03	17.23	0.87	27.38	OK	34.78	34.26	34.26	-	33.43	OK	OK	1.7	5.2	868	224.42	OK
20-Jun-12	85.70	0.87	84.83	137.53	0.87	221.48	OK	256.38	255.86	255.86	1.30	256.33	OK	OK	66.2	220.1	3,216	831.51	OK
21-Jun-12	86.30	0.87	85.43	137.23	0.87	221.78	OK	256.38	255.86	255.86	1.30	256.33	OK	OK	66.1	219.8	3,215	831.06	OK
22-Jun-12	15.60	0.87	14.73	19.83	0.87	33.68	OK	37.08	36.56	36.56	-	35.73	OK	OK	1.9	6.1	915	236.52	OK

23-Jun-12	12.70	0.87	11.83	16.03	0.87	26.98	OK	36.18	35.66	35.66	-	34.83	OK	OK	1.9	5.8	901	232.97	OK
24-Jun-12	12.70	0.87	11.83	16.03	0.87	26.98	OK	34.28	33.76	33.76	-	32.93	OK	OK	1.6	5.1	862	222.98	OK
25-Jun-12	12.60	0.87	11.73	15.83	0.87	26.68	OK	27.98	27.46	27.46	-	26.63	OK	OK	1.2	3.9	-	-	OK
26-Jun-12	12.60	0.87	11.73	15.83	0.87	26.68	OK	27.68	27.16	27.16	-	26.33	OK	OK	1.2	3.8	-	-	OK
27-Jun-12	37.10	0.87	36.23	49.03	0.87	84.38	OK	87.38	86.86	86.86	-	86.03	OK	OK	9.8	31.4	1,627	420.50	OK
28-Jun-12	37.60	0.87	36.73	49.43	0.87	85.28	OK	88.08	87.56	87.56	-	86.73	OK	OK	10.0	32.0	1,638	423.47	OK
29-Jun-12	12.40	0.87	11.53	15.53	0.87	26.18	OK	26.58	26.06	26.06	-	25.23	OK	OK	1.2	3.7	-	-	OK
30-Jun-12	12.60	0.87	11.73	15.63	0.87	26.48	OK	26.78	26.26	26.26	-	25.43	OK	OK	1.2	3.8	-	-	OK
01-Jul-12	12.40	0.87	11.53	15.43	0.87	26.08	OK	40.08	39.56	39.56	11.90	50.63	OK	OK	2.5	7.9	1,006	259.99	OK
02-Jul-12	12.40	0.87	11.53	15.33	0.87	25.98	OK	39.88	39.36	39.36	11.90	50.43	OK	OK	2.5	7.9	1,002	259.11	OK
03-Jul-12	12.30	0.87	11.43	17.13	0.87	27.68	OK	39.18	38.66	38.66	1.10	38.93	OK	OK	2.2	7.0	960	248.16	OK
04-Jul-12	12.30	0.87	11.43	17.13	0.87	27.68	OK	37.78	37.26	37.26	0.40	36.83	OK	OK	2.0	6.3	928	239.87	OK
05-Jul-12	12.20	0.87	11.33	15.03	0.87	25.48	OK	25.58	25.06	25.06	0.10	24.33	OK	OK	1.1	3.5	-	-	OK
06-Jul-12	12.10	0.87	11.23	14.93	0.87	25.28	OK	25.38	24.86	24.86	-	24.03	OK	OK	1.1	3.5	-	-	OK
07-Jul-12	10.30	0.87	9.43	13.03	0.87	21.58	OK	33.98	33.46	33.46	7.90	40.53	OK	OK	1.9	6.0	911	235.64	OK
08-Jul-12	8.20	0.87	7.33	11.83	0.87	18.28	OK	41.38	40.86	40.86	19.90	59.93	OK	OK	4.1	13.1	1,197	309.33	OK
09-Jul-12	100.20	0.87	99.33	136.03	0.87	234.48	OK	256.88	256.36	256.36	11.90	267.43	OK	OK	68.1	226.5	3,249	839.88	OK
10-Jul-12	101.10	0.87	100.23	136.03	0.87	235.38	OK	244.38	243.86	243.86	1.70	244.73	OK	OK	66.0	219.4	3,212	830.49	OK
11-Jul-12	13.20	0.87	12.33	15.83	0.87	27.28	OK	35.88	35.36	35.36	0.90	35.43	OK	OK	1.8	5.7	896	231.72	OK
12-Jul-12	12.60	0.87	11.73	15.13	0.87	25.98	OK	27.18	26.66	26.66	0.10	25.93	OK	OK	1.2	3.7	-	-	OK
13-Jul-12	12.70	0.87	11.83	15.23	0.87	26.18	OK	27.08	26.56	26.56	-	25.73	OK	OK	1.2	3.8	-	-	OK
14-Jul-12	12.10	0.87	11.23	28.63	0.87	38.98	OK	62.98	62.46	62.46	4.80	66.43	OK	OK	6.8	21.7	1,429	369.52	OK
15-Jul-12	10.60	0.87	9.73	34.13	0.87	42.98	OK	90.18	89.66	89.66	9.70	98.53	OK	OK	18.2	59.0	2,029	524.60	OK
16-Jul-12	10.90	0.87	10.03	20.33	0.87	29.48	OK	53.18	52.66	52.66	4.80	56.63	OK	OK	5.2	16.7	1,303	336.90	OK
17-Jul-12	13.20	0.87	12.33	33.63	0.87	45.08	OK	68.48	67.96	67.96	1.10	68.23	OK	OK	7.7	24.8	1,498	387.31	OK
18-Jul-12	13.30	0.87	12.43	33.93	0.87	45.48	OK	69.18	68.66	68.66	1.10	68.93	OK	OK	7.9	25.3	1,509	390.10	OK
19-Jul-12	10.90	0.87	10.03	13.53	0.87	22.68	OK	27.18	26.66	26.66	0.30	26.13	OK	OK	1.1	3.4	-	-	OK
20-Jul-12	10.80	0.87	9.93	20.93	0.87	29.98	OK	43.58	43.06	43.06	0.60	42.83	OK	OK	2.9	9.3	1,061	274.37	OK
21-Jul-12	13.20	0.87	12.33	24.13	0.87	35.58	OK	48.58	48.06	48.06	0.50	47.73	OK	OK	3.3	10.5	1,110	287.04	OK
22-Jul-12	25.50	0.87	24.63	32.93	0.87	56.68	OK	61.18	60.66	60.66	-	59.83	OK	OK	4.8	15.4	1,268	327.82	OK
23-Jul-12	23.60	0.87	22.73	30.13	0.87	51.98	OK	55.48	54.96	54.96	-	54.13	OK	OK	4.1	13.1	1,196	309.31	OK
24-Jul-12	11.70	0.87	10.83	13.83	0.87	23.78	OK	25.58	25.06	25.06	-	24.23	OK	OK	1.1	3.3	-	-	OK
25-Jul-12	11.50	0.87	10.63	14.23	0.87	23.98	OK	26.08	25.56	25.56	-	24.73	OK	OK	1.1	3.3	-	-	OK
26-Jul-12	9.60	0.87	8.73	12.23	0.87	20.08	OK	21.78	21.26	21.26	-	20.43	OK	OK	0.8	2.4	-	-	OK
27-Jul-12	4.10	0.87	3.23	6.13	0.87	8.48	OK	9.18	8.66	8.66	-	7.83	OK	OK	0.2	0.6	-	-	OK
28-Jul-12	5.50	0.87	4.63	7.53	0.87	11.28	OK	11.88	11.36	11.36	-	10.53	OK	OK	0.3	0.9	-	-	OK
29-Jul-12	5.00	0.87	4.13	7.03	0.87	10.28	OK	10.68	10.16	10.16	-	9.33	OK	OK	0.3	0.8	-	-	OK
30-Jul-12	5.10	0.87	4.23	7.03	0.87	10.38	OK	10.68	10.16	10.16	-	9.33	OK	OK	0.3	0.8	-	-	OK
31-Jul-12	5.00	0.87	4.13	6.93	0.87	10.18	OK	10.38	9.86	9.86	-	9.03	OK	OK	0.3	0.8	-	-	OK
01-Aug-12	22.20	0.87	21.33	30.23	0.87	50.68	OK	52.48	51.96	51.96	-	51.13	OK	OK	3.8	12.1	1,165	301.14	OK
02-Aug-12	22.90	0.87	22.03	30.93	0.87	52.08	OK	53.78	53.26	53.26	-	52.43	OK	OK	4.0	12.7	1,185	306.47	OK
03-Aug-12	6.10	0.87	5.23	8.23	0.87	12.58	OK	13.08	12.56	12.56	-	11.73	OK	OK	0.4	1.1	-	-	OK
04-Aug-12	13.20	0.87	12.33	23.83	0.87	35.28	OK	44.28	43.76	43.76	0.40	43.33	OK	OK	2.7	8.5	1,030	266.34	OK
05-Aug-12	13.50	0.87	12.63	23.83	0.87	35.58	OK	44.18	43.66	43.66	0.40	43.23	OK	OK	2.7	8.4	1,025	264.90	OK
06-Aug-12	35.80	0.87	34.93	48.03	0.87	82.08	OK	84.88	84.36	84.36	-	83.53	OK	OK	9.2	29.7	1,595	412.41	OK
07-Aug-12	39.30	0.87	38.43	52.33	0.87	89.88	OK	92.88	92.36	92.36	-	91.53	OK	OK	10.9	35.2	1,694	437.96	OK
08-Aug-12	12.90	0.87	12.03	16.33	0.87	27.48	OK	35.38	34.86	34.86	-	34.03	OK	OK	1.7	5.4	881	227.86	OK
09-Aug-12	9.70	0.87	8.83	20.63	0.87	28.58	OK	40.38	39.86	39.86	0.50	39.53	OK	OK	2.6	8.2	1,017	262.96	OK
10-Aug-12	7.50	0.87	6.63	17.53	0.87	23.28	OK	34.78	34.26	34.26	0.50	33.93	OK	OK	2.2	6.8	952	246.21	OK
11-Aug-12	36.90	0.87	36.03	49.03	0.87	84.18	OK	87.08	86.56	86.56	-	85.73	OK	OK	9.7	31.2	1,623	419.61	OK
12-Aug-12	138.80	0.87	137.93	186.73	0.87	323.78	OK	335.88	335.36	335.36	-	334.53	OK	OK	120.3	403.8	3,977	1,028.27	OK
13-Aug-12	121.70	0.87	120.83	161.73	0.87	281.68	OK	291.78	291.26	291.26	-	290.43	OK	OK	92.7	309.9	3,625	937.23	OK
14-Aug-12	66.00	0.87	65.13	85.03	0.87	149.28	OK	153.88	153.36	153.36	-	152.53	OK	OK	28.3	92.8	2,377	614.55	OK
15-Aug-12	91.80	0.87	90.93	119.53	0.87	209.58	OK	232.48	231.96	231.96	13.90	245.03	OK	OK	56.5	187.1	3,038	785.52	OK
16-Aug-12	60.10	0.87	59.23	75.63	0.87	133.98	OK	153.68	153.16	153.16	13.90	166.23	OK	OK	25.8	84.3	2,298	594.16	OK
17-Aug-12	34.10	0.87	33.23	39.93	0.87	72.28	OK	74.48	73.96	73.96	-	73.13	OK	OK	7.7	24.5	1,492	385.75	OK
18-Aug-12	31.80	0.87	30.93	40.13	0.87	70.18	OK	77.28	76.76	76.76	0.30	76.23	OK	OK	7.4	23.5	1,471	380.27	OK
19-Aug-12	30.90	0.87	30.03	49.33	0.87	78.48	OK	98.98	98.46	98.46	0.90	98.53	OK	OK	11.3	36.4	1,713	442.86	OK
20-Aug-12	31.40	0.87	30.53	46.73	0.87	76.38	OK	108.58	108.06	108.06	14.60	121.83	OK	OK	14.5	47.1	1,875	484.62	OK
21-Aug-12	33.80	0.87	32.93	59.53	0.87	91.58	OK	136.68	136.16	136.16	15.20	150.53	OK	OK	24.1	78.7	2,244	580.22	OK
22-Aug-12	31.50	0.87	30.63	57.13	0.87	86.88	OK	159.08	158.56	158.56	38.20	195.93	OK	OK	41.1	135.4	2,713	701.47	OK
23-Aug-12	23.90	0.87	23.03	27.23	0.87	49.38	OK	94.58	94.06	94.06	37.00	130.23	OK	OK	16.3	52.9	1,952	504.69	OK
24-Aug-12	21.90	0.87	21.03	35.03	0.87	55.18	OK	71.08	70.56	70.56	3.50	73.23	OK	OK	6.2	19.8	1,384	357.72	OK
25-Aug-12	22.10	0.87	21.23	128.13	0.87	148.48	OK	289.48	288.96	288.96	8.30	296.43	OK	OK	175.1	591.7	4,546	1,175.34	OK
26-Aug-12	24.30	0.87	23.43	120.13	0.87	142.68	OK	269.18	268.66	268.66	7.00	274.83	OK	OK	144.5	486.8	4,246	1,097.73	OK

27-Aug-12	41.60	0.87	40.73	50.73	0.87	90.58	OK	104.48	103.96	103.96	4.10	107.23	OK	OK	12.7	40.9	1,785	461.40	OK
28-Aug-12	66.30	0.87	65.43	85.53	0.87	150.08	OK	167.68	167.16	167.16	5.10	171.43	OK	OK	30.5	100.1	2,441	631.01	OK
29-Aug-12	76.40	0.87	75.53	100.03	0.87	174.68	OK	188.78	188.26	188.26	2.10	189.53	OK	OK	39.0	128.4	2,663	688.52	OK
30-Aug-12	47.90	0.87	47.03	66.63	0.87	112.78	OK	127.78	127.26	127.26	1.40	127.83	OK	OK	18.0	58.4	2,022	522.64	OK
31-Aug-12	22.00	0.87	21.13	31.13	0.87	51.38	OK	62.68	62.16	62.16	0.40	61.73	OK	OK	4.8	15.2	1,261	325.98	OK
01-Sep-12	16.00	10.65	5.35	13.05	10.65	7.76	OK	16.16	15.64	14.81	0.10	14.08	OK	OK	2.7	8.4	1,026	265.14	OK
02-Sep-12	12.40	10.65	1.75	81.75	10.65	72.86	OK	176.96	176.44	175.61	4.60	179.38	OK	OK	98.6	329.9	3,706	958.02	OK
03-Sep-12	18.90	10.65	8.25	123.05	10.65	120.66	OK	267.16	266.64	265.81	6.60	271.58	OK	OK	191.7	648.7	4,695	1,213.83	OK
04-Sep-12	18.90	10.65	8.25	51.95	10.65	49.56	OK	100.36	99.84	99.01	2.40	100.58	OK	OK	29.6	97.0	2,414	624.12	OK
05-Sep-12	10.60	10.65	-	13.30	10.65	2.65	Fail	34.85	34.33	33.50	18.00	50.67	OK	Fail	8.5	27.4	1,551	401.10	OK
06-Sep-12	10.40	10.65	-	13.80	10.65	3.15	Fail	35.55	35.03	34.20	18.00	51.37	OK	Fail	8.7	27.9	1,560	403.39	OK
07-Sep-12	11.30	10.65	0.65	9.35	10.65	-	Fail	13.20	12.67	11.85	3.00	14.02	OK	Fail	2.6	8.3	1,021	264.00	OK
08-Sep-12	10.80	10.65	0.15	5.95	10.65	-	Fail	9.40	8.87	8.05	0.80	8.02	OK	Fail	1.7	5.3	874	225.85	OK
09-Sep-12	10.90	10.65	0.25	5.95	10.65	-	Fail	8.70	8.17	7.35	0.30	6.82	OK	Fail	1.6	5.1	859	222.02	OK
10-Sep-12	10.80	10.65	0.15	5.85	10.65	-	Fail	4.00	3.47	2.65	0.10	1.92	OK	Fail	1.2	3.7	-	-	OK
11-Sep-12	10.70	10.65	0.05	5.65	10.65	-	Fail	3.00	2.47	1.65	-	0.82	OK	Fail	1.1	3.5	-	-	OK
12-Sep-12	10.60	10.65	-	5.50	10.65	-	Fail	2.30	1.77	0.95	-	0.12	OK	Fail	1.1	3.3	-	-	OK
13-Sep-12	10.10	10.65	-	5.80	10.65	-	Fail	2.10	1.57	0.75	-	-	Fail	Fail	1.0	3.1	-	-	OK
14-Sep-12	25.70	10.65	15.05	26.95	10.65	31.36	OK	34.56	34.04	33.21	-	32.38	OK	OK	5.3	17.0	1,311	338.97	OK
15-Sep-12	61.30	10.65	50.65	75.35	10.65	115.36	OK	125.86	125.34	124.51	4.00	127.68	OK	OK	26.9	88.1	2,335	603.56	OK
16-Sep-12	47.10	10.65	36.45	55.85	10.65	81.66	OK	90.56	90.04	89.21	4.00	92.38	OK	OK	16.5	53.6	1,962	507.22	OK
17-Sep-12	11.50	10.65	0.85	6.95	10.65	-	Fail	1.00	0.47	-	-	-	Fail	Fail	1.2	3.8	-	-	OK
18-Sep-12	8.60	10.65	-	5.20	10.65	-	Fail	0.60	0.07	-	-	-	Fail	Fail	0.7	2.3	-	-	OK
19-Sep-12	8.70	10.65	-	5.40	10.65	-	Fail	0.80	0.27	-	-	-	Fail	Fail	0.8	2.4	-	-	OK
20-Sep-12	8.50	10.65	-	5.40	10.65	-	Fail	0.70	0.17	-	-	-	Fail	Fail	0.7	2.3	-	-	OK
21-Sep-12	8.00	10.65	-	5.00	10.65	-	Fail	0.30	-	-	-	-	Fail	Fail	0.7	2.0	-	-	Fail
22-Sep-12	8.10	10.65	-	5.00	10.65	-	Fail	0.20	-	-	-	-	Fail	Fail	0.7	2.0	-	-	Fail
23-Sep-12	8.00	10.65	-	4.90	10.65	-	Fail	0.10	-	-	-	-	Fail	Fail	0.6	2.0	-	-	Fail
24-Sep-12	8.00	10.65	-	4.90	10.65	-	Fail	0.10	-	-	-	-	Fail	Fail	0.6	2.0	-	-	Fail
25-Sep-12	7.90	10.65	-	6.20	10.65	-	Fail	121.90	121.37	120.55	104.90	224.62	OK	Fail	82.7	275.8	3,481	899.83	OK
26-Sep-12	7.90	10.65	-	6.20	10.65	-	Fail	146.50	145.97	145.15	126.60	270.92	OK	Fail	116.9	392.4	3,938	1,017.99	OK
27-Sep-12	7.90	10.65	-	4.70	10.65	-	Fail	38.50	37.97	37.15	33.70	70.02	OK	Fail	9.8	31.5	1,629	421.12	OK
28-Sep-12	7.80	10.65	-	4.70	10.65	-	Fail	16.10	15.57	14.75	14.10	28.02	OK	Fail	2.4	7.4	982	253.79	OK
29-Sep-12	7.80	10.65	-	4.60	10.65	-	Fail	12.40	11.87	11.05	4.40	14.62	OK	Fail	1.7	5.2	868	224.35	OK
30-Sep-12	7.70	10.65	-	24.60	10.65	13.95	Fail	47.45	46.93	46.10	2.00	47.27	OK	Fail	11.4	36.7	1,719	444.38	OK
01-Oct-12	7.30	10.65	-	25.40	10.65	14.75	Fail	47.65	47.13	46.30	1.50	46.97	OK	Fail	11.4	36.6	1,717	443.91	OK
02-Oct-12	5.50	10.65	-	5.30	10.65	-	Fail	13.30	12.77	11.95	0.50	11.62	OK	Fail	1.7	5.2	865	223.75	OK
03-Oct-12	3.50	10.65	-	4.40	10.65	-	Fail	9.10	8.57	7.75	0.10	7.02	OK	Fail	0.8	2.6	-	-	OK
04-Oct-12	3.90	10.65	-	27.00	10.65	16.35	Fail	53.25	52.73	51.90	1.40	52.47	OK	Fail	13.3	42.9	1,814	469.02	OK
05-Oct-12	3.70	10.65	-	70.70	10.65	60.05	Fail	153.55	153.03	152.20	4.10	155.47	OK	Fail	78.7	262.4	3,420	884.27	OK
06-Oct-12	48.00	10.65	37.35	102.55	10.65	129.26	OK	197.36	196.84	196.01	2.80	197.98	OK	OK	66.0	219.4	3,213	830.57	OK
07-Oct-12	49.70	10.65	39.05	60.55	10.65	88.96	OK	98.26	97.74	96.91	0.40	96.48	OK	OK	18.6	60.3	2,045	528.62	OK
08-Oct-12	6.80	10.65	-	4.20	10.65	-	Fail	2.50	1.97	1.15	0.10	0.42	OK	Fail	0.5	1.6	-	-	OK
09-Oct-12	6.50	10.65	-	4.10	10.65	-	Fail	2.40	1.87	1.05	0.50	0.72	OK	Fail	0.5	1.5	-	-	OK
10-Oct-12	6.50	10.65	-	12.80	10.65	2.15	Fail	15.75	15.23	14.40	1.00	14.57	OK	Fail	2.7	8.5	1,032	266.73	OK
11-Oct-12	6.50	10.65	-	13.10	10.65	2.45	Fail	15.55	15.03	14.20	0.60	13.97	OK	Fail	2.7	8.4	1,027	265.46	OK
12-Oct-12	6.40	10.65	-	29.70	10.65	19.05	Fail	54.05	53.53	52.70	1.60	53.47	OK	Fail	13.6	43.9	1,829	472.83	OK
13-Oct-12	6.40	10.65	-	31.40	10.65	20.75	Fail	57.85	57.33	56.50	1.70	57.37	OK	Fail	15.1	48.9	1,899	491.06	OK
14-Oct-12	55.60	10.65	44.95	68.45	10.65	102.76	OK	110.36	109.84	109.01	0.20	108.38	OK	OK	22.5	73.3	2,188	565.78	OK
15-Oct-12	84.60	10.65	73.95	105.05	10.65	168.36	OK	288.86	288.34	287.51	99.40	386.08	OK	OK	127.2	427.6	4,058	1,049.02	OK
16-Oct-12	38.00	10.65	27.35	51.35	10.65	68.06	OK	220.26	219.74	218.91	119.70	337.78	OK	OK	137.6	463.1	4,173	1,078.77	OK
17-Oct-12	11.40	10.65	0.75	15.05	10.65	5.16	OK	43.36	42.84	42.01	21.90	63.08	OK	OK	11.3	36.6	1,716	443.73	OK
18-Oct-12	35.90	10.65	25.25	37.85	10.65	52.46	OK	76.66	76.14	75.31	19.20	93.68	OK	OK	12.9	41.8	1,798	464.86	OK
19-Oct-12	36.90	10.65	26.25	39.05	10.65	54.66	OK	77.46	76.94	76.11	17.70	92.98	OK	OK	13.0	42.0	1,801	465.59	OK
20-Oct-12	13.00	10.65	2.35	50.15	10.65	41.86	OK	101.86	101.34	100.51	5.90	105.58	OK	OK	36.3	119.5	2,597	671.41	OK
21-Oct-12	10.50	10.65	-	47.40	10.65	36.75	Fail	104.35	103.83	103.00	11.50	113.67	OK	Fail	41.1	135.6	2,715	701.81	OK
22-Oct-12	12.80	10.65	2.15	6.45	10.65	-	Fail	14.80	14.27	13.45	7.30	19.92	OK	Fail	2.8	8.7	1,039	268.52	OK
23-Oct-12	73.50	10.65	62.85	89.15	10.65	141.36	OK	152.46	151.94	151.11	2.20	152.48	OK	OK	36.7	120.6	2,605	673.59	OK
24-Oct-12	139.70	10.65	129.05	178.25	10.65	296.66	OK	316.36	315.84	315.01	4.70	318.88	OK	OK	123.4	414.3	4,013	1,037.54	OK
25-Oct-12	147.60	10.65	136.95	187.05	10.65	313.36	OK	337.06	336.54	335.71	8.30	343.18	OK	OK	136.6	459.8	4,162	1,076.03	OK
26-Oct-12	154.10	10.65	143.45	194.35	10.65	327.16	OK	349.36	348.84	348.01	7.10	354.28	OK	OK	146.7	494.3	4,269	1,103.67	OK
27-Oct-12	94.60	10.65	83.95	111.95	10.65	185.26	OK	221.76	221.24	220.41	25.30	244.88	OK	OK	63.9	212.3	3,176	821.07	OK
28-Oct-12	27.40	10.65	16.75	20.15	10.65	26.26	OK	53.76	53.24	52.41	23.30	74.88	OK	OK	9.7	31.3	1,626	420.28	OK
29-Oct-12	78.80	10.65	68.15	89.95	10.65	147.46	OK	160.96	160.44	159.61	6.60	165.38	OK	OK	40.1	132.3	2,691	695.74	OK
30-Oct-12	81.00	10.65	70.35	92.55	10.65	152.26	OK	197.16	196.64	195.81	31.60	226.58	OK	OK	53.2	176.2	2,975	769.15	OK

31-Oct-12	29.80	10.65	19.15	24.25	10.65	32.76	OK	73.36	72.84	72.01	30.50	101.68	OK	OK	16.0	51.9	1,939	501.32	OK
01-Nov-12	25.90	10.65	15.25	19.95	10.65	24.56	OK	38.86	38.34	37.51	8.10	44.78	OK	OK	5.9	18.8	1,359	351.31	OK
02-Nov-12	25.20	10.65	14.55	17.75	10.65	21.66	OK	185.76	185.24	184.41	140.40	323.98	OK	OK	148.3	499.8	4,285	1,107.92	OK
03-Nov-12	25.40	10.65	14.75	17.95	10.65	22.06	OK	181.06	180.54	179.71	136.30	315.18	OK	OK	140.0	471.3	4,198	1,085.36	OK
04-Nov-12	24.80	10.65	14.15	17.25	10.65	20.76	OK	24.56	24.04	23.21	0.10	22.48	OK	OK	4.2	13.2	1,202	310.66	OK
05-Nov-12	23.30	10.65	12.65	16.35	10.65	18.36	OK	92.06	91.54	90.71	62.00	151.88	OK	OK	35.1	115.5	2,567	663.59	OK
06-Nov-12	23.70	10.65	13.05	22.35	10.65	24.76	OK	105.26	104.74	103.91	62.40	165.48	OK	OK	41.5	136.9	2,724	704.17	OK
07-Nov-12	23.60	10.65	12.95	21.65	10.65	23.96	OK	33.06	32.54	31.71	5.60	36.48	OK	OK	4.8	15.1	1,260	325.63	OK
08-Nov-12	23.60	10.65	12.95	15.95	10.65	18.26	OK	35.56	35.04	34.21	15.80	49.18	OK	OK	5.7	18.2	1,343	347.29	OK
09-Nov-12	22.30	10.65	11.65	14.65	10.65	15.66	OK	32.66	32.14	31.31	14.70	45.18	OK	OK	5.3	16.8	1,306	337.61	OK
10-Nov-12	17.20	10.65	6.55	18.25	10.65	14.16	OK	26.56	26.04	25.21	3.90	28.28	OK	OK	4.0	12.7	1,185	306.32	OK
11-Nov-12	9.80	10.65	-	11.70	10.65	1.05	Fail	132.75	132.23	131.40	107.30	237.87	OK	Fail	96.6	322.9	3,678	950.89	OK
12-Nov-12	8.50	10.65	-	15.00	10.65	4.35	Fail	140.45	139.93	139.10	106.90	245.17	OK	Fail	103.1	345.2	3,765	973.30	OK
13-Nov-12	128.40	10.65	117.75	188.35	10.65	295.46	OK	345.66	345.14	344.31	10.30	353.78	OK	OK	134.7	453.0	4,141	1,070.48	OK
14-Nov-12	306.80	10.65	296.15	416.15	10.65	701.66	OK	753.86	753.34	752.51	9.70	761.38	OK	OK	569.1	1,962.1	6,916	1,788.08	OK
15-Nov-12	296.70	10.65	286.05	387.45	10.65	662.86	OK	690.76	690.24	689.41	2.90	691.48	OK	OK	506.8	1,743.8	6,637	1,715.76	OK
16-Nov-12	226.10	10.65	215.45	328.45	10.65	533.26	OK	603.66	603.14	602.31	2.70	604.18	OK	OK	364.8	1,248.3	5,904	1,526.32	OK
17-Nov-12	129.70	10.65	119.05	195.05	10.65	303.46	OK	364.26	363.74	362.91	2.50	364.58	OK	OK	147.5	496.8	4,276	1,105.59	OK
18-Nov-12	35.90	10.65	25.25	27.95	10.65	42.56	OK	42.66	42.14	41.31	-	40.48	OK	OK	8.1	25.9	1,522	393.43	OK
19-Nov-12	35.40	10.65	24.75	28.25	10.65	42.36	OK	43.56	43.04	42.21	0.10	41.48	OK	OK	7.9	25.4	1,511	390.63	OK
20-Nov-12	35.50	10.65	24.85	28.65	10.65	42.86	OK	58.16	57.64	56.81	12.30	68.28	OK	OK	9.6	30.8	1,615	417.58	OK
21-Nov-12	35.50	10.65	24.85	30.25	10.65	44.46	OK	62.06	61.54	60.71	12.40	72.28	OK	OK	10.2	32.7	1,650	426.60	OK
22-Nov-12	35.50	10.65	24.85	29.95	10.65	44.16	OK	47.56	47.04	46.21	1.10	46.48	OK	OK	8.2	26.1	1,526	394.47	OK
23-Nov-12	35.40	10.65	24.75	55.05	10.65	69.16	OK	106.06	105.54	104.71	2.00	105.88	OK	OK	22.1	72.1	2,176	562.65	OK
24-Nov-12	35.40	10.65	24.75	59.65	10.65	73.76	OK	116.96	116.44	115.61	2.10	116.88	OK	OK	26.9	87.9	2,332	603.00	OK
25-Nov-12	35.40	10.65	24.75	42.35	10.65	56.46	OK	76.66	76.14	75.31	1.00	75.48	OK	OK	12.6	40.7	1,781	460.48	OK
26-Nov-12	82.20	10.65	71.55	136.95	10.65	197.86	OK	263.56	263.04	262.21	2.90	264.28	OK	OK	89.2	298.0	3,576	924.45	OK
27-Nov-12	140.80	10.65	130.15	288.05	10.65	407.56	OK	574.66	574.14	573.31	7.40	579.88	OK	OK	390.9	1,339.2	6,051	1,564.34	OK
28-Nov-12	147.00	10.65	136.35	278.65	10.65	404.36	OK	549.76	549.24	548.41	6.40	553.98	OK	OK	341.5	1,167.0	5,766	1,490.77	OK
29-Nov-12	150.50	10.65	139.85	273.15	10.65	402.36	OK	542.66	542.14	541.31	11.90	552.38	OK	OK	326.5	1,114.9	5,675	1,467.12	OK
30-Nov-12	102.30	10.65	91.65	223.95	10.65	304.96	OK	512.96	512.44	511.61	57.30	568.08	OK	OK	380.6	1,303.3	5,994	1,549.53	OK
01-Dec-12	36.20	10.65	25.55	83.45	10.65	98.36	OK	274.66	274.14	273.31	94.20	366.68	OK	OK	193.3	654.2	4,709	1,217.36	OK
02-Dec-12	47.70	10.65	37.05	71.15	10.65	97.56	OK	183.56	183.04	182.21	47.90	229.28	OK	OK	63.3	210.2	3,165	818.25	OK
03-Dec-12	67.50	10.65	56.85	96.65	10.65	142.86	OK	270.46	269.94	269.11	7.60	275.88	OK	OK	125.8	422.7	4,042	1,044.86	OK
04-Dec-12	57.00	10.65	46.35	82.35	10.65	118.06	OK	147.76	147.24	146.41	3.10	148.68	OK	OK	33.0	108.4	2,510	649.00	OK
05-Dec-12	109.00	10.65	98.35	202.15	10.65	289.86	OK	390.76	390.24	389.41	4.90	393.48	OK	OK	183.9	621.8	4,626	1,195.95	OK
06-Dec-12	176.00	10.65	165.35	351.35	10.65	506.06	OK	692.86	692.34	691.51	9.30	699.98	OK	OK	531.9	1,831.8	6,752	1,745.57	OK
07-Dec-12	134.70	10.65	124.05	227.75	10.65	341.16	OK	499.86	499.34	498.51	61.10	558.78	OK	OK	294.6	1,004.4	5,471	1,414.48	OK
08-Dec-12	98.90	10.65	48.25	108.65	10.65	146.26	OK	276.56	276.04	276.21	59.20	333.58	OK	OK	135.2	454.7	4,146	1,071.89	OK
09-Dec-12	32.20	10.65	21.55	81.35	10.65	92.26	OK	173.96	173.44	172.61	9.20	180.98	OK	OK	66.0	219.4	3,213	830.61	OK
10-Dec-12	32.10	10.65	21.45	34.95	10.65	45.76	OK	66.46	65.94	65.11	5.50	69.78	OK	OK	10.6	34.1	1,674	432.69	OK
11-Dec-12	32.10	10.65	21.45	34.75	10.65	45.56	OK	61.06	60.54	59.71	12.40	71.28	OK	OK	9.3	30.0	1,602	414.07	OK
12-Dec-12	32.10	10.65	21.45	34.05	10.65	44.86	OK	59.36	58.84	58.01	12.30	69.48	OK	OK	9.0	29.0	1,582	409.08	OK
13-Dec-12	70.60	10.65	59.95	86.55	10.65	135.86	OK	146.76	146.24	145.41	-	144.58	OK	OK	34.4	113.1	2,548	658.64	OK
14-Dec-12	97.80	10.65	87.15	188.05	10.65	264.56	OK	418.16	417.64	416.81	54.50	470.48	OK	OK	238.3	809.4	5,073	1,311.56	OK
15-Dec-12	57.20	10.65	46.55	133.25	10.65	169.16	OK	318.96	318.44	317.61	55.50	372.28	OK	OK	183.6	620.8	4,623	1,195.29	OK
16-Dec-12	24.80	0.87	23.93	43.63	0.87	66.68	OK	87.48	86.96	86.96	7.10	93.23	OK	OK	9.4	30.2	1,605	414.92	OK
17-Dec-12	21.90	0.87	21.03	40.63	0.87	60.78	OK	91.18	90.66	90.66	16.30	106.13	OK	OK	11.5	37.2	1,727	446.46	OK
18-Dec-12	96.80	0.87	95.93	134.23	0.87	229.28	OK	263.18	262.66	262.66	22.50	284.33	OK	OK	69.2	230.1	3,266	844.46	OK
19-Dec-12	128.70	0.87	127.83	176.63	0.87	303.58	OK	351.28	350.76	350.76	32.70	382.63	OK	OK	119.0	399.6	3,963	1,024.45	OK
20-Dec-12	105.80	0.87	104.93	144.73	0.87	248.78	OK	280.08	279.56	279.56	20.40	299.13	OK	OK	78.6	261.9	3,418	883.66	OK
21-Dec-12	77.20	0.87	76.33	105.43	0.87	180.88	OK	198.38	197.86	197.86	-	197.03	OK	OK	41.9	138.0	2,731	706.14	OK
22-Dec-12	27.20	0.87	26.33	37.63	0.87	63.08	OK	77.38	76.86	76.86	4.10	80.13	OK	OK	7.0	22.5	1,448	374.27	OK
23-Dec-12	119.80	0.87	118.93	165.43	0.87	283.48	OK	332.08	331.56	331.56	28.60	359.33	OK	OK	106.7	357.5	3,811	985.34	OK
24-Dec-12	139.50	0.87	138.63	192.13	0.87	329.88	OK	373.88	373.36	373.36	24.50	397.03	OK	OK	134.9	453.6	4,142	1,070.97	OK
25-Dec-12	76.10	0.87	75.23	121.83	0.87	196.18	OK	250.18	249.66	249.66	21.00	269.83	OK	OK	64.1	213.0	3,179	821.96	OK
26-Dec-12	87.40	0.87	86.53	136.83	0.87	222.48	OK	276.68	276.16	276.16	21.00	296.33	OK	OK	76.4	254.4	3,384	874.76	OK
27-Dec-12	62.50	0.87	61.63	85.03	0.87	145.78	OK	164.78	164.26	164.26	2.40	165.83	OK	OK	29.0	95.0	2,397	619.67	OK
28-Dec-12	80.70	0.87	79.83	112.03	0.87	190.98	OK	211.88	211.36	211.36	1.40	211.93	OK	OK	46.8	154.8	2,843	735.03	OK
29-Dec-12	80.10	0.87	79.23	110.43	0.87	188.78	OK	206.58	206.06	206.06	0.90	206.13	OK	OK	45.2	149.2	2,807	725.63	OK
30-Dec-12	42.00	0.87	41.13	54.13	0.87	94.38	OK	107.68	107.16	107.16	0.30	106.63	OK	OK	13.2	42.7	1,812	468.39	OK
31-Dec-12	36.20	0.87	35.33	60.13	0.87	94.58	OK	128.88	128.36	128.36	7.10	134.63	OK	OK	19.5	63.5	2,082	538.14	OK

Appendix 6.1

WATER BALANCE SIMULATION OF THE KRUENG ACEH CATCHMENT

LULC Scenario I runs on inflow 2012 and water demand 2012 (in m^3/s)

DEMAND	Up	Down
Domestic	0.31	0.33
Non-Domestic	0.22	0.08
Water Losses	0.09	0.11
Min.Environmental Flow	1.12	0.83
Paddy Field	19.55	0.64

	Water Quantity														Water Quality at PDAM Tirta Daroy				
Date	Lampisang Sta			Darang Sta			Upstream	Pasie Sta			Sub Banda Aceh			Downstream	Upstream - Downstream	TSS (mg/l)	Turb (NTU)	Alum (kg/day)	Cost Alum (USD)	PDAM (Quantity & Quality)
	I_1	D_1	(I_1-D_1) R_1	I_2	D_2	$(R_1+I_2-D_2)$ R_2		I_3	$(R_2+I_3-D_{(D+ND+WL)})$ R_3	(R_3-D_{PF}) R_4	I_4	$(R_4+I_4-D_4)$ R_5				(R_2+I_3) = TSS (>2000) $0.000771*(R_2+I_3)^{2.899}$	Limit < 5 NTU $3.093*TSS^{1.017}$	5 NTU<Alum<2000 mg/l $1.2*(8.59*D_{(D+ND+WL)})^{0.35}$	(Alum*USD 0.259)	
RELIABILITY			**94.26%**			**95.63%**	**93.44%**		**98.91%**	**98.09%**		**98.09%**	**98.09%**	**93.44%**	**0.00%**	**6.83%**	**962,682.20**	**248,883.71**	**98.91%**
01-Jan-12	7.20	0.87	6.33	8.73	0.87	14.18	OK	23.28	22.76	22.76	2.30	24.23	OK	OK	1.0	3.2	-	-	OK
02-Jan-12	11.70	0.87	10.83	15.63	0.87	25.58	OK	33.68	33.16	33.16	0.70	33.03	OK	OK	1.6	5.0	856	221.20	OK
03-Jan-12	15.70	0.87	14.83	21.13	0.87	35.08	OK	42.38	41.86	41.86	0.30	41.33	OK	OK	2.4	7.4	980	253.48	OK
04-Jan-12	11.50	0.87	10.63	15.23	0.87	24.98	OK	31.78	31.26	31.26	0.80	31.23	OK	OK	1.4	4.4	-	-	OK
05-Jan-12	16.80	0.87	15.93	25.53	0.87	40.58	OK	110.08	109.56	109.56	12.80	121.53	OK	OK	30.7	100.8	2,447	632.66	OK
06-Jan-12	22.20	0.87	21.33	31.33	0.87	51.78	OK	125.28	124.76	124.76	13.20	137.13	OK	OK	35.3	116.0	2,570	664.45	OK
07-Jan-12	11.20	0.87	10.33	14.03	0.87	23.48	OK	32.08	31.56	31.56	1.30	32.03	OK	OK	1.5	4.7	-	-	OK
08-Jan-12	57.50	0.87	56.63	67.93	0.87	123.68	OK	131.98	131.46	131.46	0.40	131.03	OK	OK	21.1	68.6	2,139	552.91	OK
09-Jan-12	86.58	0.87	85.71	100.89	0.87	185.72	OK	199.08	198.56	198.56	0.98	198.71	OK	OK	45.6	150.5	2,816	727.90	OK
10-Jan-12	23.66	0.87	22.79	32.36	0.87	54.27	OK	72.93	72.41	72.41	3.50	75.08	OK	OK	6.6	21.1	1,416	366.03	OK
11-Jan-12	94.12	0.87	93.25	116.57	0.87	208.94	OK	230.46	229.94	229.94	2.66	231.77	OK	OK	56.7	188.0	3,043	786.82	OK
12-Jan-12	101.66	0.87	100.79	124.33	0.87	224.24	OK	241.63	241.10	241.10	1.96	242.23	OK	OK	63.7	211.5	3,171	819.90	OK
13-Jan-12	34.84	0.87	33.97	44.20	0.87	77.29	OK	88.85	88.32	88.32	1.82	89.31	OK	OK	9.3	29.8	1,597	412.78	OK
14-Jan-12	30.03	0.87	29.16	54.13	0.87	82.41	OK	144.74	144.22	144.22	17.36	160.75	OK	OK	32.7	107.3	2,501	646.54	OK
15-Jan-12	23.53	0.87	22.66	46.53	0.87	68.31	OK	131.60	131.07	131.07	17.36	147.60	OK	OK	30.9	101.3	2,451	633.76	OK
16-Jan-12	329.68	0.87	328.81	409.00	0.87	736.93	OK	764.81	764.29	764.29	1.82	765.28	OK	OK	584.4	2,015.9	6,982	1,805.09	OK
17-Jan-12	359.58	0.87	358.71	441.21	0.87	799.04	OK	824.59	824.07	824.07	1.26	824.50	OK	OK	683.0	2,362.2	7,380	1,908.05	OK
18-Jan-12	70.20	0.87	69.33	79.34	0.87	147.79	OK	155.21	154.69	154.69	0.42	154.28	OK	OK	29.8	97.8	2,421	625.99	OK
19-Jan-12	72.54	0.87	71.67	83.88	0.87	154.67	OK	164.21	163.69	163.69	0.84	163.70	OK	OK	32.3	105.9	2,489	643.60	OK
20-Jan-12	73.58	0.87	72.71	87.56	0.87	159.39	OK	171.80	171.27	171.27	0.84	171.28	OK	OK	34.0	111.6	2,536	655.63	OK
21-Jan-12	69.29	0.87	68.42	76.12	0.87	143.66	OK	151.61	151.09	151.09	0.28	150.54	OK	OK	28.9	94.7	2,394	619.01	OK
22-Jan-12	66.95	0.87	66.08	68.17	0.87	133.37	OK	134.22	133.70	133.70	-	132.87	OK	OK	26.3	86.0	2,315	598.45	OK
23-Jan-12	65.39	0.87	64.52	66.61	0.87	130.25	OK	130.89	130.37	130.37	-	129.54	OK	OK	25.1	82.2	2,278	588.97	OK
24-Jan-12	65.00	0.87	64.13	66.22	0.87	129.47	OK	130.00	129.48	129.48	-	128.65	OK	OK	24.9	81.2	2,269	586.59	OK
25-Jan-12	63.31	0.87	62.44	64.42	0.87	125.98	OK	126.41	125.88	125.88	-	125.05	OK	OK	23.6	77.2	2,229	576.21	OK
26-Jan-12	58.89	0.87	58.02	60.00	0.87	117.14	OK	117.46	116.94	116.94	-	116.11	OK	OK	20.6	67.1	2,122	548.72	OK
27-Jan-12	59.02	0.87	58.15	60.13	0.87	117.40	OK	117.62	117.09	117.09	-	116.26	OK	OK	20.7	67.4	2,126	549.54	OK
28-Jan-12	74.23	0.87	73.36	79.74	0.87	152.22	OK	153.50	152.97	152.97	-	152.14	OK	OK	32.3	105.9	2,489	643.59	OK
29-Jan-12	195.26	0.87	194.39	235.86	0.87	429.37	OK	441.99	441.46	441.46	0.14	440.77	OK	OK	212.2	719.5	4,868	1,258.60	OK
30-Jan-12	263.51	0.87	262.64	323.69	0.87	585.46	OK	623.40	622.88	622.88	10.36	632.41	OK	OK	385.4	1,320.0	6,020	1,556.43	OK
31-Jan-12	270.14	0.87	269.27	332.96	0.87	601.35	OK	641.00	640.47	640.47	10.36	650.00	OK	OK	405.2	1,388.8	6,128	1,584.37	OK
01-Feb-12	237.51	0.87	236.64	295.71	0.87	531.47	OK	564.12	563.60	563.60	4.20	566.97	OK	OK	318.4	1,086.8	5,624	1,454.08	OK
02-Feb-12	143.00	0.87	142.13	176.45	0.87	317.70	OK	346.32	345.80	345.80	5.46	350.43	OK	OK	123.6	415.1	4,016	1,038.22	OK
03-Feb-12	97.89	0.87	97.02	115.06	0.87	211.20	OK	221.06	220.54	220.54	1.40	221.11	OK	OK	56.9	188.6	3,047	787.65	OK
04-Feb-12	97.11	0.87	96.24	124.18	0.87	219.54	OK	241.17	240.64	240.64	0.56	240.37	OK	OK	61.3	203.3	3,128	808.73	OK
05-Feb-12	93.21	0.87	92.34	150.64	0.87	242.10	OK	354.99	354.47	354.47	35.28	388.92	OK	OK	140.2	472.0	4,201	1,085.99	OK
06-Feb-12	80.34	0.87	79.47	122.15	0.87	200.74	OK	297.84	297.32	297.32	34.86	331.35	OK	OK	101.5	339.7	3,744	967.85	OK
07-Feb-12	84.37	0.87	83.50	104.40	0.87	187.02	OK	203.67	203.14	203.14	3.22	205.53	OK	OK	45.5	150.1	2,813	727.30	OK
08-Feb-12	74.36	0.87	73.49	88.23	0.87	160.84	OK	172.72	172.19	172.19	1.12	172.48	OK	OK	34.5	113.4	2,550	659.25	OK
09-Feb-12	65.91	0.87	65.04	69.66	0.87	133.82	OK	142.41	141.89	141.89	0.28	141.34	OK	OK	26.2	85.6	2,311	597.49	OK
10-Feb-12	65.91	0.87	65.04	73.51	0.87	137.67	OK	149.23	148.70	148.70	0.28	148.15	OK	OK	26.9	88.1	2,335	603.57	OK
11-Feb-12	79.56	0.87	78.69	105.20	0.87	183.01	OK	227.22	226.69	226.69	11.06	236.92	OK	OK	52.9	175.1	2,968	767.45	OK
12-Feb-12	115.31	0.87	114.44	164.38	0.87	277.94	OK	347.16	346.64	346.64	16.24	362.05	OK	OK	116.7	391.8	3,935	1,017.39	OK
13-Feb-12	103.48	0.87	102.61	174.22	0.87	275.95	OK	404.64	404.11	404.11	37.94	441.22	OK	OK	180.7	610.9	4,597	1,188.55	OK

14-Feb-12	247.52	0.87	246.65	374.58	0.87	620.35	OK	771.09	770.56	770.56	34.16	803.89	OK	OK	527.2	1,815.2	6,730	1,740.04	OK
15-Feb-12	248.95	0.87	248.08	340.59	0.87	587.79	OK	649.70	649.17	649.17	3.50	651.84	OK	OK	389.3	1,333.6	6,042	1,562.02	OK
16-Feb-12	68.90	0.87	68.03	80.46	0.87	147.61	OK	162.45	161.93	161.93	1.12	162.22	OK	OK	30.3	99.3	2,434	629.39	OK
17-Feb-12	63.57	0.87	62.70	73.26	0.87	135.08	OK	146.21	145.69	145.69	0.42	145.28	OK	OK	25.4	83.2	2,288	591.50	OK
18-Feb-12	60.06	0.87	59.19	68.43	0.87	126.74	OK	135.12	134.59	134.59	0.14	133.90	OK	OK	22.5	73.3	2,189	565.92	OK
19-Feb-12	57.07	0.87	56.20	65.33	0.87	120.65	OK	126.91	126.38	126.38	-	125.55	OK	OK	20.3	66.0	2,110	545.50	OK
20-Feb-12	54.47	0.87	53.60	62.62	0.87	115.34	OK	120.11	119.59	119.59	-	118.76	OK	OK	18.5	60.1	2,042	528.01	OK
21-Feb-12	54.21	0.87	53.34	64.34	0.87	116.80	OK	123.06	122.53	122.53	0.14	121.84	OK	OK	18.7	60.9	2,051	530.27	OK
22-Feb-12	62.92	0.87	62.05	80.20	0.87	141.37	OK	157.49	156.96	156.96	3.50	159.63	OK	OK	27.3	89.3	2,345	606.37	OK
23-Feb-12	70.85	0.87	69.98	91.54	0.87	160.64	OK	178.24	177.72	177.72	3.64	180.53	OK	OK	34.4	112.9	2,546	658.22	OK
24-Feb-12	55.38	0.87	54.51	72.55	0.87	126.18	OK	145.69	145.16	145.16	5.32	149.65	OK	OK	23.0	75.1	2,207	570.62	OK
25-Feb-12	60.58	0.87	59.71	76.21	0.87	135.04	OK	150.73	150.21	150.21	5.18	154.56	OK	OK	25.2	82.4	2,280	589.56	OK
26-Feb-12	58.11	0.87	57.24	71.21	0.87	127.57	OK	139.13	138.60	138.60	0.42	138.19	OK	OK	22.3	72.8	2,184	564.62	OK
27-Feb-12	108.68	0.87	107.81	145.32	0.87	252.25	OK	281.62	281.09	281.09	5.18	285.44	OK	OK	80.1	267.1	3,442	889.74	OK
28-Feb-12	153.79	0.87	152.92	206.49	0.87	358.53	OK	399.03	398.50	398.50	9.80	407.47	OK	OK	154.7	521.7	4,350	1,124.66	OK
29-Feb-12	91.78	0.87	90.91	127.65	0.87	217.68	OK	251.60	251.08	251.08	6.72	256.97	OK	OK	63.4	210.6	3,167	818.68	OK
01-Mar-12	47.84	10.65	37.19	54.46	10.65	81.01	OK	98.40	97.87	97.04	1.82	98.03	OK	OK	17.9	58.1	2,018	521.79	OK
02-Mar-12	43.03	10.65	32.38	47.78	10.65	69.52	OK	83.30	82.78	81.95	0.70	81.82	OK	OK	14.2	46.1	1,861	481.17	OK
03-Mar-12	44.20	10.65	33.55	51.92	10.65	74.83	OK	88.40	87.88	87.05	0.56	86.78	OK	OK	15.4	50.1	1,915	495.17	OK
04-Mar-12	165.88	10.65	155.23	204.40	10.65	348.99	OK	370.51	369.99	369.16	4.76	373.09	OK	OK	164.8	556.2	4,449	1,150.17	OK
05-Mar-12	235.95	10.65	225.30	293.94	10.65	508.60	OK	534.68	534.15	533.32	4.76	537.26	OK	OK	319.3	1,089.9	5,630	1,455.51	OK
06-Mar-12	162.24	10.65	151.59	191.30	10.65	332.25	OK	391.19	390.66	389.83	49.84	438.85	OK	OK	171.4	578.9	4,512	1,166.41	OK
07-Mar-12	85.54	10.65	74.89	95.79	10.65	160.04	OK	218.87	218.35	217.52	50.26	266.95	OK	OK	65.2	216.7	3,199	826.95	OK
08-Mar-12	95.68	10.65	85.03	108.68	10.65	183.07	OK	197.70	197.18	196.35	4.48	200.00	OK	OK	56.8	188.3	3,045	787.35	OK
09-Mar-12	96.72	10.65	86.07	118.41	10.65	193.84	OK	218.01	217.49	216.66	2.10	217.93	OK	OK	63.2	209.8	3,163	817.64	OK
10-Mar-12	119.99	10.65	109.34	254.43	10.65	353.13	OK	512.45	511.93	511.10	8.54	518.81	OK	OK	329.9	1,126.8	5,696	1,472.58	OK
11-Mar-12	206.57	10.65	195.92	402.50	10.65	587.78	OK	816.64	816.11	815.28	29.26	843.71	OK	OK	717.6	2,483.9	7,511	1,941.90	OK
12-Mar-12	142.09	10.65	131.44	211.19	10.65	331.99	OK	455.38	454.85	454.02	57.82	511.01	OK	OK	230.1	781.1	5,010	1,295.35	OK
13-Mar-12	169.13	10.65	158.48	196.54	10.65	344.38	OK	388.48	387.95	387.12	35.84	422.14	OK	OK	173.5	586.2	4,531	1,171.51	OK
14-Mar-12	172.12	10.65	161.47	214.93	10.65	365.76	OK	425.12	424.60	423.77	33.32	456.26	OK	OK	195.8	663.0	4,731	1,223.08	OK
15-Mar-12	114.14	10.65	103.49	148.15	10.65	241.00	OK	307.36	306.83	306.00	34.02	339.20	OK	OK	110.3	369.8	3,856	997.02	OK
16-Mar-12	237.64	10.65	226.99	293.98	10.65	510.33	OK	535.56	535.04	534.21	4.76	538.14	OK	OK	321.7	1,098.3	5,645	1,459.41	OK
17-Mar-12	233.35	10.65	222.70	286.50	10.65	498.56	OK	522.52	521.99	521.16	1.82	522.16	OK	OK	309.0	1,054.4	5,565	1,438.77	OK
18-Mar-12	194.35	10.65	183.70	234.30	10.65	407.36	OK	429.20	428.67	427.84	2.24	429.26	OK	OK	217.3	737.1	4,910	1,269.30	OK
19-Mar-12	177.32	10.65	166.67	216.83	10.65	372.86	OK	400.42	399.90	399.07	2.38	400.62	OK	OK	187.0	632.7	4,654	1,203.24	OK
20-Mar-12	132.47	10.65	121.82	157.68	10.65	268.86	OK	291.76	291.23	290.40	1.12	290.70	OK	OK	107.4	359.9	3,820	987.65	OK
21-Mar-12	141.96	10.65	131.31	155.84	10.65	276.51	OK	293.68	293.16	292.33	-	291.50	OK	OK	115.3	386.9	3,918	1,012.99	OK
22-Mar-12	129.35	10.65	118.70	141.25	10.65	249.31	OK	262.99	262.46	261.63	-	260.80	OK	OK	96.3	322.2	3,675	950.10	OK
23-Mar-12	98.80	10.65	88.15	137.32	10.65	214.83	OK	268.68	268.16	267.33	2.52	269.02	OK	OK	86.9	290.3	3,543	916.04	OK
24-Mar-12	74.10	10.65	63.45	105.47	10.65	158.28	OK	215.73	215.21	214.38	10.08	223.63	OK	OK	62.3	206.8	3,147	813.55	OK
25-Mar-12	73.58	10.65	62.93	77.89	10.65	130.18	OK	151.49	150.96	150.13	7.56	156.87	OK	OK	35.9	118.1	2,587	668.70	OK
26-Mar-12	67.60	10.65	56.95	111.07	10.65	157.38	OK	219.50	218.97	218.14	2.94	220.26	OK	OK	67.0	222.8	3,230	835.03	OK
27-Mar-12	63.70	10.65	53.05	110.69	10.65	153.10	OK	236.63	236.11	235.28	22.82	257.27	OK	OK	83.6	278.9	3,494	903.35	OK
28-Mar-12	57.33	10.65	46.68	71.65	10.65	107.69	OK	180.83	180.31	179.48	55.58	234.23	OK	OK	54.6	181.0	3,003	776.41	OK
29-Mar-12	59.67	10.65	49.02	71.24	10.65	109.62	OK	157.53	157.01	156.18	35.70	191.05	OK	OK	38.2	125.9	2,645	683.73	OK
30-Mar-12	73.06	10.65	62.41	80.45	10.65	132.22	OK	152.47	151.94	151.11	-	150.29	OK	OK	35.9	118.0	2,585	668.40	OK
31-Mar-12	60.06	10.65	49.41	65.47	10.65	104.24	OK	119.51	118.98	118.15	-	117.32	OK	OK	24.7	80.7	2,263	585.13	OK
01-Apr-12	47.06	10.65	36.41	48.07	10.65	73.84	OK	84.44	83.92	83.09	-	82.26	OK	OK	15.2	49.2	1,904	492.12	OK
02-Apr-12	251.29	10.65	240.64	315.22	10.65	545.22	OK	568.75	568.23	567.40	-	566.57	OK	OK	359.7	1,230.5	5,874	1,518.65	OK
03-Apr-12	316.03	10.65	305.38	398.88	10.65	693.62	OK	719.80	719.28	718.45	-	717.62	OK	OK	554.5	1,911.0	6,853	1,771.65	OK
04-Apr-12	182.52	10.65	171.87	229.40	10.65	390.63	OK	412.79	412.26	411.43	0.42	411.02	OK	OK	199.3	675.0	4,761	1,230.81	OK
05-Apr-12	154.96	10.65	144.31	194.14	10.65	327.81	OK	356.43	355.91	355.08	10.78	365.03	OK	OK	149.5	503.7	4,297	1,110.97	OK
06-Apr-12	94.12	10.65	83.47	108.44	10.65	181.27	OK	198.55	198.03	197.20	11.62	207.99	OK	OK	56.2	186.1	3,033	784.12	OK
07-Apr-12	88.92	10.65	78.27	111.49	10.65	179.12	OK	197.78	197.25	196.42	1.96	197.56	OK	OK	54.3	179.7	2,996	774.50	OK
08-Apr-12	120.38	10.65	109.73	198.61	10.65	297.70	OK	375.61	375.09	374.26	4.06	377.49	OK	OK	160.0	539.8	4,403	1,138.19	OK
09-Apr-12	108.68	10.65	98.03	175.25	10.65	262.64	OK	329.53	329.00	328.17	3.50	330.85	OK	OK	126.5	425.1	4,050	1,046.94	OK
10-Apr-12	97.63	10.65	86.98	113.49	10.65	189.83	OK	325.72	325.20	324.37	142.52	466.06	OK	OK	159.0	536.4	4,393	1,135.66	OK
11-Apr-12	76.31	10.65	65.66	83.81	10.65	138.83	OK	270.91	270.38	269.55	142.38	411.11	OK	OK	131.3	441.4	4,103	1,060.82	OK
12-Apr-12	51.09	10.65	40.44	51.11	10.65	80.91	OK	94.16	93.64	92.81	12.60	104.58	OK	OK	17.7	57.6	2,011	519.99	OK
13-Apr-12	50.83	10.65	40.18	52.28	10.65	81.82	OK	96.13	95.61	94.78	6.58	100.53	OK	OK	18.0	58.4	2,022	522.65	OK
14-Apr-12	50.70	10.65	40.05	57.87	10.65	87.28	OK	121.10	120.57	119.74	20.44	139.35	OK	OK	24.8	81.0	2,266	585.91	OK
15-Apr-12	50.44	10.65	39.79	55.96	10.65	85.11	OK	112.78	112.25	111.42	16.80	127.40	OK	OK	22.0	71.7	2,172	561.59	OK
16-Apr-12	49.53	10.65	38.88	48.78	10.65	77.02	OK	81.05	80.53	79.70	0.14	79.01	OK	OK	15.6	50.7	1,924	497.29	OK
17-Apr-12	64.61	10.65	53.96	68.81	10.65	112.13	OK	126.34	125.81	124.98	10.78	134.93	OK	OK	27.4	89.8	2,350	607.43	OK
18-Apr-12	65.39	10.65	54.74	69.81	10.65	113.91	OK	132.57	132.04	131.21	16.10	146.49	OK	OK	29.0	94.9	2,396	619.40	OK

19-Apr-12	45.50	10.65	34.85	44.75	10.65	68.96	OK	75.85	75.33	74.50	5.32	78.99	OK	OK	13.6	44.1	1,833	473.86	OK
20-Apr-12	31.20	10.65	20.55	60.26	10.65	70.17	OK	109.92	109.40	108.57	2.24	109.98	OK	OK	25.6	83.8	2,294	593.08	OK
21-Apr-12	29.51	10.65	18.86	58.46	10.65	66.68	OK	106.11	105.59	104.76	2.24	106.17	OK	OK	24.8	81.1	2,268	586.29	OK
22-Apr-12	24.31	10.65	13.66	25.98	10.65	29.00	OK	33.67	33.14	32.31	0.70	32.18	OK	OK	5.1	16.1	1,287	332.64	OK
23-Apr-12	23.01	10.65	12.36	60.10	10.65	61.82	OK	111.43	110.91	110.08	3.08	112.33	OK	OK	32.1	105.4	2,486	642.59	OK
24-Apr-12	22.10	10.65	11.45	121.45	10.65	122.26	OK	251.16	250.63	249.80	7.70	256.68	OK	OK	161.7	545.7	4,419	1,142.56	OK
25-Apr-12	18.98	10.65	8.33	84.34	10.65	82.03	OK	167.68	167.16	166.33	5.04	170.54	OK	OK	77.7	259.0	3,405	880.18	OK
26-Apr-12	16.77	10.65	6.12	16.57	10.65	12.05	OK	24.45	23.93	23.10	1.12	23.39	OK	OK	3.7	11.8	1,155	298.60	OK
27-Apr-12	15.21	10.65	4.56	13.36	10.65	7.28	OK	15.13	14.60	13.77	0.28	13.22	OK	OK	2.6	8.1	1,012	261.69	OK
28-Apr-12	13.78	10.65	3.13	11.82	10.65	4.31	OK	22.23	21.70	20.87	13.44	33.48	OK	OK	4.0	12.6	1,183	305.89	OK
29-Apr-12	87.62	10.65	76.97	108.98	10.65	175.31	OK	198.74	198.21	197.38	13.58	210.14	OK	OK	53.8	178.1	2,987	772.16	OK
30-Apr-12	131.95	10.65	121.30	165.63	10.65	276.29	OK	289.75	289.23	288.40	1.26	288.83	OK	OK	108.5	363.6	3,834	991.21	OK
01-May-12	62.27	10.65	51.62	72.52	10.65	113.50	OK	121.45	120.93	120.10	3.08	122.35	OK	OK	26.2	85.7	2,312	597.75	OK
02-May-12	27.69	10.65	17.04	27.27	10.65	33.67	OK	38.44	37.92	37.09	2.80	39.06	OK	OK	5.8	18.6	1,353	349.85	OK
03-May-12	34.19	10.65	23.54	35.64	10.65	48.54	OK	50.87	50.35	49.52	-	48.69	OK	OK	8.4	26.9	1,541	398.43	OK
04-May-12	30.94	10.65	20.29	31.29	10.65	40.94	OK	52.28	51.76	50.93	10.78	60.88	OK	OK	7.8	25.0	1,502	388.42	OK
05-May-12	110.24	10.65	99.59	134.57	10.65	223.52	OK	240.59	240.06	239.23	10.78	249.19	OK	OK	77.3	257.6	3,398	878.53	OK
06-May-12	110.76	10.65	100.11	134.10	10.65	223.57	OK	259.40	258.88	258.05	32.34	289.56	OK	OK	83.6	278.8	3,494	903.18	OK
07-May-12	26.78	10.65	16.13	24.05	10.65	29.54	OK	58.80	58.27	57.44	32.34	88.96	OK	OK	10.5	33.8	1,670	431.72	OK
08-May-12	26.13	10.65	15.48	78.40	10.65	89.24	OK	153.73	153.21	152.38	4.20	155.75	OK	OK	56.7	187.8	3,043	786.62	OK
09-May-12	26.13	10.65	15.48	78.29	10.65	83.13	OK	153.52	152.99	152.16	4.20	155.53	OK	OK	56.5	187.3	3,040	785.82	OK
10-May-12	51.61	10.65	40.96	56.36	10.65	86.68	OK	93.57	93.05	92.22	-	91.39	OK	OK	18.0	58.4	2,022	522.62	OK
11-May-12	65.39	10.65	54.74	94.01	10.65	138.11	OK	170.34	169.81	168.98	1.54	169.69	OK	OK	41.2	135.7	2,715	702.04	OK
12-May-12	85.80	10.65	75.15	125.09	10.65	189.60	OK	228.61	228.09	227.26	1.96	228.39	OK	OK	66.5	221.0	3,221	832.70	OK
13-May-12	100.49	10.65	89.84	123.39	10.65	202.59	OK	216.27	215.74	214.91	0.42	214.50	OK	OK	65.1	216.4	3,197	826.53	OK
14-May-12	64.35	10.65	53.70	70.64	10.65	113.70	OK	120.17	119.64	118.81	-	117.99	OK	OK	26.6	87.0	2,324	600.81	OK
15-May-12	39.39	0.87	38.52	47.65	0.87	85.29	OK	90.06	89.54	89.54	-	88.71	OK	OK	10.4	33.3	1,661	429.47	OK
16-May-12	73.19	0.87	72.32	92.01	0.87	163.45	OK	174.58	174.06	174.06	5.46	178.69	OK	OK	34.5	113.5	2,551	659.40	OK
17-May-12	194.35	0.87	193.48	250.68	0.87	443.28	OK	467.77	467.25	467.25	10.78	477.20	OK	OK	222.1	753.7	4,948	1,279.21	OK
18-May-12	180.18	0.87	179.31	230.68	0.87	409.11	OK	426.71	426.19	426.19	5.46	430.82	OK	OK	190.1	643.3	4,681	1,210.23	OK
19-May-12	59.93	0.87	59.06	72.81	0.87	130.99	OK	137.46	136.94	136.94	-	136.11	OK	OK	22.9	74.7	2,203	569.51	OK
20-May-12	36.79	0.87	35.92	42.74	0.87	77.78	OK	81.39	80.86	80.86	-	80.03	OK	OK	8.9	28.5	1,572	406.34	OK
21-May-12	36.40	0.87	35.53	42.35	0.87	77.00	OK	79.76	79.24	79.24	-	78.41	OK	OK	8.7	27.8	1,558	402.89	OK
22-May-12	40.95	0.87	40.08	48.77	0.87	87.97	OK	116.38	115.86	115.86	29.12	144.15	OK	OK	16.0	51.9	1,940	501.57	OK
23-May-12	35.75	0.87	34.88	43.46	0.87	77.46	OK	112.55	112.03	112.03	37.38	148.58	OK	OK	16.2	52.5	1,948	503.60	OK
24-May-12	31.07	0.87	30.20	46.70	0.87	76.02	OK	125.95	125.43	125.43	41.58	166.18	OK	OK	23.0	75.0	2,206	570.39	OK
25-May-12	30.42	0.87	29.55	45.94	0.87	74.61	OK	140.44	139.92	139.92	60.06	199.15	OK	OK	33.1	108.7	2,512	649.54	OK
26-May-12	30.42	0.87	29.55	36.04	0.87	64.71	OK	88.88	88.36	88.36	26.60	114.13	OK	OK	10.0	32.1	1,639	423.69	OK
27-May-12	29.77	0.87	28.90	38.36	0.87	66.39	OK	80.48	79.96	79.96	11.20	90.33	OK	OK	7.6	24.4	1,490	385.23	OK
28-May-12	284.31	0.87	283.44	371.00	0.87	653.56	OK	699.78	699.26	699.26	24.92	723.35	OK	OK	466.2	1,601.8	6,442	1,665.49	OK
29-May-12	293.41	0.87	292.54	376.91	0.87	668.57	OK	701.12	700.59	700.59	13.72	713.48	OK	OK	482.1	1,657.6	6,520	1,685.58	OK
30-May-12	105.95	0.87	105.08	130.60	0.87	234.80	OK	265.65	265.13	265.13	29.54	293.84	OK	OK	73.0	243.0	3,330	860.82	OK
31-May-12	105.82	0.87	104.95	130.36	0.87	234.43	OK	270.05	269.53	269.53	35.00	303.70	OK	OK	74.7	248.8	3,357	867.95	OK
01-Jun-12	43.94	0.87	43.07	49.12	0.87	91.31	OK	97.78	97.26	97.26	5.88	102.31	OK	OK	12.4	40.0	1,770	457.66	OK
02-Jun-12	42.51	0.87	41.64	47.58	0.87	88.34	OK	89.62	89.09	89.09	0.14	88.40	OK	OK	11.4	36.6	1,717	443.81	OK
03-Jun-12	37.57	0.87	36.70	135.70	0.87	171.52	OK	290.99	290.46	290.46	7.28	296.91	OK	OK	142.8	480.9	4,228	1,093.07	OK
04-Jun-12	30.16	0.87	29.29	128.29	0.87	156.70	OK	275.95	275.43	275.43	7.14	281.74	OK	OK	139.6	469.7	4,193	1,084.14	OK
05-Jun-12	30.68	0.87	29.81	35.64	0.87	64.57	OK	107.29	106.77	106.77	48.16	154.10	OK	OK	17.4	56.5	1,998	516.60	OK
06-Jun-12	30.42	0.87	29.55	35.27	0.87	63.94	OK	116.20	115.68	115.68	59.22	174.07	OK	OK	22.5	73.4	2,190	566.22	OK
07-Jun-12	30.42	0.87	29.55	46.05	0.87	74.72	OK	115.43	114.90	114.90	31.22	145.29	OK	OK	17.9	58.2	2,019	521.89	OK
08-Jun-12	30.16	0.87	29.29	45.79	0.87	74.20	OK	107.59	107.07	107.07	22.96	129.20	OK	OK	14.6	47.3	1,878	485.45	OK
09-Jun-12	29.64	0.87	28.77	34.27	0.87	62.16	OK	73.29	72.77	72.77	5.74	77.68	OK	OK	6.7	21.3	1,421	367.43	OK
10-Jun-12	29.64	0.87	28.77	34.27	0.87	62.16	OK	70.54	70.01	70.01	2.80	71.98	OK	OK	6.3	20.2	1,393	360.20	OK
11-Jun-12	58.37	0.87	57.50	71.58	0.87	128.20	OK	134.78	134.25	134.25	-	133.42	OK	OK	21.9	71.4	2,169	560.80	OK
12-Jun-12	59.54	0.87	58.67	73.30	0.87	131.09	OK	137.35	136.82	136.82	-	135.99	OK	OK	22.8	74.3	2,199	568.46	OK
13-Jun-12	31.46	0.87	30.59	39.28	0.87	68.99	OK	75.88	75.36	75.36	0.28	74.81	OK	OK	7.1	22.9	1,456	376.34	OK
14-Jun-12	26.13	0.87	25.26	33.29	0.87	57.67	OK	63.08	62.56	62.56	0.28	62.01	OK	OK	5.1	16.2	1,289	333.36	OK
15-Jun-12	10.40	0.87	9.53	14.70	0.87	23.35	OK	24.73	24.21	24.21	-	23.38	OK	OK	1.0	3.0	-	-	OK
16-Jun-12	13.65	0.87	12.78	17.95	0.87	29.85	OK	30.91	30.39	30.39	-	29.56	OK	OK	1.5	4.6	-	-	OK
17-Jun-12	8.32	0.87	7.45	16.91	0.87	23.48	OK	29.84	29.32	29.32	0.28	28.77	OK	OK	1.4	4.5	-	-	OK
18-Jun-12	9.75	0.87	8.88	18.23	0.87	26.23	OK	32.38	31.86	31.86	0.28	31.31	OK	OK	1.6	4.9	-	-	OK
19-Jun-12	15.73	0.87	14.86	21.79	0.87	35.77	OK	36.73	36.20	36.20	-	35.37	OK	OK	2.0	6.4	931	240.75	OK
20-Jun-12	112.19	0.87	111.32	169.84	0.87	280.28	OK	317.17	316.65	316.65	1.82	317.64	OK	OK	98.8	330.5	3,708	958.65	OK
21-Jun-12	112.97	0.87	112.10	169.63	0.87	280.85	OK	317.42	316.90	316.90	1.82	317.89	OK	OK	98.9	331.0	3,710	959.13	OK
22-Jun-12	20.41	0.87	19.54	25.37	0.87	44.03	OK	47.64	47.11	47.11	-	46.28	OK	OK	3.1	9.8	1,082	279.72	OK

23-Jun-12	16.64	0.87	15.77	20.50	0.87	35.39	OK	37.94	37.41	37.41	-	36.58	OK	OK	2.1	6.5	940	242.89	OK
24-Jun-12	16.64	0.87	15.77	20.50	0.87	35.39	OK	37.30	36.78	36.78	-	35.95	OK	OK	2.1	6.5	936	241.97	OK
25-Jun-12	16.51	0.87	15.64	20.26	0.87	35.02	OK	36.40	35.88	35.88	-	35.05	OK	OK	2.0	6.3	928	239.91	OK
26-Jun-12	16.51	0.87	15.64	20.26	0.87	35.02	OK	36.08	35.56	35.56	-	34.73	OK	OK	2.0	6.3	927	239.63	OK
27-Jun-12	48.49	0.87	47.62	61.81	0.87	108.55	OK	111.73	111.21	111.21	-	110.38	OK	OK	15.7	50.8	1,926	497.87	OK
28-Jun-12	49.14	0.87	48.27	62.46	0.87	109.85	OK	112.82	112.30	112.30	-	111.47	OK	OK	16.0	52.0	1,941	501.85	OK
29-Jun-12	16.25	0.87	15.38	19.89	0.87	34.39	OK	34.82	34.29	34.29	-	33.46	OK	OK	1.9	6.1	915	236.63	OK
30-Jun-12	16.51	0.87	15.64	20.04	0.87	34.80	OK	35.12	34.60	34.60	-	33.77	OK	OK	2.0	6.2	923	238.64	OK
01-Jul-12	16.25	0.87	15.38	19.78	0.87	34.28	OK	49.02	48.49	48.49	16.66	64.32	OK	OK	3.4	10.8	1,119	289.26	OK
02-Jul-12	16.25	0.87	15.38	19.67	0.87	34.17	OK	48.91	48.38	48.38	16.66	64.21	OK	OK	3.4	10.8	1,118	289.05	OK
03-Jul-12	16.12	0.87	15.25	21.74	0.87	36.11	OK	39.08	38.56	38.56	1.54	39.27	OK	OK	2.1	6.7	947	244.93	OK
04-Jul-12	16.12	0.87	15.25	21.63	0.87	36.00	OK	38.87	38.34	38.34	0.56	38.07	OK	OK	2.1	6.7	945	244.33	OK
05-Jul-12	15.99	0.87	15.12	19.30	0.87	33.54	OK	33.65	33.13	33.13	0.14	32.44	OK	OK	1.9	5.8	902	233.27	OK
06-Jul-12	15.86	0.87	14.99	19.17	0.87	33.28	OK	33.39	32.87	32.87	-	32.04	OK	OK	1.8	5.7	898	232.08	OK
07-Jul-12	13.52	0.87	12.65	16.72	0.87	28.49	OK	38.25	37.72	37.72	11.06	47.95	OK	OK	2.1	6.5	935	241.76	OK
08-Jul-12	10.79	0.87	9.92	14.98	0.87	24.02	OK	48.40	47.88	47.88	27.72	74.77	OK	OK	4.9	15.5	1,270	328.23	OK
09-Jul-12	131.04	0.87	130.17	170.98	0.87	300.27	OK	323.91	323.39	323.39	16.66	339.22	OK	OK	107.9	361.6	3,826	989.24	OK
10-Jul-12	132.21	0.87	131.34	171.05	0.87	301.51	OK	310.95	310.42	310.42	2.38	311.97	OK	OK	106.0	355.0	3,802	982.95	OK
11-Jul-12	17.29	0.87	16.42	20.38	0.87	35.92	OK	38.26	37.73	37.73	1.12	38.02	OK	OK	2.2	6.8	953	246.32	OK
12-Jul-12	16.38	0.87	15.51	19.36	0.87	33.99	OK	35.27	34.74	34.74	0.14	34.05	OK	OK	1.9	6.1	915	236.58	OK
13-Jul-12	16.51	0.87	15.64	19.49	0.87	34.25	OK	35.21	34.68	34.68	-	33.85	OK	OK	2.0	6.1	919	237.51	OK
14-Jul-12	15.86	0.87	14.99	34.35	0.87	48.46	OK	73.80	73.27	73.27	6.72	79.16	OK	OK	8.3	26.7	1,538	397.51	OK
15-Jul-12	13.78	0.87	12.91	39.97	0.87	52.00	OK	101.82	101.30	101.30	13.44	113.91	OK	OK	21.0	68.3	2,136	552.17	OK
16-Jul-12	14.30	0.87	13.43	24.87	0.87	37.42	OK	62.44	61.92	61.92	6.72	67.81	OK	OK	6.4	20.3	1,397	361.05	OK
17-Jul-12	17.29	0.87	16.42	40.07	0.87	55.61	OK	80.31	79.79	79.79	1.54	80.50	OK	OK	9.6	30.8	1,616	417.92	OK
18-Jul-12	17.42	0.87	16.55	40.42	0.87	56.09	OK	81.11	80.59	80.59	1.54	81.30	OK	OK	9.8	31.5	1,628	420.85	OK
19-Jul-12	14.17	0.87	13.30	17.26	0.87	29.68	OK	34.45	33.93	33.93	0.42	33.52	OK	OK	1.7	5.2	868	224.31	OK
20-Jul-12	14.17	0.87	13.30	25.62	0.87	38.04	OK	52.35	51.83	51.83	0.84	51.84	OK	OK	3.8	12.1	1,166	301.36	OK
21-Jul-12	17.29	0.87	16.42	29.62	0.87	45.16	OK	58.94	58.42	58.42	0.70	58.29	OK	OK	4.5	14.3	1,236	319.48	OK
22-Jul-12	33.41	0.87	32.54	41.78	0.87	73.44	OK	78.21	77.69	77.69	-	76.86	OK	OK	7.8	25.0	1,501	388.16	OK
23-Jul-12	30.94	0.87	30.07	38.32	0.87	67.51	OK	71.22	70.70	70.70	-	69.87	OK	OK	6.7	21.3	1,420	366.99	OK
24-Jul-12	15.21	0.87	14.34	17.75	0.87	31.21	OK	33.12	32.60	32.60	-	31.77	OK	OK	1.7	5.3	872	225.47	OK
25-Jul-12	15.08	0.87	14.21	18.17	0.87	31.50	OK	33.73	33.21	33.21	-	32.38	OK	OK	1.7	5.3	875	226.19	OK
26-Jul-12	12.48	0.87	11.61	15.57	0.87	26.30	OK	28.11	27.58	27.58	-	26.75	OK	OK	1.2	3.8	-	-	OK
27-Jul-12	5.33	0.87	4.46	7.76	0.87	11.34	OK	12.09	11.56	11.56	-	10.73	OK	OK	0.3	0.9	-	-	OK
28-Jul-12	7.28	0.87	6.41	9.71	0.87	15.24	OK	15.88	15.36	15.36	-	14.53	OK	OK	0.5	1.5	-	-	OK
29-Jul-12	6.63	0.87	5.76	8.95	0.87	13.83	OK	14.26	13.73	13.73	-	12.90	OK	OK	0.4	1.2	-	-	OK
30-Jul-12	6.76	0.87	5.89	9.08	0.87	14.09	OK	14.41	13.89	13.89	-	13.06	OK	OK	0.4	1.3	-	-	OK
31-Jul-12	6.63	0.87	5.76	8.95	0.87	13.83	OK	14.05	13.52	13.52	-	12.69	OK	OK	0.4	1.2	-	-	OK
01-Aug-12	28.99	0.87	28.12	38.02	0.87	65.26	OK	67.17	66.65	66.65	-	65.82	OK	OK	6.1	19.4	1,374	355.31	OK
02-Aug-12	29.90	0.87	29.03	38.93	0.87	67.08	OK	68.89	68.36	68.36	-	67.53	OK	OK	6.4	20.4	1,400	361.87	OK
03-Aug-12	8.06	0.87	7.19	10.60	0.87	16.91	OK	17.44	16.92	16.92	-	16.09	OK	OK	0.6	1.7	-	-	OK
04-Aug-12	17.29	0.87	16.42	29.18	0.87	44.72	OK	54.26	53.74	53.74	0.56	53.47	OK	OK	3.8	12.0	1,160	300.01	OK
05-Aug-12	17.68	0.87	16.81	29.24	0.87	45.17	OK	54.29	53.77	53.77	0.56	53.50	OK	OK	3.8	11.9	1,158	299.40	OK
06-Aug-12	46.80	0.87	45.93	60.45	0.87	105.50	OK	108.47	107.95	107.95	-	107.12	OK	OK	14.8	48.0	1,887	487.80	OK
07-Aug-12	51.35	0.87	50.48	65.99	0.87	115.59	OK	118.77	118.25	118.25	-	117.42	OK	OK	17.6	57.1	2,005	518.45	OK
08-Aug-12	16.90	0.87	16.03	20.87	0.87	36.02	OK	36.98	36.45	36.45	-	35.62	OK	OK	2.1	6.6	943	243.67	OK
09-Aug-12	12.74	0.87	11.87	25.07	0.87	36.06	OK	48.57	48.05	48.05	0.70	47.92	OK	OK	3.4	10.8	1,118	289.16	OK
10-Aug-12	9.88	0.87	9.01	21.22	0.87	29.35	OK	41.44	40.91	40.91	0.70	40.78	OK	OK	2.7	8.6	1,035	267.68	OK
11-Aug-12	48.23	0.87	47.36	61.77	0.87	108.25	OK	111.33	110.80	110.80	-	109.97	OK	OK	15.6	50.5	1,921	496.64	OK
12-Aug-12	181.35	0.87	180.48	234.60	0.87	414.20	OK	427.03	426.51	426.51	-	425.68	OK	OK	193.0	653.1	4,706	1,216.65	OK
13-Aug-12	158.86	0.87	157.99	203.31	0.87	360.42	OK	371.02	370.50	370.50	-	369.67	OK	OK	148.8	501.5	4,291	1,109.24	OK
14-Aug-12	86.19	0.87	85.32	107.43	0.87	191.87	OK	196.75	196.23	196.23	-	195.40	OK	OK	45.8	151.2	2,820	729.16	OK
15-Aug-12	119.99	0.87	119.12	150.91	0.87	269.15	OK	293.32	292.80	292.80	19.46	311.43	OK	OK	89.7	299.6	3,583	926.27	OK
16-Aug-12	78.52	0.87	77.65	95.80	0.87	172.57	OK	193.35	192.83	192.83	19.46	211.46	OK	OK	40.6	133.7	2,701	698.40	OK
17-Aug-12	44.46	0.87	43.59	51.07	0.87	93.78	OK	96.12	95.59	95.59	-	94.76	OK	OK	12.5	40.4	1,777	459.46	OK
18-Aug-12	41.47	0.87	40.60	50.83	0.87	90.55	OK	98.08	97.56	97.56	0.42	97.15	OK	OK	11.7	37.8	1,736	448.86	OK
19-Aug-12	40.30	0.87	39.43	60.77	0.87	99.32	OK	120.95	120.42	120.42	1.26	120.85	OK	OK	16.1	52.1	1,942	502.20	OK
20-Aug-12	40.95	0.87	40.08	58.01	0.87	97.21	OK	131.24	130.72	130.72	20.44	150.33	OK	OK	19.7	64.2	2,090	540.22	OK
21-Aug-12	44.20	0.87	43.33	72.81	0.87	115.26	OK	162.86	162.33	162.33	21.28	182.78	OK	OK	31.2	102.3	2,460	635.90	OK
22-Aug-12	41.21	0.87	40.34	69.71	0.87	109.17	OK	185.49	184.97	184.97	53.34	237.48	OK	OK	49.6	164.0	2,902	750.13	OK
23-Aug-12	31.20	0.87	30.33	34.95	0.87	64.40	OK	112.21	111.69	111.69	51.66	162.52	OK	OK	20.2	65.7	2,106	544.48	OK
24-Aug-12	28.60	0.87	27.73	43.24	0.87	70.09	OK	86.95	86.42	86.42	4.76	90.35	OK	OK	8.8	28.1	1,565	404.65	OK
25-Aug-12	28.86	0.87	27.99	146.24	0.87	173.35	OK	322.28	321.76	321.76	11.62	332.55	OK	OK	202.5	686.1	4,788	1,237.85	OK
26-Aug-12	31.72	0.87	30.85	137.88	0.87	167.85	OK	301.52	301.00	301.00	9.80	309.97	OK	OK	168.0	567.2	4,479	1,158.09	OK

27-Aug-12	54.34	0.87	53.47	64.58	0.87	117.17	OK	131.80	131.28	131.28	5.74	136.19	OK	OK	20.0	65.1	2,099	542.76	OK
28-Aug-12	86.58	0.87	85.71	108.04	0.87	192.87	OK	211.42	210.90	210.90	7.14	217.21	OK	OK	48.3	159.8	2,875	743.29	OK
29-Aug-12	99.71	0.87	98.84	125.90	0.87	223.86	OK	238.70	238.18	238.18	2.94	240.29	OK	OK	62.1	206.3	3,144	812.83	OK
30-Aug-12	62.53	0.87	61.66	83.44	0.87	144.22	OK	160.12	159.60	159.60	1.96	160.73	OK	OK	27.9	91.3	2,363	611.03	OK
31-Aug-12	28.73	0.87	27.86	38.97	0.87	65.95	OK	77.83	77.30	77.30	0.56	77.03	OK	OK	7.1	22.7	1,453	375.69	OK
01-Sep-12	20.93	10.65	10.28	18.75	10.65	18.39	OK	27.30	26.77	25.94	0.14	25.25	OK	OK	4.0	12.6	1,181	305.26	OK
02-Sep-12	16.12	10.65	5.47	93.91	10.65	88.74	OK	198.66	198.14	197.31	6.44	202.92	OK	OK	113.6	381.1	3,898	1,007.65	OK
03-Sep-12	24.70	10.65	14.05	140.99	10.65	144.40	OK	299.27	298.74	297.91	9.24	306.33	OK	OK	221.6	751.7	4,944	1,278.08	OK
04-Sep-12	24.57	10.65	13.92	62.32	10.65	65.60	OK	119.24	118.71	117.88	3.36	120.42	OK	OK	35.3	116.1	2,571	664.67	OK
05-Sep-12	15.60	10.65	4.95	19.69	10.65	14.00	OK	48.03	47.50	46.67	25.20	71.05	OK	OK	10.4	33.4	1,663	429.97	OK
06-Sep-12	15.08	10.65	4.43	19.72	10.65	13.51	OK	47.75	47.23	46.40	25.20	70.77	OK	OK	10.5	33.7	1,668	431.29	OK
07-Sep-12	14.69	10.65	4.04	13.61	10.65	7.01	OK	21.00	20.48	19.65	4.20	23.02	OK	OK	3.5	10.9	1,125	290.87	OK
08-Sep-12	14.04	10.65	3.39	9.77	10.65	2.52	OK	10.05	9.52	8.69	1.12	8.99	OK	OK	2.1	6.5	936	241.93	OK
09-Sep-12	14.17	10.65	3.52	9.90	10.65	2.78	OK	8.40	7.88	7.05	0.42	6.64	OK	OK	1.9	6.0	911	235.43	OK
10-Sep-12	14.04	10.65	3.39	9.66	10.65	2.41	OK	6.65	6.13	5.30	0.14	4.61	OK	OK	1.8	5.6	888	229.52	OK
11-Sep-12	14.04	10.65	3.39	9.55	10.65	2.30	OK	5.48	4.96	4.13	-	3.30	OK	OK	1.7	5.3	876	226.36	OK
12-Sep-12	13.91	10.65	3.26	9.42	10.65	2.04	OK	4.37	3.85	3.02	-	2.19	OK	OK	1.7	5.2	865	223.53	OK
13-Sep-12	13.13	10.65	2.48	8.86	10.65	0.70	OK	2.93	2.40	1.57	-	0.75	OK	OK	1.5	4.8	-	-	OK
14-Sep-12	33.54	10.65	22.89	35.98	10.65	48.23	OK	51.62	51.10	50.27	-	49.44	OK	OK	8.3	26.7	1,538	397.55	OK
15-Sep-12	80.08	10.65	69.43	96.71	10.65	155.50	OK	166.63	166.11	165.28	5.60	170.05	OK	OK	42.5	140.3	2,747	710.16	OK
16-Sep-12	61.49	10.65	50.84	72.29	10.65	112.49	OK	121.93	121.40	120.57	5.60	125.34	OK	OK	26.0	85.0	2,305	595.97	OK
17-Sep-12	15.08	10.65	4.43	11.25	10.65	5.04	OK	6.10	5.58	4.75	-	3.92	OK	OK	1.9	5.9	908	234.82	OK
18-Sep-12	11.31	10.65	0.66	6.38	10.65	-	Fail	0.64	0.11	-	-	-	Fail	Fail	1.1	3.5	-	-	OK
19-Sep-12	11.31	10.65	0.66	6.71	10.65	-	Fail	0.85	0.32	-	-	-	Fail	Fail	1.2	3.6	-	-	OK
20-Sep-12	11.05	10.65	0.40	6.34	10.65	-	Fail	0.74	0.22	-	-	-	Fail	Fail	1.1	3.5	-	-	OK
21-Sep-12	10.53	10.65	-	5.61	10.65	-	Fail	0.32	-	-	-	-	Fail	Fail	1.0	3.2	-	-	Fail
22-Sep-12	10.53	10.65	-	5.50	10.65	-	Fail	0.21	-	-	-	-	Fail	Fail	1.0	3.1	-	-	Fail
23-Sep-12	10.53	10.65	-	5.50	10.65	-	Fail	0.11	-	-	-	-	Fail	Fail	1.0	3.1	-	-	Fail
24-Sep-12	10.40	10.65	-	5.39	10.65	-	Fail	0.11	-	-	-	-	Fail	Fail	1.0	3.0	-	-	Fail
25-Sep-12	10.40	10.65	-	6.93	10.65	-	Fail	128.90	128.37	127.54	146.58	273.29	OK	Fail	92.2	308.2	3,619	935.51	OK
26-Sep-12	10.27	10.65	-	6.82	10.65	-	Fail	154.87	154.34	153.51	176.82	329.50	OK	Fail	130.2	437.8	4,091	1,057.72	OK
27-Sep-12	10.27	10.65	-	5.28	10.65	-	Fail	40.70	40.18	39.35	47.04	85.56	OK	Fail	11.2	36.0	1,706	441.04	OK
28-Sep-12	10.14	10.65	-	5.17	10.65	-	Fail	17.07	16.54	15.71	19.74	34.62	OK	Fail	2.9	9.1	1,054	272.56	OK
29-Sep-12	10.14	10.65	-	5.17	10.65	-	Fail	11.98	11.45	10.62	6.16	15.95	OK	Fail	1.9	6.0	913	236.12	OK
30-Sep-12	10.14	10.65	-	27.17	10.65	16.52	Fail	51.93	51.40	50.57	2.80	52.54	OK	Fail	13.3	43.0	1,815	469.34	OK
01-Oct-12	9.62	10.65	-	28.05	10.65	17.40	Fail	52.17	51.65	50.82	2.10	52.09	OK	Fail	13.2	42.8	1,814	468.85	OK
02-Oct-12	7.28	10.65	-	5.94	10.65	-	Fail	13.99	13.47	12.64	0.70	12.51	OK	Fail	2.0	6.2	924	238.88	OK
03-Oct-12	4.55	10.65	-	4.95	10.65	-	Fail	9.65	9.12	8.29	0.14	7.60	OK	Fail	1.0	3.1	-	-	OK
04-Oct-12	5.07	10.65	-	29.81	10.65	19.16	Fail	58.17	57.65	56.82	1.96	57.95	OK	Fail	15.2	49.4	1,907	492.92	OK
05-Oct-12	4.81	10.65	-	78.10	10.65	67.45	Fail	166.35	165.83	165.00	5.74	169.91	OK	Fail	90.4	302.1	3,593	928.98	OK
06-Oct-12	62.66	10.65	52.01	124.17	10.65	165.54	OK	237.52	236.99	236.16	3.92	239.25	OK	OK	83.5	278.7	3,493	903.10	OK
07-Oct-12	64.87	10.65	54.22	77.98	10.65	121.56	OK	131.42	130.90	130.07	0.56	129.80	OK	OK	29.1	95.3	2,399	620.30	OK
08-Oct-12	8.84	10.65	-	4.62	10.65	-	Fail	2.65	2.12	1.30	0.14	0.61	OK	Fail	0.8	2.4	-	-	OK
09-Oct-12	8.45	10.65	-	4.62	10.65	-	Fail	2.54	2.02	1.19	0.70	1.06	OK	Fail	0.7	2.2	-	-	OK
10-Oct-12	8.58	10.65	-	14.19	10.65	3.54	Fail	17.96	17.44	16.61	1.40	17.18	OK	Fail	3.3	10.5	1,109	286.71	OK
11-Oct-12	8.45	10.65	-	14.41	10.65	3.76	Fail	17.65	17.13	16.30	0.84	16.31	OK	Fail	3.3	10.3	1,100	284.49	OK
12-Oct-12	8.45	10.65	-	32.89	10.65	22.24	Fail	59.34	58.82	57.99	2.24	59.40	OK	Fail	15.9	51.5	1,934	500.01	OK
13-Oct-12	8.32	10.65	-	34.65	10.65	24.00	Fail	63.22	62.70	61.87	2.38	63.42	OK	Fail	17.5	56.9	2,003	517.88	OK
14-Oct-12	72.54	10.65	61.89	87.85	10.65	139.10	OK	147.16	146.63	145.80	0.28	145.26	OK	OK	35.4	116.3	2,573	665.15	OK
15-Oct-12	110.37	10.65	99.72	134.15	10.65	223.23	OK	350.64	350.12	349.29	138.88	487.34	OK	OK	164.4	554.9	4,445	1,149.25	OK
16-Oct-12	49.53	10.65	38.88	65.39	10.65	93.63	OK	254.65	254.12	253.29	167.30	419.76	OK	OK	158.4	534.2	4,386	1,134.04	OK
17-Oct-12	14.95	10.65	4.30	20.03	10.65	13.69	OK	54.18	53.66	52.83	30.52	82.52	OK	OK	13.3	43.0	1,816	469.47	OK
18-Oct-12	46.93	10.65	36.28	50.14	10.65	75.78	OK	101.43	100.91	100.08	26.88	126.13	OK	OK	18.9	61.6	2,059	532.36	OK
19-Oct-12	48.10	10.65	37.45	51.64	10.65	78.45	OK	102.62	102.10	101.27	24.78	125.22	OK	OK	19.2	62.4	2,069	534.81	OK
20-Oct-12	17.03	10.65	6.38	59.18	10.65	54.92	OK	118.31	117.79	116.96	8.26	124.39	OK	OK	42.3	139.6	2,742	709.00	OK
21-Oct-12	16.77	10.65	6.12	58.59	10.65	54.07	OK	125.62	125.10	124.27	15.96	139.40	OK	OK	48.2	159.3	2,872	742.53	OK
22-Oct-12	16.77	10.65	6.12	10.85	10.65	6.33	OK	21.91	21.39	20.56	10.22	29.95	OK	OK	3.7	11.7	1,153	298.01	OK
23-Oct-12	95.94	10.65	85.29	114.33	10.65	188.98	OK	200.64	200.12	199.29	3.08	201.54	OK	OK	58.3	193.4	3,074	794.64	OK
24-Oct-12	182.26	10.65	171.61	226.06	10.65	387.03	OK	407.91	407.39	406.56	6.58	412.31	OK	OK	196.6	665.5	4,737	1,224.69	OK
25-Oct-12	192.53	10.65	181.88	237.21	10.65	408.45	OK	433.57	433.05	432.22	11.62	443.01	OK	OK	217.6	738.1	4,912	1,269.89	OK
26-Oct-12	200.98	10.65	190.33	246.65	10.65	426.34	OK	449.77	449.24	448.41	9.94	457.53	OK	OK	234.3	795.6	5,043	1,303.80	OK
27-Oct-12	123.37	10.65	112.72	143.74	10.65	245.82	OK	284.41	283.88	283.05	35.42	317.64	OK	OK	99.1	331.7	3,713	959.87	OK
28-Oct-12	35.75	10.65	25.10	28.84	10.65	43.30	OK	72.35	71.82	70.99	32.48	102.64	OK	OK	13.5	43.5	1,823	471.43	OK
29-Oct-12	102.83	10.65	92.18	116.27	10.65	197.81	OK	212.12	211.60	210.77	9.24	219.18	OK	OK	64.5	214.2	3,186	823.60	OK
30-Oct-12	105.56	10.65	94.91	119.44	10.65	203.71	OK	251.20	250.68	249.85	44.10	293.12	OK	OK	79.9	266.4	3,439	888.96	OK

31-Oct-12	38.87	10.65	28.22	33.83	10.65	51.41	OK	94.34	93.82	92.99	42.56	134.72	OK	OK	20.9	68.0	2,132	551.17	OK
01-Nov-12	33.80	10.65	23.15	28.32	10.65	40.83	OK	55.99	55.47	54.64	11.34	65.15	OK	OK	8.9	28.7	1,576	407.44	OK
02-Nov-12	32.89	10.65	22.24	25.76	10.65	37.36	OK	210.99	210.47	209.64	196.28	405.09	OK	OK	167.4	565.1	4,474	1,156.56	OK
03-Nov-12	33.15	10.65	22.50	26.02	10.65	37.88	OK	206.10	205.58	204.75	190.54	394.46	OK	OK	158.1	533.3	4,384	1,133.38	OK
04-Nov-12	32.37	10.65	21.72	25.24	10.65	36.32	OK	40.35	39.83	39.00	0.14	38.31	OK	OK	6.8	21.8	1,432	370.24	OK
05-Nov-12	30.42	10.65	19.77	23.84	10.65	32.97	OK	110.99	110.46	109.63	86.80	195.61	OK	OK	41.1	135.5	2,714	701.58	OK
06-Nov-12	30.94	10.65	20.29	30.63	10.65	40.28	OK	125.51	124.98	124.15	87.22	210.54	OK	OK	48.3	159.8	2,875	743.27	OK
07-Nov-12	30.68	10.65	20.03	29.60	10.65	38.99	OK	48.64	48.11	47.28	7.84	54.30	OK	OK	7.3	23.3	1,465	378.78	OK
08-Nov-12	30.68	10.65	20.03	23.33	10.65	32.72	OK	50.95	50.43	49.60	22.12	70.89	OK	OK	8.3	26.5	1,533	396.39	OK
09-Nov-12	29.12	10.65	18.47	21.77	10.65	29.60	OK	47.52	46.99	46.16	20.58	65.91	OK	OK	7.6	24.4	1,490	385.25	OK
10-Nov-12	22.49	10.65	11.84	24.82	10.65	26.02	OK	39.06	38.54	37.71	5.46	42.34	OK	OK	5.6	18.0	1,338	345.98	OK
11-Nov-12	16.90	10.65	6.25	19.12	10.65	14.73	OK	154.12	153.60	152.77	150.08	302.02	OK	OK	108.8	364.6	3,838	992.13	OK
12-Nov-12	11.18	10.65	0.53	17.14	10.65	7.03	OK	151.09	150.56	149.73	149.38	298.28	OK	OK	115.3	386.7	3,918	1,012.81	OK
13-Nov-12	167.44	10.65	156.79	234.78	10.65	380.93	OK	434.04	433.51	432.68	14.42	446.28	OK	OK	201.8	683.4	4,781	1,236.14	OK
14-Nov-12	400.14	10.65	389.49	522.04	10.65	900.89	OK	956.12	955.59	954.76	13.58	967.52	OK	OK	898.1	3,120.5	8,136	2,103.36	OK
15-Nov-12	386.88	10.65	376.23	488.21	10.65	853.80	OK	883.38	882.85	882.02	4.06	885.25	OK	OK	810.5	2,811.2	7,844	2,027.90	OK
16-Nov-12	294.71	10.65	284.06	408.80	10.65	682.22	OK	756.63	756.11	755.28	3.78	758.23	OK	OK	556.1	1,916.6	6,860	1,773.44	OK
17-Nov-12	169.13	10.65	158.48	242.41	10.65	390.25	OK	454.59	454.07	453.24	3.50	455.91	OK	OK	217.3	737.1	4,910	1,269.29	OK
18-Nov-12	46.80	10.65	36.15	39.12	10.65	64.63	OK	64.74	64.21	63.38	-	62.56	OK	OK	13.4	43.2	1,819	470.36	OK
19-Nov-12	46.15	10.65	35.50	39.35	10.65	64.21	OK	65.48	64.96	64.13	0.14	63.44	OK	OK	13.1	42.3	1,805	466.71	OK
20-Nov-12	46.28	10.65	35.63	39.81	10.65	64.80	OK	81.02	80.50	79.67	17.22	96.06	OK	OK	14.9	48.4	1,892	489.22	OK
21-Nov-12	46.28	10.65	35.63	41.68	10.65	66.67	OK	85.33	84.80	83.97	17.36	100.51	OK	OK	15.6	50.6	1,923	497.03	OK
22-Nov-12	46.28	10.65	35.63	41.35	10.65	66.34	OK	69.95	69.42	68.59	1.54	69.30	OK	OK	13.4	43.2	1,819	470.33	OK
23-Nov-12	46.15	10.65	35.50	68.94	10.65	93.80	OK	132.92	132.39	131.56	2.80	133.53	OK	OK	29.4	96.4	2,409	622.91	OK
24-Nov-12	46.15	10.65	35.50	74.11	10.65	98.97	OK	144.66	144.13	143.30	2.94	145.42	OK	OK	34.9	114.6	2,560	661.75	OK
25-Nov-12	46.15	10.65	35.50	54.97	10.65	79.83	OK	101.14	100.61	99.78	1.40	100.36	OK	OK	18.4	60.0	2,040	527.47	OK
26-Nov-12	107.12	10.65	96.47	168.63	10.65	254.46	OK	324.00	323.47	322.64	4.06	325.88	OK	OK	122.6	411.7	4,004	1,035.22	OK
27-Nov-12	183.56	10.65	172.91	347.15	10.65	509.42	OK	686.23	685.71	684.88	10.36	694.41	OK	OK	506.0	1,741.0	6,633	1,714.79	OK
28-Nov-12	191.62	10.65	180.97	338.05	10.65	508.38	OK	662.29	661.77	660.94	8.96	669.07	OK	OK	453.8	1,558.5	6,381	1,649.62	OK
29-Nov-12	196.17	10.65	185.52	332.59	10.65	507.47	OK	655.98	655.45	654.62	16.66	670.46	OK	OK	438.6	1,505.6	6,304	1,629.79	OK
30-Nov-12	133.38	10.65	122.73	268.81	10.65	380.90	OK	601.17	600.65	599.82	80.08	679.07	OK	OK	465.0	1,597.5	6,436	1,663.94	OK
01-Dec-12	47.19	10.65	36.54	100.45	10.65	126.35	OK	312.91	312.39	311.56	131.74	442.47	OK	OK	221.5	751.3	4,943	1,277.83	OK
02-Dec-12	62.14	10.65	51.49	89.11	10.65	129.96	OK	221.02	220.49	219.66	66.92	285.75	OK	OK	78.6	262.1	3,419	883.92	OK
03-Dec-12	88.01	10.65	77.36	121.25	10.65	187.97	OK	221.68	221.16	220.33	10.64	230.14	OK	OK	63.0	209.3	3,160	816.96	OK
04-Dec-12	74.36	10.65	63.71	103.42	10.65	156.49	OK	187.87	187.34	186.51	4.34	190.03	OK	OK	48.0	158.6	2,868	741.43	OK
05-Dec-12	141.96	10.65	131.31	245.82	10.65	366.49	OK	473.34	472.82	471.99	6.86	478.02	OK	OK	246.0	836.2	5,131	1,326.58	OK
06-Dec-12	229.45	10.65	218.80	423.95	10.65	632.11	OK	829.91	829.38	828.55	13.02	840.75	OK	OK	698.3	2,416.1	7,439	1,923.20	OK
07-Dec-12	175.63	10.65	164.98	279.38	10.65	433.72	OK	601.73	601.21	600.38	85.54	685.09	OK	OK	387.4	1,326.8	6,031	1,559.25	OK
08-Dec-12	76.70	10.65	66.05	132.71	10.65	188.12	OK	326.03	325.50	324.67	82.74	406.59	OK	OK	163.6	552.2	4,438	1,147.28	OK
09-Dec-12	41.99	10.65	31.34	97.23	10.65	117.93	OK	204.43	203.90	203.07	12.74	214.99	OK	OK	79.0	263.3	3,424	885.30	OK
10-Dec-12	41.86	10.65	31.21	46.06	10.65	66.63	OK	88.57	88.05	87.22	7.70	94.09	OK	OK	15.4	50.0	1,914	494.82	OK
11-Dec-12	41.86	10.65	31.21	45.95	10.65	66.52	OK	82.95	82.43	81.60	17.36	98.13	OK	OK	14.1	45.5	1,852	478.88	OK
12-Dec-12	41.86	10.65	31.21	45.07	10.65	65.64	OK	81.01	80.49	79.66	17.22	96.05	OK	OK	13.7	44.2	1,834	474.23	OK
13-Dec-12	92.04	10.65	81.39	110.76	10.65	181.51	OK	193.07	192.54	191.71	-	190.88	OK	OK	54.5	180.4	3,000	775.60	OK
14-Dec-12	127.53	10.65	116.88	228.20	10.65	334.44	OK	497.05	496.52	495.69	76.30	571.16	OK	OK	299.9	1,022.8	5,506	1,423.49	OK
15-Dec-12	74.49	10.65	63.84	159.43	10.65	212.63	OK	371.21	370.68	369.85	77.70	446.73	OK	OK	218.9	742.3	4,922	1,272.45	OK
16-Dec-12	32.37	0.87	31.50	53.28	0.87	83.90	OK	105.95	105.43	105.43	9.94	114.54	OK	OK	12.9	41.7	1,796	464.35	OK
17-Dec-12	28.47	0.87	27.60	49.27	0.87	75.99	OK	108.11	107.59	107.59	22.82	129.58	OK	OK	14.8	47.8	1,884	487.20	OK
18-Dec-12	126.10	0.87	125.23	167.47	0.87	291.82	OK	327.76	327.23	327.23	31.36	357.76	OK	OK	106.4	356.4	3,807	984.30	OK
19-Dec-12	167.70	0.87	166.83	220.62	0.87	386.57	OK	437.14	436.61	436.61	45.78	481.56	OK	OK	182.9	618.6	4,618	1,193.78	OK
20-Dec-12	137.80	0.87	136.93	180.82	0.87	316.87	OK	350.05	349.53	349.53	28.56	377.26	OK	OK	122.1	410.1	3,999	1,033.85	OK
21-Dec-12	100.49	0.87	99.62	131.74	0.87	230.48	OK	249.03	248.51	248.51	-	247.68	OK	OK	65.6	217.9	3,205	828.54	OK
22-Dec-12	35.49	0.87	34.62	47.16	0.87	80.90	OK	96.06	95.54	95.54	5.74	100.45	OK	OK	10.5	33.9	1,670	431.81	OK
23-Dec-12	156.00	0.87	155.13	206.50	0.87	360.75	OK	412.27	411.75	411.75	40.04	450.96	OK	OK	162.8	549.3	4,429	1,145.14	OK
24-Dec-12	181.74	0.87	180.87	239.83	0.87	419.82	OK	466.46	465.94	465.94	34.30	499.41	OK	OK	208.8	707.8	4,840	1,251.39	OK
25-Dec-12	99.06	0.87	98.19	149.56	0.87	246.87	OK	304.01	303.48	303.48	29.40	332.05	OK	OK	90.6	302.5	3,595	929.40	OK
26-Dec-12	87.60	0.87	86.73	137.13	0.87	222.99	OK	277.16	276.66	276.66	21.00	296.83	OK	OK	76.6	255.3	3,387	875.77	OK
27-Dec-12	62.60	0.87	61.73	85.23	0.87	146.08	OK	165.08	164.56	164.56	2.40	166.13	OK	OK	29.1	95.3	2,400	620.42	OK
28-Dec-12	80.80	0.87	79.93	112.13	0.87	191.18	OK	212.08	211.56	211.56	1.40	212.13	OK	OK	46.9	155.0	2,845	735.52	OK
29-Dec-12	80.30	0.87	79.43	110.63	0.87	189.18	OK	206.98	206.46	206.46	0.90	206.53	OK	OK	45.4	149.8	2,811	726.63	OK
30-Dec-12	42.10	0.87	41.23	54.23	0.87	94.58	OK	107.88	107.36	107.36	0.30	106.83	OK	OK	13.3	42.9	1,814	469.01	OK
31-Dec-12	36.30	0.87	35.43	60.23	0.87	94.78	OK	128.98	128.46	128.46	7.10	134.73	OK	OK	19.5	63.5	2,082	538.16	OK

Appendix 6.2

WATER BALANCE SIMULATION OF THE KRUENG ACEH CATCHMENT

LULC Scenario II runs on inflow 2012 and water demand 2012 (in m^3/s)

DEMAND (m^3/s)	Up	Down
Domestic	0.31	0.33
Non-Domestic	0.22	0.08
Water Losses	0.09	0.11
Min.Environmental Flow	1.12	0.83
Paddy Field	19.55	0.64

	Water Quantity														Water Quality at PDAM Tirta Daroy				
	Lampisang Sta			Darang Sta				Pasie Sta			Sub Banda Aceh				TSS (mg/l)	Turb (NTU)	Alum (kg/day)	Cost Alum (USD)	PDAM
Date	I_1	D_1	(I_1-D_1)	I_2	D_2	$(R_1+I_2-D_2)$	Upstream	I_3	$(R_2+I_3-D_{(D+ND+WL)})$	(R_3-D_{PF})	I_4	$(R_4+I_4-D_4)$	Downstream	Upstream - Downstream	(R_2+I_3) = TSS (>2000)	Limit < 5 NTU	5 NTU<Alum<2000 mg/l	(Alum*USD 0.259)	(Quantity & Quality)
			R_1			R_2			R_3	R_4		R_5			$0.000771*(R_2+I_3)^{2.899}$	$3.093*TSS^{1.017}$	$1.2*(8.59*D_{(D+ND+WL)})^{0.35}$		
RELIABILITY			**93.17%**			**93.99%**	**91.53%**		**98.91%**	**98.09%**		**97.81%**	**97.81%**	**91.26%**	**0.00%**	**11.48%**	**894,713.47**	**231,311.65**	**98.91%**
01-Jan-12	7.20	0.87	6.33	8.73	0.87	14.18	OK	23.28	22.76	22.76	2.30	24.23	OK	OK	1.0	3.2	-	-	OK
02-Jan-12	11.60	0.87	10.73	15.53	0.87	25.38	OK	33.48	32.96	32.96	0.70	32.83	OK	OK	1.6	5.0	-	-	OK
03-Jan-12	15.30	0.87	14.43	20.73	0.87	34.28	OK	41.58	41.06	41.06	0.30	40.53	OK	OK	2.3	7.1	968	250.38	OK
04-Jan-12	11.10	0.87	10.23	14.83	0.87	24.18	OK	30.98	30.46	30.46	0.80	30.43	OK	OK	1.4	4.3	-	-	OK
05-Jan-12	16.20	0.87	15.33	24.93	0.87	39.38	OK	106.18	105.66	105.66	12.40	117.23	OK	OK	28.6	93.6	2,384	616.38	OK
06-Jan-12	21.40	0.87	20.53	30.53	0.87	50.18	OK	120.68	120.16	120.16	12.80	132.13	OK	OK	32.7	107.3	2,501	646.57	OK
07-Jan-12	10.90	0.87	10.03	13.73	0.87	22.88	OK	31.16	30.66	30.66	1.20	31.03	OK	OK	1.4	4.5	-	-	OK
08-Jan-12	62.94	0.87	62.07	74.06	0.87	135.26	OK	143.92	143.40	143.40	0.43	143.00	OK	OK	24.9	81.3	2,270	586.84	OK
09-Jan-12	72.89	0.87	72.01	86.64	0.87	157.78	OK	170.84	170.31	170.31	0.76	170.24	OK	OK	33.5	110.0	2,523	652.22	OK
10-Jan-12	20.00	0.87	19.13	28.37	0.87	46.63	OK	64.82	64.29	64.29	2.59	66.05	OK	OK	5.5	17.4	1,323	342.05	OK
11-Jan-12	79.89	0.87	79.02	101.46	0.87	179.61	OK	200.58	200.05	200.05	1.94	201.17	OK	OK	42.9	141.5	2,756	712.43	OK
12-Jan-12	86.22	0.87	85.35	107.90	0.87	192.37	OK	209.39	208.86	208.86	1.40	209.44	OK	OK	47.7	157.7	2,862	739.85	OK
13-Jan-12	29.61	0.87	28.73	38.63	0.87	66.50	OK	77.84	77.31	77.31	1.40	77.89	OK	OK	7.2	22.9	1,457	376.76	OK
14-Jan-12	25.54	0.87	24.67	48.76	0.87	72.55	OK	133.65	133.12	133.12	12.64	144.93	OK	OK	30.0	98.5	2,427	627.48	OK
15-Jan-12	19.89	0.87	19.02	42.01	0.87	60.15	OK	122.21	121.69	121.69	12.74	133.60	OK	OK	28.8	94.3	2,391	618.09	OK
16-Jan-12	282.27	0.87	281.40	359.17	0.87	639.70	OK	667.09	666.57	666.57	1.30	667.04	OK	OK	443.6	1,523.0	6,329	1,636.36	OK
17-Jan-12	307.93	0.87	307.05	387.02	0.87	693.20	OK	718.35	717.82	717.82	0.97	717.97	OK	OK	517.4	1,780.9	6,686	1,728.45	OK
18-Jan-12	60.00	0.87	59.13	68.92	0.87	127.18	OK	134.46	133.93	133.93	0.32	133.43	OK	OK	22.4	73.0	2,186	565.14	OK
19-Jan-12	62.04	0.87	61.17	73.05	0.87	133.34	OK	142.65	142.12	142.12	0.54	141.83	OK	OK	24.3	79.4	2,251	582.00	OK
20-Jan-12	62.83	0.87	61.96	76.48	0.87	137.56	OK	149.65	149.13	149.13	0.65	148.95	OK	OK	25.7	84.1	2,297	593.78	OK
21-Jan-12	59.21	0.87	58.34	65.82	0.87	123.29	OK	131.10	130.57	130.57	0.22	129.96	OK	OK	21.6	70.6	2,160	558.35	OK
22-Jan-12	57.18	0.87	56.31	58.40	0.87	113.83	OK	114.69	114.16	114.16	-	113.33	OK	OK	19.5	63.4	2,081	537.99	OK
23-Jan-12	55.94	0.87	55.06	57.15	0.87	111.34	OK	111.99	111.46	111.46	-	110.63	OK	OK	18.7	60.8	2,050	530.04	OK
24-Jan-12	55.60	0.87	54.72	56.81	0.87	110.67	OK	111.09	110.57	110.57	-	109.74	OK	OK	18.5	60.1	2,042	527.85	OK
25-Jan-12	54.13	0.87	53.26	55.24	0.87	107.62	OK	107.94	107.41	107.41	-	106.59	OK	OK	17.6	57.1	2,005	518.36	OK
26-Jan-12	50.51	0.87	49.64	51.62	0.87	100.39	OK	100.71	100.18	100.18	-	99.35	OK	OK	15.4	49.9	1,914	494.72	OK
27-Jan-12	50.51	0.87	49.64	51.62	0.87	100.39	OK	100.60	100.08	100.08	-	99.25	OK	OK	15.4	49.9	1,914	494.72	OK
28-Jan-12	63.73	0.87	62.86	69.13	0.87	131.12	OK	132.40	131.88	131.88	-	131.05	OK	OK	24.2	79.1	2,248	581.13	OK
29-Jan-12	168.03	0.87	167.16	207.64	0.87	373.93	OK	386.34	385.81	385.81	0.11	385.09	OK	OK	161.9	546.5	4,421	1,143.08	OK
30-Jan-12	226.90	0.87	226.03	285.76	0.87	510.92	OK	548.37	547.85	547.85	7.56	554.58	OK	OK	296.6	1,011.4	5,484	1,417.91	OK
31-Jan-12	232.89	0.87	232.02	294.39	0.87	525.54	OK	564.70	564.18	564.18	7.67	571.02	OK	OK	312.7	1,067.3	5,589	1,444.87	OK
01-Feb-12	204.76	0.87	203.88	261.85	0.87	464.87	OK	497.18	496.66	496.66	3.02	498.85	OK	OK	246.0	836.2	5,131	1,326.61	OK
02-Feb-12	123.28	0.87	122.41	156.18	0.87	277.72	OK	305.97	305.44	305.44	4.00	308.61	OK	OK	96.0	321.0	3,670	948.85	OK
03-Feb-12	84.41	0.87	83.54	101.25	0.87	183.92	OK	193.76	193.24	193.24	1.08	193.49	OK	OK	43.6	143.7	2,770	716.25	OK
04-Feb-12	83.62	0.87	82.75	110.25	0.87	192.12	OK	213.52	213.00	213.00	0.43	212.60	OK	OK	47.9	158.3	2,866	740.88	OK
05-Feb-12	80.34	0.87	79.47	136.89	0.87	215.49	OK	327.41	326.89	326.89	26.14	352.19	OK	OK	126.4	424.7	4,048	1,046.59	OK
06-Feb-12	69.16	0.87	68.28	110.30	0.87	177.72	OK	274.02	273.49	273.49	25.70	298.37	OK	OK	91.1	304.5	3,603	931.48	OK
07-Feb-12	72.66	0.87	71.79	92.47	0.87	163.38	OK	179.97	179.44	179.44	2.38	180.99	OK	OK	35.3	116.2	2,572	664.85	OK
08-Feb-12	64.07	0.87	63.20	77.83	0.87	140.16	OK	151.93	151.40	151.40	0.86	151.44	OK	OK	26.6	86.9	2,324	600.71	OK
09-Feb-12	56.73	0.87	55.85	60.36	0.87	115.35	OK	123.91	123.38	123.38	0.22	122.77	OK	OK	19.8	64.6	2,094	541.41	OK
10-Feb-12	56.73	0.87	55.85	64.21	0.87	119.20	OK	130.65	130.12	130.12	0.22	129.51	OK	OK	20.6	67.0	2,122	548.48	OK
11-Feb-12	68.48	0.87	67.61	93.79	0.87	160.52	OK	204.39	203.87	203.87	8.21	211.24	OK	OK	43.6	143.8	2,771	716.32	OK
12-Feb-12	99.44	0.87	98.57	147.85	0.87	245.54	OK	314.35	313.82	313.82	11.99	324.98	OK	OK	98.0	327.8	3,697	955.84	OK

13-Feb-12	89.16	0.87	88.29	159.02	0.87	246.43	OK	374.61	374.09	374.09	28.19	401.45	OK	OK	164.5	555.4	4,447	1,149.57	OK
14-Feb-12	214.02	0.87	213.15	339.65	0.87	551.93	OK	702.26	701.74	701.74	25.49	726.40	OK	OK	448.7	1,540.8	6,355	1,643.02	OK
15-Feb-12	215.15	0.87	214.28	305.80	0.87	519.21	OK	581.05	580.53	580.53	2.59	582.29	OK	OK	311.3	1,062.2	5,579	1,442.44	OK
16-Feb-12	59.33	0.87	58.45	70.77	0.87	128.35	OK	143.12	142.60	142.60	0.76	142.52	OK	OK	23.4	76.4	2,221	574.14	OK
17-Feb-12	54.81	0.87	53.93	64.27	0.87	117.33	OK	128.36	127.83	127.83	0.32	127.33	OK	OK	19.6	63.6	2,083	538.58	OK
18-Feb-12	51.75	0.87	50.88	60.01	0.87	110.02	OK	118.37	117.84	117.84	0.11	117.12	OK	OK	17.2	55.8	1,990	514.49	OK
19-Feb-12	49.27	0.87	48.40	57.42	0.87	104.94	OK	111.15	110.62	110.62	-	109.79	OK	OK	15.5	50.3	1,919	496.14	OK
20-Feb-12	47.01	0.87	46.14	55.05	0.87	100.31	OK	105.13	104.60	104.60	-	103.77	OK	OK	14.2	45.8	1,857	480.05	OK
21-Feb-12	46.67	0.87	45.80	56.58	0.87	101.50	OK	107.71	107.18	107.18	0.11	106.46	OK	OK	14.3	46.4	1,865	482.15	OK
22-Feb-12	54.24	0.87	53.37	71.30	0.87	123.79	OK	139.84	139.32	139.32	2.59	141.08	OK	OK	21.5	70.0	2,154	556.95	OK
23-Feb-12	61.13	0.87	60.26	81.60	0.87	140.99	OK	158.54	158.01	158.01	2.70	159.88	OK	OK	27.1	88.8	2,341	605.25	OK
24-Feb-12	47.80	0.87	46.93	64.75	0.87	110.80	OK	130.28	129.75	129.75	3.89	132.81	OK	OK	18.5	60.1	2,042	527.83	OK
25-Feb-12	52.32	0.87	51.45	67.84	0.87	118.41	OK	134.03	133.51	133.51	3.78	136.46	OK	OK	19.9	64.8	2,096	541.92	OK
26-Feb-12	50.06	0.87	49.19	63.05	0.87	111.36	OK	122.81	122.29	122.29	0.32	121.78	OK	OK	17.3	56.3	1,996	516.06	OK
27-Feb-12	94.02	0.87	93.14	130.32	0.87	222.60	OK	252.02	251.50	251.50	3.89	254.56	OK	OK	64.1	213.0	3,179	821.98	OK
28-Feb-12	133.00	0.87	132.13	185.26	0.87	316.52	OK	356.96	356.44	356.44	7.34	362.95	OK	OK	123.7	415.5	4,017	1,038.57	OK
29-Feb-12	79.21	0.87	78.34	114.75	0.87	192.22	OK	226.14	225.61	225.61	4.97	229.75	OK	OK	51.6	170.7	2,943	760.78	OK
01-Mar-12	41.25	10.65	30.60	47.65	10.65	67.60	OK	84.94	84.41	83.58	1.40	84.16	OK	OK	14.4	46.7	1,869	483.31	OK
02-Mar-12	37.18	10.65	26.53	41.71	10.65	57.60	OK	71.40	70.87	70.05	0.54	69.76	OK	OK	11.5	37.0	1,722	445.28	OK
03-Mar-12	38.19	10.65	27.55	45.81	10.65	62.71	OK	76.30	75.77	74.95	0.43	74.55	OK	OK	12.5	40.5	1,778	459.68	OK
04-Mar-12	143.74	10.65	133.09	181.82	10.65	304.26	OK	325.88	325.35	324.52	3.56	327.26	OK	OK	129.5	435.3	4,083	1,055.62	OK
05-Mar-12	204.42	10.65	193.77	261.86	10.65	444.99	OK	471.09	470.57	469.74	3.56	472.48	OK	OK	250.3	850.9	5,163	1,334.74	OK
06-Mar-12	140.46	10.65	129.81	169.19	10.65	288.36	OK	347.42	346.90	346.07	37.37	382.61	OK	OK	137.5	462.8	4,172	1,078.51	OK
07-Mar-12	74.02	10.65	63.37	84.16	10.65	136.88	OK	195.84	195.31	194.49	37.69	231.35	OK	OK	55.2	183.0	3,015	779.40	OK
08-Mar-12	82.94	10.65	72.30	95.84	10.65	157.49	OK	172.04	171.51	170.68	3.35	173.20	OK	OK	44.5	146.8	2,791	721.62	OK
09-Mar-12	83.73	10.65	73.09	105.21	10.65	167.65	OK	191.83	191.31	190.48	1.62	191.27	OK	OK	50.4	166.9	2,919	754.69	OK
10-Mar-12	103.96	10.65	93.31	237.41	10.65	320.08	OK	479.73	479.20	478.37	6.37	483.92	OK	OK	310.0	1,057.7	5,571	1,440.31	OK
11-Mar-12	178.99	10.65	168.35	373.61	10.65	531.31	OK	760.71	760.19	759.36	22.03	780.56	OK	OK	662.9	2,291.6	7,302	1,887.91	OK
12-Mar-12	123.06	10.65	112.41	191.72	10.65	293.49	OK	417.18	416.65	415.82	43.52	458.52	OK	OK	203.9	690.8	4,799	1,240.80	OK
13-Mar-12	146.56	10.65	135.92	173.76	10.65	299.02	OK	343.22	342.69	341.86	27.00	368.03	OK	OK	137.1	461.3	4,167	1,077.28	OK
14-Mar-12	149.16	10.65	138.51	191.64	10.65	319.51	OK	379.11	378.59	377.76	25.16	402.09	OK	OK	158.2	533.7	4,385	1,133.63	OK
15-Mar-12	98.88	10.65	88.23	132.56	10.65	210.14	OK	276.70	276.17	275.34	25.70	300.22	OK	OK	93.0	310.9	3,629	938.32	OK
16-Mar-12	206.11	10.65	195.47	262.13	10.65	446.95	OK	472.20	471.67	470.84	3.67	473.69	OK	OK	252.4	858.3	5,178	1,338.75	OK
17-Mar-12	202.38	10.65	191.74	255.21	10.65	436.30	OK	460.37	459.85	459.02	1.40	459.59	OK	OK	242.2	822.6	5,102	1,319.14	OK
18-Mar-12	168.48	10.65	157.84	208.11	10.65	355.30	OK	377.23	376.71	375.88	1.73	376.78	OK	OK	169.9	573.9	4,498	1,162.85	OK
19-Mar-12	153.79	10.65	143.15	193.09	10.65	325.59	OK	353.30	352.78	351.95	1.84	352.95	OK	OK	147.4	496.6	4,276	1,105.41	OK
20-Mar-12	114.92	10.65	104.28	140.03	10.65	233.65	OK	256.55	256.03	255.20	0.86	255.23	OK	OK	84.7	282.5	3,510	907.40	OK
21-Mar-12	123.06	10.65	112.41	136.83	10.65	238.60	OK	255.82	255.30	254.47	-	253.64	OK	OK	89.3	298.3	3,577	924.77	OK
22-Mar-12	112.10	10.65	101.45	123.89	10.65	214.69	OK	228.39	227.87	227.04	-	226.21	OK	OK	74.5	248.0	3,353	866.88	OK
23-Mar-12	85.65	10.65	75.01	123.96	10.65	188.32	OK	242.36	241.83	241.00	1.94	242.12	OK	OK	73.9	245.9	3,344	864.43	OK
24-Mar-12	64.18	10.65	53.54	95.34	10.65	138.23	OK	195.90	195.38	194.55	7.56	201.28	OK	OK	54.7	181.3	3,005	776.90	OK
25-Mar-12	63.73	10.65	53.09	67.94	10.65	110.38	OK	131.78	131.25	130.42	5.72	135.32	OK	OK	28.4	93.1	2,380	615.21	OK
26-Mar-12	58.53	10.65	47.89	101.68	10.65	138.92	OK	201.30	200.78	199.95	2.16	201.28	OK	OK	60.6	201.1	3,116	805.65	OK
27-Mar-12	55.26	10.65	44.61	101.92	10.65	135.89	OK	219.77	219.25	218.42	17.28	234.87	OK	OK	78.1	260.1	3,410	881.57	OK
28-Mar-12	49.72	10.65	39.07	63.93	10.65	92.36	OK	165.87	165.35	164.52	42.12	205.81	OK	OK	50.3	166.3	2,915	753.71	OK
29-Mar-12	51.75	10.65	41.11	63.22	10.65	93.68	OK	141.83	141.31	140.48	27.00	166.65	OK	OK	33.3	109.5	2,519	651.17	OK
30-Mar-12	63.28	10.65	52.63	70.67	10.65	112.66	OK	132.99	132.47	131.64	-	130.81	OK	OK	28.5	93.3	2,382	615.76	OK
31-Mar-12	52.09	10.65	41.45	57.40	10.65	88.20	OK	103.50	102.97	102.15	-	101.32	OK	OK	19.6	63.6	2,085	539.10	OK
01-Apr-12	40.79	10.65	30.15	41.70	10.65	61.20	OK	71.79	71.27	70.44	-	69.61	OK	OK	12.0	38.6	1,749	452.17	OK
02-Apr-12	218.09	10.65	207.44	281.69	10.65	478.49	OK	502.03	501.51	500.68	-	499.85	OK	OK	283.0	964.1	5,393	1,394.37	OK
03-Apr-12	274.25	10.65	263.61	356.78	10.65	609.73	OK	636.06	635.53	634.70	-	633.87	OK	OK	436.0	1,496.5	6,291	1,626.34	OK
04-Apr-12	158.31	10.65	147.67	204.98	10.65	342.00	OK	364.25	363.73	362.90	0.32	362.40	OK	OK	157.4	531.0	4,377	1,131.63	OK
05-Apr-12	134.47	10.65	123.82	173.43	10.65	286.61	OK	315.40	314.87	314.04	8.10	321.31	OK	OK	118.9	399.0	3,961	1,023.97	OK
06-Apr-12	81.59	10.65	70.94	95.80	10.65	156.09	OK	173.54	173.01	172.18	8.86	180.21	OK	OK	44.3	146.1	2,786	720.30	OK
07-Apr-12	77.18	10.65	66.53	99.53	10.65	155.42	OK	174.15	173.62	172.79	1.51	173.47	OK	OK	43.6	143.8	2,771	716.33	OK
08-Apr-12	104.41	10.65	93.77	182.32	10.65	265.44	OK	343.76	343.24	342.41	3.13	344.71	OK	OK	141.1	475.0	4,210	1,088.33	OK
09-Apr-12	94.24	10.65	83.60	160.49	10.65	233.44	OK	300.63	300.11	299.28	2.70	301.15	OK	OK	110.8	371.6	3,863	998.77	OK
10-Apr-12	84.75	10.65	74.10	100.50	10.65	163.96	OK	300.60	300.08	299.25	108.32	406.74	OK	OK	147.4	496.4	4,275	1,105.32	OK
11-Apr-12	66.22	10.65	55.57	73.61	10.65	118.54	OK	251.33	250.80	249.97	108.32	357.47	OK	OK	124.3	417.5	4,024	1,040.33	OK
12-Apr-12	44.30	10.65	33.65	44.21	10.65	67.21	OK	80.48	79.96	79.13	9.61	87.91	OK	OK	14.0	45.2	1,848	477.88	OK
13-Apr-12	44.07	10.65	33.42	45.41	10.65	68.19	OK	82.64	82.11	81.28	4.97	85.42	OK	OK	14.3	46.3	1,863	481.64	OK
14-Apr-12	43.96	10.65	33.31	51.02	10.65	73.69	OK	107.71	107.19	106.36	15.55	121.08	OK	OK	21.2	69.0	2,143	553.91	OK
15-Apr-12	43.73	10.65	33.09	49.15	10.65	71.58	OK	99.40	98.88	98.05	12.85	110.07	OK	OK	18.4	59.8	2,038	526.85	OK
16-Apr-12	43.05	10.65	32.41	42.20	10.65	63.96	OK	68.02	67.50	66.67	0.11	65.95	OK	OK	12.2	39.2	1,759	454.73	OK
17-Apr-12	56.16	10.65	45.52	60.37	10.65	95.23	OK	109.47	108.94	108.11	8.21	115.49	OK	OK	21.7	70.7	2,161	558.80	OK

18-Apr-12	56.73	10.65	46.08	61.04	10.65	96.47	OK	115.20	114.67	113.85	12.31	125.33	OK	OK	23.0	75.1	2,208	570.76	OK
19-Apr-12	39.55	10.65	28.90	38.69	10.65	56.95	OK	63.91	63.38	62.55	4.10	65.83	OK	OK	10.7	34.4	1,680	434.45	OK
20-Apr-12	27.01	10.65	16.36	55.96	10.65	61.68	OK	101.69	101.17	100.34	1.73	101.24	OK	OK	24.2	79.2	2,249	581.33	OK
21-Apr-12	25.65	10.65	15.01	54.50	10.65	58.85	OK	98.55	98.03	97.20	1.73	98.10	OK	OK	23.6	77.1	2,227	575.84	OK
22-Apr-12	21.13	10.65	10.49	22.81	10.65	22.64	OK	27.35	26.83	26.00	0.54	25.71	OK	OK	4.2	13.2	1,201	310.40	OK
23-Apr-12	19.89	10.65	9.24	56.76	10.65	55.36	OK	105.33	104.80	103.97	2.38	105.52	OK	OK	31.4	102.9	2,465	637.21	OK
24-Apr-12	19.10	10.65	8.45	118.12	10.65	115.93	OK	245.61	245.09	244.26	5.83	249.26	OK	OK	161.6	545.4	4,418	1,142.32	OK
25-Apr-12	16.50	10.65	5.85	81.64	10.65	76.85	OK	162.98	162.46	161.63	3.89	164.69	OK	OK	77.4	258.0	3,400	879.02	OK
26-Apr-12	14.46	10.65	3.82	14.16	10.65	7.33	OK	19.85	19.32	18.50	0.86	18.53	OK	OK	3.3	10.3	1,102	284.94	OK
27-Apr-12	13.22	10.65	2.58	11.27	10.65	3.19	OK	11.11	10.59	9.76	0.22	9.15	OK	OK	2.2	6.9	957	247.53	OK
28-Apr-12	11.98	10.65	1.33	10.02	10.65	0.71	OK	18.68	18.16	17.33	10.26	26.76	OK	OK	3.7	11.7	1,152	297.77	OK
29-Apr-12	76.05	10.65	65.40	97.19	10.65	151.95	OK	175.60	175.07	174.24	10.37	183.78	OK	OK	43.5	143.4	2,768	715.64	OK
30-Apr-12	114.58	10.65	103.94	148.16	10.65	241.45	OK	254.93	254.40	253.57	0.97	253.72	OK	OK	86.0	287.2	3,530	912.67	OK
01-May-12	54.01	10.65	43.37	64.16	10.65	96.88	OK	104.91	104.38	103.55	2.27	104.99	OK	OK	20.8	67.7	2,128	550.27	OK
02-May-12	24.07	10.65	13.42	23.65	10.65	26.43	OK	31.25	30.72	29.89	2.16	31.22	OK	OK	4.7	14.9	1,252	323.63	OK
03-May-12	29.61	10.65	18.96	30.95	10.65	39.26	OK	41.62	41.09	40.26	-	39.44	OK	OK	6.6	21.1	1,416	366.20	OK
04-May-12	26.89	10.65	16.25	27.25	10.65	32.85	OK	44.30	43.77	42.95	8.21	50.32	OK	OK	6.4	20.5	1,400	362.04	OK
05-May-12	95.60	10.65	84.95	119.82	10.65	194.13	OK	211.25	210.72	209.89	8.21	217.27	OK	OK	61.2	203.2	3,127	808.49	OK
06-May-12	96.05	10.65	85.40	119.28	10.65	194.04	OK	230.10	229.58	228.75	24.73	252.65	OK	OK	67.4	224.1	3,236	836.72	OK
07-May-12	23.28	10.65	12.63	20.44	10.65	22.43	OK	51.85	51.33	50.50	24.73	74.40	OK	OK	9.5	30.5	1,610	416.18	OK
08-May-12	22.71	10.65	12.07	74.77	10.65	76.19	OK	147.13	146.60	145.78	3.24	148.19	OK	OK	55.8	185.1	3,027	782.50	OK
09-May-12	22.71	10.65	12.07	74.66	10.65	76.08	OK	146.91	146.39	145.56	3.24	147.97	OK	OK	55.7	184.5	3,024	781.70	OK
10-May-12	44.75	10.65	34.10	49.39	10.65	72.85	OK	79.80	79.28	78.45	-	77.62	OK	OK	14.2	45.8	1,857	480.04	OK
11-May-12	56.73	10.65	46.08	85.24	10.65	120.67	OK	153.10	152.57	151.74	1.19	152.10	OK	OK	35.3	115.9	2,570	664.33	OK
12-May-12	74.47	10.65	63.82	113.54	10.65	166.72	OK	205.99	205.46	204.63	1.51	205.31	OK	OK	56.6	187.5	3,041	786.12	OK
13-May-12	87.24	10.65	76.59	110.03	10.65	175.97	OK	189.67	189.15	188.32	0.32	187.81	OK	OK	51.7	171.1	2,945	761.36	OK
14-May-12	55.82	10.65	45.18	62.12	10.65	96.65	OK	103.07	102.54	101.71	-	100.88	OK	OK	20.8	67.8	2,130	550.73	OK
15-May-12	34.24	0.87	33.37	42.50	0.87	74.99	OK	79.81	79.28	79.28	-	78.45	OK	OK	8.1	26.0	1,523	393.82	OK
16-May-12	63.51	0.87	62.63	82.21	0.87	143.98	OK	155.21	154.69	154.69	4.10	157.96	OK	OK	27.2	88.9	2,342	605.47	OK
17-May-12	168.82	0.87	167.95	225.04	0.87	392.12	OK	416.73	416.20	416.20	8.21	423.58	OK	OK	175.4	592.8	4,549	1,176.15	OK
18-May-12	156.51	0.87	155.63	206.89	0.87	361.65	OK	379.42	378.89	378.89	4.10	382.17	OK	OK	149.7	504.3	4,299	1,111.43	OK
19-May-12	52.09	0.87	51.22	64.86	0.87	115.21	OK	121.74	121.21	121.21	-	120.38	OK	OK	17.9	58.1	2,018	521.80	OK
20-May-12	31.87	0.87	30.99	37.81	0.87	67.94	OK	71.57	71.05	71.05	-	70.22	OK	OK	6.9	21.9	1,434	370.80	OK
21-May-12	31.64	0.87	30.77	37.48	0.87	67.37	OK	70.16	69.63	69.63	-	68.80	OK	OK	6.7	21.5	1,424	368.13	OK
22-May-12	35.48	0.87	34.61	43.19	0.87	76.93	OK	105.50	104.97	104.97	22.25	126.39	OK	OK	13.6	44.0	1,830	473.19	OK
23-May-12	31.08	0.87	30.20	38.78	0.87	68.11	OK	103.42	102.90	102.90	28.51	130.58	OK	OK	14.4	46.7	1,869	483.27	OK
24-May-12	26.89	0.87	26.02	42.41	0.87	67.56	OK	117.85	117.33	117.33	31.75	148.25	OK	OK	21.7	70.7	2,162	558.88	OK
25-May-12	26.44	0.87	25.57	41.96	0.87	66.66	OK	133.00	132.47	132.47	45.90	177.54	OK	OK	32.1	105.4	2,485	642.54	OK
26-May-12	26.44	0.87	25.57	31.95	0.87	56.65	OK	80.94	80.41	80.41	20.41	100.00	OK	OK	8.6	27.7	1,556	402.38	OK
27-May-12	25.88	0.87	25.01	34.47	0.87	58.60	OK	72.72	72.20	72.20	8.53	79.90	OK	OK	6.3	20.2	1,393	360.21	OK
28-May-12	246.91	0.87	246.03	333.37	0.87	578.53	OK	625.08	624.55	624.55	19.12	642.84	OK	OK	369.9	1,265.9	5,933	1,533.81	OK
29-May-12	254.82	0.87	253.94	338.09	0.87	591.16	OK	624.01	623.49	623.49	10.58	633.24	OK	OK	379.9	1,300.7	5,989	1,548.45	OK
30-May-12	91.98	0.87	91.11	116.52	0.87	206.76	OK	237.90	237.37	237.37	22.57	259.11	OK	OK	58.3	193.3	3,073	794.55	OK
31-May-12	91.98	0.87	91.11	116.41	0.87	206.65	OK	242.60	242.08	242.08	26.78	268.03	OK	OK	60.2	199.7	3,108	803.63	OK
01-Jun-12	38.19	0.87	37.32	43.37	0.87	79.82	OK	86.35	85.82	85.82	4.54	89.53	OK	OK	9.6	31.0	1,619	418.48	OK
02-Jun-12	36.95	0.87	36.08	42.02	0.87	77.23	OK	78.51	77.99	77.99	0.11	77.26	OK	OK	8.8	28.1	1,566	404.76	OK
03-Jun-12	32.66	0.87	31.79	130.57	0.87	161.48	OK	281.85	281.33	281.33	5.51	286.01	OK	OK	141.7	477.0	4,216	1,089.98	OK
04-Jun-12	26.10	0.87	25.23	124.01	0.87	149.37	OK	268.53	268.01	268.01	5.51	272.69	OK	OK	139.1	468.1	4,188	1,082.83	OK
05-Jun-12	26.67	0.87	25.80	31.52	0.87	56.44	OK	99.56	99.04	99.04	36.94	135.14	OK	OK	16.2	52.5	1,948	503.61	OK
06-Jun-12	26.44	0.87	25.57	31.29	0.87	55.99	OK	108.63	108.11	108.11	45.36	152.64	OK	OK	21.4	69.6	2,150	555.84	OK
07-Jun-12	26.33	0.87	25.46	41.96	0.87	66.54	OK	107.52	107.00	107.00	23.87	130.04	OK	OK	16.6	54.0	1,966	508.34	OK
08-Jun-12	26.10	0.87	25.23	41.62	0.87	65.98	OK	99.58	99.05	99.05	17.60	115.83	OK	OK	13.3	42.9	1,815	469.29	OK
09-Jun-12	25.76	0.87	24.89	30.39	0.87	54.41	OK	65.65	65.12	65.12	4.43	68.72	OK	OK	5.4	17.2	1,317	340.42	OK
10-Jun-12	25.76	0.87	24.89	30.39	0.87	54.41	OK	62.87	62.34	62.34	2.16	63.67	OK	OK	5.0	16.0	1,284	331.93	OK
11-Jun-12	50.74	0.87	49.87	63.95	0.87	112.94	OK	119.57	119.05	119.05	-	118.22	OK	OK	17.2	55.8	1,990	514.36	OK
12-Jun-12	51.64	0.87	50.77	65.40	0.87	115.30	OK	121.61	121.08	121.08	-	120.26	OK	OK	17.8	57.8	2,014	520.70	OK
13-Jun-12	27.35	0.87	26.47	35.16	0.87	60.77	OK	67.61	67.09	67.09	0.22	66.48	OK	OK	5.7	18.1	1,341	346.81	OK
14-Jun-12	22.71	0.87	21.84	29.87	0.87	50.84	OK	56.30	55.77	55.77	0.22	55.16	OK	OK	4.1	12.9	1,190	307.72	OK
15-Jun-12	9.04	0.87	8.17	13.34	0.87	20.63	OK	22.03	21.50	21.50	-	20.67	OK	OK	0.8	2.5	-	-	OK
16-Jun-12	11.87	0.87	10.99	16.05	0.87	26.17	OK	27.24	26.72	26.72	-	25.89	OK	OK	1.2	3.7	-	-	OK
17-Jun-12	7.23	0.87	6.36	15.71	0.87	21.20	OK	27.62	27.09	27.09	0.22	26.48	OK	OK	1.3	4.1	-	-	OK
18-Jun-12	8.48	0.87	7.60	16.95	0.87	23.68	OK	29.89	29.37	29.37	0.22	28.75	OK	OK	1.4	4.4	-	-	OK
19-Jun-12	13.56	0.87	12.69	19.62	0.87	31.43	OK	32.40	31.87	31.87	-	31.04	OK	OK	1.6	5.1	859	222.16	OK
20-Jun-12	97.41	0.87	96.53	154.94	0.87	250.61	OK	287.74	287.21	287.21	1.40	287.79	OK	OK	82.3	274.6	3,475	898.47	OK
21-Jun-12	98.08	0.87	97.21	154.63	0.87	250.97	OK	287.78	287.26	287.26	1.40	287.83	OK	OK	82.3	274.4	3,474	898.17	OK

22-Jun-12	17.74	0.87	16.87	22.59	0.87	38.59	OK	42.22	41.70	41.70	-	40.87	OK	OK	2.5	7.7	995	257.30	OK
23-Jun-12	14.46	0.87	13.59	18.32	0.87	31.04	OK	33.61	33.09	33.09	-	32.26	OK	OK	1.7	5.2	865	223.52	OK
24-Jun-12	14.46	0.87	13.59	18.32	0.87	31.04	OK	32.97	32.44	32.44	-	31.61	OK	OK	1.6	5.1	860	222.43	OK
25-Jun-12	14.35	0.87	13.48	18.10	0.87	30.71	OK	32.10	31.57	31.57	-	30.74	OK	OK	1.6	5.0	-	-	OK
26-Jun-12	14.35	0.87	13.48	18.10	0.87	30.71	OK	31.78	31.25	31.25	-	30.42	OK	OK	1.6	4.9	-	-	OK
27-Jun-12	42.15	0.87	41.28	55.47	0.87	95.87	OK	99.08	98.56	98.56	-	97.73	OK	OK	12.4	39.9	1,769	457.41	OK
28-Jun-12	42.71	0.87	41.84	56.03	0.87	97.00	OK	100.00	99.47	99.47	-	98.64	OK	OK	12.6	40.8	1,783	460.93	OK
29-Jun-12	14.13	0.87	13.25	17.65	0.87	30.03	OK	30.46	29.94	29.94	-	29.11	OK	OK	1.5	4.7	-	-	OK
30-Jun-12	14.24	0.87	13.37	17.77	0.87	30.26	OK	30.58	30.06	30.06	-	29.23	OK	OK	1.5	4.8	-	-	OK
01-Jul-12	14.13	0.87	13.25	17.65	0.87	30.03	OK	44.91	44.38	44.38	12.74	56.30	OK	OK	3.0	9.5	1,072	277.03	OK
02-Jul-12	14.13	0.87	13.25	17.54	0.87	29.92	OK	44.69	44.17	44.17	12.74	56.08	OK	OK	3.0	9.4	1,068	276.13	OK
03-Jul-12	14.01	0.87	13.14	19.52	0.87	31.79	OK	34.68	34.15	34.15	1.19	34.51	OK	OK	1.7	5.4	876	226.40	OK
04-Jul-12	14.01	0.87	13.14	19.52	0.87	31.79	OK	34.68	34.15	34.15	0.43	33.76	OK	OK	1.7	5.4	876	226.40	OK
05-Jul-12	13.90	0.87	13.03	17.21	0.87	29.36	OK	29.47	28.94	28.94	0.11	28.22	OK	OK	1.5	4.5	-	-	OK
06-Jul-12	13.67	0.87	12.80	16.87	0.87	28.80	OK	28.91	28.38	28.38	-	27.55	OK	OK	1.4	4.4	-	-	OK
07-Jul-12	11.64	0.87	10.77	14.84	0.87	24.73	OK	34.47	33.94	33.94	8.53	41.65	OK	OK	1.7	5.5	882	227.98	OK
08-Jul-12	9.38	0.87	8.51	13.46	0.87	21.09	OK	45.70	45.18	45.18	21.28	65.62	OK	OK	4.7	15.0	1,257	325.08	OK
09-Jul-12	113.79	0.87	112.92	153.62	0.87	265.67	OK	289.42	288.90	288.90	12.74	300.81	OK	OK	85.8	286.3	3,526	911.63	OK
10-Jul-12	114.81	0.87	113.94	153.65	0.87	266.71	OK	276.23	275.71	275.71	1.84	276.72	OK	OK	83.5	278.6	3,493	903.00	OK
11-Jul-12	15.03	0.87	14.16	18.01	0.87	31.29	OK	33.65	33.12	33.12	0.86	33.16	OK	OK	1.7	5.3	873	225.63	OK
12-Jul-12	14.24	0.87	13.37	17.22	0.87	29.71	OK	30.99	30.47	30.47	0.11	29.75	OK	OK	1.5	4.7	-	-	OK
13-Jul-12	14.35	0.87	13.48	17.33	0.87	29.94	OK	30.90	30.37	30.37	-	29.55	OK	OK	1.5	4.8	-	-	OK
14-Jul-12	13.79	0.87	12.91	32.27	0.87	44.32	OK	69.89	69.36	69.36	5.18	73.72	OK	OK	8.0	25.7	1,516	391.95	OK
15-Jul-12	11.98	0.87	11.11	38.17	0.87	48.40	OK	98.58	98.06	98.06	10.37	107.60	OK	OK	20.9	68.0	2,132	551.26	OK
16-Jul-12	12.43	0.87	11.56	23.00	0.87	33.68	OK	58.94	58.41	58.41	5.18	62.77	OK	OK	6.1	19.5	1,376	355.85	OK
17-Jul-12	15.03	0.87	14.16	37.70	0.87	50.98	OK	75.91	75.39	75.39	1.08	75.64	OK	OK	9.2	29.4	1,590	411.15	OK
18-Jul-12	15.14	0.87	14.27	38.14	0.87	51.54	OK	76.79	76.27	76.27	1.19	76.62	OK	OK	9.4	30.1	1,604	414.60	OK
19-Jul-12	12.32	0.87	11.45	15.30	0.87	25.87	OK	30.68	30.16	30.16	0.32	29.65	OK	OK	1.3	4.2	-	-	OK
20-Jul-12	12.32	0.87	11.45	23.66	0.87	34.23	OK	48.67	48.15	48.15	0.65	47.97	OK	OK	3.5	11.1	1,131	292.33	OK
21-Jul-12	15.03	0.87	14.16	27.36	0.87	40.64	OK	54.55	54.03	54.03	0.54	53.74	OK	OK	4.1	12.9	1,191	307.87	OK
22-Jul-12	29.04	0.87	28.17	37.41	0.87	64.71	OK	69.52	69.00	69.00	-	68.17	OK	OK	6.2	19.6	1,381	356.94	OK
23-Jul-12	26.78	0.87	25.91	34.16	0.87	59.20	OK	62.94	62.42	62.42	-	61.59	OK	OK	5.2	16.6	1,301	336.24	OK
24-Jul-12	13.22	0.87	12.35	15.76	0.87	27.24	OK	29.06	28.53	28.53	-	27.70	OK	OK	1.3	4.1	-	-	OK
25-Jul-12	13.11	0.87	12.24	16.20	0.87	27.56	OK	29.81	29.28	29.28	-	28.45	OK	OK	1.3	4.2	-	-	OK
26-Jul-12	10.85	0.87	9.98	13.94	0.87	23.04	OK	24.86	24.33	24.33	-	23.51	OK	OK	1.0	3.0	-	-	OK
27-Jul-12	4.63	0.87	3.76	7.06	0.87	9.95	OK	10.70	10.17	10.17	-	9.35	OK	OK	0.3	0.8	-	-	OK
28-Jul-12	6.33	0.87	5.46	8.76	0.87	13.34	OK	13.98	13.46	13.46	-	12.63	OK	OK	0.4	1.2	-	-	OK
29-Jul-12	5.76	0.87	4.89	8.08	0.87	12.10	OK	12.53	12.00	12.00	-	11.17	OK	OK	0.3	1.0	-	-	OK
30-Jul-12	5.88	0.87	5.00	8.19	0.87	12.33	OK	12.65	12.12	12.12	-	11.29	OK	OK	0.3	1.0	-	-	OK
31-Jul-12	5.76	0.87	4.89	8.08	0.87	12.10	OK	12.31	11.79	11.79	-	10.96	OK	OK	0.3	1.0	-	-	OK
01-Aug-12	25.20	0.87	24.33	34.23	0.87	57.68	OK	59.50	58.98	58.98	-	58.15	OK	OK	4.8	15.3	1,266	327.26	OK
02-Aug-12	25.99	0.87	25.12	35.02	0.87	59.26	OK	61.08	60.56	60.56	-	59.73	OK	OK	5.1	16.1	1,289	333.15	OK
03-Aug-12	7.01	0.87	6.13	9.43	0.87	14.70	OK	15.23	14.71	14.71	-	13.88	OK	OK	0.4	1.4	-	-	OK
04-Aug-12	15.03	0.87	14.16	26.92	0.87	40.20	OK	49.83	49.31	49.31	0.43	48.91	OK	OK	3.3	10.5	1,108	286.56	OK
05-Aug-12	15.37	0.87	14.50	26.93	0.87	40.55	OK	49.75	49.23	49.23	0.43	48.83	OK	OK	3.3	10.4	1,103	285.24	OK
06-Aug-12	40.68	0.87	39.81	54.33	0.87	93.26	OK	96.26	95.74	95.74	-	94.91	OK	OK	11.7	37.7	1,735	448.57	OK
07-Aug-12	44.64	0.87	43.76	59.27	0.87	102.16	OK	105.37	104.85	104.85	-	104.02	OK	OK	13.9	44.9	1,843	476.53	OK
08-Aug-12	14.69	0.87	13.82	18.66	0.87	31.60	OK	32.57	32.04	32.04	-	31.21	OK	OK	1.7	5.2	866	223.76	OK
09-Aug-12	10.96	0.87	10.09	23.18	0.87	32.40	OK	44.92	44.39	44.39	0.54	44.10	OK	OK	3.1	9.8	1,083	279.95	OK
10-Aug-12	8.59	0.87	7.72	19.82	0.87	26.66	OK	38.86	38.33	38.33	0.54	38.04	OK	OK	2.6	8.1	1,013	261.97	OK
11-Aug-12	41.81	0.87	40.94	55.35	0.87	95.41	OK	98.52	97.99	97.99	-	97.16	OK	OK	12.2	39.5	1,763	455.69	OK
12-Aug-12	157.52	0.87	156.65	210.66	0.87	366.44	OK	379.39	378.86	378.86	-	378.03	OK	OK	152.0	512.3	4,323	1,117.55	OK
13-Aug-12	138.09	0.87	137.21	182.42	0.87	318.77	OK	329.47	328.94	328.94	-	328.11	OK	OK	117.1	393.0	3,940	1,018.51	OK
14-Aug-12	74.81	0.87	73.93	95.93	0.87	169.00	OK	173.92	173.39	173.39	-	172.56	OK	OK	35.8	117.6	2,583	667.70	OK
15-Aug-12	104.19	0.87	103.31	134.99	0.87	237.44	OK	261.83	261.31	261.31	14.90	275.38	OK	OK	71.0	236.3	3,297	852.34	OK
16-Aug-12	68.25	0.87	67.38	85.53	0.87	152.04	OK	173.01	172.49	172.49	14.90	186.56	OK	OK	32.3	106.1	2,491	644.08	OK
17-Aug-12	38.65	0.87	37.77	45.25	0.87	82.16	OK	84.51	83.99	83.99	-	83.16	OK	OK	9.7	31.2	1,623	419.56	OK
18-Aug-12	36.05	0.87	35.18	45.30	0.87	79.60	OK	87.20	86.67	86.67	0.32	86.17	OK	OK	9.2	29.7	1,595	412.47	OK
19-Aug-12	35.03	0.87	34.16	55.50	0.87	88.78	OK	110.51	109.98	109.98	0.97	110.12	OK	OK	13.8	44.5	1,838	475.16	OK
20-Aug-12	35.60	0.87	34.72	52.65	0.87	86.50	OK	120.85	120.33	120.33	15.66	135.16	OK	OK	17.4	56.7	2,000	517.09	OK
21-Aug-12	38.31	0.87	37.44	66.81	0.87	103.37	OK	151.30	150.78	150.78	16.31	166.26	OK	OK	28.5	93.3	2,382	615.80	OK
22-Aug-12	35.71	0.87	34.84	64.10	0.87	98.06	OK	174.99	174.47	174.47	40.93	214.57	OK	OK	47.6	157.2	2,859	739.15	OK
23-Aug-12	27.01	0.87	26.14	30.76	0.87	56.02	OK	104.17	103.64	103.64	39.64	142.45	OK	OK	18.9	61.4	2,057	531.85	OK
24-Aug-12	24.75	0.87	23.88	39.39	0.87	62.39	OK	79.29	78.77	78.77	3.67	81.61	OK	OK	7.5	24.1	1,482	383.20	OK
25-Aug-12	25.09	0.87	24.21	142.35	0.87	165.70	OK	315.82	315.29	315.29	8.86	323.32	OK	OK	203.0	687.7	4,792	1,238.83	OK

26-Aug-12	27.57	0.87	26.70	133.62	0.87	159.45	OK	294.16	293.64	293.64	7.56	300.37	OK	OK	167.8	566.7	4,478	1,157.72	OK
27-Aug-12	47.23	0.87	46.36	57.36	0.87	102.85	OK	117.62	117.09	117.09	4.43	120.69	OK	OK	15.9	51.5	1,934	499.96	OK
28-Aug-12	75.26	0.87	74.39	96.61	0.87	170.12	OK	188.85	188.32	188.32	5.51	193.00	OK	OK	38.3	126.2	2,648	684.48	OK
29-Aug-12	86.67	0.87	85.80	112.86	0.87	197.79	OK	212.77	212.24	212.24	2.27	213.68	OK	OK	49.1	162.3	2,891	747.41	OK
30-Aug-12	54.35	0.87	53.48	75.15	0.87	127.76	OK	143.81	143.29	143.29	1.51	143.97	OK	OK	22.5	73.4	2,189	566.05	OK
31-Aug-12	24.97	0.87	24.10	35.10	0.87	58.33	OK	70.31	69.79	69.79	0.43	69.39	OK	OK	5.9	18.8	1,358	351.15	OK
01-Sep-12	18.19	10.65	7.55	16.02	10.65	12.92	OK	21.91	21.38	20.55	0.11	19.83	OK	OK	3.3	10.4	1,106	286.01	OK
02-Sep-12	14.01	10.65	3.37	91.70	10.65	84.42	OK	195.27	194.74	193.91	4.86	197.95	OK	OK	114.2	383.1	3,905	1,009.45	OK
03-Sep-12	21.47	10.65	10.82	137.65	10.65	137.83	OK	293.95	293.42	292.59	7.02	298.78	OK	OK	222.5	754.9	4,951	1,279.95	OK
04-Sep-12	21.36	10.65	10.71	59.00	10.65	59.07	OK	113.21	112.68	111.85	2.59	113.62	OK	OK	34.6	113.9	2,554	660.19	OK
05-Sep-12	13.56	10.65	2.91	17.65	10.65	9.92	OK	44.27	43.74	42.92	19.33	61.42	OK	OK	10.1	32.6	1,648	426.19	OK
06-Sep-12	13.11	10.65	2.46	17.75	10.65	9.57	OK	44.02	43.50	42.67	19.33	61.17	OK	OK	10.2	32.8	1,653	427.26	OK
07-Sep-12	12.77	10.65	2.12	11.69	10.65	3.17	OK	17.29	16.77	15.94	3.24	18.35	OK	OK	3.1	9.9	1,087	281.02	OK
08-Sep-12	12.20	10.65	1.56	7.94	10.65	-	Fail	7.60	7.07	6.24	0.86	6.28	OK	Fail	1.8	5.5	883	228.40	OK
09-Sep-12	12.32	10.65	1.67	8.05	10.65	-	Fail	5.67	5.15	4.32	0.32	3.81	OK	Fail	1.6	5.0	-	-	OK
10-Sep-12	12.20	10.65	1.56	7.83	10.65	-	Fail	4.28	3.75	2.93	0.11	2.20	OK	Fail	1.5	4.6	-	-	OK
11-Sep-12	12.20	10.65	1.56	7.72	10.65	-	Fail	3.21	2.68	1.86	-	1.03	OK	Fail	1.4	4.4	-	-	OK
12-Sep-12	12.09	10.65	1.45	7.61	10.65	-	Fail	2.35	1.83	1.00	-	0.17	OK	Fail	1.3	4.2	-	-	OK
13-Sep-12	11.41	10.65	0.77	7.15	10.65	-	Fail	2.25	1.72	0.89	-	0.06	OK	Fail	1.3	3.9	-	-	OK
14-Sep-12	29.15	10.65	18.51	31.60	10.65	39.46	OK	42.88	42.36	41.53	-	40.70	OK	OK	6.7	21.4	1,422	367.54	OK
15-Sep-12	69.50	10.65	58.85	86.13	10.65	134.33	OK	145.57	145.04	144.21	4.32	147.70	OK	OK	33.8	111.1	2,532	654.64	OK
16-Sep-12	53.45	10.65	42.80	64.14	10.65	96.30	OK	105.82	105.30	104.47	4.32	107.96	OK	OK	20.8	67.6	2,128	550.07	OK
17-Sep-12	13.00	10.65	2.35	9.17	10.65	0.87	OK	1.94	1.42	0.59	-	-	Fail	Fail	1.5	4.7	-	-	OK
18-Sep-12	9.83	10.65	-	5.72	10.65	-	Fail	0.64	0.12	-	-	-	Fail	Fail	0.9	2.9	-	-	OK
19-Sep-12	9.83	10.65	-	5.94	10.65	-	Fail	0.86	0.33	-	-	-	Fail	Fail	1.0	3.0	-	-	OK
20-Sep-12	9.61	10.65	-	5.94	10.65	-	Fail	0.75	0.22	-	-	-	Fail	Fail	0.9	2.9	-	-	OK
21-Sep-12	9.15	10.65	-	5.61	10.65	-	Fail	0.32	-	-	-	-	Fail	Fail	0.8	2.6	-	-	Fail
22-Sep-12	9.15	10.65	-	5.50	10.65	-	Fail	0.21	-	-	-	-	Fail	Fail	0.8	2.6	-	-	Fail
23-Sep-12	9.15	10.65	-	5.50	10.65	-	Fail	0.11	-	-	-	-	Fail	Fail	0.8	2.5	-	-	Fail
24-Sep-12	9.04	10.65	-	5.39	10.65	-	Fail	0.11	-	-	-	-	Fail	Fail	0.8	2.5	-	-	Fail
25-Sep-12	9.04	10.65	-	6.93	10.65	-	Fail	129.90	129.37	128.54	112.54	240.25	OK	Fail	93.4	312.2	3,635	939.72	OK
26-Sep-12	8.93	10.65	-	6.82	10.65	-	Fail	156.11	155.59	154.76	135.65	289.58	OK	Fail	132.0	444.0	4,111	1,062.93	OK
27-Sep-12	8.93	10.65	-	5.17	10.65	-	Fail	41.09	40.56	39.73	36.18	75.08	OK	Fail	11.2	36.0	1,706	441.05	OK
28-Sep-12	8.81	10.65	-	5.17	10.65	-	Fail	17.23	16.70	15.87	15.12	30.16	OK	Fail	2.8	8.7	1,036	267.96	OK
29-Sep-12	8.81	10.65	-	5.06	10.65	-	Fail	12.09	11.57	10.74	4.75	14.66	OK	Fail	1.8	5.5	886	228.94	OK
30-Sep-12	8.81	10.65	-	27.17	10.65	16.52	Fail	52.16	51.63	50.80	2.05	52.02	OK	Fail	13.2	42.7	1,812	468.40	OK
01-Oct-12	8.36	10.65	-	28.05	10.65	17.40	Fail	52.50	51.98	51.15	1.62	51.94	OK	Fail	13.2	42.8	1,813	468.63	OK
02-Oct-12	6.33	10.65	-	5.83	10.65	-	Fail	14.12	13.60	12.77	0.54	12.48	OK	Fail	1.9	6.0	911	235.61	OK
03-Oct-12	3.96	10.65	-	4.84	10.65	-	Fail	9.74	9.21	8.38	0.11	7.66	OK	Fail	1.0	3.0	-	-	OK
04-Oct-12	4.41	10.65	-	29.81	10.65	19.16	Fail	58.54	58.02	57.19	1.51	57.87	OK	Fail	15.4	49.8	1,912	494.34	OK
05-Oct-12	4.18	10.65	-	77.99	10.65	67.34	Fail	167.07	166.54	165.71	4.43	169.31	OK	Fail	91.2	304.7	3,604	931.69	OK
06-Oct-12	54.47	10.65	43.82	115.87	10.65	149.04	OK	221.70	221.17	220.34	3.02	222.54	OK	OK	78.6	261.9	3,418	883.65	OK
07-Oct-12	56.39	10.65	45.74	69.39	10.65	104.49	OK	114.44	113.91	113.08	0.43	112.69	OK	OK	23.3	76.0	2,217	573.09	OK
08-Oct-12	7.68	10.65	-	4.62	10.65	-	Fail	2.68	2.15	1.32	0.11	0.60	OK	Fail	0.7	2.0	-	-	OK
09-Oct-12	7.35	10.65	-	4.62	10.65	-	Fail	2.57	2.04	1.21	0.54	0.92	OK	Fail	0.6	1.9	-	-	OK
10-Oct-12	7.35	10.65	-	14.19	10.65	3.54	Fail	18.10	17.57	16.74	1.08	16.99	OK	Fail	3.2	10.2	1,096	283.30	OK
11-Oct-12	7.35	10.65	-	14.41	10.65	3.76	Fail	17.78	17.26	16.43	0.65	16.25	OK	Fail	3.2	10.0	1,089	281.46	OK
12-Oct-12	7.35	10.65	-	32.78	10.65	22.13	Fail	59.46	58.95	58.12	1.73	59.02	OK	Fail	15.8	51.3	1,932	499.37	OK
13-Oct-12	7.23	10.65	-	34.65	10.65	24.00	Fail	63.59	63.07	62.24	1.84	63.25	OK	Fail	17.6	57.1	2,005	518.45	OK
14-Oct-12	63.05	10.65	52.41	78.37	10.65	120.13	OK	128.26	127.74	126.91	0.22	126.30	OK	OK	28.2	92.5	2,375	613.89	OK
15-Oct-12	95.94	10.65	85.29	119.61	10.65	194.26	OK	322.76	322.24	321.41	106.60	427.18	OK	OK	150.0	505.4	4,302	1,112.24	OK
16-Oct-12	43.05	10.65	32.41	58.81	10.65	80.57	OK	242.89	242.36	241.53	128.52	369.22	OK	OK	157.0	529.6	4,373	1,130.59	OK
17-Oct-12	13.00	10.65	2.35	18.08	10.65	9.78	OK	50.55	50.02	49.20	23.54	71.91	OK	OK	13.1	42.3	1,805	466.63	OK
18-Oct-12	40.68	10.65	30.03	43.89	10.65	63.28	OK	89.18	88.65	87.82	20.63	107.62	OK	OK	15.8	51.3	1,932	499.50	OK
19-Oct-12	41.81	10.65	31.16	45.24	10.65	65.76	OK	90.16	89.63	88.80	19.01	106.98	OK	OK	15.9	51.7	1,937	500.86	OK
20-Oct-12	14.80	10.65	4.16	56.85	10.65	50.36	OK	114.34	113.82	112.99	6.37	118.53	OK	OK	42.2	139.3	2,740	708.43	OK
21-Oct-12	14.58	10.65	3.93	56.29	10.65	49.58	OK	121.69	121.17	120.34	12.31	131.82	OK	OK	48.1	159.1	2,871	742.22	OK
22-Oct-12	14.58	10.65	3.93	8.66	10.65	1.95	OK	17.68	17.15	16.32	7.88	23.38	OK	OK	3.3	10.4	1,105	285.76	OK
23-Oct-12	83.28	10.65	72.64	101.57	10.65	163.55	OK	175.32	174.80	173.97	2.38	175.52	OK	OK	46.0	152.0	2,826	730.51	OK
24-Oct-12	158.31	10.65	147.67	202.01	10.65	339.03	OK	360.11	359.58	358.75	5.08	363.00	OK	OK	155.2	523.4	4,355	1,125.98	OK
25-Oct-12	167.24	10.65	156.59	211.92	10.65	357.87	OK	383.12	382.60	381.77	8.86	389.80	OK	OK	171.8	580.4	4,516	1,167.45	OK
26-Oct-12	174.70	10.65	164.05	220.26	10.65	373.67	OK	397.32	396.79	395.96	7.67	402.80	OK	OK	184.8	625.0	4,634	1,198.13	OK
27-Oct-12	107.24	10.65	96.59	127.50	10.65	213.45	OK	252.39	251.87	251.04	27.22	277.43	OK	OK	79.7	265.6	3,435	887.99	OK
28-Oct-12	31.08	10.65	20.43	24.17	10.65	33.95	OK	63.27	62.75	61.92	25.06	86.14	OK	OK	11.7	37.7	1,734	448.39	OK
29-Oct-12	89.27	10.65	78.62	102.71	10.65	170.69	OK	185.14	184.61	183.78	7.13	190.08	OK	OK	50.5	167.2	2,921	755.15	OK

30-Oct-12	91.76	10.65	81.11	105.64	10.65	176.10	OK	224.04	223.52	222.69	33.91	255.77	OK	OK	65.6	217.9	3,205	828.59	OK
31-Oct-12	33.79	10.65	23.14	28.75	10.65	41.25	OK	84.58	84.06	83.23	32.72	115.12	OK	OK	18.9	61.4	2,058	531.94	OK
01-Nov-12	29.38	10.65	18.73	23.90	10.65	31.99	OK	47.29	46.77	45.94	8.75	53.86	OK	OK	7.3	23.3	1,466	378.92	OK
02-Nov-12	28.59	10.65	17.94	21.46	10.65	28.76	OK	203.92	203.39	202.57	150.98	352.72	OK	OK	168.5	568.9	4,484	1,159.28	OK
03-Nov-12	28.82	10.65	18.17	21.69	10.65	29.21	OK	198.91	198.39	197.56	146.56	343.29	OK	OK	159.0	536.5	4,393	1,135.72	OK
04-Nov-12	28.14	10.65	17.49	21.01	10.65	27.86	OK	31.92	31.40	30.57	0.11	29.85	OK	OK	5.3	16.8	1,307	338.01	OK
05-Nov-12	26.44	10.65	15.80	19.87	10.65	25.02	OK	103.66	103.14	102.31	66.74	168.22	OK	OK	40.3	132.7	2,694	696.49	OK
06-Nov-12	26.89	10.65	16.25	26.48	10.65	32.08	OK	118.00	117.48	116.65	67.07	182.89	OK	OK	47.5	157.1	2,858	738.95	OK
07-Nov-12	26.67	10.65	16.02	25.59	10.65	30.97	OK	40.71	40.18	39.35	5.94	44.46	OK	OK	5.9	18.8	1,359	351.42	OK
08-Nov-12	26.67	10.65	16.02	19.32	10.65	24.70	OK	43.10	42.58	41.75	16.96	57.88	OK	OK	6.9	22.1	1,439	371.94	OK
09-Nov-12	25.31	10.65	14.67	17.97	10.65	21.99	OK	40.07	39.54	38.72	15.77	53.65	OK	OK	6.4	20.5	1,400	362.02	OK
10-Nov-12	19.55	10.65	8.90	21.77	10.65	20.03	OK	33.19	32.67	31.84	4.21	35.22	OK	OK	4.9	15.5	1,270	328.37	OK
11-Nov-12	14.69	10.65	4.04	16.91	10.65	10.31	OK	150.91	150.39	149.56	115.45	264.18	OK	OK	110.1	369.0	3,854	996.33	OK
12-Nov-12	9.72	10.65	-	16.61	10.65	5.96	Fail	151.27	150.75	149.92	115.02	264.11	OK	Fail	116.9	392.4	3,938	1,017.98	OK
13-Nov-12	145.43	10.65	134.79	212.67	10.65	336.80	OK	390.41	389.89	389.06	11.12	399.35	OK	OK	166.8	563.1	4,468	1,155.16	OK
14-Nov-12	347.70	10.65	337.06	469.50	10.65	795.90	OK	851.54	851.02	850.19	10.48	859.84	OK	OK	714.6	2,473.4	7,500	1,939.03	OK
15-Nov-12	336.18	10.65	325.53	437.40	10.65	752.28	OK	782.14	781.61	780.78	3.13	783.08	OK	OK	638.2	2,204.8	7,204	1,862.57	OK
16-Nov-12	256.06	10.65	245.41	370.04	10.65	604.81	OK	679.92	679.40	678.57	2.92	680.66	OK	OK	453.8	1,558.5	6,381	1,649.60	OK
17-Nov-12	146.90	10.65	136.25	220.07	10.65	345.68	OK	410.52	410.00	409.17	2.70	411.04	OK	OK	181.7	614.5	4,607	1,190.99	OK
18-Nov-12	40.68	10.65	30.03	33.00	10.65	52.39	OK	52.50	51.97	51.15	-	50.32	OK	OK	10.3	33.0	1,656	428.08	OK
19-Nov-12	40.12	10.65	29.47	33.32	10.65	52.14	OK	53.43	52.90	52.07	0.11	51.35	OK	OK	10.1	32.3	1,644	424.97	OK
20-Nov-12	40.23	10.65	29.58	33.76	10.65	52.70	OK	69.07	68.54	67.72	13.18	80.06	OK	OK	11.9	38.5	1,747	451.53	OK
21-Nov-12	40.23	10.65	29.58	35.63	10.65	54.57	OK	73.40	72.88	72.05	13.39	84.61	OK	OK	12.6	40.7	1,782	460.65	OK
22-Nov-12	40.12	10.65	29.47	35.19	10.65	54.01	OK	57.65	57.13	56.30	1.19	56.66	OK	OK	10.3	33.1	1,656	428.24	OK
23-Nov-12	40.12	10.65	29.47	62.91	10.65	81.73	OK	121.22	120.69	119.86	2.16	121.19	OK	OK	26.6	86.9	2,323	600.67	OK
24-Nov-12	40.12	10.65	29.47	67.97	10.65	86.79	OK	132.91	132.38	131.56	2.27	132.99	OK	OK	32.0	105.1	2,483	641.99	OK
25-Nov-12	40.12	10.65	29.47	48.94	10.65	67.76	OK	89.27	88.74	87.92	1.08	88.17	OK	OK	15.5	50.1	1,916	495.47	OK
26-Nov-12	93.11	10.65	82.47	154.52	10.65	226.34	OK	296.53	296.00	295.17	3.13	297.48	OK	OK	108.0	362.0	3,828	989.64	OK
27-Nov-12	159.44	10.65	148.80	322.93	10.65	461.08	OK	639.45	638.92	638.09	7.99	645.26	OK	OK	466.7	1,603.6	6,445	1,666.17	OK
28-Nov-12	166.56	10.65	155.92	312.89	10.65	458.16	OK	613.41	612.89	612.06	6.91	618.14	OK	OK	410.5	1,407.5	6,157	1,591.79	OK
29-Nov-12	170.52	10.65	159.87	306.83	10.65	456.06	OK	605.86	605.33	604.50	12.85	616.53	OK	OK	393.2	1,347.0	6,063	1,567.50	OK
30-Nov-12	115.94	10.65	105.29	251.26	10.65	345.91	OK	568.04	567.52	566.69	61.67	627.53	OK	OK	446.1	1,531.8	6,342	1,639.65	OK
01-Dec-12	41.02	10.65	30.37	94.17	10.65	113.90	OK	302.11	301.59	300.76	101.41	401.34	OK	OK	221.3	750.9	4,942	1,277.57	OK
02-Dec-12	54.01	10.65	43.37	80.99	10.65	113.71	OK	205.62	205.10	204.27	51.52	254.96	OK	OK	74.2	247.0	3,348	865.67	OK
03-Dec-12	76.50	10.65	65.86	109.64	10.65	164.84	OK	198.87	198.35	197.52	8.21	204.90	OK	OK	52.8	174.8	2,967	766.98	OK
04-Dec-12	64.52	10.65	53.88	93.48	10.65	136.71	OK	168.38	167.86	167.03	3.35	169.55	OK	OK	40.5	133.4	2,699	697.84	OK
05-Dec-12	123.40	10.65	112.75	227.15	10.65	329.25	OK	437.00	436.48	435.65	5.29	440.11	OK	OK	221.3	750.9	4,942	1,277.56	OK
06-Dec-12	199.33	10.65	188.69	393.73	10.65	571.77	OK	771.21	770.69	769.86	10.04	779.08	OK	OK	637.5	2,202.1	7,201	1,861.76	OK
07-Dec-12	152.55	10.65	141.90	256.19	10.65	387.45	OK	556.94	556.42	555.59	65.88	620.64	OK	OK	351.3	1,201.1	5,825	1,505.87	OK
08-Dec-12	66.67	10.65	56.02	122.57	10.65	167.95	OK	307.05	306.53	305.70	63.72	368.59	OK	OK	157.3	530.5	4,376	1,131.31	OK
09-Dec-12	36.50	10.65	25.85	91.74	10.65	106.95	OK	194.26	193.74	192.91	9.83	201.91	OK	OK	77.2	257.3	3,397	878.23	OK
10-Dec-12	36.39	10.65	25.74	40.59	10.65	55.68	OK	77.73	77.20	76.37	5.94	81.48	OK	OK	12.9	41.8	1,798	464.77	OK
11-Dec-12	36.39	10.65	25.74	40.37	10.65	55.46	OK	72.05	71.52	70.70	13.28	83.15	OK	OK	11.6	37.3	1,727	446.60	OK
12-Dec-12	36.27	10.65	25.63	39.49	10.65	54.47	OK	69.98	69.46	68.63	13.18	80.98	OK	OK	11.1	35.9	1,705	440.87	OK
13-Dec-12	80.00	10.65	69.36	98.73	10.65	157.44	OK	169.10	168.58	167.75	-	166.92	OK	OK	43.3	142.7	2,764	714.49	OK
14-Dec-12	110.74	10.65	100.09	211.30	10.65	300.75	OK	464.89	464.37	463.54	58.75	521.46	OK	OK	281.3	958.4	5,382	1,391.45	OK
15-Dec-12	64.75	10.65	54.10	149.58	10.65	193.04	OK	353.01	352.48	351.65	59.83	410.65	OK	OK	213.5	723.8	4,879	1,261.25	OK
16-Dec-12	28.14	0.87	27.27	49.05	0.87	75.44	OK	97.69	97.17	97.17	7.67	104.01	OK	OK	11.4	36.8	1,720	444.55	OK
17-Dec-12	24.75	0.87	23.88	45.55	0.87	68.55	OK	100.97	100.44	100.44	17.50	117.11	OK	OK	13.7	44.2	1,834	474.04	OK
18-Dec-12	109.61	0.87	108.74	150.98	0.87	258.84	OK	295.12	294.59	294.59	24.19	317.96	OK	OK	86.1	287.4	3,531	912.90	OK
19-Dec-12	145.66	0.87	144.79	198.58	0.87	342.49	OK	393.42	392.90	392.90	35.21	427.27	OK	OK	147.9	498.2	4,281	1,106.69	OK
20-Dec-12	119.78	0.87	118.91	162.80	0.87	280.83	OK	314.22	313.69	313.69	22.03	334.90	OK	OK	98.0	328.0	3,698	956.04	OK
21-Dec-12	87.35	0.87	86.48	118.60	0.87	204.20	OK	222.93	222.40	222.40	-	221.57	OK	OK	52.3	173.3	2,958	764.68	OK
22-Dec-12	30.85	0.87	29.98	42.41	0.87	71.51	OK	86.81	86.29	86.29	4.43	89.89	OK	OK	8.7	27.9	1,560	403.43	OK
23-Dec-12	135.60	0.87	134.73	185.99	0.87	319.84	OK	371.74	371.21	371.21	30.78	401.17	OK	OK	132.3	444.9	4,115	1,063.75	OK
24-Dec-12	157.86	0.87	156.99	215.95	0.87	372.07	OK	419.04	418.51	418.51	26.35	444.04	OK	OK	167.9	567.0	4,479	1,157.95	OK
25-Dec-12	86.11	0.87	85.23	136.49	0.87	220.86	OK	278.53	278.00	278.00	22.57	299.75	OK	OK	77.9	259.7	3,408	881.01	OK
26-Dec-12	98.99	0.87	98.12	153.56	0.87	250.80	OK	308.69	308.16	308.16	22.68	330.01	OK	OK	93.4	312.3	3,635	939.84	OK
27-Dec-12	70.74	0.87	69.87	95.61	0.87	164.60	OK	184.93	184.41	184.41	2.59	186.17	OK	OK	36.1	118.9	2,592	670.21	OK
28-Dec-12	80.80	0.87	79.93	112.13	0.87	191.18	OK	212.08	211.56	211.56	1.40	212.13	OK	OK	46.9	155.0	2,845	735.52	OK
29-Dec-12	80.20	0.87	79.33	110.53	0.87	189.98	OK	206.78	206.26	206.26	0.90	206.33	OK	OK	45.3	149.5	2,809	726.13	OK
30-Dec-12	42.00	0.87	41.13	54.13	0.87	94.38	OK	107.68	107.16	107.16	0.30	106.63	OK	OK	13.2	42.7	1,812	468.39	OK
31-Dec-12	36.20	0.87	35.33	60.13	0.87	94.58	OK	128.78	128.26	128.26	7.10	134.53	OK	OK	19.5	63.4	2,080	537.74	OK

Appendix 6.3

WATER BALANCE SIMULATION OF THE KRUENG ACEH CATCHMENT

LULC Scenario I runs on inflow 2012 and water demand 2040 (in m^3/s)

DEMAND	Up	Down
Domestic	0.60	0.64
Non-Domestic	0.44	0.16
Water Losses	0.17	0.21
Min.Environmental Flow	2.18	1.61
Paddy Field	27.28	-

	Water Quantity														Water Quality at PDAM Tirta Daroy				
Date	Lampisang Sta			Darang Sta			Upstream	Pasie Sta			Sub Banda Aceh			Downstream	Upstream - Downstream	TSS (mg/l)	Turb (NTU)	Alum (kg/day)	Cost Alum (USD)	PDAM (Quantity & Quality)
	I_1	D_1	(I_1-D_1) R_1	I_2	D_2	$(R_1+I_2-D_2)$ R_2		I_3	$(R_2+I_3-D_{(D+ND+WL)})$ R_3	(R_3-D_{PF}) R_4	I_4	$(R_4+I_4-D_4)$ R_5				(R_2+I_3) = TSS (>2000) $0.000771*(R_2+I_3)^{2.899}$	Limit < 5 NTU $3.093*TSS^{1.017}$	5 NTU<Alum<2000 mg/l $1.2*(8.59*D_{(D+ND+WL)})^{0.35}$	(Alum*USD 0.259)	
RELIABILITY			**87.70%**			**90.16%**	**87.43%**		**97.81%**	**96.72%**		**96.17%**	**96.17%**	**87.43%**	**0.00%**	**13.93%**	**1,612,600.37**	**416,908.06**	**97.81%**
01-Jan-12	7.20	1.69	5.51	7.91	1.69	11.72	OK	20.82	19.80	19.80	2.30	20.49	OK	OK	1.0	3.2	-	-	OK
02-Jan-12	11.70	1.69	10.01	14.81	1.69	23.12	OK	31.22	30.20	30.20	0.70	29.29	OK	OK	1.6	5.0	1,662	429.72	OK
03-Jan-12	15.70	1.69	14.01	20.31	1.69	32.62	OK	39.92	38.90	38.90	0.30	37.59	OK	OK	2.4	7.4	1,905	492.42	OK
04-Jan-12	11.50	1.69	9.81	14.41	1.69	22.52	OK	29.32	28.30	28.30	0.80	27.49	OK	OK	1.4	4.4	-	-	OK
05-Jan-12	16.80	1.69	15.11	24.71	1.69	38.12	OK	107.62	106.60	106.60	12.80	117.79	OK	OK	30.7	100.8	4,754	1,229.04	OK
06-Jan-12	22.20	1.69	20.51	30.51	1.69	49.32	OK	122.82	121.80	121.80	13.20	133.39	OK	OK	35.3	116.0	4,993	1,290.81	OK
07-Jan-12	11.20	1.69	9.51	13.21	1.69	21.02	OK	29.62	28.60	28.60	1.30	28.29	OK	OK	1.5	4.7	-	-	OK
08-Jan-12	57.50	1.69	55.81	67.11	1.69	121.22	OK	129.52	128.50	128.50	0.40	127.29	OK	OK	21.1	68.6	4,155	1,074.13	OK
09-Jan-12	66.60	1.69	64.91	78.71	1.69	141.92	OK	154.52	153.50	153.50	0.70	152.59	OK	OK	28.4	93.0	4,622	1,194.87	OK
10-Jan-12	18.20	1.69	16.51	25.21	1.69	40.02	OK	57.62	56.60	56.60	2.50	57.49	OK	OK	4.8	15.3	2,460	635.94	OK
11-Jan-12	72.40	1.69	70.71	91.91	1.69	160.92	OK	181.22	180.20	180.20	1.90	180.49	OK	OK	36.1	118.8	5,036	1,301.88	OK
12-Jan-12	78.20	1.69	76.51	97.91	1.69	172.72	OK	189.12	188.10	188.10	1.40	187.89	OK	OK	40.1	132.1	5,225	1,350.84	OK
13-Jan-12	26.80	1.69	25.11	34.41	1.69	57.82	OK	68.72	67.70	67.70	1.30	67.39	OK	OK	6.1	19.3	2,667	689.62	OK
14-Jan-12	23.10	1.69	21.41	44.11	1.69	63.82	OK	122.62	121.60	121.60	12.40	132.39	OK	OK	27.4	89.5	4,561	1,179.08	OK
15-Jan-12	18.10	1.69	16.41	38.11	1.69	52.82	OK	112.52	111.50	111.50	12.40	122.29	OK	OK	26.4	86.3	4,503	1,164.10	OK
16-Jan-12	253.60	1.69	251.91	324.81	1.69	575.02	OK	601.32	600.30	600.30	1.30	599.99	OK	OK	364.9	1,248.4	11,470	2,965.24	OK
17-Jan-12	276.60	1.69	274.91	349.91	1.69	623.12	OK	647.22	646.20	646.20	0.90	645.49	OK	OK	425.0	1,457.9	12,110	3,130.69	OK
18-Jan-12	54.00	1.69	52.31	61.41	1.69	112.02	OK	119.02	118.00	118.00	0.30	116.69	OK	OK	18.4	59.8	3,960	1,023.89	OK
19-Jan-12	55.80	1.69	54.11	65.21	1.69	117.62	OK	126.62	125.60	125.60	0.60	124.59	OK	OK	20.0	65.2	4,081	1,054.99	OK
20-Jan-12	56.60	1.69	54.91	68.41	1.69	121.62	OK	133.32	132.30	132.30	0.60	131.29	OK	OK	21.3	69.4	4,171	1,078.40	OK
21-Jan-12	53.30	1.69	51.61	58.61	1.69	108.52	OK	116.02	115.00	115.00	0.20	113.59	OK	OK	17.8	57.8	3,913	1,011.69	OK
22-Jan-12	51.50	1.69	49.81	51.71	1.69	99.82	OK	100.62	99.60	99.60	-	97.99	OK	OK	16.0	51.8	3,767	973.79	OK
23-Jan-12	50.30	1.69	48.61	50.51	1.69	97.42	OK	98.02	97.00	97.00	-	95.39	OK	OK	15.3	49.5	3,707	958.37	OK
24-Jan-12	50.00	1.69	48.31	50.21	1.69	96.82	OK	97.32	96.30	96.30	-	94.69	OK	OK	15.1	49.0	3,692	954.49	OK
25-Jan-12	48.70	1.69	47.01	48.81	1.69	94.12	OK	94.52	93.50	93.50	-	91.89	OK	OK	14.4	46.5	3,627	937.58	OK
26-Jan-12	45.30	1.69	43.61	45.41	1.69	87.32	OK	87.62	86.60	86.60	-	84.99	OK	OK	12.5	40.5	3,454	892.88	OK
27-Jan-12	45.40	1.69	43.71	45.51	1.69	87.52	OK	87.72	86.70	86.70	-	85.09	OK	OK	12.6	40.6	3,459	894.19	OK
28-Jan-12	57.10	1.69	55.41	61.21	1.69	114.92	OK	116.12	115.10	115.10	-	113.49	OK	OK	19.7	64.0	4,055	1,048.40	OK
29-Jan-12	150.20	1.69	148.51	186.21	1.69	333.02	OK	344.92	343.90	343.90	0.10	342.39	OK	OK	131.6	442.6	7,979	2,062.78	OK
30-Jan-12	202.70	1.69	201.01	256.51	1.69	455.82	OK	491.62	490.60	490.60	7.40	496.39	OK	OK	241.7	821.2	9,906	2,560.89	OK
31-Jan-12	207.80	1.69	206.11	264.01	1.69	468.42	OK	505.82	504.80	504.80	7.40	510.59	OK	OK	254.3	864.9	10,087	2,607.78	OK
01-Feb-12	182.70	1.69	181.01	234.71	1.69	414.02	OK	444.82	443.80	443.80	3.00	445.19	OK	OK	200.0	677.4	9,260	2,394.08	OK
02-Feb-12	110.00	1.69	108.31	139.51	1.69	246.12	OK	273.12	272.10	272.10	3.90	274.39	OK	OK	78.3	260.8	6,630	1,714.10	OK
03-Feb-12	75.30	1.69	73.61	90.01	1.69	161.92	OK	171.22	170.20	170.20	1.00	169.59	OK	OK	35.2	115.9	4,991	1,290.45	OK
04-Feb-12	74.70	1.69	73.01	98.41	1.69	169.72	OK	190.12	189.10	189.10	0.40	187.89	OK	OK	39.2	129.2	5,185	1,340.59	OK
05-Feb-12	71.70	1.69	70.01	123.01	1.69	191.32	OK	297.82	296.80	296.80	25.20	320.39	OK	OK	110.1	369.2	7,488	1,935.94	OK
06-Feb-12	61.80	1.69	60.11	98.91	1.69	157.32	OK	248.92	247.90	247.90	24.90	271.19	OK	OK	79.5	265.0	6,667	1,723.62	OK
07-Feb-12	64.90	1.69	63.21	82.21	1.69	143.72	OK	159.42	158.40	158.40	2.30	159.09	OK	OK	28.8	94.4	4,646	1,201.08	OK
08-Feb-12	57.20	1.69	55.51	68.91	1.69	122.72	OK	133.92	132.90	132.90	0.80	132.09	OK	OK	21.6	70.4	4,192	1,083.66	OK
09-Feb-12	50.70	1.69	49.01	53.21	1.69	100.52	OK	108.62	107.60	107.60	0.20	106.19	OK	OK	16.1	52.2	3,776	976.13	OK
10-Feb-12	50.70	1.69	49.01	56.71	1.69	104.02	OK	114.92	113.90	113.90	0.20	112.49	OK	OK	16.7	54.4	3,830	990.09	OK
11-Feb-12	61.20	1.69	59.51	83.61	1.69	141.42	OK	183.12	182.10	182.10	7.90	188.39	OK	OK	36.6	120.3	5,058	1,307.61	OK
12-Feb-12	88.70	1.69	87.01	132.41	1.69	217.72	OK	283.02	282.00	282.00	11.60	291.99	OK	OK	82.4	274.8	6,753	1,745.77	OK
13-Feb-12	79.60	1.69	77.91	143.01	1.69	219.22	OK	340.62	339.60	339.60	27.10	365.09	OK	OK	142.7	480.4	8,211	2,122.71	OK

14-Feb-12	190.40	1.69	188.71	305.01	1.69	492.02	OK	634.22	633.20	633.20	24.40	655.99	OK	OK	375.9	1,287.0	11,592	2,996.96	OK
15-Feb-12	191.50	1.69	189.81	273.91	1.69	462.02	OK	520.42	519.40	519.40	2.50	520.29	OK	OK	254.0	863.8	10,082	2,606.62	OK
16-Feb-12	53.00	1.69	51.31	62.61	1.69	112.22	OK	126.22	125.20	125.20	0.80	124.39	OK	OK	19.1	62.1	4,012	1,037.12	OK
17-Feb-12	48.90	1.69	47.21	56.81	1.69	102.32	OK	112.82	111.80	111.80	0.30	110.49	OK	OK	15.9	51.5	3,758	971.68	OK
18-Feb-12	46.20	1.69	44.51	52.91	1.69	95.72	OK	103.62	102.60	102.60	0.10	101.09	OK	OK	13.9	45.1	3,587	927.42	OK
19-Feb-12	43.90	1.69	42.21	50.51	1.69	91.02	OK	96.92	95.90	95.90	-	94.29	OK	OK	12.5	40.5	3,454	893.02	OK
20-Feb-12	41.90	1.69	40.21	48.41	1.69	86.92	OK	91.42	90.40	90.40	-	88.79	OK	OK	11.4	36.8	3,342	863.91	OK
21-Feb-12	41.70	1.69	40.01	50.01	1.69	88.32	OK	94.22	93.20	93.20	0.10	91.69	OK	OK	11.6	37.6	3,365	870.06	OK
22-Feb-12	48.40	1.69	46.71	63.21	1.69	108.22	OK	123.42	122.40	122.40	2.50	123.29	OK	OK	17.6	57.1	3,896	1,007.33	OK
23-Feb-12	54.50	1.69	52.81	72.41	1.69	123.52	OK	140.12	139.10	139.10	2.60	140.09	OK	OK	22.2	72.3	4,231	1,093.90	OK
24-Feb-12	42.60	1.69	40.91	57.31	1.69	96.52	OK	114.92	113.90	113.90	3.80	116.09	OK	OK	15.2	49.2	3,699	956.35	OK
25-Feb-12	46.60	1.69	44.91	59.91	1.69	103.12	OK	117.92	116.90	116.90	3.70	118.99	OK	OK	16.2	52.6	3,786	978.73	OK
26-Feb-12	44.70	1.69	43.01	55.71	1.69	97.02	OK	107.92	106.90	106.90	0.30	105.59	OK	OK	14.1	45.8	3,606	932.15	OK
27-Feb-12	83.60	1.69	81.91	116.01	1.69	196.22	OK	223.92	222.90	222.90	3.70	224.99	OK	OK	52.2	172.9	5,741	1,484.30	OK
28-Feb-12	118.30	1.69	116.61	165.31	1.69	280.22	OK	318.42	317.40	317.40	7.00	322.79	OK	OK	100.8	337.4	7,255	1,875.74	OK
29-Feb-12	70.60	1.69	68.91	102.31	1.69	169.52	OK	201.52	200.50	200.50	4.80	203.69	OK	OK	42.5	140.2	5,335	1,379.30	OK
01-Mar-12	36.80	15.34	21.46	37.16	15.34	43.29	OK	59.69	58.67	57.06	1.30	56.75	OK	OK	11.9	38.4	3,392	876.85	OK
02-Mar-12	33.10	15.34	17.76	31.76	15.34	34.19	OK	47.19	46.17	44.56	0.50	43.45	OK	OK	9.4	30.2	3,118	805.99	OK
03-Mar-12	34.00	15.34	18.66	35.36	15.34	38.69	OK	51.49	50.47	48.86	0.40	47.65	OK	OK	10.3	33.0	3,216	831.53	OK
04-Mar-12	127.60	15.34	112.26	156.96	15.34	253.89	OK	274.19	273.17	271.56	3.40	273.35	OK	OK	104.3	349.3	7,344	1,898.63	OK
05-Mar-12	181.50	15.34	166.16	228.56	15.34	379.39	OK	403.99	402.97	401.36	3.40	403.15	OK	OK	201.4	682.3	9,284	2,400.08	OK
06-Mar-12	124.80	15.34	109.46	145.56	15.34	239.69	OK	295.29	294.27	292.66	35.60	326.65	OK	OK	112.3	376.4	7,539	1,949.06	OK
07-Mar-12	65.80	15.34	50.46	69.46	15.34	104.59	OK	160.09	159.07	157.46	35.90	191.75	OK	OK	46.2	152.5	5,495	1,420.72	OK
08-Mar-12	73.60	15.34	58.26	79.76	15.34	122.69	OK	136.49	135.47	133.86	3.20	135.45	OK	OK	35.8	117.6	5,017	1,297.15	OK
09-Mar-12	74.40	15.34	59.06	88.46	15.34	132.19	OK	154.99	153.97	152.36	1.50	152.25	OK	OK	41.0	135.0	5,266	1,361.38	OK
10-Mar-12	92.30	15.34	76.96	208.86	15.34	270.49	OK	420.79	419.77	418.16	6.10	422.65	OK	OK	265.5	903.5	10,242	2,647.94	OK
11-Mar-12	158.90	15.34	143.56	331.36	15.34	459.59	OK	675.49	674.47	672.86	20.90	692.15	OK	OK	564.6	1,946.3	13,398	3,463.82	OK
12-Mar-12	109.30	15.34	93.96	166.46	15.34	245.09	OK	361.49	360.47	358.86	41.30	398.55	OK	OK	172.2	581.7	8,780	2,269.80	OK
13-Mar-12	130.10	15.34	114.76	149.36	15.34	248.79	OK	290.39	289.37	287.76	25.60	311.75	OK	OK	110.9	371.7	7,505	1,940.39	OK
14-Mar-12	132.40	15.34	117.06	165.66	15.34	267.39	OK	323.39	322.37	320.76	23.80	342.95	OK	OK	128.9	433.1	7,918	2,047.15	OK
15-Mar-12	87.80	15.34	72.46	113.06	15.34	170.19	OK	232.79	231.77	230.16	24.30	252.85	OK	OK	77.2	257.2	6,598	1,705.80	OK
16-Mar-12	182.80	15.34	167.46	228.36	15.34	380.49	OK	404.29	403.27	401.66	3.40	403.45	OK	OK	202.6	686.1	9,302	2,404.77	OK
17-Mar-12	179.50	15.34	164.16	222.16	15.34	370.99	OK	393.59	392.57	390.96	1.30	390.65	OK	OK	194.3	657.5	9,164	2,369.20	OK
18-Mar-12	149.50	15.34	134.16	180.16	15.34	298.99	OK	319.59	318.57	316.96	1.60	316.95	OK	OK	136.4	459.0	8,081	2,089.16	OK
19-Mar-12	136.40	15.34	121.06	166.66	15.34	272.39	OK	298.39	297.37	295.76	1.70	295.85	OK	OK	118.5	397.6	7,685	1,986.76	OK
20-Mar-12	101.90	15.34	86.56	119.16	15.34	190.39	OK	211.99	210.97	209.36	0.80	208.55	OK	OK	68.1	226.3	6,309	1,630.98	OK
21-Mar-12	109.20	15.34	93.86	116.16	15.34	194.69	OK	210.89	209.87	208.26	-	206.65	OK	OK	71.5	238.0	6,421	1,660.05	OK
22-Mar-12	99.50	15.34	84.16	104.66	15.34	173.49	OK	186.39	185.37	183.76	-	182.15	OK	OK	59.6	197.9	6,019	1,556.16	OK
23-Mar-12	76.00	15.34	60.66	105.36	15.34	150.69	OK	201.49	200.47	198.86	1.80	199.05	OK	OK	61.1	202.9	6,072	1,569.80	OK
24-Mar-12	57.00	15.34	41.66	79.86	15.34	106.19	OK	160.39	159.37	157.76	7.20	163.35	OK	OK	46.0	151.8	5,486	1,418.18	OK
25-Mar-12	56.60	15.34	41.26	54.86	15.34	80.79	OK	100.89	99.87	98.26	5.40	102.05	OK	OK	23.0	75.1	4,289	1,108.86	OK
26-Mar-12	52.00	15.34	36.66	85.86	15.34	107.19	OK	165.79	164.77	163.16	2.10	163.65	OK	OK	51.2	169.6	5,703	1,474.32	OK
27-Mar-12	49.00	15.34	33.66	86.06	15.34	104.39	OK	183.19	182.17	180.56	16.30	195.25	OK	OK	66.8	221.9	6,266	1,619.92	OK
28-Mar-12	44.10	15.34	28.76	51.46	15.34	64.89	OK	133.89	132.87	131.26	39.70	169.35	OK	OK	43.0	142.0	5,359	1,385.52	OK
29-Mar-12	45.90	15.34	30.56	50.76	15.34	65.99	OK	111.19	110.17	108.56	25.50	132.45	OK	OK	28.0	91.5	4,596	1,188.23	OK
30-Mar-12	56.20	15.34	40.86	57.26	15.34	82.79	OK	101.89	100.87	99.26	-	97.65	OK	OK	23.1	75.3	4,292	1,109.56	OK
31-Mar-12	46.20	15.34	30.86	45.46	15.34	60.99	OK	75.39	74.37	72.76	-	71.15	OK	OK	15.8	51.4	3,755	970.80	OK
01-Apr-12	36.20	15.34	20.86	31.46	15.34	36.99	OK	46.99	45.97	44.36	-	42.75	OK	OK	9.7	31.1	3,149	814.08	OK
02-Apr-12	193.30	15.34	177.96	245.76	15.34	408.39	OK	430.59	429.57	427.96	-	426.35	OK	OK	226.9	770.0	9,685	2,503.78	OK
03-Apr-12	243.10	15.34	227.76	312.76	15.34	525.19	OK	549.89	548.87	547.26	-	545.65	OK	OK	349.4	1,194.6	11,294	2,919.81	OK
04-Apr-12	140.40	15.34	125.06	177.36	15.34	287.09	OK	307.99	306.97	305.36	0.30	304.05	OK	OK	126.5	425.0	7,866	2,033.60	OK
05-Apr-12	119.20	15.34	103.86	149.16	15.34	237.69	OK	264.69	263.67	262.06	7.70	268.15	OK	OK	95.7	320.1	7,123	1,841.50	OK
06-Apr-12	72.40	15.34	57.06	79.76	15.34	121.49	OK	137.79	136.77	135.16	8.30	141.85	OK	OK	35.6	117.1	5,010	1,295.20	OK
07-Apr-12	68.40	15.34	53.06	83.26	15.34	120.99	OK	138.59	137.57	135.96	1.40	135.75	OK	OK	35.2	115.7	4,989	1,289.82	OK
08-Apr-12	92.60	15.34	77.26	158.06	15.34	219.99	OK	293.49	292.47	290.86	2.90	292.15	OK	OK	117.5	394.2	7,662	1,980.84	OK
09-Apr-12	83.60	15.34	68.26	138.46	15.34	191.39	OK	254.49	253.47	251.86	2.50	252.75	OK	OK	92.2	308.2	7,029	1,817.24	OK
10-Apr-12	75.10	15.34	59.76	83.86	15.34	128.29	OK	256.49	255.47	253.86	101.80	354.05	OK	OK	126.6	425.4	7,869	2,034.32	OK
11-Apr-12	58.70	15.34	43.36	59.86	15.34	87.89	OK	212.49	211.47	209.86	101.70	309.95	OK	OK	107.7	361.0	7,429	1,920.61	OK
12-Apr-12	39.30	15.34	23.96	33.66	15.34	42.29	OK	54.79	53.77	52.16	9.00	59.55	OK	OK	11.3	36.4	3,329	860.54	OK
13-Apr-12	39.10	15.34	23.76	34.76	15.34	43.19	OK	56.69	55.67	54.06	4.70	57.15	OK	OK	11.6	37.3	3,356	867.51	OK
14-Apr-12	39.00	15.34	23.66	39.86	15.34	48.19	OK	80.09	79.07	77.46	14.60	90.45	OK	OK	17.6	57.2	3,898	1,007.69	OK
15-Apr-12	38.80	15.34	23.46	38.16	15.34	46.29	OK	72.39	71.37	69.76	12.00	80.15	OK	OK	15.2	49.2	3,697	955.87	OK
16-Apr-12	38.10	15.34	22.76	31.76	15.34	39.19	OK	42.99	41.97	40.36	0.10	38.85	OK	OK	9.7	31.2	3,152	814.85	OK
17-Apr-12	49.70	15.34	34.36	47.86	15.34	66.89	OK	80.29	79.27	77.66	7.70	83.75	OK	OK	17.4	56.5	3,882	1,003.56	OK
18-Apr-12	50.30	15.34	34.96	48.66	15.34	68.29	OK	85.89	84.87	83.26	11.50	93.15	OK	OK	18.6	60.5	3,976	1,028.03	OK

19-Apr-12	35.00	15.34	19.66	28.66	15.34	32.99	OK	39.49	38.47	36.86	3.80	39.05	OK	OK	8.5	27.4	3,015	779.35	OK
20-Apr-12	24.00	15.34	8.66	44.76	15.34	38.09	OK	75.59	74.57	72.96	1.60	72.95	OK	OK	20.6	67.1	4,122	1,065.63	OK
21-Apr-12	22.70	15.34	7.36	43.36	15.34	35.39	OK	72.59	71.57	69.96	1.60	69.95	OK	OK	20.0	65.2	4,082	1,055.40	OK
22-Apr-12	18.70	15.34	3.36	14.56	15.34	2.59	OK	6.99	5.97	4.36	0.50	3.25	OK	OK	3.4	10.6	2,161	558.65	OK
23-Apr-12	17.70	15.34	2.36	45.76	15.34	32.79	OK	79.59	78.57	76.96	2.20	77.55	OK	OK	26.9	88.1	4,534	1,172.28	OK
24-Apr-12	17.00	15.34	1.66	101.66	15.34	87.99	OK	209.59	208.57	206.96	5.50	210.85	OK	OK	139.8	470.4	8,151	2,107.21	OK
25-Apr-12	14.60	15.34	-	69.10	15.34	53.76	Fail	134.56	133.54	131.93	3.60	133.92	OK	Fail	66.9	222.2	6,269	1,620.65	OK
26-Apr-12	12.90	15.34	-	9.50	15.34	-	Fail	11.70	10.68	9.07	0.80	8.26	OK	Fail	2.7	8.6	2,012	520.28	OK
27-Apr-12	11.70	15.34	-	8.00	15.34	-	Fail	7.40	6.38	4.77	0.20	3.36	OK	Fail	1.8	5.7	1,738	449.22	OK
28-Apr-12	10.60	15.34	-	7.90	15.34	-	Fail	16.90	15.88	14.27	9.60	22.26	OK	Fail	3.2	10.0	2,116	547.14	OK
29-Apr-12	67.40	15.34	52.06	81.16	15.34	117.89	OK	139.99	138.97	137.36	9.70	145.45	OK	OK	35.2	115.6	4,988	1,289.49	OK
30-Apr-12	101.50	15.34	86.16	126.46	15.34	197.29	OK	209.99	208.97	207.36	0.90	206.65	OK	OK	69.0	229.4	6,339	1,638.96	OK
01-May-12	47.90	15.34	32.56	51.56	15.34	68.79	OK	76.29	75.27	73.66	2.20	74.25	OK	OK	16.7	54.2	3,826	989.23	OK
02-May-12	21.30	15.34	5.96	15.26	15.34	5.89	OK	10.39	9.37	7.76	2.00	8.15	OK	OK	3.8	11.9	2,249	581.39	OK
03-May-12	26.30	15.34	10.96	21.96	15.34	17.59	OK	19.79	18.77	17.16	-	15.55	OK	OK	5.3	17.0	2,549	659.06	OK
04-May-12	23.80	15.34	8.46	18.46	15.34	11.59	OK	22.29	21.27	19.66	7.70	25.75	OK	OK	5.2	16.5	2,525	652.69	OK
05-May-12	84.80	15.34	69.46	101.26	15.34	155.39	OK	171.49	170.47	168.86	7.70	174.95	OK	OK	49.3	162.9	5,623	1,453.74	OK
06-May-12	85.20	15.34	69.86	100.76	15.34	155.29	OK	189.09	188.07	186.46	23.10	207.95	OK	OK	54.7	181.2	5,837	1,509.01	OK
07-May-12	20.60	15.34	5.26	12.46	15.34	2.39	OK	29.99	28.97	27.36	23.10	48.85	OK	OK	8.1	25.8	2,951	762.93	OK
08-May-12	20.10	15.34	4.76	61.96	15.34	51.39	OK	117.89	116.87	115.26	3.00	116.65	OK	OK	48.1	158.8	5,574	1,440.94	OK
09-May-12	20.10	15.34	4.76	61.86	15.34	51.29	OK	117.69	116.67	115.06	3.00	116.45	OK	OK	47.9	158.4	5,568	1,439.46	OK
10-May-12	39.70	15.34	24.36	38.36	15.34	47.39	OK	53.89	52.87	51.26	-	49.65	OK	OK	11.4	36.7	3,338	862.96	OK
11-May-12	50.30	15.34	34.96	70.66	15.34	90.29	OK	120.69	119.67	118.06	1.10	117.55	OK	OK	29.1	95.2	4,660	1,204.69	OK
12-May-12	66.00	15.34	50.66	96.06	15.34	131.39	OK	168.19	167.17	165.56	1.40	165.35	OK	OK	46.5	153.7	5,510	1,424.41	OK
13-May-12	77.30	15.34	61.96	92.46	15.34	139.09	OK	151.99	150.97	149.36	0.30	148.05	OK	OK	41.5	136.9	5,292	1,368.12	OK
14-May-12	49.50	15.34	34.16	49.56	15.34	68.39	OK	74.49	73.47	71.86	-	70.25	OK	OK	16.7	54.1	3,824	988.65	OK
15-May-12	30.30	1.69	28.61	36.91	1.69	63.82	OK	68.32	67.30	67.30	-	65.69	OK	OK	6.5	20.7	2,731	705.93	OK
16-May-12	56.30	1.69	54.61	72.51	1.69	125.42	OK	135.92	134.90	134.90	3.90	137.19	OK	OK	21.8	71.1	4,207	1,087.70	OK
17-May-12	149.50	1.69	147.81	199.81	1.69	345.92	OK	369.02	368.00	368.00	7.70	374.09	OK	OK	140.5	472.9	8,166	2,111.06	OK
18-May-12	138.60	1.69	136.91	183.61	1.69	318.82	OK	335.42	334.40	334.40	3.90	336.69	OK	OK	119.7	401.8	7,713	1,994.02	OK
19-May-12	46.10	1.69	44.41	56.91	1.69	99.62	OK	105.72	104.70	104.70	-	103.09	OK	OK	14.3	46.2	3,619	935.53	OK
20-May-12	28.30	1.69	26.61	32.81	1.69	57.72	OK	61.12	60.10	60.10	-	58.49	OK	OK	5.5	17.5	2,575	665.69	OK
21-May-12	28.00	1.69	26.31	32.51	1.69	57.12	OK	59.72	58.70	58.70	-	57.09	OK	OK	5.4	17.0	2,552	659.65	OK
22-May-12	31.50	1.69	29.81	37.71	1.69	65.82	OK	92.62	91.60	91.60	20.80	110.79	OK	OK	11.3	36.5	3,333	861.57	OK
23-May-12	27.50	1.69	25.81	33.61	1.69	57.72	OK	90.82	89.80	89.80	26.70	114.89	OK	OK	12.2	39.3	3,418	883.76	OK
24-May-12	23.90	1.69	22.21	37.21	1.69	57.72	OK	104.82	103.80	103.80	29.70	131.89	OK	OK	18.7	60.8	3,983	1,029.74	OK
25-May-12	23.40	1.69	21.71	36.61	1.69	56.62	OK	118.72	117.70	117.70	42.90	158.99	OK	OK	27.8	91.1	4,589	1,186.35	OK
26-May-12	23.40	1.69	21.71	27.61	1.69	47.62	OK	70.42	69.40	69.40	19.00	86.79	OK	OK	7.2	23.1	2,838	733.68	OK
27-May-12	22.90	1.69	21.21	29.81	1.69	49.32	OK	62.62	61.60	61.60	8.00	67.99	OK	OK	5.2	16.4	2,520	651.61	OK
28-May-12	218.70	1.69	217.01	296.61	1.69	511.92	OK	555.52	554.50	554.50	17.80	570.69	OK	OK	296.8	1,012.1	10,657	2,755.28	OK
29-May-12	225.70	1.69	224.01	300.71	1.69	523.02	OK	553.72	552.70	552.70	9.80	560.89	OK	OK	304.1	1,037.1	10,749	2,778.91	OK
30-May-12	81.50	1.69	79.81	103.01	1.69	181.12	OK	210.22	209.20	209.20	21.10	228.69	OK	OK	47.0	155.4	5,531	1,430.04	OK
31-May-12	81.40	1.69	79.71	102.81	1.69	180.82	OK	214.42	213.40	213.40	25.00	236.79	OK	OK	48.6	160.7	5,597	1,446.91	OK
01-Jun-12	33.80	1.69	32.11	37.61	1.69	68.02	OK	74.12	73.10	73.10	4.20	75.69	OK	OK	7.7	24.6	2,900	749.82	OK
02-Jun-12	32.70	1.69	31.01	36.41	1.69	65.72	OK	66.92	65.90	65.90	0.10	64.39	OK	OK	7.0	22.3	2,802	724.38	OK
03-Jun-12	28.90	1.69	27.21	117.21	1.69	142.72	OK	255.42	254.40	254.40	5.20	257.99	OK	OK	122.0	409.6	7,765	2,007.51	OK
04-Jun-12	23.20	1.69	21.51	111.51	1.69	131.32	OK	243.82	242.80	242.80	5.10	246.29	OK	OK	119.9	402.6	7,718	1,995.41	OK
05-Jun-12	23.60	1.69	21.91	27.21	1.69	47.42	OK	87.72	86.70	86.70	34.40	119.49	OK	OK	13.8	44.8	3,579	925.19	OK
06-Jun-12	23.40	1.69	21.71	26.91	1.69	46.92	OK	96.22	95.20	95.20	42.30	135.89	OK	OK	18.4	60.0	3,964	1,024.76	OK
07-Jun-12	23.40	1.69	21.71	36.71	1.69	56.72	OK	95.12	94.10	94.10	22.30	114.79	OK	OK	14.2	46.0	3,614	934.23	OK
08-Jun-12	23.20	1.69	21.51	36.51	1.69	56.32	OK	87.82	86.80	86.80	16.40	101.59	OK	OK	11.3	36.4	3,330	860.84	OK
09-Jun-12	22.80	1.69	21.11	26.11	1.69	45.52	OK	56.02	55.00	55.00	4.10	57.49	OK	OK	4.4	13.6	2,372	613.20	OK
10-Jun-12	22.80	1.69	21.11	26.11	1.69	45.52	OK	53.42	52.40	52.40	2.00	52.79	OK	OK	4.0	12.8	2,307	596.54	OK
11-Jun-12	44.90	1.69	43.21	56.01	1.69	97.52	OK	103.72	102.70	102.70	-	101.09	OK	OK	13.7	44.3	3,566	921.99	OK
12-Jun-12	45.80	1.69	44.11	57.41	1.69	99.82	OK	105.72	104.70	104.70	-	103.09	OK	OK	14.2	46.1	3,615	934.57	OK
13-Jun-12	24.20	1.69	22.51	30.41	1.69	51.22	OK	57.72	56.70	56.70	0.20	55.29	OK	OK	4.6	14.5	2,411	623.30	OK
14-Jun-12	20.10	1.69	18.41	25.71	1.69	42.42	OK	47.52	46.50	46.50	0.20	45.09	OK	OK	3.3	10.3	2,138	552.73	OK
15-Jun-12	8.00	1.69	6.31	11.01	1.69	15.62	OK	16.92	15.90	15.90	-	14.29	OK	OK	0.6	2.0	-	-	OK
16-Jun-12	10.50	1.69	8.81	13.51	1.69	20.62	OK	21.62	20.60	20.60	-	18.99	OK	OK	1.0	3.0	-	-	OK
17-Jun-12	6.40	1.69	4.71	13.31	1.69	16.32	OK	22.32	21.30	21.30	0.20	19.89	OK	OK	1.1	3.4	-	-	OK
18-Jun-12	7.50	1.69	5.81	14.31	1.69	18.42	OK	24.22	23.20	23.20	0.20	21.79	OK	OK	1.2	3.7	-	-	OK
19-Jun-12	12.10	1.69	10.41	16.71	1.69	25.42	OK	26.32	25.30	25.30	-	23.69	OK	OK	1.3	4.1	-	-	OK
20-Jun-12	86.30	1.69	84.61	137.81	1.69	220.72	OK	255.52	254.50	254.50	1.30	254.19	OK	OK	67.1	222.9	6,276	1,622.43	OK
21-Jun-12	86.90	1.69	85.21	137.51	1.69	221.02	OK	255.52	254.50	254.50	1.30	254.19	OK	OK	67.0	222.6	6,272	1,621.56	OK
22-Jun-12	15.70	1.69	14.01	19.31	1.69	31.62	OK	35.02	34.00	34.00	-	32.39	OK	OK	2.0	6.2	1,789	462.43	OK

23-Jun-12	12.80	1.69	11.11	15.41	1.69	24.82	OK	27.22	26.20	26.20	-	24.59	OK	OK	1.3	4.1	-	-	OK
24-Jun-12	12.80	1.69	11.11	15.41	1.69	24.82	OK	26.62	25.60	25.60	-	23.99	OK	OK	1.3	4.0	-	-	OK
25-Jun-12	12.70	1.69	11.01	15.21	1.69	24.52	OK	25.82	24.80	24.80	-	23.19	OK	OK	1.3	3.9	-	-	OK
26-Jun-12	12.70	1.69	11.01	15.21	1.69	24.52	OK	25.52	24.50	24.50	-	22.89	OK	OK	1.3	3.9	-	-	OK
27-Jun-12	37.30	1.69	35.61	48.51	1.69	82.42	OK	85.42	84.40	84.40	-	82.79	OK	OK	9.9	31.7	3,172	820.01	OK
28-Jun-12	37.80	1.69	36.11	49.01	1.69	83.42	OK	86.22	85.20	85.20	-	83.59	OK	OK	10.1	32.4	3,196	826.26	OK
29-Jun-12	12.50	1.69	10.81	14.91	1.69	24.02	OK	24.42	23.40	23.40	-	21.79	OK	OK	1.2	3.8	-	-	OK
30-Jun-12	12.70	1.69	11.01	15.01	1.69	24.32	OK	24.62	23.60	23.60	-	21.99	OK	OK	1.2	3.9	-	-	OK
01-Jul-12	12.50	1.69	10.81	14.81	1.69	23.92	OK	37.82	36.80	36.80	11.90	47.09	OK	OK	2.5	8.0	1,955	505.36	OK
02-Jul-12	12.50	1.69	10.81	14.71	1.69	23.82	OK	37.72	36.70	36.70	11.90	46.99	OK	OK	2.5	7.9	1,953	504.95	OK
03-Jul-12	12.40	1.69	10.71	16.61	1.69	25.62	OK	28.42	27.40	27.40	1.10	26.89	OK	OK	1.4	4.3	-	-	OK
04-Jul-12	12.40	1.69	10.71	16.51	1.69	25.52	OK	28.22	27.20	27.20	0.40	25.99	OK	OK	1.4	4.3	-	-	OK
05-Jul-12	12.30	1.69	10.61	14.41	1.69	23.32	OK	23.42	22.40	22.40	0.10	20.89	OK	OK	1.2	3.6	-	-	OK
06-Jul-12	12.20	1.69	10.51	14.31	1.69	23.12	OK	23.22	22.20	22.20	-	20.59	OK	OK	1.1	3.6	-	-	OK
07-Jul-12	10.40	1.69	8.71	12.41	1.69	19.42	OK	28.62	27.60	27.60	7.90	33.89	OK	OK	1.5	4.6	-	-	OK
08-Jul-12	8.30	1.69	6.61	11.21	1.69	16.12	OK	39.12	38.10	38.10	19.80	56.29	OK	OK	4.1	13.0	2,322	600.38	OK
09-Jul-12	100.80	1.69	99.11	136.21	1.69	233.62	OK	255.92	254.90	254.90	11.90	265.19	OK	OK	68.9	229.2	6,337	1,638.32	OK
10-Jul-12	101.70	1.69	100.01	136.11	1.69	234.42	OK	243.32	242.30	242.30	1.70	242.39	OK	OK	66.8	221.9	6,266	1,619.99	OK
11-Jul-12	13.30	1.69	11.61	15.21	1.69	25.12	OK	27.32	26.30	26.30	0.80	25.49	OK	OK	1.4	4.2	-	-	OK
12-Jul-12	12.60	1.69	10.91	14.41	1.69	23.62	OK	24.82	23.80	23.80	0.10	22.29	OK	OK	1.2	3.8	-	-	OK
13-Jul-12	12.70	1.69	11.01	14.51	1.69	23.82	OK	24.72	23.70	23.70	-	22.09	OK	OK	1.2	3.8	-	-	OK
14-Jul-12	12.20	1.69	10.51	28.11	1.69	36.92	OK	60.82	59.80	59.80	4.80	62.99	OK	OK	6.8	21.8	2,781	719.02	OK
15-Jul-12	10.60	1.69	8.91	33.51	1.69	40.72	OK	87.72	86.70	86.70	9.60	94.69	OK	OK	18.1	58.9	3,938	1,018.17	OK
16-Jul-12	11.00	1.69	9.31	19.71	1.69	27.32	OK	50.92	49.90	49.90	4.80	53.09	OK	OK	5.2	16.7	2,531	654.46	OK
17-Jul-12	13.30	1.69	11.61	33.11	1.69	43.02	OK	66.32	65.30	65.30	1.10	64.79	OK	OK	7.8	24.9	2,916	753.85	OK
18-Jul-12	13.40	1.69	11.71	33.41	1.69	43.42	OK	67.02	66.00	66.00	1.10	65.49	OK	OK	7.9	25.5	2,937	759.27	OK
19-Jul-12	10.90	1.69	9.21	12.81	1.69	20.32	OK	24.82	23.80	23.80	0.30	22.49	OK	OK	1.1	3.4	-	-	OK
20-Jul-12	10.90	1.69	9.21	20.41	1.69	27.92	OK	41.42	40.40	40.40	0.60	39.39	OK	OK	3.0	9.4	2,068	534.71	OK
21-Jul-12	13.30	1.69	11.61	23.61	1.69	33.52	OK	46.52	45.50	45.50	0.50	44.39	OK	OK	3.4	10.7	2,168	560.51	OK
22-Jul-12	25.70	1.69	24.01	32.41	1.69	54.72	OK	59.22	58.20	58.20	-	56.59	OK	OK	4.9	15.6	2,477	640.30	OK
23-Jul-12	23.80	1.69	22.11	29.61	1.69	50.02	OK	53.52	52.50	52.50	-	50.89	OK	OK	4.2	13.3	2,338	604.45	OK
24-Jul-12	11.70	1.69	10.01	13.11	1.69	21.42	OK	23.22	22.20	22.20	-	20.59	OK	OK	1.1	3.3	-	-	OK
25-Jul-12	11.60	1.69	9.91	13.51	1.69	21.72	OK	23.82	22.80	22.80	-	21.19	OK	OK	1.1	3.3	-	-	OK
26-Jul-12	9.60	1.69	7.91	11.51	1.69	17.72	OK	19.42	18.40	18.40	-	16.79	OK	OK	0.8	2.4	-	-	OK
27-Jul-12	4.10	1.69	2.41	5.41	1.69	6.12	OK	6.82	5.80	5.80	-	4.19	OK	OK	0.2	0.6	-	-	OK
28-Jul-12	5.60	1.69	3.91	6.91	1.69	9.12	OK	9.72	8.70	8.70	-	7.09	OK	OK	0.3	0.9	-	-	OK
29-Jul-12	5.10	1.69	3.41	6.31	1.69	8.02	OK	8.42	7.40	7.40	-	5.79	OK	OK	0.3	0.8	-	-	OK
30-Jul-12	5.20	1.69	3.51	6.41	1.69	8.22	OK	8.52	7.50	7.50	-	5.89	OK	OK	0.3	0.8	-	-	OK
31-Jul-12	5.10	1.69	3.41	6.31	1.69	8.02	OK	8.22	7.20	7.20	-	5.59	OK	OK	0.3	0.8	-	-	OK
01-Aug-12	22.30	1.69	20.61	29.61	1.69	48.52	OK	50.32	49.30	49.30	-	47.69	OK	OK	3.9	12.2	2,271	587.18	OK
02-Aug-12	23.00	1.69	21.31	30.31	1.69	49.92	OK	51.62	50.60	50.60	-	48.99	OK	OK	4.1	12.8	2,311	597.51	OK
03-Aug-12	6.20	1.69	4.51	7.61	1.69	10.42	OK	10.92	9.90	9.90	-	8.29	OK	OK	0.4	1.1	-	-	OK
04-Aug-12	13.30	1.69	11.61	23.21	1.69	33.12	OK	42.12	41.10	41.10	0.40	39.89	OK	OK	2.7	8.6	2,010	519.63	OK
05-Aug-12	13.60	1.69	11.91	23.21	1.69	33.42	OK	42.02	41.00	41.00	0.40	39.79	OK	OK	2.7	8.5	1,999	516.86	OK
06-Aug-12	36.00	1.69	34.31	47.51	1.69	80.12	OK	82.92	81.90	81.90	-	80.29	OK	OK	9.3	30.0	3,111	804.33	OK
07-Aug-12	39.50	1.69	37.81	51.91	1.69	88.02	OK	91.02	90.00	90.00	-	88.39	OK	OK	11.1	35.7	3,305	854.37	OK
08-Aug-12	13.00	1.69	11.31	15.71	1.69	25.32	OK	26.22	25.20	25.20	-	23.59	OK	OK	1.3	4.1	-	-	OK
09-Aug-12	9.80	1.69	8.11	20.11	1.69	26.52	OK	38.32	37.30	37.30	0.90	36.19	OK	OK	2.7	8.3	1,988	513.95	OK
10-Aug-12	7.60	1.69	5.91	17.01	1.69	21.22	OK	32.62	31.60	31.60	0.50	30.49	OK	OK	2.2	6.9	1,858	480.23	OK
11-Aug-12	37.10	1.69	35.41	48.51	1.69	82.22	OK	85.12	84.10	84.10	-	82.49	OK	OK	9.8	31.5	3,165	818.28	OK
12-Aug-12	139.50	1.69	137.81	187.01	1.69	323.12	OK	335.22	334.20	334.20	-	332.59	OK	OK	121.5	408.1	7,755	2,004.85	OK
13-Aug-12	122.20	1.69	120.51	161.71	1.69	280.52	OK	290.52	289.50	289.50	-	287.89	OK	OK	93.5	312.5	7,063	1,826.10	OK
14-Aug-12	66.30	1.69	64.61	84.71	1.69	147.62	OK	152.22	151.20	151.20	-	149.59	OK	OK	28.6	93.7	4,634	1,197.92	OK
15-Aug-12	92.30	1.69	90.61	119.51	1.69	208.42	OK	231.22	230.20	230.20	13.90	242.49	OK	OK	57.0	189.0	5,924	1,531.49	OK
16-Aug-12	60.40	1.69	58.71	75.21	1.69	132.22	OK	151.82	150.80	150.80	13.90	163.09	OK	OK	26.0	84.9	4,477	1,157.43	OK
17-Aug-12	34.20	1.69	32.51	39.31	1.69	70.12	OK	72.32	71.30	71.30	-	69.69	OK	OK	7.7	24.7	2,905	751.14	OK
18-Aug-12	31.90	1.69	30.21	39.51	1.69	68.02	OK	75.12	74.10	74.10	0.30	72.79	OK	OK	7.4	23.7	2,864	740.55	OK
19-Aug-12	31.00	1.69	29.31	48.71	1.69	76.32	OK	96.72	95.70	95.70	0.90	94.99	OK	OK	11.3	36.5	3,332	861.30	OK
20-Aug-12	31.50	1.69	29.81	46.11	1.69	74.22	OK	106.32	105.30	105.30	14.60	118.29	OK	OK	14.6	47.1	3,643	941.92	OK
21-Aug-12	34.00	1.69	32.31	59.11	1.69	89.72	OK	134.62	133.60	133.60	15.20	147.19	OK	OK	24.1	78.9	4,363	1,127.87	OK
22-Aug-12	31.70	1.69	30.01	56.71	1.69	85.02	OK	157.02	156.00	156.00	38.10	192.49	OK	OK	41.1	135.3	5,270	1,362.51	OK
23-Aug-12	24.00	1.69	22.31	26.51	1.69	47.12	OK	92.22	91.20	91.20	36.90	126.49	OK	OK	16.3	52.8	3,790	979.96	OK
24-Aug-12	22.00	1.69	20.31	34.41	1.69	53.02	OK	68.92	67.90	67.90	3.40	69.69	OK	OK	6.2	19.9	2,695	696.74	OK
25-Aug-12	22.20	1.69	20.51	128.01	1.69	146.82	OK	287.32	286.30	286.30	8.30	292.99	OK	OK	175.1	591.6	8,831	2,283.22	OK
26-Aug-12	24.40	1.69	22.71	120.01	1.69	141.02	OK	267.12	266.10	266.10	7.00	271.49	OK	OK	144.7	487.2	8,251	2,133.20	OK

27-Aug-12	41.80	1.69	40.11	50.21	1.69	88.62	OK	102.42	101.40	101.40	4.10	103.89	OK	OK	12.8	41.2	3,476	898.69	OK
28-Aug-12	66.60	1.69	64.91	85.21	1.69	148.42	OK	165.92	164.90	164.90	5.10	168.39	OK	OK	30.8	100.9	4,755	1,229.41	OK
29-Aug-12	76.70	1.69	75.01	99.61	1.69	172.92	OK	186.92	185.90	185.90	2.10	186.39	OK	OK	39.2	129.3	5,186	1,340.78	OK
30-Aug-12	48.10	1.69	46.41	66.21	1.69	110.92	OK	125.92	124.90	124.90	1.40	124.69	OK	OK	18.1	58.9	3,940	1,018.52	OK
31-Aug-12	22.10	1.69	20.41	30.51	1.69	49.22	OK	60.42	59.40	59.40	0.40	58.19	OK	OK	4.8	15.2	2,454	634.49	OK
01-Sep-12	16.10	15.34	0.76	8.46	15.34	-	Fail	8.40	7.38	5.77	0.10	4.26	OK	Fail	2.7	8.5	1,998	516.48	OK
02-Sep-12	12.40	15.34	-	80.40	15.34	65.06	Fail	168.76	167.74	166.13	4.60	169.12	OK	Fail	98.5	329.6	7,196	1,860.50	OK
03-Sep-12	19.00	15.34	3.66	119.06	15.34	107.39	OK	253.49	252.47	250.86	6.60	255.85	OK	OK	191.8	649.2	9,124	2,358.72	OK
04-Sep-12	18.90	15.34	3.56	47.56	15.34	35.79	OK	86.39	85.37	83.76	2.40	84.55	OK	OK	29.6	97.1	4,692	1,212.99	OK
05-Sep-12	12.00	15.34	-	13.40	15.34	-	Fail	32.10	31.08	29.47	18.00	45.86	OK	Fail	8.7	28.0	3,038	785.31	OK
06-Sep-12	11.60	15.34	-	13.90	15.34	-	Fail	32.30	31.28	29.67	18.00	46.06	OK	Fail	8.8	28.4	3,050	788.61	OK
07-Sep-12	11.30	15.34	-	8.70	15.34	-	Fail	13.20	12.18	10.57	3.00	11.96	OK	Fail	2.6	8.3	1,984	512.86	OK
08-Sep-12	10.80	15.34	-	5.80	15.34	-	Fail	7.10	6.08	4.47	0.80	3.66	OK	Fail	1.4	4.5	-	-	OK
09-Sep-12	10.90	15.34	-	5.80	15.34	-	Fail	5.30	4.28	2.67	0.30	1.36	OK	Fail	1.3	4.0	-	-	OK
10-Sep-12	10.80	15.34	-	5.70	15.34	-	Fail	4.00	2.98	1.37	0.10	-	Fail	Fail	1.2	3.7	-	-	OK
11-Sep-12	10.80	15.34	-	5.60	15.34	-	Fail	3.00	1.98	0.37	-	-	Fail	Fail	1.1	3.5	-	-	OK
12-Sep-12	10.70	15.34	-	5.60	15.34	-	Fail	2.20	1.18	-	-	-	Fail	Fail	1.1	3.3	-	-	OK
13-Sep-12	10.10	15.34	-	5.80	15.34	-	Fail	2.10	1.08	-	-	-	Fail	Fail	1.0	3.1	-	-	OK
14-Sep-12	25.80	15.34	10.46	22.36	15.34	17.49	OK	20.69	19.67	18.06	-	16.45	OK	OK	5.4	17.1	2,552	659.89	OK
15-Sep-12	61.60	15.34	46.26	71.06	15.34	101.99	OK	112.49	111.47	109.86	4.00	112.25	OK	OK	27.2	88.9	4,549	1,176.18	OK
16-Sep-12	47.30	15.34	31.96	51.46	15.34	68.09	OK	76.99	75.97	74.36	4.00	76.75	OK	OK	16.7	54.1	3,822	988.18	OK
17-Sep-12	11.60	15.34	-	6.20	15.34	-	Fail	1.00	-	-	-	-	Fail	Fail	1.2	3.8	-	-	Fail
18-Sep-12	8.70	15.34	-	5.20	15.34	-	Fail	0.60	-	-	-	-	Fail	Fail	0.8	2.3	-	-	Fail
19-Sep-12	8.70	15.34	-	5.50	15.34	-	Fail	0.80	-	-	-	-	Fail	Fail	0.8	2.4	-	-	Fail
20-Sep-12	8.50	15.34	-	5.40	15.34	-	Fail	0.70	-	-	-	-	Fail	Fail	0.7	2.3	-	-	Fail
21-Sep-12	8.10	15.34	-	5.10	15.34	-	Fail	0.30	-	-	-	-	Fail	Fail	0.7	2.1	-	-	Fail
22-Sep-12	8.10	15.34	-	5.00	15.34	-	Fail	0.20	-	-	-	-	Fail	Fail	0.7	2.0	-	-	Fail
23-Sep-12	8.10	15.34	-	5.00	15.34	-	Fail	0.10	-	-	-	-	Fail	Fail	0.7	2.0	-	-	Fail
24-Sep-12	8.00	15.34	-	4.90	15.34	-	Fail	0.10	-	-	-	-	Fail	Fail	0.6	2.0	-	-	Fail
25-Sep-12	8.00	15.34	-	6.30	15.34	-	Fail	121.60	120.58	118.97	104.70	222.06	OK	Fail	82.3	274.6	6,751	1,745.34	OK
26-Sep-12	7.90	15.34	-	6.20	15.34	-	Fail	146.10	145.08	143.47	126.30	268.16	OK	Fail	116.3	390.4	7,635	1,973.99	OK
27-Sep-12	7.90	15.34	-	4.80	15.34	-	Fail	38.40	37.38	35.77	33.60	67.76	OK	Fail	9.8	31.4	3,160	816.97	OK
28-Sep-12	7.80	15.34	-	4.70	15.34	-	Fail	16.10	15.08	13.47	14.10	25.96	OK	Fail	2.4	7.4	1,907	493.04	OK
29-Sep-12	7.80	15.34	-	4.70	15.34	-	Fail	11.30	10.28	8.67	4.40	11.46	OK	Fail	1.5	4.7	-	-	OK
30-Sep-12	7.80	15.34	-	24.70	15.34	9.36	Fail	42.76	41.74	40.13	2.00	40.52	OK	Fail	11.4	36.7	3,339	863.32	OK
01-Oct-12	7.40	15.34	-	25.50	15.34	10.16	Fail	42.96	41.94	40.33	1.50	40.22	OK	Fail	11.4	36.6	3,336	862.43	OK
02-Oct-12	5.60	15.34	-	5.40	15.34	-	Fail	13.20	12.18	10.57	0.50	9.46	OK	Fail	1.7	5.2	1,681	434.50	OK
03-Oct-12	3.50	15.34	-	4.50	15.34	-	Fail	9.10	8.08	6.47	0.10	4.96	OK	Fail	0.8	2.6	-	-	OK
04-Oct-12	3.90	15.34	-	27.10	15.34	11.76	Fail	48.56	47.54	45.93	1.40	45.72	OK	Fail	13.2	42.8	3,523	910.90	OK
05-Oct-12	3.70	15.34	-	71.00	15.34	55.66	Fail	148.96	147.94	146.33	4.10	148.82	OK	Fail	78.8	262.5	6,646	1,718.12	OK
06-Oct-12	48.20	15.34	32.86	98.46	15.34	115.99	OK	183.89	182.87	181.26	2.80	182.45	OK	OK	66.3	220.3	6,250	1,615.71	OK
07-Oct-12	49.90	15.34	34.56	56.16	15.34	75.39	OK	84.69	83.67	82.06	0.40	80.85	OK	OK	18.7	60.8	3,983	1,029.71	OK
08-Oct-12	6.80	15.34	-	4.20	15.34	-	Fail	2.50	1.48	-	0.10	-	Fail	Fail	0.5	1.6	-	-	OK
09-Oct-12	6.50	15.34	-	4.20	15.34	-	Fail	2.40	1.38	-	0.50	-	Fail	Fail	0.5	1.5	-	-	OK
10-Oct-12	6.60	15.34	-	12.90	15.34	-	Fail	13.60	12.58	10.97	1.00	10.36	OK	Fail	2.7	8.6	2,011	519.94	OK
11-Oct-12	6.50	15.34	-	13.10	15.34	-	Fail	13.10	12.08	10.47	0.60	9.46	OK	Fail	2.7	8.4	1,995	515.70	OK
12-Oct-12	6.50	15.34	-	29.90	15.34	14.56	Fail	49.56	48.54	46.93	1.60	46.92	OK	Fail	13.6	44.1	3,560	920.50	OK
13-Oct-12	6.40	15.34	-	31.50	15.34	16.16	Fail	53.16	52.14	50.53	1.70	50.62	OK	Fail	15.1	48.9	3,689	953.84	OK
14-Oct-12	55.80	15.34	40.46	64.06	15.34	89.19	OK	96.79	95.77	94.16	0.20	92.75	OK	OK	22.6	73.8	4,262	1,101.83	OK
15-Oct-12	84.90	15.34	69.56	100.86	15.34	155.09	OK	275.29	274.27	272.66	99.20	370.25	OK	OK	127.2	427.5	7,882	2,037.75	OK
16-Oct-12	38.10	15.34	22.76	46.86	15.34	54.29	OK	206.19	205.17	203.56	119.50	321.45	OK	OK	137.2	461.8	8,098	2,093.56	OK
17-Oct-12	11.50	15.34	-	14.30	15.34	-	Fail	38.20	37.18	35.57	21.80	55.76	OK	Fail	11.4	36.6	3,336	862.43	OK
18-Oct-12	36.10	15.34	20.76	33.36	15.34	38.79	OK	62.99	61.97	60.36	19.20	77.95	OK	OK	13.0	42.1	3,501	905.19	OK
19-Oct-12	37.00	15.34	21.66	34.56	15.34	40.89	OK	63.69	62.67	61.06	17.70	77.15	OK	OK	13.1	42.2	3,504	905.99	OK
20-Oct-12	13.10	15.34	-	48.00	15.34	32.66	Fail	92.46	91.44	89.83	5.90	94.12	OK	Fail	36.3	119.5	5,045	1,304.23	OK
21-Oct-12	12.90	15.34	-	47.70	15.34	32.36	Fail	99.86	98.84	97.23	11.40	107.02	OK	Fail	41.6	137.1	5,295	1,368.82	OK
22-Oct-12	12.90	15.34	-	4.30	15.34	-	Fail	14.70	13.68	12.07	7.30	17.76	OK	Fail	2.8	8.7	2,017	521.50	OK
23-Oct-12	73.80	15.34	58.46	84.86	15.34	127.99	OK	138.99	137.97	136.36	2.20	136.95	OK	OK	36.9	121.5	5,074	1,311.87	OK
24-Oct-12	140.20	15.34	124.86	174.36	15.34	283.89	OK	303.59	302.57	300.96	4.70	304.05	OK	OK	124.3	417.4	7,816	2,020.79	OK
25-Oct-12	148.10	15.34	132.76	183.06	15.34	300.49	OK	324.19	323.17	321.56	8.30	328.25	OK	OK	137.5	462.8	8,104	2,095.12	OK
26-Oct-12	154.60	15.34	139.26	190.46	15.34	314.39	OK	336.49	335.47	333.86	7.10	339.35	OK	OK	147.7	497.5	8,312	2,148.93	OK
27-Oct-12	94.90	15.34	79.56	107.76	15.34	171.99	OK	208.39	207.37	205.76	25.30	229.45	OK	OK	64.3	213.4	6,181	1,598.00	OK
28-Oct-12	27.50	15.34	12.16	15.56	15.34	12.39	OK	39.79	38.77	37.16	23.20	58.75	OK	OK	9.7	31.3	3,158	816.46	OK
29-Oct-12	79.10	15.34	63.76	85.66	15.34	134.09	OK	147.59	146.57	144.96	6.60	149.95	OK	OK	40.4	133.2	5,241	1,355.02	OK
30-Oct-12	81.20	15.34	65.86	88.16	15.34	138.69	OK	183.49	182.47	180.86	31.50	210.75	OK	OK	53.4	176.7	5,786	1,495.74	OK

31-Oct-12	29.90	15.34	14.56	19.66	15.34	18.89	OK	59.39	58.37	56.76	30.40	85.55	OK	OK	16.0	51.8	3,766	973.65	OK
01-Nov-12	26.00	15.34	10.66	15.36	15.34	10.69	OK	24.99	23.97	22.36	8.10	28.85	OK	OK	5.9	18.9	2,645	683.78	OK
02-Nov-12	25.30	15.34	9.96	13.16	15.34	7.79	OK	171.59	170.57	168.96	140.20	307.55	OK	OK	147.9	498.2	8,316	2,149.89	OK
03-Nov-12	25.50	15.34	10.16	13.36	15.34	8.19	OK	166.89	165.87	164.26	136.10	298.75	OK	OK	139.5	469.7	8,146	2,106.04	OK
04-Nov-12	24.90	15.34	9.56	12.76	15.34	6.99	OK	10.79	9.77	8.16	0.10	6.65	OK	OK	4.2	13.3	2,341	605.33	OK
05-Nov-12	23.40	15.34	8.06	11.76	15.34	4.49	OK	78.09	77.07	75.46	62.00	135.85	OK	OK	35.1	115.4	4,984	1,288.44	OK
06-Nov-12	23.80	15.34	8.46	17.86	15.34	10.99	OK	91.39	90.37	88.76	62.30	149.45	OK	OK	41.5	136.7	5,289	1,367.42	OK
07-Nov-12	23.60	15.34	8.26	16.96	15.34	9.89	OK	18.99	17.97	16.36	5.60	20.35	OK	OK	4.8	15.1	2,447	632.60	OK
08-Nov-12	23.60	15.34	8.26	11.26	15.34	4.19	OK	21.39	20.37	18.76	15.80	32.95	OK	OK	5.7	18.1	2,606	673.74	OK
09-Nov-12	22.40	15.34	7.06	10.06	15.34	1.79	OK	18.69	17.67	16.06	14.70	29.15	OK	OK	5.3	16.8	2,538	656.13	OK
10-Nov-12	17.30	15.34	1.96	13.76	15.34	0.39	OK	12.69	11.67	10.06	3.90	12.35	OK	OK	4.0	12.8	2,306	596.20	OK
11-Nov-12	13.00	15.34	-	11.70	15.34	-	Fail	131.50	130.48	128.87	107.20	234.46	OK	Fail	96.8	323.7	7,151	1,848.69	OK
12-Nov-12	8.60	15.34	-	15.10	15.34	-	Fail	135.90	134.88	133.27	106.70	238.36	OK	Fail	102.8	344.3	7,307	1,889.15	OK
13-Nov-12	128.80	15.34	113.46	184.36	15.34	282.49	OK	332.59	331.57	329.96	10.30	338.65	OK	OK	135.4	455.5	8,059	2,083.50	OK
14-Nov-12	307.80	15.34	292.46	412.96	15.34	690.09	OK	742.19	741.17	739.56	9.70	747.65	OK	OK	572.6	1,974.4	13,465	3,481.25	OK
15-Nov-12	297.60	15.34	282.26	384.06	15.34	650.99	OK	678.89	677.87	676.26	2.90	677.55	OK	OK	509.8	1,754.3	12,920	3,340.16	OK
16-Nov-12	226.70	15.34	211.36	324.76	15.34	520.79	OK	590.99	589.97	588.36	2.70	589.45	OK	OK	366.5	1,254.1	11,488	2,969.93	OK
17-Nov-12	130.10	15.34	114.76	191.06	15.34	290.49	OK	351.19	350.17	348.56	2.50	349.45	OK	OK	148.2	499.3	8,322	2,151.54	OK
18-Nov-12	36.00	15.34	20.66	23.36	15.34	28.69	OK	28.79	27.77	26.16	-	24.55	OK	OK	8.1	26.1	2,962	765.74	OK
19-Nov-12	35.50	15.34	20.16	23.66	15.34	28.49	OK	29.69	28.67	27.06	0.10	25.55	OK	OK	8.0	25.6	2,941	760.29	OK
20-Nov-12	35.60	15.34	20.26	24.06	15.34	28.99	OK	44.29	43.27	41.66	12.30	52.35	OK	OK	9.6	30.9	3,143	812.49	OK
21-Nov-12	35.60	15.34	20.26	25.76	15.34	30.69	OK	48.29	47.27	45.66	12.40	56.45	OK	OK	10.2	32.9	3,211	830.18	OK
22-Nov-12	35.60	15.34	20.26	25.46	15.34	30.39	OK	33.79	32.77	31.16	1.10	30.65	OK	OK	8.2	26.3	2,971	767.99	OK
23-Nov-12	35.50	15.34	20.16	50.56	15.34	55.39	OK	92.29	91.27	89.66	2.00	90.05	OK	OK	22.2	72.4	4,233	1,094.43	OK
24-Nov-12	35.50	15.34	20.16	55.26	15.34	60.09	OK	103.19	102.17	100.56	2.10	101.05	OK	OK	26.9	88.1	4,536	1,172.59	OK
25-Nov-12	35.50	15.34	20.16	37.86	15.34	42.69	OK	62.79	61.77	60.16	1.00	59.55	OK	OK	12.6	40.8	3,464	895.54	OK
26-Nov-12	82.40	15.34	67.06	132.66	15.34	184.39	OK	249.99	248.97	247.36	2.90	248.65	OK	OK	89.5	298.8	6,954	1,797.71	OK
27-Nov-12	141.20	15.34	125.86	284.26	15.34	394.79	OK	561.59	560.57	558.96	7.40	564.75	OK	OK	391.8	1,342.3	11,764	3,041.43	OK
28-Nov-12	147.40	15.34	132.06	274.86	15.34	391.59	OK	536.79	535.77	534.16	6.40	538.95	OK	OK	342.5	1,170.6	11,214	2,899.21	OK
29-Nov-12	150.90	15.34	135.56	269.26	15.34	389.49	OK	529.59	528.57	526.96	11.90	537.25	OK	OK	327.3	1,118.0	11,035	2,852.87	OK
30-Nov-12	102.60	15.34	87.26	220.06	15.34	291.99	OK	499.79	498.77	497.16	57.20	552.75	OK	OK	381.2	1,305.4	11,650	3,011.92	OK
01-Dec-12	36.30	15.34	20.96	79.06	15.34	84.69	OK	260.69	259.67	258.06	94.10	350.55	OK	OK	192.9	652.9	9,142	2,363.37	OK
02-Dec-12	47.80	15.34	32.46	66.66	15.34	83.79	OK	169.69	168.67	167.06	47.80	213.25	OK	OK	63.3	210.3	6,149	1,589.61	OK
03-Dec-12	67.70	15.34	52.36	92.26	15.34	129.29	OK	161.09	160.07	158.46	7.60	164.45	OK	OK	43.0	141.9	5,358	1,385.23	OK
04-Dec-12	57.20	15.34	41.86	77.96	15.34	104.49	OK	134.09	133.07	131.46	3.10	132.95	OK	OK	33.2	108.9	4,884	1,262.63	OK
05-Dec-12	109.20	15.34	93.86	197.96	15.34	276.49	OK	377.29	376.27	374.66	4.90	377.95	OK	OK	184.3	623.4	8,995	2,325.38	OK
06-Dec-12	176.50	15.34	161.16	347.66	15.34	493.49	OK	680.09	679.07	677.46	9.30	685.15	OK	OK	533.4	1,836.8	13,129	3,394.34	OK
07-Dec-12	135.10	15.34	119.76	223.76	15.34	328.19	OK	486.69	485.67	484.06	61.10	543.55	OK	OK	295.2	1,006.3	10,636	2,749.75	OK
08-Dec-12	59.00	15.34	43.66	104.26	15.34	132.59	OK	262.69	261.67	260.06	59.10	317.55	OK	OK	135.1	454.5	8,053	2,081.95	OK
09-Dec-12	32.30	15.34	16.96	76.86	15.34	78.49	OK	160.09	159.07	157.46	9.10	164.95	OK	OK	66.1	219.5	6,242	1,613.74	OK
10-Dec-12	32.20	15.34	16.86	30.36	15.34	31.89	OK	52.59	51.57	49.96	5.50	53.85	OK	OK	10.6	34.2	3,256	841.66	OK
11-Dec-12	32.20	15.34	16.86	30.26	15.34	31.79	OK	47.29	46.27	44.66	12.40	55.45	OK	OK	9.4	30.2	3,118	806.12	OK
12-Dec-12	32.20	15.34	16.86	29.46	15.34	30.99	OK	45.49	44.47	42.86	12.30	53.55	OK	OK	9.1	29.1	3,079	795.92	OK
13-Dec-12	70.80	15.34	55.46	82.16	15.34	122.29	OK	133.19	132.17	130.56	-	128.95	OK	OK	34.6	113.7	4,959	1,282.02	OK
14-Dec-12	98.10	15.34	82.76	183.96	15.34	251.39	OK	404.79	403.77	402.16	54.50	455.05	OK	OK	238.6	810.5	9,860	2,549.16	OK
15-Dec-12	57.30	15.34	41.96	128.86	15.34	155.49	OK	305.09	304.07	302.46	55.50	356.35	OK	OK	183.5	620.6	8,981	2,321.81	OK
16-Dec-12	24.90	1.69	23.21	43.01	1.69	64.52	OK	85.32	84.30	84.30	7.10	89.79	OK	OK	9.5	30.4	3,124	807.74	OK
17-Dec-12	21.90	1.69	20.21	39.91	1.69	58.42	OK	88.72	87.70	87.70	16.30	102.39	OK	OK	11.5	37.2	3,354	867.00	OK
18-Dec-12	97.00	1.69	95.31	133.71	1.69	227.32	OK	261.22	260.20	260.20	22.40	280.99	OK	OK	69.4	230.9	6,354	1,642.64	OK
19-Dec-12	129.00	1.69	127.31	176.21	1.69	301.82	OK	349.52	348.50	348.50	32.70	379.59	OK	OK	119.5	401.1	7,708	1,992.88	OK
20-Dec-12	106.00	1.69	104.31	144.21	1.69	246.82	OK	278.12	277.10	277.10	20.40	295.89	OK	OK	78.9	262.8	6,648	1,718.77	OK
21-Dec-12	77.30	1.69	75.61	104.81	1.69	178.72	OK	196.22	195.20	195.20	-	193.59	OK	OK	42.0	138.4	5,312	1,373.19	OK
22-Dec-12	27.30	1.69	25.61	37.01	1.69	60.92	OK	75.22	74.20	74.20	4.10	76.69	OK	OK	7.1	22.7	2,819	728.86	OK
23-Dec-12	120.00	1.69	118.31	165.01	1.69	281.62	OK	330.22	329.20	329.20	28.60	356.19	OK	OK	107.1	358.7	7,413	1,916.49	OK
24-Dec-12	139.80	1.69	138.11	191.71	1.69	328.12	OK	372.12	371.10	371.10	24.50	393.99	OK	OK	135.3	455.3	8,058	2,083.24	OK
25-Dec-12	76.20	1.69	74.51	121.21	1.69	194.02	OK	247.92	246.90	246.90	21.00	266.29	OK	OK	64.2	213.2	6,179	1,597.46	OK
26-Dec-12	87.60	1.69	85.91	136.31	1.69	220.52	OK	274.72	273.70	273.70	21.00	293.09	OK	OK	76.6	255.3	6,581	1,701.33	OK
27-Dec-12	62.60	1.69	60.91	84.41	1.69	143.62	OK	162.62	161.60	161.60	2.40	162.39	OK	OK	29.1	95.3	4,662	1,205.28	OK
28-Dec-12	80.80	1.69	79.11	111.31	1.69	188.72	OK	209.62	208.60	208.60	1.40	208.39	OK	OK	46.9	155.0	5,527	1,428.87	OK
29-Dec-12	80.30	1.69	78.61	109.81	1.69	186.72	OK	204.52	203.50	203.50	0.90	202.79	OK	OK	45.4	149.8	5,460	1,411.61	OK
30-Dec-12	42.10	1.69	40.41	53.41	1.69	92.12	OK	105.42	104.40	104.40	0.30	103.09	OK	OK	13.3	42.9	3,524	911.13	OK
31-Dec-12	36.30	1.69	34.61	59.41	1.69	92.32	OK	126.52	125.50	125.50	7.10	130.99	OK	OK	19.5	63.5	4,044	1,045.47	OK

Appendix 6.4

WATER BALANCE SIMULATION OF THE KRUENG ACEH CATCHMENT

LULC Scenario II runs on inflow 2012 and water demand 2040 (in m^3/s)

DEMAND	Up	Down
Domestic	0.60	0.64
Non-Domestic	0.44	0.16
Water Losses	0.17	0.21
Min.Environmental Flow	2.18	1.61
Paddy Field	27.28	-

	Water Quantity														Water Quality at PDAM Tirta Daroy				
Date	Lampisang Sta			Darang Sta			Upstream	Pasie Sta			Sub Banda Aceh			Downstream	Upstream - Downstream	TSS (mg/l)	Turb (NTU)	Alum (kg/day)	Cost Alum (USD)	PDAM (Quantity & Quality)
	I_1	D_1	(I_1-D_1) R_1	I_2	D_2	$(R_1+I_2-D_2)$ R_2		I_3	$(R_2+I_3-D_{(D+ND+WL)})$ R_3	(R_3-D_{PF}) R_4	I_4	$(R_4+I_4-D_4)$ R_5				(R_2+I_3) = TSS (>2000) $0.000771*(R_2+I_3)^{2.899}$	Limit < 5 NTU $3.093*TSS^{1.017}$	5 NTU<Alum<2000 mg/l $1.2*(8.59*D_{(D+ND+WL)})^{0.35}$	(Alum*USD 0.259)	
RELIABILITY			**87.70%**			**90.16%**	**87.43%**		**97.81%**	**96.72%**		**96.17%**	**96.17%**	**87.43%**		**0.00%**	**14.21%**	**1,547,989.69**	**400,204.16**	**97.81%**
01-Jan-40	7.20	1.69	5.51	7.91	1.69	11.72	OK	20.82	19.80	19.80	2.30	20.49	OK	OK	1.0	3.2	-	-	OK	
02-Jan-40	11.60	1.69	9.91	14.71	1.69	22.92	OK	31.02	30.00	30.00	0.70	29.09	OK	OK	1.6	5.0	-	-	OK	
03-Jan-40	15.30	1.69	13.61	19.91	1.69	31.82	OK	39.12	38.10	38.10	0.30	36.79	OK	OK	2.3	7.1	1,881	486.41	OK	
04-Jan-40	11.10	1.69	9.41	14.01	1.69	21.72	OK	28.52	27.50	27.50	0.80	26.69	OK	OK	1.4	4.3	-	-	OK	
05-Jan-40	16.20	1.69	14.51	24.11	1.69	36.92	OK	103.72	102.70	102.70	12.40	113.49	OK	OK	28.6	93.6	4,632	1,197.42	OK	
06-Jan-40	21.40	1.69	19.71	29.71	1.69	47.72	OK	118.22	117.20	117.20	12.80	128.39	OK	OK	32.7	107.3	4,858	1,256.07	OK	
07-Jan-40	10.90	1.69	9.21	12.91	1.69	20.42	OK	28.72	27.70	27.70	1.20	27.29	OK	OK	1.4	4.5	-	-	OK	
08-Jan-40	55.70	1.69	54.01	64.91	1.69	117.22	OK	125.32	124.30	124.30	0.40	123.09	OK	OK	19.8	64.5	4,066	1,051.27	OK	
09-Jan-40	64.50	1.69	62.81	76.11	1.69	137.22	OK	149.42	148.40	148.40	0.70	147.49	OK	OK	26.7	87.4	4,522	1,169.08	OK	
10-Jan-40	17.70	1.69	16.01	24.41	1.69	38.72	OK	55.72	54.70	54.70	2.40	55.49	OK	OK	4.5	14.4	2,408	622.50	OK	
11-Jan-40	70.70	1.69	69.01	89.41	1.69	156.72	OK	176.32	175.30	175.30	1.80	175.49	OK	OK	34.4	113.1	4,949	1,279.36	OK	
12-Jan-40	76.30	1.69	74.61	95.11	1.69	168.02	OK	183.92	182.90	182.90	1.30	182.59	OK	OK	38.1	125.5	5,133	1,327.08	OK	
13-Jan-40	26.20	1.69	24.51	33.51	1.69	56.32	OK	66.92	65.90	65.90	1.30	65.59	OK	OK	5.8	18.5	2,624	678.34	OK	
14-Jan-40	22.60	1.69	20.91	42.81	1.69	62.02	OK	119.12	118.10	118.10	11.70	128.19	OK	OK	25.9	84.6	4,472	1,156.03	OK	
15-Jan-40	17.60	1.69	15.91	36.81	1.69	51.02	OK	109.02	108.00	108.00	11.80	118.19	OK	OK	24.9	81.5	4,413	1,140.86	OK	
16-Jan-40	194.84	1.69	193.15	263.85	1.69	455.31	OK	480.91	479.89	479.89	1.20	479.48	OK	OK	233.1	791.5	9,778	2,528.03	OK	
17-Jan-40	212.55	1.69	210.86	283.56	1.69	492.72	OK	516.22	515.20	515.20	0.90	514.49	OK	OK	269.9	918.9	10,303	2,663.59	OK	
18-Jan-40	53.10	1.69	51.41	60.31	1.69	110.02	OK	116.82	115.80	115.80	0.30	114.49	OK	OK	17.8	57.9	3,915	1,012.04	OK	
19-Jan-40	54.90	1.69	53.21	64.01	1.69	115.52	OK	124.22	123.20	123.20	0.50	122.09	OK	OK	19.4	63.0	4,033	1,042.76	OK	
20-Jan-40	55.60	1.69	53.91	67.11	1.69	119.32	OK	130.62	129.60	129.60	0.60	128.59	OK	OK	20.5	66.9	4,118	1,064.75	OK	
21-Jan-40	52.40	1.69	50.71	57.51	1.69	106.52	OK	113.82	112.80	112.80	0.20	111.39	OK	OK	17.2	55.9	3,867	999.79	OK	
22-Jan-40	50.60	1.69	48.91	50.81	1.69	98.02	OK	98.82	97.80	97.80	-	96.19	OK	OK	15.5	50.1	3,722	962.28	OK	
23-Jan-40	49.50	1.69	47.81	49.71	1.69	95.82	OK	96.42	95.40	95.40	-	93.79	OK	OK	14.8	48.0	3,667	948.06	OK	
24-Jan-40	49.20	1.69	47.51	49.41	1.69	95.22	OK	95.62	94.60	94.60	-	92.99	OK	OK	14.7	47.5	3,652	944.14	OK	
25-Jan-40	47.90	1.69	46.21	48.01	1.69	92.52	OK	92.82	91.80	91.80	-	90.19	OK	OK	13.9	45.1	3,586	927.14	OK	
26-Jan-40	44.70	1.69	43.01	44.81	1.69	86.12	OK	86.42	85.40	85.40	-	83.79	OK	OK	12.2	39.4	3,423	884.88	OK	
27-Jan-40	44.70	1.69	43.01	44.81	1.69	86.12	OK	86.32	85.30	85.30	-	83.69	OK	OK	12.2	39.4	3,423	884.87	OK	
28-Jan-40	56.40	1.69	54.71	60.41	1.69	113.42	OK	114.62	113.60	113.60	-	111.99	OK	OK	19.2	62.5	4,021	1,039.65	OK	
29-Jan-40	115.99	1.69	114.29	151.09	1.69	263.69	OK	275.29	274.27	274.27	0.10	272.76	OK	OK	83.9	280.0	6,797	1,757.33	OK	
30-Jan-40	156.62	1.69	154.93	209.23	1.69	362.47	OK	397.47	396.45	396.45	7.00	401.84	OK	OK	157.2	530.3	8,499	2,197.37	OK	
31-Jan-40	160.76	1.69	159.06	215.76	1.69	373.13	OK	409.73	408.71	408.71	7.10	414.20	OK	OK	166.1	560.7	8,667	2,240.78	OK	
01-Feb-40	141.34	1.69	139.64	192.34	1.69	330.29	OK	360.49	359.47	359.47	2.80	360.66	OK	OK	131.0	440.4	7,965	2,059.13	OK	
02-Feb-40	85.10	1.69	83.40	114.10	1.69	195.81	OK	222.21	221.19	221.19	3.70	223.28	OK	OK	51.9	171.6	5,727	1,480.52	OK	
03-Feb-40	74.70	1.69	73.01	89.11	1.69	160.42	OK	169.62	168.60	168.60	1.00	167.99	OK	OK	34.7	114.0	4,963	1,262.98	OK	
04-Feb-40	74.00	1.69	72.31	97.31	1.69	167.92	OK	187.92	186.90	186.90	0.40	185.69	OK	OK	38.4	126.5	5,148	1,330.82	OK	
05-Feb-40	71.10	1.69	69.41	121.61	1.69	189.32	OK	207.10	206.08	206.08	24.20	228.67	OK	OK	47.9	158.3	5,567	1,439.36	OK	
06-Feb-40	61.20	1.69	59.51	97.71	1.69	155.52	OK	173.69	172.67	172.67	23.80	194.86	OK	OK	33.4	109.6	4,896	1,265.65	OK	
07-Feb-40	64.30	1.69	62.61	81.41	1.69	142.32	OK	157.82	156.80	156.80	2.20	157.39	OK	OK	28.3	92.7	4,616	1,193.31	OK	
08-Feb-40	56.70	1.69	55.01	68.31	1.69	121.62	OK	132.62	131.60	131.60	0.80	130.79	OK	OK	21.2	69.1	4,166	1,077.02	OK	
09-Feb-40	50.20	1.69	48.51	52.61	1.69	99.42	OK	107.42	106.40	106.40	0.20	104.99	OK	OK	15.8	51.2	3,750	969.48	OK	
10-Feb-40	50.20	1.69	48.51	56.11	1.69	102.92	OK	113.62	112.60	112.60	0.20	111.19	OK	OK	16.4	53.3	3,803	983.14	OK	
11-Feb-40	47.27	1.69	45.57	69.37	1.69	113.25	OK	154.25	153.23	153.23	7.60	159.22	OK	OK	27.6	90.3	4,573	1,182.39	OK	
12-Feb-40	68.64	1.69	66.95	111.75	1.69	177.00	OK	227.80	226.78	226.78	11.10	236.26	OK	OK	55.3	183.2	5,859	1,514.81	OK	
13-Feb-40	61.54	1.69	59.85	124.15	1.69	182.30	OK	276.94	275.92	275.92	26.10	300.41	OK	OK	97.3	325.7	7,166	1,852.66	OK	

14-Feb-40	147.73	1.69	146.04	170.37	1.69	314.72	OK	425.71	424.69	424.69	23.60	446.68	OK	OK	190.5	644.6	9,100	2,352.76	OK
15-Feb-40	148.51	1.69	146.82	230.02	1.69	375.14	OK	420.80	419.78	419.78	2.40	420.57	OK	OK	171.6	579.6	8,769	2,266.94	OK
16-Feb-40	52.50	1.69	50.81	62.01	1.69	111.12	OK	124.92	123.90	123.90	0.70	122.99	OK	OK	18.7	60.9	3,985	1,030.28	OK
17-Feb-40	48.50	1.69	46.81	56.21	1.69	101.32	OK	111.62	110.60	110.60	0.30	109.29	OK	OK	15.6	50.6	3,735	965.60	OK
18-Feb-40	45.80	1.69	44.11	52.41	1.69	94.82	OK	102.62	101.60	101.60	0.10	100.09	OK	OK	13.7	44.3	3,566	921.83	OK
19-Feb-40	43.60	1.69	41.91	50.11	1.69	90.32	OK	96.12	95.10	95.10	-	93.49	OK	OK	12.4	39.9	3,437	888.64	OK
20-Feb-40	41.60	1.69	39.91	48.01	1.69	86.22	OK	90.72	89.70	89.70	-	88.09	OK	OK	11.3	36.3	3,325	859.66	OK
21-Feb-40	41.30	1.69	39.61	49.41	1.69	87.32	OK	93.12	92.10	92.10	0.10	90.59	OK	OK	11.4	36.8	3,342	863.94	OK
22-Feb-40	48.00	1.69	46.31	62.61	1.69	107.22	OK	122.22	121.20	121.20	2.40	121.99	OK	OK	17.3	56.1	3,872	1,001.12	OK
23-Feb-40	54.10	1.69	52.41	71.81	1.69	122.52	OK	138.92	137.90	137.90	2.50	138.79	OK	OK	21.8	71.2	4,208	1,087.92	OK
24-Feb-40	42.30	1.69	40.61	56.81	1.69	95.72	OK	113.92	112.90	112.90	3.60	114.89	OK	OK	15.0	48.5	3,679	951.03	OK
25-Feb-40	46.30	1.69	44.61	59.51	1.69	102.42	OK	117.02	116.00	116.00	3.50	117.89	OK	OK	16.0	51.9	3,768	974.02	OK
26-Feb-40	44.30	1.69	42.61	55.21	1.69	96.12	OK	106.82	105.80	105.80	0.30	104.49	OK	OK	13.9	44.9	3,583	926.20	OK
27-Feb-40	83.20	1.69	81.51	115.31	1.69	195.12	OK	222.62	221.60	221.60	3.60	223.59	OK	OK	51.7	171.0	5,720	1,478.70	OK
28-Feb-40	117.70	1.69	116.01	164.31	1.69	278.62	OK	316.42	315.40	315.40	6.80	320.59	OK	OK	99.6	333.5	7,226	1,868.12	OK
29-Feb-40	70.10	1.69	68.41	101.51	1.69	168.22	OK	199.92	198.90	198.90	4.60	201.89	OK	OK	41.9	138.1	5,307	1,372.07	OK
01-Mar-40	36.50	15.34	21.16	36.66	15.34	42.49	OK	58.69	57.67	56.06	1.30	55.75	OK	OK	11.7	37.7	3,370	871.27	OK
02-Mar-40	32.90	15.34	17.56	31.36	15.34	33.59	OK	46.49	45.47	43.86	0.50	42.75	OK	OK	9.3	29.8	3,102	801.94	OK
03-Mar-40	33.80	15.34	18.46	35.06	15.34	38.19	OK	50.89	49.87	48.26	0.40	47.05	OK	OK	10.1	32.6	3,203	828.09	OK
04-Mar-40	99.22	15.34	83.88	128.18	15.34	196.72	OK	216.92	215.90	214.29	3.30	215.98	OK	OK	70.1	233.2	6,375	1,648.22	OK
05-Mar-40	141.10	15.34	125.77	187.67	15.34	298.10	OK	322.50	321.48	319.87	3.30	321.55	OK	OK	134.7	453.0	8,044	2,079.58	OK
06-Mar-40	96.95	15.34	81.62	117.42	15.34	183.70	OK	238.90	237.88	236.27	34.60	269.26	OK	OK	79.2	264.1	6,660	1,721.70	OK
07-Mar-40	65.50	15.34	50.16	69.06	15.34	103.89	OK	158.99	157.97	156.36	34.90	189.65	OK	OK	45.7	150.9	5,474	1,415.28	OK
08-Mar-40	73.40	15.34	58.06	79.46	15.34	122.19	OK	135.79	134.77	133.16	3.10	134.65	OK	OK	35.5	116.9	5,006	1,294.24	OK
09-Mar-40	74.10	15.34	58.76	87.96	15.34	131.39	OK	153.99	152.97	151.36	1.50	151.25	OK	OK	40.6	133.8	5,249	1,356.96	OK
10-Mar-40	92.00	15.34	76.66	182.77	15.34	244.10	OK	361.97	360.95	359.34	5.90	363.63	OK	OK	187.9	635.5	9,056	2,341.14	OK
11-Mar-40	120.38	15.34	105.05	256.19	15.34	345.91	OK	515.28	514.26	512.65	20.40	531.44	OK	OK	356.4	1,219.0	11,374	2,940.58	OK
12-Mar-40	82.76	15.34	67.43	139.53	15.34	191.62	OK	282.94	281.92	280.31	40.30	319.00	OK	OK	116.8	392.1	7,647	1,977.01	OK
13-Mar-40	98.57	15.34	83.24	117.64	15.34	185.54	OK	226.84	225.82	224.21	25.00	247.59	OK	OK	72.6	241.8	6,457	1,669.23	OK
14-Mar-40	100.32	15.34	84.98	133.28	15.34	202.93	OK	258.63	257.61	256.00	23.30	277.69	OK	OK	89.2	298.0	6,947	1,796.06	OK
15-Mar-40	87.50	15.34	72.16	112.46	15.34	169.29	OK	231.49	230.47	228.86	23.80	251.05	OK	OK	76.5	254.8	6,576	1,700.22	OK
16-Mar-40	142.27	15.34	126.94	187.54	15.34	299.14	OK	322.74	321.72	320.11	3.40	321.89	OK	OK	135.3	455.0	8,056	2,082.77	OK
17-Mar-40	139.70	15.34	124.36	182.06	15.34	291.09	OK	313.59	312.57	310.96	1.30	310.65	OK	OK	129.3	434.5	7,927	2,049.43	OK
18-Mar-40	116.30	15.34	100.96	146.66	15.34	232.29	OK	252.79	251.77	250.16	1.60	250.15	OK	OK	90.4	302.1	6,980	1,804.62	OK
19-Mar-40	106.16	15.34	90.82	136.22	15.34	211.71	OK	237.61	236.59	234.98	1.70	235.07	OK	OK	79.9	266.3	6,679	1,726.79	OK
20-Mar-40	79.33	15.34	63.99	96.49	15.34	145.14	OK	166.54	165.52	163.91	0.80	163.10	OK	OK	45.9	151.5	5,483	1,417.51	OK
21-Mar-40	84.94	15.34	69.61	91.81	15.34	146.08	OK	162.18	161.16	159.55	-	157.93	OK	OK	46.2	152.7	5,498	1,421.29	OK
22-Mar-40	77.38	15.34	62.04	82.44	15.34	129.14	OK	141.94	140.92	139.31	-	137.70	OK	OK	38.4	126.6	5,148	1,330.84	OK
23-Mar-40	75.80	15.34	60.46	104.96	15.34	150.09	OK	200.59	199.57	197.96	1.80	198.15	OK	OK	60.7	201.4	6,056	1,565.73	OK
24-Mar-40	56.80	15.34	41.46	79.46	15.34	105.59	OK	159.49	158.47	156.86	7.00	162.25	OK	OK	45.5	150.4	5,468	1,413.75	OK
25-Mar-40	56.40	15.34	41.06	54.56	15.34	80.29	OK	100.29	99.27	97.66	5.30	101.35	OK	OK	22.9	74.6	4,278	1,105.92	OK
26-Mar-40	51.80	15.34	36.46	85.36	15.34	106.49	OK	164.79	163.77	162.16	2.00	162.55	OK	OK	50.8	167.9	5,683	1,469.34	OK
27-Mar-40	48.90	15.34	33.56	85.66	15.34	103.89	OK	182.29	181.27	179.66	16.00	194.05	OK	OK	66.2	220.0	6,246	1,614.90	OK
28-Mar-40	44.00	15.34	28.66	51.26	15.34	64.59	OK	133.29	132.27	130.66	39.00	168.05	OK	OK	42.7	140.9	5,345	1,381.97	OK
29-Mar-40	45.80	15.34	30.46	50.56	15.34	65.69	OK	110.69	109.67	108.06	25.00	131.45	OK	OK	27.8	90.9	4,585	1,185.46	OK
30-Mar-40	56.00	15.34	40.66	57.06	15.34	82.39	OK	101.39	100.37	98.76	-	97.15	OK	OK	22.9	74.8	4,282	1,106.97	OK
31-Mar-40	46.10	15.34	30.76	45.26	15.34	60.69	OK	74.99	73.97	72.36	-	70.75	OK	OK	15.8	51.1	3,747	968.81	OK
01-Apr-40	36.10	15.34	20.76	31.26	15.34	36.69	OK	46.59	45.57	43.96	-	42.35	OK	OK	9.6	30.8	3,141	811.97	OK
02-Apr-40	193.00	15.34	177.66	245.16	15.34	407.49	OK	429.49	428.47	426.86	-	425.25	OK	OK	226.0	767.0	9,672	2,500.40	OK
03-Apr-40	242.70	15.34	227.36	312.06	15.34	524.09	OK	548.69	547.67	546.06	-	544.45	OK	OK	348.1	1,190.2	11,279	2,916.07	OK
04-Apr-40	140.10	15.34	124.76	176.86	15.34	286.29	OK	307.09	306.07	304.46	0.30	303.15	OK	OK	125.9	423.0	7,853	2,030.27	OK
05-Apr-40	119.00	15.34	103.66	148.76	15.34	237.09	OK	263.99	262.97	261.36	7.50	267.25	OK	OK	95.3	318.6	7,113	1,838.84	OK
06-Apr-40	72.20	15.34	56.86	79.46	15.34	120.99	OK	137.29	136.27	134.66	8.20	141.25	OK	OK	35.4	116.5	5,000	1,292.77	OK
07-Apr-40	68.30	15.34	52.96	82.96	15.34	120.59	OK	138.09	137.07	135.46	1.40	135.25	OK	OK	35.0	115.2	4,980	1,287.59	OK
08-Apr-40	92.40	15.34	77.06	142.27	15.34	204.00	OK	277.20	276.18	274.57	2.90	275.86	OK	OK	104.5	349.9	7,349	1,899.87	OK
09-Apr-40	83.40	15.34	68.06	124.68	15.34	177.41	OK	227.02	226.00	224.39	2.50	225.28	OK	OK	73.8	245.7	6,493	1,678.69	OK
10-Apr-40	75.00	15.34	59.66	83.66	15.34	127.99	OK	228.87	227.85	226.24	100.30	324.93	OK	OK	93.5	312.6	7,064	1,826.33	OK
11-Apr-40	58.60	15.34	43.26	59.66	15.34	87.59	OK	185.63	184.61	183.00	100.30	281.69	OK	OK	76.4	254.4	6,573	1,699.34	OK
12-Apr-40	39.20	15.34	23.86	33.46	15.34	41.99	OK	54.39	53.37	51.76	8.90	59.05	OK	OK	11.2	36.2	3,321	858.49	OK
13-Apr-40	39.00	15.34	23.66	34.56	15.34	42.89	OK	56.39	55.37	53.76	4.60	56.75	OK	OK	11.5	37.1	3,349	865.89	OK
14-Apr-40	38.90	15.34	23.56	39.66	15.34	47.89	OK	79.69	78.67	77.06	14.40	89.85	OK	OK	17.5	56.8	3,889	1,005.55	OK
15-Apr-40	38.70	15.34	23.36	37.96	15.34	45.99	OK	71.99	70.97	69.36	11.90	79.65	OK	OK	15.1	48.8	3,689	953.71	OK
16-Apr-40	38.10	15.34	22.76	31.66	15.34	39.09	OK	42.89	41.87	40.26	0.10	38.75	OK	OK	9.7	31.1	3,150	814.49	OK
17-Apr-40	49.70	15.34	34.36	47.86	15.34	66.89	OK	80.19	79.17	77.56	7.60	83.55	OK	OK	17.4	56.4	3,880	1,003.20	OK
18-Apr-40	50.20	15.34	34.86	48.46	15.34	67.99	OK	85.49	84.47	82.86	11.40	92.65	OK	OK	18.5	60.2	3,969	1,026.11	OK

19-Apr-40	35.00	15.34	19.66	28.56	15.34	32.89	OK	39.39	38.37	36.76	3.80	38.95	OK	OK	8.5	27.4	3,013	778.96	OK
20-Apr-40	23.90	15.34	8.56	44.56	15.34	37.79	OK	75.19	74.17	72.56	1.60	72.55	OK	OK	20.5	66.7	4,114	1,063.48	OK
21-Apr-40	22.70	15.34	7.36	43.26	15.34	35.29	OK	72.39	71.37	69.76	1.60	69.75	OK	OK	20.0	65.0	4,076	1,053.78	OK
22-Apr-40	18.70	15.34	3.36	14.56	15.34	2.59	OK	6.99	5.97	4.36	0.50	3.25	OK	OK	3.4	10.6	2,161	558.65	OK
23-Apr-40	17.60	15.34	2.26	45.46	15.34	32.39	OK	79.09	78.07	76.46	2.20	77.05	OK	OK	26.7	87.5	4,524	1,169.53	OK
24-Apr-40	16.90	15.34	1.56	101.26	15.34	87.49	OK	208.69	207.67	206.06	5.40	209.85	OK	OK	138.9	467.5	8,133	2,102.64	OK
25-Apr-40	14.60	15.34	-	68.90	15.34	53.56	Fail	134.06	133.04	131.43	3.60	133.42	OK	Fail	66.4	220.8	6,255	1,617.05	OK
26-Apr-40	12.80	15.34	-	9.40	15.34	-	Fail	11.70	10.68	9.07	0.80	8.26	OK	Fail	2.7	8.6	2,005	518.27	OK
27-Apr-40	11.70	15.34	-	7.90	15.34	-	Fail	7.40	6.38	4.77	0.20	3.36	OK	Fail	1.8	5.6	1,734	448.26	OK
28-Apr-40	10.60	15.34	-	7.90	15.34	-	Fail	16.80	15.78	14.17	9.50	22.06	OK	Fail	3.1	9.9	2,111	545.81	OK
29-Apr-40	67.30	15.34	51.96	80.86	15.34	117.49	OK	139.59	138.57	136.96	9.60	144.95	OK	OK	35.0	115.2	4,980	1,287.59	OK
30-Apr-40	101.40	15.34	86.06	126.26	15.34	196.99	OK	209.59	208.57	206.96	0.90	206.25	OK	OK	68.8	228.9	6,334	1,637.50	OK
01-May-40	47.80	15.34	32.46	51.36	15.34	68.49	OK	75.99	74.97	73.36	2.10	73.85	OK	OK	16.6	54.0	3,820	987.57	OK
02-May-40	21.30	15.34	5.96	15.26	15.34	5.89	OK	10.39	9.37	7.76	2.00	8.15	OK	OK	3.8	11.9	2,249	581.39	OK
03-May-40	26.20	15.34	10.86	21.76	15.34	17.29	OK	19.49	18.47	16.86	-	15.25	OK	OK	5.3	16.8	2,541	657.00	OK
04-May-40	23.80	15.34	8.46	18.46	15.34	11.59	OK	22.29	21.27	19.66	7.60	25.65	OK	OK	5.2	16.5	2,525	652.69	OK
05-May-40	84.60	15.34	69.26	100.96	15.34	154.89	OK	170.89	169.87	168.26	7.60	174.25	OK	OK	49.0	162.1	5,613	1,451.18	OK
06-May-40	85.00	15.34	69.66	100.46	15.34	154.79	OK	188.49	187.47	185.86	22.90	207.15	OK	OK	54.4	180.3	5,827	1,506.44	OK
07-May-40	20.60	15.34	5.26	12.36	15.34	2.29	OK	29.79	28.77	27.16	22.90	48.45	OK	OK	8.0	25.7	2,945	761.46	OK
08-May-40	20.10	15.34	4.76	61.76	15.34	51.19	OK	117.49	116.47	114.86	3.00	116.25	OK	OK	47.8	157.9	5,562	1,437.98	OK
09-May-40	20.10	15.34	4.76	61.66	15.34	51.09	OK	117.29	116.27	114.66	3.00	116.05	OK	OK	47.6	157.4	5,556	1,436.50	OK
10-May-40	39.60	15.34	24.26	38.16	15.34	47.09	OK	53.59	52.57	50.96	-	49.35	OK	OK	11.3	36.5	3,331	861.21	OK
11-May-40	50.20	15.34	34.86	70.46	15.34	89.99	OK	120.29	119.27	117.66	1.10	117.15	OK	OK	28.9	94.8	4,652	1,202.68	OK
12-May-40	65.90	15.34	50.56	95.76	15.34	130.99	OK	167.69	166.67	165.06	1.40	164.85	OK	OK	46.3	152.9	5,500	1,421.99	OK
13-May-40	77.20	15.34	61.86	92.26	15.34	138.79	OK	151.59	150.57	148.96	0.30	147.65	OK	OK	41.4	136.5	5,286	1,366.49	OK
14-May-40	49.40	15.34	34.06	49.46	15.34	68.19	OK	74.19	73.17	71.56	-	69.95	OK	OK	16.6	53.9	3,819	987.27	OK
15-May-40	30.30	1.69	28.61	36.91	1.69	63.82	OK	68.32	67.30	67.30	-	65.69	OK	OK	6.5	20.7	2,731	705.93	OK
16-May-40	56.20	1.69	54.51	72.31	1.69	125.12	OK	135.62	134.60	134.60	3.80	136.79	OK	OK	21.7	70.8	4,201	1,086.16	OK
17-May-40	149.40	1.69	147.71	199.61	1.69	345.62	OK	368.62	367.60	367.60	7.60	373.59	OK	OK	140.2	472.1	8,161	2,109.77	OK
18-May-40	138.50	1.69	136.81	183.41	1.69	318.52	OK	335.12	334.10	334.10	3.80	336.29	OK	OK	119.5	401.1	7,708	1,992.85	OK
19-May-40	46.10	1.69	44.41	56.81	1.69	99.52	OK	105.62	104.60	104.60	-	102.99	OK	OK	14.3	46.2	3,617	935.14	OK
20-May-40	28.20	1.69	26.51	32.71	1.69	57.52	OK	60.92	59.90	59.90	-	58.29	OK	OK	5.5	17.4	2,569	664.21	OK
21-May-40	28.00	1.69	26.31	32.41	1.69	57.02	OK	59.62	58.60	58.60	-	56.99	OK	OK	5.3	17.0	2,550	659.27	OK
22-May-40	31.40	1.69	29.71	37.51	1.69	65.52	OK	92.22	91.20	91.20	20.60	110.19	OK	OK	11.3	36.3	3,324	859.37	OK
23-May-40	27.50	1.69	25.81	33.61	1.69	57.72	OK	90.72	89.70	89.70	26.40	114.49	OK	OK	12.1	39.2	3,414	882.74	OK
24-May-40	23.80	1.69	22.11	37.01	1.69	57.42	OK	104.42	103.40	103.40	29.40	131.19	OK	OK	18.6	60.5	3,975	1,027.72	OK
25-May-40	23.40	1.69	21.71	36.61	1.69	56.62	OK	118.62	117.60	117.60	42.50	158.49	OK	OK	27.8	90.9	4,585	1,185.29	OK
26-May-40	23.40	1.69	21.71	27.51	1.69	47.52	OK	70.22	69.20	69.20	18.90	86.49	OK	OK	7.2	23.0	2,833	732.35	OK
27-May-40	22.90	1.69	21.21	29.81	1.69	49.32	OK	62.52	61.50	61.50	7.90	67.79	OK	OK	5.2	16.4	2,517	650.83	OK
28-May-40	218.50	1.69	216.81	296.21	1.69	511.32	OK	554.82	553.80	553.80	17.70	569.89	OK	OK	296.2	1,009.9	10,649	2,753.11	OK
29-May-40	225.50	1.69	223.81	300.31	1.69	522.42	OK	553.12	552.10	552.10	9.80	560.29	OK	OK	303.4	1,035.0	10,741	2,776.91	OK
30-May-40	81.40	1.69	79.71	102.81	1.69	180.82	OK	209.92	208.90	208.90	20.90	228.19	OK	OK	46.9	155.0	5,526	1,428.76	OK
31-May-40	81.40	1.69	79.71	102.71	1.69	180.72	OK	214.32	213.30	213.30	24.80	236.49	OK	OK	48.6	160.6	5,595	1,446.61	OK
01-Jun-40	33.80	1.69	32.11	37.61	1.69	68.02	OK	74.12	73.10	73.10	4.20	75.69	OK	OK	7.7	24.6	2,900	749.82	OK
02-Jun-40	32.70	1.69	31.01	36.41	1.69	65.72	OK	66.92	65.90	65.90	0.10	64.39	OK	OK	7.0	22.3	2,802	724.38	OK
03-Jun-40	28.90	1.69	27.21	117.01	1.69	142.52	OK	231.39	230.37	230.37	5.10	233.86	OK	OK	96.1	321.5	7,134	1,844.45	OK
04-Jun-40	23.10	1.69	21.41	111.21	1.69	130.92	OK	219.64	218.62	218.62	5.10	222.10	OK	OK	94.1	314.8	7,081	1,830.73	OK
05-Jun-40	23.60	1.69	21.91	27.11	1.69	47.32	OK	79.16	78.14	78.14	34.20	110.72	OK	OK	10.2	32.9	3,212	830.53	OK
06-Jun-40	23.40	1.69	21.71	26.91	1.69	46.92	OK	85.79	84.77	84.77	42.00	125.16	OK	OK	13.1	42.4	3,510	907.50	OK
07-Jun-40	23.30	1.69	21.61	36.61	1.69	56.52	OK	86.78	85.76	85.76	22.10	106.24	OK	OK	10.9	35.0	3,284	848.96	OK
08-Jun-40	23.10	1.69	21.41	36.31	1.69	56.02	OK	87.42	86.40	86.40	16.30	101.09	OK	OK	11.2	36.2	3,321	858.51	OK
09-Jun-40	22.80	1.69	21.11	26.11	1.69	45.52	OK	56.02	55.00	55.00	4.10	57.49	OK	OK	4.4	13.6	2,372	613.20	OK
10-Jun-40	22.80	1.69	21.11	26.11	1.69	45.52	OK	53.42	52.40	52.40	2.00	52.79	OK	OK	4.0	12.8	2,307	596.54	OK
11-Jun-40	44.90	1.69	43.21	56.01	1.69	97.52	OK	103.72	102.70	102.70	-	101.09	OK	OK	13.7	44.3	3,566	921.99	OK
12-Jun-40	45.70	1.69	44.01	57.31	1.69	99.62	OK	105.52	104.50	104.50	-	102.89	OK	OK	14.2	45.9	3,610	933.34	OK
13-Jun-40	24.20	1.69	22.51	30.41	1.69	51.22	OK	57.62	56.60	56.60	0.20	55.19	OK	OK	4.6	14.5	2,409	622.85	OK
14-Jun-40	20.10	1.69	18.41	25.71	1.69	42.42	OK	47.52	46.50	46.50	0.20	45.09	OK	OK	3.3	10.3	2,138	552.73	OK
15-Jun-40	8.00	1.69	6.31	11.01	1.69	15.62	OK	16.92	15.90	15.90	-	14.29	OK	OK	0.6	2.0	-	-	OK
16-Jun-40	10.50	1.69	8.81	13.41	1.69	20.52	OK	21.52	20.50	20.50	-	18.89	OK	OK	0.9	2.9	-	-	OK
17-Jun-40	6.40	1.69	4.71	13.21	1.69	16.22	OK	22.22	21.20	21.20	0.20	19.79	OK	OK	1.1	3.4	-	-	OK
18-Jun-40	7.50	1.69	5.81	14.31	1.69	18.42	OK	24.22	23.20	23.20	0.20	21.79	OK	OK	1.2	3.7	-	-	OK
19-Jun-40	12.00	1.69	10.31	16.61	1.69	25.22	OK	26.12	25.10	25.10	-	23.49	OK	OK	1.3	4.1	-	-	OK
20-Jun-40	86.20	1.69	84.51	137.61	1.69	220.42	OK	255.12	254.10	254.10	1.30	253.79	OK	OK	66.9	222.2	6,269	1,620.75	OK
21-Jun-40	86.80	1.69	85.11	137.31	1.69	220.72	OK	255.12	254.10	254.10	1.30	253.79	OK	OK	66.8	221.9	6,266	1,619.88	OK
22-Jun-40	15.70	1.69	14.01	19.21	1.69	31.52	OK	34.92	33.90	33.90	-	32.29	OK	OK	2.0	6.2	1,786	461.80	OK

23-Jun-40	12.80	1.69	11.11	15.41	1.69	24.82	OK	27.22	26.20	26.20	-	24.59	OK	OK	1.3	4.1	-	-	OK
24-Jun-40	12.80	1.69	11.11	15.41	1.69	24.82	OK	26.62	25.60	25.60	-	23.99	OK	OK	1.3	4.0	-	-	OK
25-Jun-40	12.70	1.69	11.01	15.21	1.69	24.52	OK	25.82	24.80	24.80	-	23.19	OK	OK	1.3	3.9	-	-	OK
26-Jun-40	12.70	1.69	11.01	15.21	1.69	24.52	OK	25.52	24.50	24.50	-	22.89	OK	OK	1.3	3.9	-	-	OK
27-Jun-40	37.30	1.69	35.61	48.51	1.69	82.42	OK	85.42	84.40	84.40	-	82.79	OK	OK	9.9	31.7	3,172	820.01	OK
28-Jun-40	37.80	1.69	36.11	49.01	1.69	83.42	OK	86.22	85.20	85.20	-	83.59	OK	OK	10.1	32.4	3,196	826.26	OK
29-Jun-40	12.50	1.69	10.81	14.81	1.69	23.92	OK	24.32	23.30	23.30	-	21.69	OK	OK	1.2	3.8	-	-	OK
30-Jun-40	12.60	1.69	10.91	14.91	1.69	24.12	OK	24.42	23.40	23.40	-	21.79	OK	OK	1.2	3.8	-	-	OK
01-Jul-40	12.50	1.69	10.81	14.81	1.69	23.92	OK	37.82	36.80	36.80	11.80	46.99	OK	OK	2.5	8.0	1,955	505.36	OK
02-Jul-40	12.50	1.69	10.81	14.71	1.69	23.82	OK	37.62	36.60	36.60	11.80	46.79	OK	OK	2.5	7.9	1,948	503.66	OK
03-Jul-40	12.40	1.69	10.71	16.51	1.69	25.52	OK	28.22	27.20	27.20	1.10	26.69	OK	OK	1.4	4.3	-	-	OK
04-Jul-40	12.40	1.69	10.71	16.51	1.69	25.52	OK	28.22	27.20	27.20	0.40	25.99	OK	OK	1.4	4.3	-	-	OK
05-Jul-40	12.30	1.69	10.61	14.41	1.69	23.32	OK	23.42	22.40	22.40	0.10	20.89	OK	OK	1.2	3.6	-	-	OK
06-Jul-40	12.10	1.69	10.41	14.11	1.69	22.82	OK	22.92	21.90	21.90	-	20.29	OK	OK	1.1	3.5	-	-	OK
07-Jul-40	10.30	1.69	8.61	12.31	1.69	19.22	OK	28.32	27.30	27.30	7.90	33.59	OK	OK	1.4	4.5	-	-	OK
08-Jul-40	8.30	1.69	6.61	11.11	1.69	16.02	OK	39.02	38.00	38.00	19.70	56.09	OK	OK	4.1	13.0	2,321	600.04	OK
09-Jul-40	100.70	1.69	99.01	136.01	1.69	233.32	OK	255.52	254.50	254.50	11.80	264.69	OK	OK	68.7	228.6	6,331	1,636.80	OK
10-Jul-40	101.60	1.69	99.91	136.01	1.69	234.22	OK	243.12	242.10	242.10	1.70	242.19	OK	OK	66.7	221.6	6,263	1,619.06	OK
11-Jul-40	13.30	1.69	11.61	15.11	1.69	25.02	OK	27.22	26.20	26.20	0.80	25.39	OK	OK	1.4	4.2	-	-	OK
12-Jul-40	12.60	1.69	10.91	14.41	1.69	23.62	OK	24.82	23.80	23.80	0.10	22.29	OK	OK	1.2	3.8	-	-	OK
13-Jul-40	12.70	1.69	11.01	14.51	1.69	23.82	OK	24.72	23.70	23.70	-	22.09	OK	OK	1.2	3.8	-	-	OK
14-Jul-40	12.20	1.69	10.51	28.11	1.69	36.92	OK	60.82	59.80	59.80	4.80	62.99	OK	OK	6.8	21.8	2,781	719.02	OK
15-Jul-40	10.60	1.69	8.91	33.51	1.69	40.72	OK	87.62	86.60	86.60	9.60	94.59	OK	OK	18.1	58.7	3,934	1,017.08	OK
16-Jul-40	11.00	1.69	9.31	19.71	1.69	27.32	OK	50.92	49.90	49.90	4.80	53.09	OK	OK	5.2	16.7	2,531	654.46	OK
17-Jul-40	13.30	1.69	11.61	33.01	1.69	42.92	OK	66.22	65.20	65.20	1.00	64.59	OK	OK	7.8	24.9	2,912	752.93	OK
18-Jul-40	13.40	1.69	11.71	33.41	1.69	43.42	OK	67.02	66.00	66.00	1.10	65.49	OK	OK	7.9	25.5	2,937	759.27	OK
19-Jul-40	10.90	1.69	9.21	12.71	1.69	20.22	OK	24.72	23.70	23.70	0.30	22.39	OK	OK	1.1	3.4	-	-	OK
20-Jul-40	10.90	1.69	9.21	20.31	1.69	27.82	OK	41.32	40.30	40.30	0.60	39.29	OK	OK	3.0	9.3	2,065	533.76	OK
21-Jul-40	13.30	1.69	11.61	23.61	1.69	33.52	OK	46.52	45.50	45.50	0.50	44.39	OK	OK	3.4	10.7	2,168	560.51	OK
22-Jul-40	25.70	1.69	24.01	32.41	1.69	54.72	OK	59.22	58.20	58.20	-	56.59	OK	OK	4.9	15.6	2,477	640.30	OK
23-Jul-40	23.70	1.69	22.01	29.51	1.69	49.82	OK	53.32	52.30	52.30	-	50.69	OK	OK	4.2	13.2	2,332	602.94	OK
24-Jul-40	11.70	1.69	10.01	13.11	1.69	21.42	OK	23.12	22.10	22.10	-	20.49	OK	OK	1.1	3.3	-	-	OK
25-Jul-40	11.60	1.69	9.91	13.51	1.69	21.72	OK	23.82	22.80	22.80	-	21.19	OK	OK	1.1	3.3	-	-	OK
26-Jul-40	9.60	1.69	7.91	11.51	1.69	17.72	OK	19.42	18.40	18.40	-	16.79	OK	OK	0.8	2.4	-	-	OK
27-Jul-40	4.10	1.69	2.41	5.41	1.69	6.12	OK	6.82	5.80	5.80	-	4.19	OK	OK	0.2	0.6	-	-	OK
28-Jul-40	5.60	1.69	3.91	6.91	1.69	9.12	OK	9.72	8.70	8.70	-	7.09	OK	OK	0.3	0.9	-	-	OK
29-Jul-40	5.10	1.69	3.41	6.31	1.69	8.02	OK	8.42	7.40	7.40	-	5.79	OK	OK	0.3	0.8	-	-	OK
30-Jul-40	5.20	1.69	3.51	6.41	1.69	8.22	OK	8.52	7.50	7.50	-	5.89	OK	OK	0.3	0.8	-	-	OK
31-Jul-40	5.10	1.69	3.41	6.31	1.69	8.02	OK	8.22	7.20	7.20	-	5.59	OK	OK	0.3	0.8	-	-	OK
01-Aug-40	22.30	1.69	20.61	29.61	1.69	48.52	OK	50.22	49.20	49.20	-	47.59	OK	OK	3.9	12.2	2,271	587.03	OK
02-Aug-40	23.00	1.69	21.31	30.31	1.69	49.92	OK	51.62	50.60	50.60	-	48.99	OK	OK	4.1	12.8	2,311	597.51	OK
03-Aug-40	6.20	1.69	4.51	7.51	1.69	10.32	OK	10.82	9.80	9.80	-	8.19	OK	OK	0.4	1.1	-	-	OK
04-Aug-40	13.30	1.69	11.61	23.21	1.69	33.12	OK	42.12	41.10	41.10	0.40	39.89	OK	OK	2.7	8.6	2,010	519.63	OK
05-Aug-40	13.60	1.69	11.91	23.21	1.69	33.42	OK	42.02	41.00	41.00	0.40	39.79	OK	OK	2.7	8.5	1,999	516.86	OK
06-Aug-40	36.00	1.69	34.31	47.51	1.69	80.12	OK	82.92	81.90	81.90	-	80.29	OK	OK	9.3	30.0	3,111	804.33	OK
07-Aug-40	39.50	1.69	37.81	51.91	1.69	88.02	OK	91.02	90.00	90.00	-	88.39	OK	OK	11.1	35.7	3,305	854.37	OK
08-Aug-40	13.00	1.69	11.31	15.71	1.69	25.32	OK	26.22	25.20	25.20	-	23.59	OK	OK	1.3	4.1	-	-	OK
09-Aug-40	9.70	1.69	8.01	19.91	1.69	26.22	OK	37.92	36.90	36.90	0.50	35.79	OK	OK	2.6	8.2	1,976	510.86	OK
10-Aug-40	7.60	1.69	5.91	16.91	1.69	21.12	OK	32.52	31.50	31.50	0.50	30.39	OK	OK	2.2	6.8	1,853	479.08	OK
11-Aug-40	37.00	1.69	35.31	48.41	1.69	82.02	OK	84.92	83.90	83.90	-	82.29	OK	OK	9.8	31.4	3,160	816.98	OK
12-Aug-40	139.40	1.69	137.71	186.81	1.69	322.82	OK	334.92	333.90	333.90	-	332.29	OK	OK	121.3	407.4	7,750	2,003.67	OK
13-Aug-40	122.20	1.69	120.51	161.61	1.69	280.42	OK	290.42	289.40	289.40	-	287.79	OK	OK	93.4	312.3	7,062	1,825.76	OK
14-Aug-40	66.20	1.69	64.51	84.51	1.69	147.32	OK	151.92	150.90	150.90	-	149.29	OK	OK	28.5	93.4	4,628	1,196.44	OK
15-Aug-40	92.20	1.69	90.51	119.31	1.69	208.12	OK	230.92	229.90	229.90	13.80	242.09	OK	OK	56.9	188.6	5,919	1,530.21	OK
16-Aug-40	60.40	1.69	58.71	75.21	1.69	132.22	OK	151.82	150.80	150.80	13.80	162.99	OK	OK	26.0	84.9	4,477	1,157.43	OK
17-Aug-40	34.20	1.69	32.51	39.31	1.69	70.12	OK	72.32	71.30	71.30	-	69.69	OK	OK	7.7	24.7	2,905	751.14	OK
18-Aug-40	31.90	1.69	30.21	39.41	1.69	67.92	OK	75.02	74.00	74.00	0.30	72.69	OK	OK	7.4	23.7	2,863	740.11	OK
19-Aug-40	31.00	1.69	29.31	48.71	1.69	76.32	OK	96.62	95.60	95.60	0.90	94.89	OK	OK	11.3	36.4	3,329	860.61	OK
20-Aug-40	31.50	1.69	29.81	46.11	1.69	74.22	OK	106.32	105.30	105.30	14.50	118.19	OK	OK	14.6	47.1	3,643	941.92	OK
21-Aug-40	33.90	1.69	32.21	58.91	1.69	89.42	OK	134.22	133.20	133.20	15.10	146.69	OK	OK	24.0	78.5	4,355	1,125.78	OK
22-Aug-40	31.60	1.69	29.91	56.51	1.69	84.72	OK	156.62	155.60	155.60	37.90	191.89	OK	OK	40.9	134.8	5,263	1,360.73	OK
23-Aug-40	23.90	1.69	22.21	26.41	1.69	46.92	OK	91.92	90.90	90.90	36.70	125.99	OK	OK	16.2	52.5	3,784	978.20	OK
24-Aug-40	21.90	1.69	20.21	34.31	1.69	52.82	OK	68.62	67.60	67.60	3.40	69.39	OK	OK	6.2	19.8	2,688	694.84	OK
25-Aug-40	22.20	1.69	20.51	127.91	1.69	146.72	OK	287.02	286.00	286.00	8.20	292.59	OK	OK	174.7	590.2	8,824	2,281.34	OK
26-Aug-40	24.40	1.69	22.71	119.91	1.69	140.92	OK	266.82	265.80	265.80	7.00	271.19	OK	OK	144.3	485.9	8,244	2,131.27	OK

27-Aug-40	41.80	1.69	40.11	50.11	1.69	88.52	OK	102.32	101.30	101.30	4.10	103.79	OK	OK	12.7	41.2	3,475	898.35	OK
28-Aug-40	66.60	1.69	64.91	85.11	1.69	148.32	OK	165.82	164.80	164.80	5.10	168.29	OK	OK	30.7	100.8	4,754	1,229.04	OK
29-Aug-40	76.70	1.69	75.01	99.61	1.69	172.92	OK	186.92	185.90	185.90	2.10	186.39	OK	OK	39.2	129.3	5,186	1,340.78	OK
30-Aug-40	48.10	1.69	46.41	66.11	1.69	110.82	OK	125.82	124.80	124.80	1.40	124.59	OK	OK	18.1	58.9	3,938	1,018.02	OK
31-Aug-40	22.10	1.69	20.41	30.41	1.69	49.12	OK	60.32	59.30	59.30	0.40	58.09	OK	OK	4.8	15.2	2,452	633.85	OK
01-Sep-40	16.10	15.34	0.76	8.46	15.34	-	Fail	8.40	7.38	5.77	0.10	4.26	OK	Fail	2.7	8.5	1,998	516.48	OK
02-Sep-40	12.40	15.34	-	80.30	15.34	64.96	Fail	146.81	145.79	144.18	4.50	147.07	OK	Fail	76.6	255.2	6,580	1,701.09	OK
03-Sep-40	19.00	15.34	3.66	118.96	15.34	107.29	OK	196.49	195.47	193.86	6.50	198.75	OK	OK	121.4	407.7	7,752	2,004.16	OK
04-Sep-40	18.90	15.34	3.56	47.46	15.34	35.69	OK	75.67	74.65	73.04	2.40	73.82	OK	OK	24.0	78.4	4,353	1,125.50	OK
05-Sep-40	12.00	15.34	-	13.40	15.34	-	Fail	32.10	31.08	29.47	17.90	45.76	OK	Fail	8.7	28.0	3,038	785.31	OK
06-Sep-40	11.60	15.34	-	13.90	15.34	-	Fail	32.20	31.18	29.57	17.90	45.86	OK	Fail	8.8	28.2	3,046	787.39	OK
07-Sep-40	11.30	15.34	-	8.70	15.34	-	Fail	13.20	12.18	10.57	3.00	11.96	OK	Fail	2.6	8.3	1,984	512.86	OK
08-Sep-40	10.80	15.34	-	5.80	15.34	-	Fail	7.10	6.08	4.47	0.80	3.66	OK	Fail	1.4	4.5	-	-	OK
09-Sep-40	10.90	15.34	-	5.80	15.34	-	Fail	5.30	4.28	2.67	0.30	1.36	OK	Fail	1.3	4.0	-	-	OK
10-Sep-40	10.80	15.34	-	5.70	15.34	-	Fail	4.00	2.98	1.37	0.10	-	Fail	Fail	1.2	3.7	-	-	OK
11-Sep-40	10.80	15.34	-	5.60	15.34	-	Fail	3.00	1.98	0.37	-	-	Fail	Fail	1.1	3.5	-	-	OK
12-Sep-40	10.70	15.34	-	5.60	15.34	-	Fail	2.20	1.18	-	-	-	Fail	Fail	1.1	3.3	-	-	OK
13-Sep-40	10.10	15.34	-	5.80	15.34	-	Fail	2.10	1.08	-	-	-	Fail	Fail	1.0	3.1	-	-	OK
14-Sep-40	25.80	15.34	10.46	22.36	15.34	17.49	OK	20.69	19.67	18.06	-	16.45	OK	OK	5.4	17.1	2,552	659.89	OK
15-Sep-40	61.50	15.34	46.16	70.96	15.34	101.79	OK	112.29	111.27	109.66	4.00	112.05	OK	OK	27.1	88.7	4,545	1,175.11	OK
16-Sep-40	47.30	15.34	31.96	51.36	15.34	67.99	OK	76.89	75.87	74.26	4.00	76.65	OK	OK	16.6	54.0	3,820	987.67	OK
17-Sep-40	11.50	15.34	-	6.20	15.34	-	Fail	1.00	-	-	-	-	Fail	Fail	1.2	3.8	-	-	Fail
18-Sep-40	8.70	15.34	-	5.20	15.34	-	Fail	0.60	-	-	-	-	Fail	Fail	0.8	2.3	-	-	Fail
19-Sep-40	8.70	15.34	-	5.40	15.34	-	Fail	0.80	-	-	-	-	Fail	Fail	0.8	2.4	-	-	Fail
20-Sep-40	8.50	15.34	-	5.40	15.34	-	Fail	0.70	-	-	-	-	Fail	Fail	0.7	2.3	-	-	Fail
21-Sep-40	8.10	15.34	-	5.10	15.34	-	Fail	0.30	-	-	-	-	Fail	Fail	0.7	2.1	-	-	Fail
22-Sep-40	8.10	15.34	-	5.00	15.34	-	Fail	0.20	-	-	-	-	Fail	Fail	0.7	2.0	-	-	Fail
23-Sep-40	8.10	15.34	-	5.00	15.34	-	Fail	0.10	-	-	-	-	Fail	Fail	0.7	2.0	-	-	Fail
24-Sep-40	8.00	15.34	-	4.90	15.34	-	Fail	0.10	-	-	-	-	Fail	Fail	0.6	2.0	-	-	Fail
25-Sep-40	8.00	15.34	-	6.30	15.34	-	Fail	95.91	94.89	93.28	104.20	195.86	OK	Fail	52.7	174.5	5,761	1,489.28	OK
26-Sep-40	7.90	15.34	-	6.20	15.34	-	Fail	115.26	114.24	112.63	125.60	236.62	OK	Fail	74.4	247.8	6,513	1,683.71	OK
27-Sep-40	7.90	15.34	-	4.70	15.34	-	Fail	30.34	29.32	27.71	33.50	59.59	OK	Fail	6.5	20.6	2,728	705.23	OK
28-Sep-40	7.80	15.34	-	4.70	15.34	-	Fail	16.10	15.08	13.47	14.00	25.86	OK	Fail	2.4	7.4	1,907	493.04	OK
29-Sep-40	7.80	15.34	-	4.60	15.34	-	Fail	11.30	10.28	8.67	4.40	11.46	OK	Fail	1.5	4.7	-	-	OK
30-Sep-40	7.80	15.34	-	24.70	15.34	9.36	Fail	42.66	41.64	40.03	1.90	40.32	OK	Fail	11.4	36.6	3,335	862.24	OK
01-Oct-40	7.40	15.34	-	25.50	15.34	10.16	Fail	42.96	41.94	40.33	1.50	40.22	OK	Fail	11.4	36.6	3,336	862.43	OK
02-Oct-40	5.60	15.34	-	5.30	15.34	-	Fail	13.20	12.18	10.57	0.50	9.46	OK	Fail	1.6	5.1	1,678	433.79	OK
03-Oct-40	3.50	15.34	-	4.40	15.34	-	Fail	9.10	8.08	6.47	0.10	4.96	OK	Fail	0.8	2.6	-	-	OK
04-Oct-40	3.90	15.34	-	27.10	15.34	11.76	Fail	48.56	47.54	45.93	1.40	45.72	OK	Fail	13.2	42.8	3,523	910.90	OK
05-Oct-40	3.70	15.34	-	70.90	15.34	55.56	Fail	129.19	128.17	126.56	4.10	129.05	OK	Fail	60.8	201.8	6,061	1,567.07	OK
06-Oct-40	48.20	15.34	32.86	98.36	15.34	115.89	OK	169.53	168.51	166.90	2.80	168.09	OK	OK	56.5	187.2	5,903	1,526.20	OK
07-Oct-40	49.90	15.34	34.56	56.06	15.34	75.29	OK	84.59	83.57	81.96	0.40	80.75	OK	OK	18.7	60.7	3,981	1,029.18	OK
08-Oct-40	6.80	15.34	-	4.20	15.34	-	Fail	2.50	1.48	-	0.10	-	Fail	Fail	0.5	1.6	-	-	OK
09-Oct-40	6.50	15.34	-	4.20	15.34	-	Fail	2.40	1.38	-	0.50	-	Fail	Fail	0.5	1.5	-	-	OK
10-Oct-40	6.50	15.34	-	12.90	15.34	-	Fail	13.60	12.58	10.97	1.00	10.36	OK	Fail	2.7	8.6	2,009	519.32	OK
11-Oct-40	6.50	15.34	-	13.10	15.34	-	Fail	13.10	12.08	10.47	0.60	9.46	OK	Fail	2.7	8.4	1,995	515.70	OK
12-Oct-40	6.50	15.34	-	29.80	15.34	14.46	Fail	49.36	48.34	46.73	1.60	46.72	OK	Fail	13.6	43.9	3,553	918.63	OK
13-Oct-40	6.40	15.34	-	31.50	15.34	16.16	Fail	53.16	52.14	50.53	1.70	50.62	OK	Fail	15.1	48.9	3,689	953.84	OK
14-Oct-40	55.80	15.34	40.46	64.06	15.34	89.19	OK	96.79	95.77	94.16	0.20	92.75	OK	OK	22.6	73.8	4,262	1,101.83	OK
15-Oct-40	84.90	15.34	69.56	100.76	15.34	154.99	OK	275.09	274.07	272.46	98.70	369.55	OK	OK	127.0	426.9	7,878	2,036.82	OK
16-Oct-40	38.10	15.34	22.76	46.76	15.34	54.19	OK	205.89	204.87	203.26	119.00	320.65	OK	OK	136.9	460.6	8,091	2,091.71	OK
17-Oct-40	11.50	15.34	-	14.30	15.34	-	Fail	38.10	37.08	35.47	21.80	55.66	OK	Fail	11.3	36.5	3,331	861.21	OK
18-Oct-40	36.00	15.34	20.66	33.26	15.34	38.59	OK	62.79	61.77	60.16	19.10	77.65	OK	OK	13.0	41.9	3,497	904.13	OK
19-Oct-40	37.00	15.34	21.66	34.46	15.34	40.79	OK	63.59	62.57	60.96	17.60	76.95	OK	OK	13.0	42.1	3,503	905.58	OK
20-Oct-40	13.10	15.34	-	47.90	15.34	32.56	Fail	92.36	91.34	89.73	5.90	94.02	OK	Fail	36.3	119.3	5,042	1,303.53	OK
21-Oct-40	12.90	15.34	-	47.60	15.34	32.26	Fail	99.66	98.64	97.03	11.40	106.82	OK	Fail	41.5	136.7	5,289	1,367.29	OK
22-Oct-40	12.90	15.34	-	4.30	15.34	-	Fail	14.70	13.68	12.07	7.30	17.76	OK	Fail	2.8	8.7	2,017	521.50	OK
23-Oct-40	73.70	15.34	58.36	84.66	15.34	127.69	OK	138.69	137.67	136.06	2.20	136.65	OK	OK	36.8	121.1	5,069	1,310.44	OK
24-Oct-40	140.10	15.34	124.76	174.16	15.34	283.59	OK	303.29	302.27	300.66	4.70	303.75	OK	OK	124.1	416.7	7,812	2,019.62	OK
25-Oct-40	148.00	15.34	132.66	182.96	15.34	300.29	OK	323.89	322.87	321.26	8.20	327.85	OK	OK	137.3	462.1	8,100	2,094.13	OK
26-Oct-40	154.60	15.34	139.26	190.36	15.34	314.29	OK	336.39	335.37	333.76	7.10	339.25	OK	OK	147.6	497.3	8,311	2,148.62	OK
27-Oct-40	94.90	15.34	79.56	107.66	15.34	171.89	OK	208.29	207.27	205.66	25.20	229.25	OK	OK	64.2	213.3	6,180	1,597.69	OK
28-Oct-40	27.50	15.34	12.16	15.56	15.34	12.39	OK	39.79	38.77	37.16	23.20	58.75	OK	OK	9.7	31.3	3,158	816.46	OK
29-Oct-40	79.00	15.34	63.66	85.56	15.34	133.89	OK	147.39	146.37	144.76	6.60	149.75	OK	OK	40.3	132.9	5,237	1,353.99	OK
30-Oct-40	81.20	15.34	65.86	88.16	15.34	138.69	OK	183.49	182.47	180.86	31.40	210.65	OK	OK	53.4	176.7	5,786	1,495.74	OK

31-Oct-40	29.90	15.34	14.56	19.66	15.34	18.89	OK	59.39	58.37	56.76	30.30	85.45	OK	OK	16.0	51.8	3,766	973.65	OK
01-Nov-40	26.00	15.34	10.66	15.36	15.34	10.69	OK	24.99	23.97	22.36	8.10	28.85	OK	OK	5.9	18.9	2,645	683.78	OK
02-Nov-40	25.30	15.34	9.96	13.16	15.34	7.79	OK	137.11	136.09	134.48	139.80	272.67	OK	OK	95.9	320.7	7,128	1,842.82	OK
03-Nov-40	25.50	15.34	10.16	13.36	15.34	8.19	OK	133.49	132.47	130.86	135.70	264.94	OK	OK	90.6	302.8	6,986	1,805.98	OK
04-Nov-40	24.90	15.34	9.56	12.76	15.34	6.99	OK	10.79	9.77	8.16	0.10	6.65	OK	OK	4.2	13.3	2,341	605.33	OK
05-Nov-40	23.40	15.34	8.06	11.76	15.34	4.49	OK	77.99	76.97	75.36	61.80	135.55	OK	OK	35.0	115.1	4,980	1,287.38	OK
06-Nov-40	23.80	15.34	8.46	17.76	15.34	10.89	OK	91.19	90.17	88.56	62.10	149.05	OK	OK	41.4	136.4	5,285	1,366.24	OK
07-Nov-40	23.60	15.34	8.26	16.96	15.34	9.89	OK	18.99	17.97	16.36	5.50	20.25	OK	OK	4.8	15.1	2,447	632.60	OK
08-Nov-40	23.60	15.34	8.26	11.26	15.34	4.19	OK	21.39	20.37	18.76	15.70	32.85	OK	OK	5.7	18.1	2,606	673.74	OK
09-Nov-40	22.40	15.34	7.06	10.06	15.34	1.79	OK	18.69	17.67	16.06	14.60	29.05	OK	OK	5.3	16.8	2,538	656.13	OK
10-Nov-40	17.30	15.34	1.96	13.66	15.34	0.29	OK	12.59	11.57	9.96	3.90	12.25	OK	OK	4.0	12.7	2,303	595.38	OK
11-Nov-40	13.00	15.34	-	11.70	15.34	-	Fail	103.81	102.79	101.18	106.90	206.46	OK	Fail	62.5	207.5	6,121	1,582.42	OK
12-Nov-40	8.60	15.34	-	15.10	15.34	-	Fail	107.28	106.26	104.65	106.50	209.54	OK	Fail	66.4	220.6	6,253	1,616.53	OK
13-Nov-40	128.70	15.34	113.36	184.16	15.34	282.19	OK	332.29	331.27	329.66	10.30	338.35	OK	OK	135.2	454.7	8,054	2,082.33	OK
14-Nov-40	307.70	15.34	292.36	412.76	15.34	689.79	OK	741.79	740.77	739.16	9.70	747.25	OK	OK	572.1	1,972.7	13,461	3,480.21	OK
15-Nov-40	297.50	15.34	282.16	383.86	15.34	650.69	OK	678.59	677.57	675.96	2.90	677.25	OK	OK	509.4	1,752.9	12,916	3,339.24	OK
16-Nov-40	226.60	15.34	211.26	324.56	15.34	520.49	OK	590.69	589.67	588.06	2.70	589.15	OK	OK	366.1	1,252.9	11,484	2,968.94	OK
17-Nov-40	130.00	15.34	114.66	190.86	15.34	290.19	OK	350.79	349.77	348.16	2.50	349.05	OK	OK	147.9	498.3	8,316	2,150.05	OK
18-Nov-40	36.00	15.34	20.66	23.36	15.34	28.69	OK	28.79	27.77	26.16	-	24.55	OK	OK	8.1	26.1	2,962	765.74	OK
19-Nov-40	35.50	15.34	20.16	23.66	15.34	28.49	OK	29.69	28.67	27.06	0.10	25.55	OK	OK	8.0	25.6	2,941	760.29	OK
20-Nov-40	35.60	15.34	20.26	24.06	15.34	28.99	OK	44.29	43.27	41.66	12.20	52.25	OK	OK	9.6	30.9	3,143	812.49	OK
21-Nov-40	35.60	15.34	20.26	25.76	15.34	30.69	OK	48.29	47.27	45.66	12.40	56.45	OK	OK	10.2	32.9	3,211	830.18	OK
22-Nov-40	35.50	15.34	20.16	25.36	15.34	30.19	OK	33.59	32.57	30.96	1.10	30.45	OK	OK	8.2	26.2	2,965	766.58	OK
23-Nov-40	35.50	15.34	20.16	50.56	15.34	55.39	OK	92.29	91.27	89.66	2.00	90.05	OK	OK	22.2	72.4	4,233	1,094.43	OK
24-Nov-40	35.50	15.34	20.16	55.16	15.34	59.99	OK	103.09	102.07	100.46	2.10	100.95	OK	OK	26.9	88.0	4,533	1,171.95	OK
25-Nov-40	35.50	15.34	20.16	37.86	15.34	42.69	OK	62.79	61.77	60.16	1.00	59.55	OK	OK	12.6	40.8	3,464	895.54	OK
26-Nov-40	82.40	15.34	67.06	120.12	15.34	171.85	OK	237.45	236.43	234.82	2.90	236.11	OK	OK	81.1	270.4	6,714	1,735.85	OK
27-Nov-40	141.10	15.34	125.76	253.99	15.34	364.41	OK	496.11	495.09	493.48	7.40	499.27	OK	OK	293.3	999.9	10,612	2,743.57	OK
28-Nov-40	147.40	15.34	132.06	247.65	15.34	364.38	OK	479.01	477.99	476.38	6.40	481.17	OK	OK	264.5	900.2	10,229	2,644.57	OK
29-Nov-40	150.90	15.34	135.56	243.78	15.34	364.01	OK	474.61	473.59	471.98	11.90	482.27	OK	OK	256.4	872.0	10,116	2,615.28	OK
30-Nov-40	102.60	15.34	87.26	194.75	15.34	266.68	OK	430.68	429.66	428.05	57.10	483.54	OK	OK	267.6	910.7	10,271	2,655.32	OK
01-Dec-40	36.30	15.34	20.96	67.94	15.34	73.57	OK	212.53	211.51	209.90	93.90	302.19	OK	OK	126.7	425.8	7,871	2,034.89	OK
02-Dec-40	47.80	15.34	32.46	66.66	15.34	83.79	OK	169.69	168.67	167.06	47.70	213.15	OK	OK	63.3	210.3	6,149	1,589.61	OK
03-Dec-40	67.70	15.34	52.36	92.16	15.34	129.19	OK	160.99	159.97	158.36	7.60	164.35	OK	OK	43.0	141.7	5,356	1,384.69	OK
04-Dec-40	57.10	15.34	41.76	77.76	15.34	104.19	OK	133.79	132.77	131.16	3.10	132.65	OK	OK	33.0	108.5	4,878	1,261.17	OK
05-Dec-40	109.20	15.34	93.86	197.86	15.34	276.39	OK	355.94	354.92	353.31	4.90	356.60	OK	OK	163.5	551.9	8,619	2,228.36	OK
06-Dec-40	176.40	15.34	161.06	347.46	15.34	493.19	OK	640.45	639.43	637.82	9.30	645.51	OK	OK	466.3	1,602.3	12,516	3,235.89	OK
07-Dec-40	135.00	15.34	119.66	223.56	15.34	327.89	OK	453.03	452.01	450.40	61.00	509.79	OK	OK	246.1	836.5	9,970	2,577.44	OK
08-Dec-40	59.00	15.34	43.66	104.16	15.34	132.49	OK	235.19	234.17	232.56	59.00	289.95	OK	OK	101.5	339.7	7,273	1,880.26	OK
09-Dec-40	32.30	15.34	16.96	76.86	15.34	78.49	OK	160.09	159.07	157.46	9.10	164.95	OK	OK	66.1	219.5	6,242	1,613.74	OK
10-Dec-40	32.20	15.34	16.86	30.36	15.34	31.89	OK	52.49	51.47	49.86	5.50	53.75	OK	OK	10.6	34.1	3,253	840.93	OK
11-Dec-40	32.20	15.34	16.86	30.16	15.34	31.69	OK	47.19	46.17	44.56	12.30	55.25	OK	OK	9.4	30.2	3,116	805.59	OK
12-Dec-40	32.10	15.34	16.76	29.36	15.34	30.79	OK	45.29	44.27	42.66	12.20	53.25	OK	OK	9.0	29.0	3,074	794.72	OK
13-Dec-40	70.80	15.34	55.46	82.16	15.34	122.29	OK	133.19	132.17	130.56	-	128.95	OK	OK	34.6	113.7	4,959	1,282.02	OK
14-Dec-40	98.00	15.34	82.66	164.55	15.34	231.88	OK	385.28	384.26	382.65	54.40	435.44	OK	OK	219.4	744.4	9,571	2,474.32	OK
15-Dec-40	57.30	15.34	41.96	128.76	15.34	155.39	OK	304.89	303.87	302.26	55.40	356.05	OK	OK	183.3	619.8	8,976	2,320.69	OK
16-Dec-40	24.90	1.69	23.21	43.01	1.69	64.52	OK	85.32	84.30	84.30	7.10	89.79	OK	OK	9.5	30.4	3,124	807.74	OK
17-Dec-40	21.90	1.69	20.21	39.91	1.69	58.42	OK	88.72	87.70	87.70	16.20	102.29	OK	OK	11.5	37.2	3,354	867.00	OK
18-Dec-40	97.00	1.69	95.31	133.71	1.69	227.32	OK	261.22	260.20	260.20	22.40	280.99	OK	OK	69.4	230.9	6,354	1,642.64	OK
19-Dec-40	128.90	1.69	127.21	176.11	1.69	301.62	OK	349.22	348.20	348.20	32.60	379.19	OK	OK	119.3	400.5	7,704	1,991.76	OK
20-Dec-40	106.00	1.69	104.31	144.21	1.69	246.82	OK	278.02	277.00	277.00	20.40	295.79	OK	OK	78.8	262.7	6,647	1,718.48	OK
21-Dec-40	77.30	1.69	75.61	104.81	1.69	178.72	OK	196.22	195.20	195.20	-	193.59	OK	OK	42.0	138.4	5,312	1,373.19	OK
22-Dec-40	27.30	1.69	25.61	36.91	1.69	60.82	OK	75.12	74.10	74.10	4.10	76.59	OK	OK	7.1	22.6	2,817	728.30	OK
23-Dec-40	120.00	1.69	118.31	164.91	1.69	281.52	OK	330.02	329.00	329.00	28.50	355.89	OK	OK	107.0	358.4	7,410	1,915.79	OK
24-Dec-40	139.70	1.69	138.01	191.61	1.69	327.92	OK	371.82	370.80	370.80	24.40	393.59	OK	OK	135.1	454.6	8,054	2,082.17	OK
25-Dec-40	76.20	1.69	74.51	121.11	1.69	193.92	OK	247.82	246.80	246.80	20.90	266.09	OK	OK	64.1	213.1	6,177	1,596.99	OK
26-Dec-40	87.60	1.69	85.91	136.31	1.69	220.52	OK	274.62	273.60	273.60	21.00	292.99	OK	OK	76.6	255.1	6,579	1,700.84	OK
27-Dec-40	62.60	1.69	60.91	84.31	1.69	143.52	OK	162.52	161.50	161.50	2.40	162.29	OK	OK	29.1	95.2	4,660	1,204.85	OK
28-Dec-40	80.80	1.69	79.11	111.31	1.69	188.72	OK	209.62	208.60	208.60	1.40	208.39	OK	OK	46.9	155.0	5,527	1,428.87	OK
29-Dec-40	80.20	1.69	78.51	109.71	1.69	186.52	OK	204.32	203.30	203.30	0.90	202.59	OK	OK	45.3	149.5	5,456	1,410.64	OK
30-Dec-40	42.00	1.69	40.31	53.31	1.69	91.92	OK	105.22	104.20	104.20	0.30	102.89	OK	OK	13.2	42.7	3,520	909.93	OK
31-Dec-40	36.20	1.69	34.51	59.31	1.69	92.12	OK	126.32	125.30	125.30	7.10	130.79	OK	OK	19.5	63.4	4,041	1,044.65	OK

WATER BALANCE SIMULATION OF THE KRUENG ACEH CATCHMENT

LULC Scenario I runs on inflow 2040 and water demand 2040 (in m^3/s)

DEMAND	Up	Down
Domestic	0.60	0.64
Non-Domestic	0.44	0.16
Water Losses	0.17	0.21
Min.Environmental Flow	2.18	1.61
Paddy Field	27.28	-

	Water Quantity														Water Quality at PDAM Tirta Daroy				
Date	Lampisang Sta			Darang Sta			Upstream	Pasie Sta			Sub Banda Aceh			Downstream	Upstream - Downstream	TSS (mg/l)	Turb (NTU)	Alum (kg/day)	Cost Alum (USD)	PDAM (Quantity & Quality)
	I_1	D_1	(I_1-D_1) R_1	I_2	D_2	$(R_1+I_2-D_2)$ R_2		I_3	$(R_2+I_3-D_{(D+ND+WL)})$ R_3	(R_3-D_{PF}) R_4	I_4	$(R_4+I_4-D_4)$ R_5				(R_2+I_3) = TSS (>2000) $0.000771*(R_2+I_3)^{2.899}$	Limit < 5 NTU $3.093*TSS^{1.017}$	5 NTU<Alum<2000 mg/l $1.2*(8.59*D_{(D+ND+WL)})^{0.35}$	(Alum*USD 0.259)	
RELIABILITY			**87.98%**			**90.71%**	**87.70%**		**97.81%**	**97.27%**		**96.45%**	**96.45%**	**87.70%**	**0.00%**	**11.20%**	**1,730,707.49**	**447,442.47**	**97.81%**
01-Jan-40	7.20	1.69	5.51	7.91	1.69	11.72	OK	20.82	19.80	19.80	2.30	20.49	OK	OK	1.0	3.2	-	-	OK
02-Jan-40	12.80	1.69	11.11	16.21	1.69	25.62	OK	33.62	32.60	32.60	0.70	31.69	OK	OK	1.8	5.6	1,729	447.01	OK
03-Jan-40	18.70	1.69	17.01	23.71	1.69	39.02	OK	46.12	45.10	45.10	0.30	43.79	OK	OK	3.0	9.5	2,083	538.62	OK
04-Jan-40	13.50	1.69	11.81	16.51	1.69	26.62	OK	33.52	32.50	32.50	0.70	31.59	OK	OK	1.8	5.5	1,722	445.11	OK
05-Jan-40	19.60	1.69	17.91	28.61	1.69	44.82	OK	125.62	124.60	124.60	15.20	138.19	OK	OK	40.9	134.7	5,261	1,360.26	OK
06-Jan-40	24.90	1.69	23.21	34.71	1.69	56.22	OK	140.42	139.40	139.40	15.70	153.49	OK	OK	45.5	150.3	5,467	1,413.33	OK
07-Jan-40	11.30	1.69	9.61	13.61	1.69	21.52	OK	29.92	28.90	28.90	1.50	28.79	OK	OK	1.5	4.8	-	-	OK
08-Jan-40	65.50	1.69	63.81	77.71	1.69	139.82	OK	147.82	146.80	146.80	0.50	145.69	OK	OK	27.0	88.3	4,538	1,173.14	OK
09-Jan-40	74.30	1.69	72.61	89.01	1.69	159.92	OK	171.82	170.80	170.80	0.80	169.99	OK	OK	34.8	114.4	4,968	1,284.51	OK
10-Jan-40	18.30	1.69	16.61	25.21	1.69	40.12	OK	59.02	58.00	58.00	2.50	58.89	OK	OK	5.1	16.4	2,515	650.28	OK
11-Jan-40	81.30	1.69	79.61	103.61	1.69	181.52	OK	203.02	202.00	202.00	1.90	202.29	OK	OK	44.7	147.7	5,433	1,404.72	OK
12-Jan-40	87.30	1.69	85.61	109.71	1.69	193.62	OK	208.92	207.90	207.90	1.30	207.59	OK	OK	48.8	161.4	5,605	1,449.09	OK
13-Jan-40	27.00	1.69	25.31	34.31	1.69	57.92	OK	68.02	67.00	67.00	1.30	66.69	OK	OK	6.0	19.1	2,654	686.19	OK
14-Jan-40	23.60	1.69	21.91	47.11	1.69	67.32	OK	132.92	131.90	131.90	14.40	144.69	OK	OK	33.0	108.3	4,875	1,260.21	OK
15-Jan-40	20.10	1.69	18.41	42.61	1.69	59.32	OK	125.82	124.80	124.80	14.50	137.69	OK	OK	32.4	106.3	4,843	1,252.10	OK
16-Jan-40	282.90	1.69	281.21	363.61	1.69	643.12	OK	672.02	671.00	671.00	1.50	670.89	OK	OK	449.9	1,544.9	12,358	3,194.84	OK
17-Jan-40	308.90	1.69	307.21	391.51	1.69	697.02	OK	723.92	722.90	722.90	1.00	722.29	OK	OK	524.7	1,806.5	13,053	3,374.60	OK
18-Jan-40	60.20	1.69	58.51	67.01	1.69	123.82	OK	131.82	130.80	130.80	0.30	129.49	OK	OK	22.4	73.2	4,250	1,098.74	OK
19-Jan-40	62.20	1.69	60.51	70.81	1.69	129.62	OK	139.12	138.10	138.10	0.60	137.09	OK	OK	24.2	79.1	4,367	1,129.06	OK
20-Jan-40	62.70	1.69	61.01	73.51	1.69	132.82	OK	144.42	143.40	143.40	0.60	142.39	OK	OK	25.2	82.4	4,429	1,145.11	OK
21-Jan-40	59.30	1.69	57.61	64.11	1.69	120.02	OK	127.92	126.90	126.90	0.20	125.49	OK	OK	21.6	70.5	4,194	1,084.21	OK
22-Jan-40	57.70	1.69	56.01	57.91	1.69	112.22	OK	113.72	112.70	112.70	-	111.09	OK	OK	19.8	64.6	4,068	1,051.70	OK
23-Jan-40	56.40	1.69	54.71	56.61	1.69	109.62	OK	110.72	109.70	109.70	-	108.09	OK	OK	19.0	61.8	4,005	1,035.49	OK
24-Jan-40	56.00	1.69	54.31	56.21	1.69	108.82	OK	109.72	108.70	108.70	-	107.09	OK	OK	18.7	60.9	3,986	1,030.46	OK
25-Jan-40	54.50	1.69	52.81	54.61	1.69	105.72	OK	106.32	105.30	105.30	-	103.69	OK	OK	17.8	57.8	3,913	1,011.61	OK
26-Jan-40	50.70	1.69	49.01	50.81	1.69	98.12	OK	98.62	97.60	97.60	-	95.99	OK	OK	15.5	50.3	3,727	963.42	OK
27-Jan-40	50.90	1.69	49.21	51.01	1.69	98.52	OK	98.92	97.90	97.90	-	96.29	OK	OK	15.6	50.7	3,736	965.96	OK
28-Jan-40	61.20	1.69	59.51	65.01	1.69	122.82	OK	124.02	123.00	123.00	-	121.39	OK	OK	22.4	73.0	4,246	1,097.66	OK
29-Jan-40	164.30	1.69	162.61	203.81	1.69	364.72	OK	375.72	374.70	374.70	0.10	373.19	OK	OK	155.8	525.3	8,471	2,190.12	OK
30-Jan-40	225.10	1.69	223.41	285.41	1.69	507.12	OK	545.02	544.00	544.00	8.60	550.99	OK	OK	294.4	1,003.5	10,626	2,747.03	OK
31-Jan-40	230.50	1.69	228.81	293.31	1.69	520.42	OK	562.32	561.30	561.30	8.60	568.29	OK	OK	310.1	1,058.1	10,824	2,798.46	OK
01-Feb-40	202.70	1.69	201.01	260.91	1.69	460.22	OK	494.62	493.60	493.60	2.80	494.79	OK	OK	244.0	829.1	9,939	2,569.47	OK
02-Feb-40	122.30	1.69	120.61	155.31	1.69	274.22	OK	302.52	301.50	301.50	3.70	303.59	OK	OK	95.1	318.0	7,107	1,837.36	OK
03-Feb-40	81.80	1.69	80.11	97.81	1.69	176.22	OK	184.62	183.60	183.60	0.90	182.89	OK	OK	41.0	135.2	5,268	1,361.94	OK
04-Feb-40	81.10	1.69	79.41	107.01	1.69	184.72	OK	207.12	206.10	206.10	0.40	204.89	OK	OK	46.9	151.7	5,485	1,418.08	OK
05-Feb-40	78.20	1.69	76.51	135.51	1.69	210.32	OK	328.72	327.70	327.70	28.60	354.69	OK	OK	133.4	448.8	8,018	2,072.79	OK
06-Feb-40	64.80	1.69	63.11	105.01	1.69	166.42	OK	267.32	266.30	266.30	28.30	292.99	OK	OK	92.7	309.7	7,042	1,820.46	OK
07-Feb-40	67.60	1.69	65.91	85.61	1.69	149.82	OK	164.22	163.20	163.20	2.60	164.19	OK	OK	30.7	100.8	4,753	1,228.84	OK
08-Feb-40	60.80	1.69	59.11	73.61	1.69	131.02	OK	141.62	140.60	140.60	0.90	139.89	OK	OK	24.1	78.7	4,359	1,126.87	OK
09-Feb-40	54.90	1.69	53.21	57.91	1.69	109.42	OK	117.42	116.40	116.40	0.20	114.99	OK	OK	18.6	60.6	3,979	1,028.57	OK
10-Feb-40	54.80	1.69	53.11	61.11	1.69	112.52	OK	122.82	121.80	121.80	0.20	120.39	OK	OK	19.2	62.3	4,018	1,038.66	OK
11-Feb-40	64.10	1.69	62.41	88.81	1.69	149.52	OK	194.12	193.10	193.10	9.00	200.49	OK	OK	40.8	134.4	5,257	1,359.22	OK
12-Feb-40	95.00	1.69	93.31	144.21	1.69	235.82	OK	307.92	306.90	306.90	12.40	317.69	OK	OK	96.8	323.9	7,153	1,849.26	OK
13-Feb-40	87.10	1.69	85.41	158.31	1.69	242.02	OK	376.42	375.40	375.40	29.80	403.59	OK	OK	172.8	583.7	8,790	2,272.45	OK

14-Feb-40	209.30	1.69	207.61	337.21	1.69	543.12	OK	700.52	699.50	699.50	27.40	725.29	OK	OK	454.1	1,559.5	12,398	3,205.36	OK
15-Feb-40	211.00	1.69	209.31	302.21	1.69	509.82	OK	573.22	572.20	572.20	2.70	573.29	OK	OK	305.0	1,040.3	10,760	2,781.86	OK
16-Feb-40	57.20	1.69	55.51	66.71	1.69	120.52	OK	135.82	134.80	134.80	0.80	133.99	OK	OK	21.9	71.5	4,216	1,089.95	OK
17-Feb-40	52.30	1.69	50.61	60.11	1.69	109.02	OK	120.52	119.50	119.50	0.40	118.29	OK	OK	18.0	58.5	3,928	1,015.63	OK
18-Feb-40	48.70	1.69	47.01	56.31	1.69	101.62	OK	110.22	109.20	109.20	0.20	107.79	OK	OK	15.5	50.2	3,725	962.99	OK
19-Feb-40	46.60	1.69	44.91	54.11	1.69	97.32	OK	103.72	102.70	102.70	-	101.09	OK	OK	14.1	45.6	3,602	931.22	OK
20-Feb-40	44.30	1.69	42.61	51.71	1.69	92.62	OK	97.42	96.40	96.40	-	94.79	OK	OK	12.7	41.2	3,475	898.46	OK
21-Feb-40	44.10	1.69	42.41	53.01	1.69	93.72	OK	99.62	98.60	98.60	0.10	97.09	OK	OK	12.9	41.8	3,493	902.98	OK
22-Feb-40	49.90	1.69	48.21	64.61	1.69	111.12	OK	125.42	124.40	124.40	2.40	125.19	OK	OK	18.2	59.3	3,947	1,020.50	OK
23-Feb-40	55.40	1.69	53.71	72.81	1.69	124.82	OK	140.22	139.20	139.20	2.40	139.99	OK	OK	22.4	72.9	4,244	1,097.27	OK
24-Feb-40	44.60	1.69	42.91	59.11	1.69	100.32	OK	117.32	116.30	116.30	3.50	118.19	OK	OK	15.8	51.4	3,755	970.85	OK
25-Feb-40	48.10	1.69	46.41	61.51	1.69	106.22	OK	119.72	118.70	118.70	3.40	120.49	OK	OK	16.8	54.6	3,835	991.44	OK
26-Feb-40	46.40	1.69	44.71	57.81	1.69	100.82	OK	111.02	110.00	110.00	0.30	108.69	OK	OK	15.0	48.6	3,683	952.05	OK
27-Feb-40	91.70	1.69	90.01	127.51	1.69	215.82	OK	245.12	244.10	244.10	3.40	245.89	OK	OK	61.9	205.5	6,100	1,576.94	OK
28-Feb-40	130.10	1.69	128.41	182.71	1.69	309.42	OK	351.12	350.10	350.10	6.40	354.89	OK	OK	121.1	406.5	7,744	2,002.10	OK
29-Feb-40	77.40	1.69	75.71	112.91	1.69	186.92	OK	222.02	221.00	221.00	4.50	223.89	OK	OK	50.9	168.3	5,698	1,470.50	OK
01-Mar-40	39.90	15.34	24.56	42.06	15.34	51.29	OK	69.09	68.07	66.46	1.20	66.05	OK	OK	14.0	45.3	3,592	928.74	OK
02-Mar-40	35.90	15.34	20.56	34.46	15.34	39.69	OK	52.69	51.67	50.06	0.40	48.85	OK	OK	10.5	33.9	3,246	839.25	OK
03-Mar-40	35.00	15.34	19.66	36.16	15.34	40.49	OK	53.19	52.17	50.56	0.40	49.35	OK	OK	10.6	34.2	3,255	841.55	OK
04-Mar-40	138.30	15.34	122.96	172.16	15.34	279.79	OK	302.89	301.87	300.26	3.10	301.75	OK	OK	122.3	410.6	7,771	2,009.16	OK
05-Mar-40	199.60	15.34	184.26	253.56	15.34	422.49	OK	449.19	448.17	446.56	3.10	448.05	OK	OK	241.7	821.3	9,906	2,560.96	OK
06-Mar-40	137.00	15.34	121.66	161.86	15.34	268.19	OK	328.89	327.87	326.26	39.90	364.55	OK	OK	134.1	450.9	8,031	2,076.17	OK
07-Mar-40	72.10	15.34	56.76	77.46	15.34	118.89	OK	179.49	178.47	176.86	40.20	215.45	OK	OK	54.8	181.4	5,839	1,509.60	OK
08-Mar-40	80.70	15.34	65.36	88.66	15.34	138.69	OK	153.79	152.77	151.16	3.60	153.15	OK	OK	42.5	140.2	5,336	1,379.52	OK
09-Mar-40	81.60	15.34	66.26	99.06	15.34	149.99	OK	175.79	174.77	173.16	1.70	173.25	OK	OK	49.3	163.0	5,624	1,454.02	OK
10-Mar-40	101.40	15.34	86.06	232.26	15.34	302.99	OK	469.99	468.97	467.36	5.70	471.45	OK	OK	322.5	1,101.3	10,977	2,837.89	OK
11-Mar-40	175.00	15.34	159.66	367.56	15.34	511.89	OK	751.09	750.07	748.46	22.20	769.05	OK	OK	683.7	2,364.8	14,343	3,708.15	OK
12-Mar-40	120.40	15.34	105.06	185.46	15.34	275.19	OK	404.39	403.37	401.76	45.90	446.05	OK	OK	208.7	707.4	9,402	2,430.65	OK
13-Mar-40	143.40	15.34	128.06	166.66	15.34	279.39	OK	324.39	323.37	321.76	28.50	348.65	OK	OK	133.1	447.8	8,011	2,071.08	OK
14-Mar-40	146.10	15.34	130.76	184.76	15.34	300.19	OK	360.89	359.87	358.26	26.60	383.25	OK	OK	154.8	522.1	8,453	2,185.47	OK
15-Mar-40	96.80	15.34	81.46	126.46	15.34	192.59	OK	261.89	260.87	259.26	27.00	284.65	OK	OK	93.3	311.7	7,057	1,824.54	OK
16-Mar-40	201.50	15.34	186.16	253.66	15.34	424.49	OK	449.09	448.07	446.46	3.80	448.65	OK	OK	243.5	827.4	9,932	2,567.62	OK
17-Mar-40	197.90	15.34	182.56	246.96	15.34	414.19	OK	434.69	433.67	432.06	1.40	431.85	OK	OK	232.9	790.8	9,776	2,527.29	OK
18-Mar-40	164.80	15.34	149.46	200.56	15.34	334.69	OK	353.29	352.27	350.66	1.60	350.65	OK	OK	163.3	551.2	8,616	2,227.42	OK
19-Mar-40	147.30	15.34	131.96	182.76	15.34	299.39	OK	326.79	325.77	324.16	1.60	324.15	OK	OK	137.8	463.6	8,109	2,096.38	OK
20-Mar-40	109.30	15.34	93.96	128.46	15.34	207.09	OK	230.49	229.47	227.86	0.70	226.95	OK	OK	77.6	258.7	6,611	1,709.17	OK
21-Mar-40	120.40	15.34	105.06	126.46	15.34	216.19	OK	233.79	232.77	231.16	-	229.55	OK	OK	85.1	284.1	6,832	1,766.25	OK
22-Mar-40	109.60	15.34	94.26	113.96	15.34	192.89	OK	206.69	205.67	204.06	-	202.45	OK	OK	70.8	235.7	6,399	1,654.38	OK
23-Mar-40	83.20	15.34	67.86	115.86	15.34	168.39	OK	224.39	223.37	221.76	1.70	221.85	OK	OK	72.3	240.7	6,447	1,666.63	OK
24-Mar-40	61.70	15.34	46.36	88.36	15.34	119.39	OK	178.09	177.07	175.46	6.50	180.35	OK	OK	53.8	178.0	5,800	1,499.60	OK
25-Mar-40	61.20	15.34	45.86	60.86	15.34	91.39	OK	113.49	112.47	110.86	4.90	114.15	OK	OK	26.9	87.9	4,531	1,171.46	OK
26-Mar-40	57.00	15.34	41.66	96.16	15.34	122.49	OK	188.19	187.17	185.56	2.00	185.95	OK	OK	62.4	207.2	6,118	1,581.60	OK
27-Mar-40	54.20	15.34	38.86	96.36	15.34	119.89	OK	207.59	206.57	204.96	17.80	221.15	OK	OK	81.1	270.4	6,714	1,735.86	OK
28-Mar-40	48.80	15.34	33.46	56.86	15.34	74.99	OK	151.69	150.67	149.06	44.10	191.55	OK	OK	51.9	171.9	5,730	1,481.47	OK
29-Mar-40	49.70	15.34	34.36	55.36	15.34	74.39	OK	124.79	123.77	122.16	28.30	148.85	OK	OK	33.1	108.7	4,882	1,262.04	OK
30-Mar-40	58.90	15.34	43.56	61.26	15.34	89.49	OK	110.69	109.67	108.06	-	106.45	OK	OK	25.6	83.8	4,456	1,152.07	OK
31-Mar-40	48.90	15.34	33.56	49.56	15.34	67.79	OK	83.69	82.67	81.06	-	79.45	OK	OK	17.9	58.1	3,921	1,013.73	OK
01-Apr-40	39.80	15.34	24.46	36.66	15.34	45.79	OK	57.09	56.07	54.46	-	52.85	OK	OK	11.7	37.8	3,371	871.49	OK
02-Apr-40	212.90	15.34	197.56	272.96	15.34	455.19	OK	479.89	478.87	477.26	-	475.65	OK	OK	273.2	930.3	10,347	2,675.12	OK
03-Apr-40	267.70	15.34	252.36	346.66	15.34	583.69	OK	610.39	609.37	607.76	-	606.15	OK	OK	420.1	1,441.0	12,060	3,117.92	OK
04-Apr-40	154.50	15.34	139.16	197.36	15.34	321.19	OK	341.09	340.07	338.46	0.30	337.15	OK	OK	151.3	509.9	8,384	2,167.49	OK
05-Apr-40	131.30	15.34	115.96	166.56	15.34	267.19	OK	292.29	291.27	289.66	8.40	296.45	OK	OK	113.9	381.9	7,577	1,958.94	OK
06-Apr-40	78.90	15.34	63.56	88.76	15.34	136.99	OK	152.29	151.27	149.66	9.00	157.05	OK	OK	41.6	137.0	5,293	1,368.31	OK
07-Apr-40	74.40	15.34	59.06	92.36	15.34	136.09	OK	152.29	151.27	149.66	1.30	149.35	OK	OK	40.8	134.5	5,259	1,359.58	OK
08-Apr-40	102.00	15.34	86.66	176.26	15.34	247.59	OK	325.89	324.87	323.26	2.70	324.35	OK	OK	139.4	469.3	8,144	2,105.37	OK
09-Apr-40	92.10	15.34	76.76	153.26	15.34	214.69	OK	283.39	282.37	280.76	2.40	281.55	OK	OK	109.5	367.0	7,473	1,931.89	OK
10-Apr-40	82.80	15.34	67.46	91.76	15.34	143.89	OK	284.59	283.57	281.96	113.00	393.35	OK	OK	150.8	508.1	8,373	2,164.74	OK
11-Apr-40	64.70	15.34	49.36	66.76	15.34	100.79	OK	238.29	237.27	235.66	112.80	346.85	OK	OK	129.6	435.8	7,936	2,051.58	OK
12-Apr-40	43.50	15.34	28.16	39.26	15.34	52.09	OK	65.79	64.77	63.16	-	61.55	OK	OK	13.7	44.4	3,568	922.39	OK
13-Apr-40	43.20	15.34	27.86	40.26	15.34	52.79	OK	66.79	65.77	64.16	1.80	64.35	OK	OK	13.8	44.7	3,578	924.90	OK
14-Apr-40	43.10	15.34	27.76	44.76	15.34	57.19	OK	91.39	90.37	88.76	14.90	102.05	OK	OK	20.6	67.2	4,126	1,066.59	OK
15-Apr-40	42.90	15.34	27.56	43.06	15.34	55.29	OK	83.99	82.97	81.36	13.10	92.85	OK	OK	18.2	59.0	3,941	1,018.91	OK
16-Apr-40	42.30	15.34	26.96	37.36	15.34	48.99	OK	53.29	52.27	50.66	-	49.05	OK	OK	11.9	38.3	3,389	876.17	OK
17-Apr-40	52.70	15.34	37.36	51.76	15.34	73.79	OK	86.39	85.37	83.76	8.40	90.55	OK	OK	19.2	62.4	4,019	1,039.03	OK
18-Apr-40	53.10	15.34	37.76	52.26	15.34	74.69	OK	90.89	89.87	88.26	11.80	98.45	OK	OK	20.1	65.5	4,087	1,056.74	OK

19-Apr-40	38.70	15.34	23.36	33.66	15.34	41.69	OK	47.89	46.87	45.26	3.40	47.05	OK	OK	10.3	33.2	3,221	832.86	OK
20-Apr-40	26.60	15.34	11.26	51.56	15.34	47.49	OK	88.89	87.87	86.26	1.50	86.15	OK	OK	25.1	82.0	4,422	1,143.32	OK
21-Apr-40	25.20	15.34	9.86	50.06	15.34	44.59	OK	85.69	84.67	83.06	1.50	82.95	OK	OK	24.5	79.9	4,382	1,132.93	OK
22-Apr-40	20.80	15.34	5.46	17.76	15.34	7.89	OK	11.99	10.97	9.36	0.50	8.25	OK	OK	4.0	12.8	2,306	596.26	OK
23-Apr-40	19.60	15.34	4.26	51.96	15.34	40.89	OK	91.79	90.77	89.16	2.00	89.55	OK	OK	31.9	104.8	4,819	1,245.77	OK
24-Apr-40	18.90	15.34	3.56	114.36	15.34	102.59	OK	236.79	235.77	234.16	5.10	237.65	OK	OK	169.1	571.0	8,723	2,255.10	OK
25-Apr-40	16.30	15.34	0.96	77.46	15.34	63.09	OK	151.79	150.77	149.16	3.40	150.95	OK	OK	80.4	268.1	6,695	1,730.76	OK
26-Apr-40	14.40	15.34	-	10.70	15.34	-	Fail	12.90	11.88	10.27	0.80	9.46	OK	Fail	3.4	10.7	2,165	559.65	OK
27-Apr-40	13.10	15.34	-	9.30	15.34	-	Fail	8.50	7.48	5.87	0.20	4.46	OK	Fail	2.3	7.3	1,895	490.00	OK
28-Apr-40	11.90	15.34	-	9.20	15.34	-	Fail	16.50	15.48	13.87	10.70	22.96	OK	Fail	3.4	10.8	2,177	562.81	OK
29-Apr-40	74.40	15.34	59.06	91.66	15.34	135.39	OK	156.29	155.27	153.66	10.70	162.75	OK	OK	41.6	137.3	5,297	1,369.33	OK
30-Apr-40	111.90	15.34	96.56	141.56	15.34	222.79	OK	234.89	233.87	232.26	-	230.65	OK	OK	83.0	276.9	6,771	1,750.50	OK
01-May-40	52.90	15.34	37.56	58.96	15.34	81.19	OK	88.49	87.47	85.86	1.80	86.05	OK	OK	20.2	65.7	4,092	1,058.02	OK
02-May-40	22.70	15.34	7.36	17.76	15.34	9.79	OK	14.29	13.27	11.66	1.80	11.85	OK	OK	4.3	13.6	2,357	609.34	OK
03-May-40	27.10	15.34	11.76	23.66	15.34	20.09	OK	22.49	21.47	19.86	-	18.25	OK	OK	5.7	18.3	2,616	676.42	OK
04-May-40	24.90	15.34	9.56	20.46	15.34	14.69	OK	24.59	23.57	21.96	8.50	28.85	OK	OK	5.5	17.6	2,593	667.81	OK
05-May-40	93.00	15.34	77.66	112.86	15.34	175.19	OK	189.89	188.87	187.26	8.50	194.15	OK	OK	58.2	193.1	5,968	1,542.87	OK
06-May-40	93.90	15.34	78.56	112.96	15.34	176.19	OK	212.39	211.37	209.76	25.60	233.75	OK	OK	65.5	217.6	6,223	1,608.81	OK
07-May-40	22.80	15.34	7.46	15.76	15.34	7.89	OK	38.39	37.37	35.76	25.60	59.75	OK	OK	9.8	31.5	3,163	817.70	OK
08-May-40	22.30	15.34	6.96	70.26	15.34	61.89	OK	135.19	134.17	132.56	2.70	133.65	OK	OK	58.0	192.4	5,961	1,541.06	OK
09-May-40	22.30	15.34	6.96	70.16	15.34	61.79	OK	134.99	133.97	132.36	2.70	133.45	OK	OK	57.9	191.9	5,955	1,539.63	OK
10-May-40	43.90	15.34	28.56	43.06	15.34	56.29	OK	63.49	62.47	60.86	-	59.25	OK	OK	13.6	44.0	3,555	919.16	OK
11-May-40	53.50	15.34	38.16	76.56	15.34	99.39	OK	132.89	131.87	130.26	1.00	129.65	OK	OK	33.3	109.4	4,892	1,264.86	OK
12-May-40	70.70	15.34	55.36	105.76	15.34	145.79	OK	184.69	183.67	182.06	1.30	181.75	OK	OK	53.8	178.1	5,801	1,499.86	OK
13-May-40	85.10	15.34	69.76	102.46	15.34	156.89	OK	168.99	167.97	166.36	0.30	165.05	OK	OK	49.2	162.5	5,619	1,452.59	OK
14-May-40	53.50	15.34	38.16	53.86	15.34	76.69	OK	83.19	82.17	80.56	-	78.95	OK	OK	19.1	62.2	4,015	1,038.06	OK
15-May-40	32.40	1.69	30.71	39.91	1.69	68.92	OK	73.82	72.80	72.80	-	71.19	OK	OK	7.4	23.7	2,863	740.31	OK
16-May-40	61.90	1.69	60.21	80.31	1.69	138.82	OK	148.82	147.80	147.80	3.40	149.59	OK	OK	26.0	85.0	4,479	1,157.88	OK
17-May-40	164.50	1.69	162.81	220.61	1.69	381.72	OK	402.92	401.90	401.90	6.90	407.19	OK	OK	167.6	566.0	8,696	2,248.08	OK
18-May-40	152.50	1.69	150.81	201.41	1.69	350.52	OK	365.82	364.80	364.80	3.40	366.59	OK	OK	142.4	479.5	8,205	2,121.38	OK
19-May-40	50.70	1.69	49.01	61.81	1.69	109.12	OK	115.72	114.70	114.70	-	113.09	OK	OK	16.9	55.0	3,845	994.04	OK
20-May-40	31.20	1.69	29.51	36.71	1.69	64.52	OK	68.42	67.40	67.40	-	65.79	OK	OK	6.7	21.3	2,757	712.79	OK
21-May-40	30.90	1.69	29.21	36.41	1.69	63.92	OK	66.82	65.80	65.80	-	64.19	OK	OK	6.5	20.7	2,733	706.52	OK
22-May-40	33.70	1.69	32.01	40.71	1.69	71.02	OK	100.52	99.50	99.50	23.10	120.99	OK	OK	13.2	42.7	3,519	909.74	OK
23-May-40	29.40	1.69	27.71	36.31	1.69	62.32	OK	97.52	96.50	96.50	28.30	123.19	OK	OK	13.8	44.5	3,572	923.46	OK
24-May-40	26.30	1.69	24.61	39.81	1.69	62.72	OK	113.42	112.40	112.40	31.70	142.49	OK	OK	21.5	70.1	4,186	1,082.18	OK
25-May-40	25.80	1.69	24.11	39.21	1.69	61.62	OK	130.12	129.10	129.10	47.50	174.99	OK	OK	33.3	109.2	4,889	1,264.01	OK
26-May-40	25.80	1.69	24.11	30.91	1.69	53.32	OK	78.32	77.30	77.30	21.10	96.79	OK	OK	8.7	27.8	3,030	783.27	OK
27-May-40	25.30	1.69	23.61	32.81	1.69	54.72	OK	66.82	65.80	65.80	8.90	73.09	OK	OK	5.8	18.3	2,619	676.97	OK
28-May-40	240.80	1.69	239.11	326.61	1.69	564.02	OK	609.52	608.50	608.50	19.80	626.69	OK	OK	354.9	1,213.9	11,357	2,936.24	OK
29-May-40	248.60	1.69	246.91	331.81	1.69	577.02	OK	610.92	609.90	609.90	10.90	619.19	OK	OK	365.7	1,251.5	11,479	2,967.79	OK
30-May-40	89.80	1.69	88.11	113.81	1.69	200.22	OK	232.42	231.40	231.40	23.30	253.09	OK	OK	56.6	187.8	5,910	1,527.89	OK
31-May-40	89.80	1.69	88.11	113.81	1.69	200.22	OK	236.52	235.50	235.50	26.80	260.69	OK	OK	58.3	193.4	5,971	1,543.78	OK
01-Jun-40	37.40	1.69	35.71	42.11	1.69	76.12	OK	82.82	81.80	81.80	4.50	84.69	OK	OK	9.3	29.9	3,109	803.65	OK
02-Jun-40	36.20	1.69	34.51	40.81	1.69	73.62	OK	75.52	74.50	74.50	0.30	73.19	OK	OK	8.5	27.2	3,007	777.35	OK
03-Jun-40	32.00	1.69	30.31	129.81	1.69	158.42	OK	283.12	282.10	282.10	4.80	285.29	OK	OK	147.7	497.8	8,313	2,149.27	OK
04-Jun-40	25.70	1.69	24.01	123.41	1.69	145.72	OK	270.02	269.00	269.00	4.70	272.09	OK	OK	144.9	488.1	8,256	2,134.54	OK
05-Jun-40	26.20	1.69	24.51	30.61	1.69	53.42	OK	98.02	97.00	97.00	38.10	133.49	OK	OK	16.8	54.6	3,836	991.81	OK
06-Jun-40	25.90	1.69	24.21	30.21	1.69	52.72	OK	105.22	104.20	104.20	46.80	149.39	OK	OK	21.1	68.9	4,160	1,075.54	OK
07-Jun-40	25.90	1.69	24.21	39.11	1.69	61.62	OK	102.22	101.20	101.20	24.70	124.29	OK	OK	16.0	51.8	3,767	973.79	OK
08-Jun-40	25.70	1.69	24.01	38.81	1.69	61.12	OK	95.52	94.50	94.50	17.80	110.69	OK	OK	13.2	42.5	3,515	908.69	OK
09-Jun-40	25.40	1.69	23.71	29.51	1.69	51.52	OK	63.02	62.00	62.00	4.30	64.69	OK	OK	5.3	17.0	2,550	659.14	OK
10-Jun-40	25.40	1.69	23.71	29.51	1.69	51.52	OK	60.22	59.20	59.20	2.00	59.59	OK	OK	5.0	15.8	2,483	642.03	OK
11-Jun-40	49.70	1.69	48.01	60.81	1.69	107.12	OK	113.92	112.90	112.90	0.10	111.39	OK	OK	16.4	53.1	3,800	982.30	OK
12-Jun-40	50.60	1.69	48.91	62.11	1.69	109.32	OK	115.52	114.50	114.50	-	112.89	OK	OK	16.9	54.9	3,843	993.50	OK
13-Jun-40	26.90	1.69	25.21	33.51	1.69	57.02	OK	63.52	62.50	62.50	0.20	61.09	OK	OK	5.5	17.4	2,569	664.10	OK
14-Jun-40	22.40	1.69	20.71	28.51	1.69	47.52	OK	52.62	51.60	51.60	0.20	50.19	OK	OK	3.9	12.4	2,284	990.39	OK
15-Jun-40	9.10	1.69	7.41	12.91	1.69	18.62	OK	20.22	19.20	19.20	-	17.59	OK	OK	0.8	2.6	-	-	OK
16-Jun-40	11.80	1.69	10.11	15.51	1.69	23.92	OK	25.12	24.10	24.10	-	22.49	OK	OK	1.2	3.7	-	-	OK
17-Jun-40	7.30	1.69	5.61	14.61	1.69	18.52	OK	24.02	23.00	23.00	0.20	21.59	OK	OK	1.2	3.7	-	-	OK
18-Jun-40	8.50	1.69	6.81	15.81	1.69	20.92	OK	26.22	25.20	25.20	0.20	23.79	OK	OK	1.3	4.1	-	-	OK
19-Jun-40	12.50	1.69	10.81	17.61	1.69	26.72	OK	27.72	26.70	26.70	-	25.09	OK	OK	1.4	4.5	-	-	OK
20-Jun-40	94.20	1.69	92.51	151.11	1.69	241.92	OK	280.12	279.10	279.10	1.10	278.59	OK	OK	79.6	265.5	6,672	1,724.87	OK
21-Jun-40	95.30	1.69	93.61	151.21	1.69	243.12	OK	281.02	280.00	280.00	1.10	279.49	OK	OK	80.0	266.6	6,682	1,727.41	OK
22-Jun-40	17.10	1.69	15.41	21.21	1.69	34.92	OK	38.62	37.60	37.60	-	35.99	OK	OK	2.3	7.3	1,896	490.08	OK

23-Jun-40	14.40	1.69	12.71	17.71	1.69	28.72	OK	31.32	30.30	30.30	-	28.69	OK	OK	1.7	5.2	1,683	434.99	OK
24-Jun-40	14.40	1.69	12.71	17.71	1.69	28.72	OK	30.72	29.70	29.70	-	28.09	OK	OK	1.6	5.1	1,675	432.98	OK
25-Jun-40	14.30	1.69	12.61	17.51	1.69	28.42	OK	29.92	28.90	28.90	-	27.29	OK	OK	1.6	5.0	-	-	OK
26-Jun-40	14.20	1.69	12.51	17.41	1.69	28.22	OK	29.32	28.30	28.30	-	26.69	OK	OK	1.6	4.9	-	-	OK
27-Jun-40	41.30	1.69	39.61	52.41	1.69	90.32	OK	93.22	92.20	92.20	-	90.59	OK	OK	11.7	37.7	3,369	871.06	OK
28-Jun-40	41.90	1.69	40.21	53.01	1.69	91.52	OK	94.22	93.20	93.20	-	91.59	OK	OK	12.0	38.6	3,398	878.50	OK
29-Jun-40	14.00	1.69	12.31	17.01	1.69	27.62	OK	28.12	27.10	27.10	-	25.49	OK	OK	1.5	4.7	-	-	OK
30-Jun-40	14.20	1.69	12.51	17.21	1.69	28.02	OK	28.32	27.30	27.30	-	25.69	OK	OK	1.5	4.8	-	-	OK
01-Jul-40	14.10	1.69	12.41	17.01	1.69	27.72	OK	40.32	39.30	39.30	13.10	50.79	OK	OK	2.6	8.2	1,979	511.74	OK
02-Jul-40	14.00	1.69	12.31	16.91	1.69	27.52	OK	40.02	39.00	39.00	13.10	50.49	OK	OK	2.6	8.1	1,970	509.31	OK
03-Jul-40	13.90	1.69	12.21	18.51	1.69	29.02	OK	31.52	30.50	30.50	1.20	30.09	OK	OK	1.7	5.2	1,686	435.81	OK
04-Jul-40	13.90	1.69	12.21	18.51	1.69	29.02	OK	31.42	30.40	30.40	0.50	29.29	OK	OK	1.7	5.2	1,684	435.45	OK
05-Jul-40	13.80	1.69	12.11	16.51	1.69	26.92	OK	27.02	26.00	26.00	0.10	24.49	OK	OK	1.5	4.5	-	-	OK
06-Jul-40	13.70	1.69	12.01	16.41	1.69	26.72	OK	26.82	25.80	25.80	-	24.19	OK	OK	1.4	4.5	-	-	OK
07-Jul-40	11.70	1.69	10.01	14.31	1.69	22.62	OK	30.82	29.80	29.80	8.70	36.89	OK	OK	1.6	4.9	-	-	OK
08-Jul-40	8.90	1.69	7.21	12.21	1.69	17.72	OK	38.42	37.40	37.40	21.80	57.59	OK	OK	3.6	11.3	2,211	571.73	OK
09-Jul-40	110.70	1.69	109.01	149.71	1.69	257.02	OK	277.02	276.00	276.00	13.10	287.49	OK	OK	81.1	270.4	6,714	1,735.91	OK
10-Jul-40	112.20	1.69	110.51	150.51	1.69	259.32	OK	267.22	266.20	266.20	1.90	266.49	OK	OK	80.3	267.8	6,692	1,730.14	OK
11-Jul-40	14.90	1.69	13.21	17.31	1.69	28.82	OK	30.72	29.70	29.70	0.90	28.99	OK	OK	1.7	5.2	1,686	435.98	OK
12-Jul-40	14.20	1.69	12.51	16.61	1.69	27.42	OK	28.52	27.50	27.50	0.10	25.99	OK	OK	1.5	4.7	-	-	OK
13-Jul-40	14.30	1.69	12.61	16.71	1.69	27.62	OK	28.42	27.40	27.40	-	25.79	OK	OK	1.5	4.8	-	-	OK
14-Jul-40	13.70	1.69	12.01	31.61	1.69	41.92	OK	68.12	67.10	67.10	4.40	69.89	OK	OK	8.3	26.5	2,977	769.54	OK
15-Jul-40	12.00	1.69	10.31	36.31	1.69	44.92	OK	96.42	95.40	95.40	8.90	102.69	OK	OK	21.3	69.4	4,172	1,078.65	OK
16-Jul-40	12.40	1.69	10.71	21.01	1.69	30.02	OK	55.92	54.90	54.90	4.40	57.69	OK	OK	6.1	19.6	2,679	692.61	OK
17-Jul-40	14.40	1.69	12.71	36.51	1.69	47.52	OK	73.12	72.10	72.10	0.90	71.39	OK	OK	9.3	30.0	3,109	803.78	OK
18-Jul-40	14.50	1.69	12.81	36.81	1.69	47.92	OK	73.62	72.60	72.60	0.90	71.89	OK	OK	9.4	30.3	3,122	807.11	OK
19-Jul-40	12.30	1.69	10.61	14.61	1.69	23.52	OK	28.42	27.40	27.40	-	25.79	OK	OK	1.4	4.2	-	-	OK
20-Jul-40	12.20	1.69	10.51	21.41	1.69	30.22	OK	43.22	42.20	42.20	0.50	41.09	OK	OK	3.0	9.6	2,085	539.06	OK
21-Jul-40	14.40	1.69	12.71	24.21	1.69	35.22	OK	47.62	46.60	46.60	0.50	45.49	OK	OK	3.4	10.8	2,173	561.72	OK
22-Jul-40	25.50	1.69	23.81	32.11	1.69	54.22	OK	59.02	58.00	58.00	-	56.39	OK	OK	4.9	15.5	2,467	637.80	OK
23-Jul-40	23.80	1.69	22.11	29.61	1.69	50.02	OK	53.72	52.70	52.70	-	51.09	OK	OK	4.2	13.3	2,340	605.00	OK
24-Jul-40	12.90	1.69	11.21	14.81	1.69	24.32	OK	26.42	25.40	25.40	-	23.79	OK	OK	1.3	4.0	-	-	OK
25-Jul-40	12.80	1.69	11.11	15.11	1.69	24.52	OK	26.72	25.70	25.70	-	24.09	OK	OK	1.3	4.0	-	-	OK
26-Jul-40	10.70	1.69	9.01	13.01	1.69	20.32	OK	22.22	21.20	21.20	-	19.59	OK	OK	1.0	3.0	-	-	OK
27-Jul-40	4.70	1.69	3.01	6.51	1.69	7.82	OK	8.72	7.70	7.70	-	6.09	OK	OK	0.3	0.8	-	-	OK
28-Jul-40	6.20	1.69	4.51	7.91	1.69	10.72	OK	11.42	10.40	10.40	-	8.79	OK	OK	0.4	1.2	-	-	OK
29-Jul-40	5.60	1.69	3.91	7.31	1.69	9.52	OK	10.02	9.00	9.00	-	7.39	OK	OK	0.3	1.0	-	-	OK
30-Jul-40	5.70	1.69	4.01	7.41	1.69	9.72	OK	10.12	9.10	9.10	-	7.49	OK	OK	0.3	1.0	-	-	OK
31-Jul-40	5.60	1.69	3.91	7.21	1.69	9.42	OK	9.72	8.70	8.70	-	7.09	OK	OK	0.3	1.0	-	-	OK
01-Aug-40	24.60	1.69	22.91	31.71	1.69	52.92	OK	54.52	53.50	53.50	-	51.89	OK	OK	4.5	14.3	2,398	619.99	OK
02-Aug-40	25.30	1.69	23.61	32.41	1.69	54.32	OK	55.82	54.80	54.80	-	53.19	OK	OK	4.7	15.0	2,438	630.24	OK
03-Aug-40	6.80	1.69	5.11	8.61	1.69	12.02	OK	12.32	11.30	11.30	-	9.69	OK	OK	0.4	1.3	-	-	OK
04-Aug-40	13.20	1.69	11.51	22.71	1.69	32.52	OK	40.52	39.50	39.50	0.30	38.19	OK	OK	2.5	8.0	1,958	506.20	OK
05-Aug-40	13.50	1.69	11.81	22.81	1.69	32.92	OK	40.62	39.60	39.60	0.30	38.29	OK	OK	2.5	8.0	1,955	505.51	OK
06-Aug-40	39.60	1.69	37.91	52.71	1.69	88.92	OK	91.52	90.50	90.50	-	88.89	OK	OK	11.2	36.2	3,322	858.76	OK
07-Aug-40	43.00	1.69	41.31	56.81	1.69	96.42	OK	99.22	98.20	98.20	-	96.59	OK	OK	13.0	42.1	3,501	905.07	OK
08-Aug-40	13.30	1.69	11.61	16.01	1.69	25.92	OK	26.72	25.70	25.70	-	24.09	OK	OK	1.4	4.3	-	-	OK
09-Aug-40	10.40	1.69	8.71	20.01	1.69	27.02	OK	37.72	36.70	36.70	0.50	35.59	OK	OK	2.5	7.7	1,936	500.45	OK
10-Aug-40	8.40	1.69	6.71	17.31	1.69	22.32	OK	32.72	31.70	31.70	0.50	30.59	OK	OK	2.1	6.5	1,818	469.91	OK
11-Aug-40	40.90	1.69	39.21	53.91	1.69	91.42	OK	94.12	93.10	93.10	-	91.49	OK	OK	11.8	38.2	3,384	874.76	OK
12-Aug-40	153.60	1.69	151.91	206.31	1.69	356.52	OK	367.52	366.50	366.50	-	364.89	OK	OK	145.7	490.7	8,272	2,138.52	OK
13-Aug-40	133.10	1.69	131.41	176.31	1.69	306.02	OK	315.12	314.10	314.10	-	312.49	OK	OK	109.7	367.8	7,478	1,933.29	OK
14-Aug-40	71.50	1.69	69.81	91.51	1.69	159.62	OK	163.82	162.80	162.80	-	161.19	OK	OK	33.0	108.3	4,874	1,260.07	OK
15-Aug-40	101.50	1.69	99.81	131.81	1.69	229.92	OK	254.32	253.30	253.30	15.30	266.99	OK	OK	68.2	226.7	6,313	1,632.10	OK
16-Aug-40	65.00	1.69	63.31	81.01	1.69	142.62	OK	164.22	163.20	163.20	15.30	176.89	OK	OK	30.0	98.3	4,712	1,218.10	OK
17-Aug-40	35.10	1.69	33.41	40.11	1.69	71.82	OK	74.22	73.20	73.20	-	71.59	OK	OK	8.1	25.9	2,954	763.72	OK
18-Aug-40	34.70	1.69	33.01	42.01	1.69	73.32	OK	80.02	79.00	79.00	0.30	77.69	OK	OK	8.4	27.1	3,001	775.91	OK
19-Aug-40	33.60	1.69	31.91	52.31	1.69	82.52	OK	101.12	100.10	100.10	0.90	99.39	OK	OK	12.1	39.2	3,415	882.84	OK
20-Aug-40	34.10	1.69	32.41	50.01	1.69	80.72	OK	113.32	112.30	112.30	16.10	126.79	OK	OK	16.1	52.1	3,772	975.26	OK
21-Aug-40	36.30	1.69	34.61	63.91	1.69	96.82	OK	146.22	145.20	145.20	16.50	160.09	OK	OK	28.4	93.0	4,622	1,194.96	OK
22-Aug-40	34.30	1.69	32.61	61.91	1.69	92.82	OK	172.12	171.10	171.10	41.80	211.29	OK	OK	49.0	162.1	5,614	1,451.40	OK
23-Aug-40	27.30	1.69	25.61	30.01	1.69	53.92	OK	103.62	102.60	102.60	40.80	141.79	OK	OK	19.8	64.6	4,067	1,051.49	OK
24-Aug-40	25.10	1.69	23.41	39.11	1.69	60.82	OK	78.22	77.20	77.20	3.80	79.39	OK	OK	7.8	24.9	2,914	753.30	OK
25-Aug-40	25.40	1.69	23.71	142.31	1.69	164.32	OK	318.82	317.80	317.80	7.70	323.89	OK	OK	210.5	713.5	9,430	2,437.94	OK
26-Aug-40	27.30	1.69	25.61	132.71	1.69	156.62	OK	295.02	294.00	294.00	6.40	298.79	OK	OK	173.2	585.0	8,797	2,274.22	OK

27-Aug-40	46.40	1.69	44.71	54.31	1.69	97.32	OK	112.52	111.50	111.50	3.60	113.49	OK	OK	15.3	49.6	3,709	958.92	OK
28-Aug-40	74.10	1.69	72.41	93.51	1.69	164.22	OK	182.12	181.10	181.10	4.60	184.09	OK	OK	36.9	121.4	5,074	1,311.66	OK
29-Aug-40	85.30	1.69	83.61	110.91	1.69	192.82	OK	207.12	206.10	206.10	2.00	206.49	OK	OK	47.8	157.8	5,562	1,437.85	OK
30-Aug-40	53.30	1.69	51.61	72.21	1.69	122.12	OK	136.82	135.80	135.80	1.20	135.39	OK	OK	21.3	69.4	4,172	1,078.48	OK
31-Aug-40	24.30	1.69	22.61	32.11	1.69	53.02	OK	64.02	63.00	63.00	0.40	61.79	OK	OK	5.3	16.9	2,546	658.28	OK
01-Sep-40	18.10	15.34	2.76	11.26	15.34	-	Fail	8.30	7.28	5.67	-	4.06	OK	Fail	3.2	10.1	2,126	549.63	OK
02-Sep-40	14.50	15.34	-	88.90	15.34	73.56	Fail	187.06	186.04	184.43	4.20	187.02	OK	Fail	118.0	396.0	7,674	1,983.86	OK
03-Sep-40	20.40	15.34	5.06	132.76	15.34	122.49	OK	282.79	281.77	280.16	6.00	284.55	OK	OK	230.1	781.3	9,734	2,516.57	OK
04-Sep-40	20.30	15.34	4.96	53.46	15.34	43.09	OK	97.89	96.87	95.26	2.00	95.65	OK	OK	34.9	114.7	4,973	1,285.80	OK
05-Sep-40	14.10	15.34	-	13.70	15.34	-	Fail	34.70	33.68	32.07	19.80	50.26	OK	Fail	10.2	32.8	3,208	829.39	OK
06-Sep-40	13.70	15.34	-	14.10	15.34	-	Fail	34.60	33.58	31.97	19.80	50.16	OK	Fail	10.1	32.6	3,203	828.19	OK
07-Sep-40	13.40	15.34	-	9.40	15.34	-	Fail	14.40	13.38	11.77	1.80	11.96	OK	Fail	3.3	10.4	2,144	554.30	OK
08-Sep-40	13.00	15.34	-	6.80	15.34	-	Fail	8.30	7.28	5.67	0.50	4.56	OK	Fail	2.0	6.3	1,799	465.05	OK
09-Sep-40	13.00	15.34	-	6.80	15.34	-	Fail	6.20	5.18	3.57	0.10	2.06	OK	Fail	1.8	5.6	1,729	446.94	OK
10-Sep-40	12.90	15.34	-	6.70	15.34	-	Fail	4.70	3.68	2.07	-	0.46	OK	Fail	1.6	5.1	1,678	433.88	OK
11-Sep-40	12.90	15.34	-	6.60	15.34	-	Fail	3.50	2.48	0.87	-	-	Fail	Fail	1.6	4.9	-	-	OK
12-Sep-40	12.70	15.34	-	6.50	15.34	-	Fail	2.60	1.58	-	-	-	Fail	Fail	1.5	4.6	-	-	OK
13-Sep-40	12.20	15.34	-	6.70	15.34	-	Fail	2.20	1.18	-	-	-	Fail	Fail	1.4	4.4	-	-	OK
14-Sep-40	29.40	15.34	14.06	26.26	15.34	24.99	OK	28.09	27.07	25.46	-	23.85	OK	OK	6.6	21.1	2,750	711.08	OK
15-Sep-40	68.70	15.34	53.36	79.66	15.34	117.69	OK	127.39	126.37	124.76	3.50	126.65	OK	OK	32.7	107.3	4,859	1,256.25	OK
16-Sep-40	52.50	15.34	37.16	58.56	15.34	80.39	OK	88.69	87.67	86.06	3.50	87.95	OK	OK	20.0	65.3	4,083	1,055.54	OK
17-Sep-40	13.20	15.34	-	6.90	15.34	-	Fail	1.00	-	-	-	-	Fail	Fail	1.6	4.9	-	-	Fail
18-Sep-40	10.50	15.34	-	6.10	15.34	-	Fail	0.60	-	-	-	-	Fail	Fail	1.1	3.3	-	-	Fail
19-Sep-40	10.60	15.34	-	6.30	15.34	-	Fail	0.60	-	-	-	-	Fail	Fail	1.1	3.4	-	-	Fail
20-Sep-40	10.40	15.34	-	6.20	15.34	-	Fail	0.50	-	-	-	-	Fail	Fail	1.1	3.3	-	-	Fail
21-Sep-40	9.90	15.34	-	5.90	15.34	-	Fail	0.20	-	-	-	-	Fail	Fail	1.0	3.0	-	-	Fail
22-Sep-40	10.00	15.34	-	5.90	15.34	-	Fail	0.20	-	-	-	-	Fail	Fail	1.0	3.0	-	-	Fail
23-Sep-40	9.90	15.34	-	5.80	15.34	-	Fail	0.10	-	-	-	-	Fail	Fail	0.9	2.9	-	-	Fail
24-Sep-40	9.80	15.34	-	5.70	15.34	-	Fail	0.10	-	-	-	-	Fail	Fail	0.9	2.9	-	-	Fail
25-Sep-40	9.80	15.34	-	7.10	15.34	-	Fail	133.70	132.68	131.07	115.40	244.86	OK	Fail	98.7	330.3	7,202	1,861.94	OK
26-Sep-40	9.70	15.34	-	7.00	15.34	-	Fail	160.70	159.68	158.07	139.20	295.66	OK	Fail	139.6	469.7	8,146	2,106.09	OK
27-Sep-40	9.70	15.34	-	5.60	15.34	-	Fail	39.40	38.38	36.77	37.10	72.26	OK	Fail	10.5	33.8	3,243	838.29	OK
28-Sep-40	9.60	15.34	-	5.50	15.34	-	Fail	15.80	14.78	13.17	15.20	26.76	OK	Fail	2.6	8.1	1,966	508.29	OK
29-Sep-40	9.50	15.34	-	5.40	15.34	-	Fail	11.80	10.78	9.17	4.70	12.26	OK	Fail	1.8	5.7	1,742	450.49	OK
30-Sep-40	9.50	15.34	-	27.50	15.34	12.16	Fail	48.86	47.84	46.23	1.90	46.52	OK	Fail	13.9	44.9	3,581	925.70	OK
01-Oct-40	9.10	15.34	-	28.10	15.34	12.76	Fail	48.56	47.54	45.93	1.30	45.62	OK	Fail	13.6	44.1	3,559	920.12	OK
02-Oct-40	7.00	15.34	-	6.00	15.34	-	Fail	14.50	13.48	11.87	0.10	10.36	OK	Fail	2.1	6.5	1,818	469.91	OK
03-Oct-40	4.80	15.34	-	5.20	15.34	-	Fail	10.20	9.18	7.57	-	5.96	OK	Fail	1.1	3.5	-	-	OK
04-Oct-40	5.20	15.34	-	30.20	15.34	14.86	Fail	55.56	54.54	52.93	1.20	52.52	OK	Fail	16.2	52.5	3,784	978.21	OK
05-Oct-40	5.00	15.34	-	78.50	15.34	63.16	Fail	166.06	165.04	163.43	3.70	165.52	OK	Fail	95.1	318.0	7,107	1,837.33	OK
06-Oct-40	53.90	15.34	38.56	111.06	15.34	134.29	OK	207.99	206.97	205.36	2.60	206.35	OK	OK	79.4	264.8	6,666	1,723.26	OK
07-Oct-40	55.80	15.34	40.46	64.56	15.34	89.69	OK	99.89	98.87	97.26	0.30	95.95	OK	OK	23.1	75.3	4,293	1,109.80	OK
08-Oct-40	8.40	15.34	-	4.90	15.34	-	Fail	3.60	2.58	0.97	0.10	-	Fail	Fail	0.8	2.4	-	-	OK
09-Oct-40	8.00	15.34	-	4.90	15.34	-	Fail	3.20	2.18	0.57	0.50	-	Fail	Fail	0.7	2.2	-	-	OK
10-Oct-40	8.10	15.34	-	12.70	15.34	-	Fail	13.00	11.98	10.37	0.90	9.66	OK	Fail	2.8	8.7	2,015	520.95	OK
11-Oct-40	8.00	15.34	-	12.80	15.34	-	Fail	12.30	11.28	9.67	0.50	8.56	OK	Fail	2.6	8.3	1,986	513.40	OK
12-Oct-40	8.00	15.34	-	33.10	15.34	17.76	Fail	56.46	55.44	53.83	1.40	53.62	OK	Fail	16.6	53.9	3,819	987.37	OK
13-Oct-40	7.90	15.34	-	34.60	15.34	19.26	Fail	59.76	58.74	57.13	1.50	57.02	OK	Fail	18.0	58.7	3,933	1,016.81	OK
14-Oct-40	62.20	15.34	46.86	72.66	15.34	104.19	OK	111.39	110.37	108.76	0.20	107.35	OK	OK	27.5	90.0	4,569	1,181.23	OK
15-Oct-40	94.30	15.34	78.96	111.66	15.34	175.29	OK	306.99	305.97	304.36	109.40	412.15	OK	OK	152.0	512.2	8,397	2,170.94	OK
16-Oct-40	42.80	15.34	27.46	52.26	15.34	64.39	OK	231.69	230.67	229.06	131.70	359.15	OK	OK	164.7	556.0	8,642	2,234.20	OK
17-Oct-40	13.40	15.34	-	16.00	15.34	0.66	Fail	42.46	41.44	39.83	23.70	61.92	OK	Fail	13.7	44.3	3,565	921.66	OK
18-Oct-40	40.50	15.34	25.16	37.66	15.34	47.49	OK	73.79	72.77	71.16	20.80	90.35	OK	OK	15.6	50.7	3,737	966.18	OK
19-Oct-40	41.60	15.34	26.26	38.96	15.34	49.89	OK	74.79	73.77	72.16	19.40	89.95	OK	OK	15.8	51.1	3,748	968.85	OK
20-Oct-40	15.20	15.34	-	52.90	15.34	37.56	Fail	103.16	102.14	100.53	6.30	105.22	OK	Fail	43.6	143.9	5,384	1,391.97	OK
21-Oct-40	15.00	15.34	-	52.70	15.34	37.36	Fail	109.96	108.94	107.33	10.70	116.42	OK	Fail	48.8	161.4	5,605	1,448.99	OK
22-Oct-40	15.00	15.34	-	4.90	15.34	-	Fail	16.10	15.08	13.47	6.60	18.46	OK	Fail	3.5	10.9	2,186	565.08	OK
23-Oct-40	81.90	15.34	66.56	95.66	15.34	146.89	OK	158.99	157.97	156.36	0.10	154.85	OK	OK	44.9	148.2	5,441	1,406.63	OK
24-Oct-40	155.10	15.34	139.76	194.36	15.34	318.79	OK	337.99	336.97	335.36	3.60	337.35	OK	OK	149.8	504.7	8,354	2,159.71	OK
25-Oct-40	163.70	15.34	148.36	204.06	15.34	337.09	OK	359.39	358.37	356.76	7.20	362.35	OK	OK	165.2	557.8	8,651	2,236.64	OK
26-Oct-40	170.90	15.34	155.56	212.16	15.34	352.39	OK	373.09	372.07	370.46	6.40	375.25	OK	OK	177.6	600.3	8,877	2,294.86	OK
27-Oct-40	105.20	15.34	89.86	121.06	15.34	195.59	OK	234.09	233.07	231.46	27.40	257.25	OK	OK	77.3	257.5	6,600	1,706.44	OK
28-Oct-40	31.00	15.34	15.66	19.66	15.34	19.99	OK	50.09	49.07	47.46	25.50	71.35	OK	OK	12.0	38.6	3,397	878.11	OK
29-Oct-40	87.70	15.34	72.36	96.76	15.34	153.79	OK	168.49	167.47	165.86	2.50	166.75	OK	OK	49.2	162.6	5,619	1,452.81	OK
30-Oct-40	90.10	15.34	74.76	99.66	15.34	159.09	OK	208.29	207.27	205.66	33.40	237.45	OK	OK	64.8	215.2	6,199	1,602.60	OK

31-Oct-40	33.70	15.34	18.36	24.06	15.34	27.09	OK	71.89	70.87	69.26	33.30	100.95	OK	OK	19.6	63.8	4,051	1,047.26	OK
01-Nov-40	29.30	15.34	13.96	19.16	15.34	17.79	OK	33.49	32.47	30.86	3.30	32.55	OK	OK	7.3	23.5	2,855	738.04	OK
02-Nov-40	28.50	15.34	13.16	16.96	15.34	14.79	OK	195.19	194.17	192.56	152.40	343.35	OK	OK	177.9	601.1	8,881	2,295.98	OK
03-Nov-40	28.70	15.34	13.36	17.06	15.34	15.09	OK	190.39	189.37	187.76	149.60	335.75	OK	OK	168.8	569.9	8,717	2,253.52	OK
04-Nov-40	28.10	15.34	12.76	16.46	15.34	13.89	OK	18.59	17.57	15.96	-	14.35	OK	OK	5.3	16.9	2,546	658.31	OK
05-Nov-40	26.40	15.34	11.06	15.16	15.34	10.89	OK	92.29	91.27	89.66	68.20	156.25	OK	OK	42.7	140.7	5,342	1,381.20	OK
06-Nov-40	26.80	15.34	11.46	20.66	15.34	16.79	OK	104.09	103.07	101.46	68.50	168.35	OK	OK	48.7	160.9	5,599	1,447.59	OK
07-Nov-40	26.70	15.34	11.36	20.06	15.34	16.09	OK	24.79	23.77	22.16	6.10	26.65	OK	OK	5.7	18.1	2,604	673.20	OK
08-Nov-40	26.70	15.34	11.36	14.86	15.34	10.89	OK	30.09	29.07	27.46	17.30	43.15	OK	OK	7.1	22.8	2,825	730.28	OK
09-Nov-40	25.30	15.34	9.96	13.46	15.34	8.09	OK	26.89	25.87	24.26	16.10	38.75	OK	OK	6.6	21.0	2,746	710.02	OK
10-Nov-40	19.60	15.34	4.26	15.56	15.34	4.49	OK	15.79	14.77	13.16	4.20	15.75	OK	OK	4.3	13.7	2,367	611.87	OK
11-Nov-40	14.90	15.34	-	11.30	15.34	-	Fail	142.50	141.48	139.87	118.00	256.26	OK	Fail	112.7	377.8	7,548	1,951.50	OK
12-Nov-40	10.00	15.34	-	16.80	15.34	1.46	Fail	151.06	150.04	148.43	117.40	264.22	OK	Fail	123.5	414.9	7,800	2,016.56	OK
13-Nov-40	142.30	15.34	126.96	205.16	15.34	316.79	OK	371.99	370.97	369.36	11.20	378.95	OK	OK	163.4	551.5	8,617	2,227.78	OK
14-Nov-40	339.30	15.34	323.96	456.76	15.34	765.39	OK	822.89	821.87	820.26	9.30	827.95	OK	OK	689.0	2,383.4	14,383	3,718.36	OK
15-Nov-40	328.10	15.34	312.76	424.86	15.34	722.29	OK	751.19	750.17	748.56	2.80	749.75	OK	OK	612.8	2,115.3	13,794	3,566.27	OK
16-Nov-40	250.10	15.34	234.76	359.66	15.34	579.09	OK	654.69	653.67	652.06	2.50	652.95	OK	OK	439.9	1,509.9	12,259	3,169.27	OK
17-Nov-40	143.70	15.34	128.36	212.46	15.34	325.49	OK	392.39	391.37	389.76	2.30	390.45	OK	OK	178.7	604.1	8,896	2,299.94	OK
18-Nov-40	40.20	15.34	24.86	28.06	15.34	37.59	OK	37.69	36.67	35.06	-	33.45	OK	OK	10.0	32.3	3,192	825.32	OK
19-Nov-40	39.70	15.34	24.36	28.16	15.34	37.19	OK	38.19	37.17	35.56	-	33.95	OK	OK	9.8	31.7	3,170	819.62	OK
20-Nov-40	39.80	15.34	24.46	28.46	15.34	37.59	OK	51.39	50.37	48.76	13.50	60.65	OK	OK	11.2	36.1	3,319	858.13	OK
21-Nov-40	39.70	15.34	24.36	29.96	15.34	38.99	OK	54.89	53.87	52.26	13.60	64.25	OK	OK	11.7	37.7	3,368	870.72	OK
22-Nov-40	39.70	15.34	24.36	29.76	15.34	38.79	OK	41.89	40.87	39.26	1.20	38.85	OK	OK	10.0	32.3	3,190	824.76	OK
23-Nov-40	39.60	15.34	24.26	57.96	15.34	66.89	OK	107.49	106.47	104.86	1.90	105.15	OK	OK	27.0	88.2	4,537	1,172.93	OK
24-Nov-40	39.60	15.34	24.26	62.06	15.34	70.99	OK	117.19	116.17	114.56	2.00	114.95	OK	OK	31.5	103.4	4,797	1,240.05	OK
25-Nov-40	39.60	15.34	24.26	42.86	15.34	51.79	OK	69.99	68.97	67.36	1.00	66.75	OK	OK	14.2	45.9	3,611	933.52	OK
26-Nov-40	91.20	15.34	75.86	148.16	15.34	208.69	OK	278.29	277.27	275.66	2.70	276.75	OK	OK	105.9	354.6	7,383	1,908.79	OK
27-Nov-40	155.90	15.34	140.56	314.96	15.34	440.19	OK	623.79	622.77	621.16	6.70	626.25	OK	OK	471.0	1,618.7	12,561	3,247.42	OK
28-Nov-40	162.70	15.34	147.36	304.76	15.34	436.79	OK	596.59	595.57	593.96	5.80	598.15	OK	OK	412.1	1,412.6	11,977	3,096.44	OK
29-Nov-40	166.60	15.34	151.26	298.66	15.34	434.59	OK	588.79	587.77	586.16	12.80	597.35	OK	OK	394.0	1,349.8	11,787	3,047.41	OK
30-Nov-40	113.40	15.34	98.06	244.36	15.34	327.09	OK	555.79	554.77	553.16	63.00	614.55	OK	OK	458.1	1,573.7	12,438	3,215.56	OK
01-Dec-40	40.40	15.34	25.06	89.16	15.34	98.89	OK	292.79	291.77	290.16	103.80	392.35	OK	OK	232.1	788.2	9,764	2,524.35	OK
02-Dec-40	53.10	15.34	37.76	75.56	15.34	97.99	OK	191.19	190.17	188.56	52.80	239.75	OK	OK	75.0	249.7	6,530	1,688.19	OK
03-Dec-40	75.00	15.34	59.66	103.66	15.34	147.99	OK	181.59	180.57	178.96	8.40	185.75	OK	OK	51.5	170.3	5,712	1,476.73	OK
04-Dec-40	60.40	15.34	45.06	83.26	15.34	112.99	OK	144.49	143.47	141.86	3.20	143.45	OK	OK	36.9	121.4	5,073	1,311.60	OK
05-Dec-40	117.60	15.34	102.26	215.16	15.34	302.09	OK	411.89	410.87	409.26	4.60	412.25	OK	OK	214.6	727.6	9,494	2,454.62	OK
06-Dec-40	194.40	15.34	179.06	384.46	15.34	548.19	OK	753.59	752.57	750.96	8.30	757.65	OK	OK	640.5	2,212.7	14,013	3,622.91	OK
07-Dec-40	148.90	15.34	133.56	248.26	15.34	366.49	OK	540.89	539.87	538.26	66.30	602.95	OK	OK	354.7	1,212.9	11,354	2,935.45	OK
08-Dec-40	65.20	15.34	49.86	116.86	15.34	151.39	OK	294.39	293.37	291.76	64.50	354.65	OK	OK	162.2	547.5	8,595	2,222.07	OK
09-Dec-40	35.80	15.34	20.46	86.66	15.34	91.79	OK	181.59	180.57	178.96	9.70	187.05	OK	OK	79.5	265.2	6,669	1,724.12	OK
10-Dec-40	35.70	15.34	20.36	35.26	15.34	40.29	OK	62.99	61.97	60.36	5.40	64.15	OK	OK	12.8	41.4	3,483	900.40	OK
11-Dec-40	35.70	15.34	20.36	35.06	15.34	40.09	OK	57.09	56.07	54.46	13.70	66.55	OK	OK	11.4	36.6	3,336	862.49	OK
12-Dec-40	35.60	15.34	20.26	34.36	15.34	39.29	OK	54.59	53.57	51.96	13.50	63.85	OK	OK	10.9	35.0	3,282	848.60	OK
13-Dec-40	78.10	15.34	62.76	92.36	15.34	139.79	OK	151.29	150.27	148.66	-	147.05	OK	OK	41.7	137.4	5,298	1,369.64	OK
14-Dec-40	108.10	15.34	92.76	204.46	15.34	281.89	OK	450.29	449.27	447.66	60.00	506.05	OK	OK	286.0	974.7	10,518	2,719.16	OK
15-Dec-40	63.30	15.34	47.96	143.76	15.34	176.39	OK	340.89	339.87	338.26	61.00	397.65	OK	OK	220.3	747.2	9,583	2,477.62	OK
16-Dec-40	27.60	1.69	25.91	46.31	1.69	70.52	OK	93.42	92.40	92.40	6.40	97.19	OK	OK	11.0	35.6	3,302	853.67	OK
17-Dec-40	24.40	1.69	22.71	43.01	1.69	64.02	OK	95.32	94.30	94.30	16.80	109.49	OK	OK	12.8	41.3	3,477	899.04	OK
18-Dec-40	106.90	1.69	105.21	147.71	1.69	251.22	OK	286.22	285.20	285.20	24.80	308.39	OK	OK	82.6	275.5	6,759	1,747.31	OK
19-Dec-40	142.10	1.69	140.41	194.61	1.69	333.32	OK	385.82	384.80	384.80	35.90	419.09	OK	OK	143.8	484.2	8,233	2,128.54	OK
20-Dec-40	116.80	1.69	115.11	159.21	1.69	272.62	OK	306.32	305.30	305.30	22.40	326.09	OK	OK	94.6	316.2	7,092	1,833.60	OK
21-Dec-40	85.30	1.69	83.61	115.81	1.69	197.72	OK	216.82	215.80	215.80	-	214.19	OK	OK	50.5	167.2	5,675	1,467.14	OK
22-Dec-40	30.50	1.69	28.81	41.51	1.69	68.62	OK	84.02	83.00	83.00	3.60	84.99	OK	OK	8.6	27.7	3,023	781.66	OK
23-Dec-40	132.40	1.69	130.71	182.21	1.69	311.22	OK	364.22	363.20	363.20	30.60	392.19	OK	OK	128.7	432.5	7,914	2,046.05	OK
24-Dec-40	154.20	1.69	152.51	210.41	1.69	361.22	OK	409.62	408.60	408.60	27.00	433.99	OK	OK	162.2	547.3	8,594	2,221.76	OK
25-Dec-40	84.30	1.69	82.61	132.71	1.69	213.62	OK	272.82	271.80	271.80	23.10	293.29	OK	OK	76.6	255.1	6,579	1,700.99	OK
26-Dec-40	96.80	1.69	95.11	150.61	1.69	244.02	OK	303.22	302.20	302.20	23.10	323.69	OK	OK	92.0	307.6	7,025	1,816.09	OK
27-Dec-40	68.30	1.69	66.61	92.21	1.69	157.12	OK	178.02	177.00	177.00	-	175.39	OK	OK	34.4	112.9	4,947	1,278.86	OK
28-Dec-40	88.30	1.69	86.61	121.81	1.69	206.72	OK	228.32	227.30	227.30	0.60	226.29	OK	OK	55.2	182.9	5,856	1,513.98	OK
29-Dec-40	88.10	1.69	86.41	120.51	1.69	205.22	OK	223.32	222.30	222.30	0.60	221.29	OK	OK	53.7	177.8	5,798	1,499.04	OK
30-Dec-40	46.20	1.69	44.51	58.41	1.69	101.22	OK	114.82	113.80	113.80	0.20	112.39	OK	OK	15.6	50.5	3,732	964.76	OK
31-Dec-40	40.30	1.69	38.61	65.81	1.69	102.72	OK	139.42	138.40	138.40	6.40	143.19	OK	OK	23.1	75.5	4,296	1,110.71	OK

Appendix 6.6

WATER BALANCE SIMULATION OF THE KRUENG ACEH CATCHMENT

LULC Scenario II runs on inflow 2040 and water demand 2040 (in m^3/s)

DEMAND	Up	Down
Domestic	0.60	0.64
Non-Domestic	0.44	0.16
Water Losses	0.17	0.21
Min.Environmental Flow	2.18	1.61
Paddy Field	27.28	-

	Water Quantity														Water Quality at PDAM Tirta Daroy				
Date	Lampisang Sta			Darang Sta			Upstream	Pasie Sta			Sub Banda Aceh		Downstream	Upstream - Downstream	TSS (mg/l)	Turb (NTU)	Alum (kg/day)	Cost Alum (USD)	PDAM (Quantity & Quality)
	I_1	D_1	(I_1-D_1) R_1	I_2	D_2	$(R_1+I_2-D_2)$ R_2		I_3	$(R_2+I_3-D_{(D+ND+WL)})$ R_3	(R_3-D_{PF}) R_4	I_4	$(R_4+I_4-D_4)$ R_5			(R_2+I_3) = TSS (>2000) $0.000771*(R_2+I_3)^{2.899}$	Limit < 5 NTU $3.093*TSS^{1.017}$	5 NTU<Alum<2000 mg/l $1.2*(8.59*D_{(D+ND+WL)})^{0.35}$	(Alum*USD 0.259)	
RELIABILITY			**87.98%**			**90.71%**	**87.70%**		**97.81%**	**97.27%**		**96.45%**	**96.45%**	**87.70%**	**0.00%**	**11.20%**	**1,560,515.03**	**403,442.36**	**97.81%**
01-Jan-40	7.20	1.69	5.51	7.91	1.69	11.72	OK	20.82	19.80	19.80	2.30	20.49	OK	OK	1.0	3.2	-	-	OK
02-Jan-40	12.70	1.69	11.01	16.11	1.69	25.42	OK	33.42	32.40	32.40	0.70	31.49	OK	OK	1.8	5.6	1,723	445.52	OK
03-Jan-40	18.20	1.69	16.51	23.21	1.69	38.02	OK	45.12	44.10	44.10	0.30	42.79	OK	OK	2.9	9.2	2,054	531.13	OK
04-Jan-40	13.10	1.69	11.41	16.11	1.69	25.82	OK	32.72	31.70	31.70	0.70	30.79	OK	OK	1.7	5.3	1,697	438.80	OK
05-Jan-40	18.90	1.69	17.21	27.91	1.69	43.42	OK	104.02	103.00	103.00	14.80	116.19	OK	OK	24.9	81.4	4,411	1,140.40	OK
06-Jan-40	24.00	1.69	22.31	33.71	1.69	54.32	OK	117.42	116.40	116.40	15.10	129.89	OK	OK	28.1	92.0	4,605	1,190.52	OK
07-Jan-40	11.00	1.69	9.31	13.31	1.69	20.92	OK	29.02	28.00	28.00	1.50	27.89	OK	OK	1.4	4.5	-	-	OK
08-Jan-40	49.53	1.69	47.84	61.24	1.69	107.38	OK	114.98	113.96	113.96	0.40	112.75	OK	OK	16.5	53.4	3,807	984.14	OK
09-Jan-40	56.24	1.69	54.54	70.34	1.69	123.19	OK	134.59	133.57	133.57	0.70	132.66	OK	OK	21.4	69.9	4,182	1,081.27	OK
10-Jan-40	13.88	1.69	12.19	20.49	1.69	30.99	OK	49.19	48.17	48.17	2.40	48.96	OK	OK	4.0	12.8	2,306	596.29	OK
11-Jan-40	61.93	1.69	60.24	83.24	1.69	141.78	OK	162.58	161.56	161.56	1.80	161.75	OK	OK	28.9	94.8	4,653	1,202.92	OK
12-Jan-40	66.53	1.69	64.84	88.04	1.69	151.19	OK	165.99	164.97	164.97	1.30	164.66	OK	OK	30.9	101.5	4,765	1,231.92	OK
13-Jan-40	26.40	1.69	24.71	33.41	1.69	56.42	OK	66.22	65.20	65.20	1.20	64.79	OK	OK	5.7	18.2	2,611	674.92	OK
14-Jan-40	23.10	1.69	21.41	45.71	1.69	65.42	OK	115.10	114.08	114.08	13.70	126.17	OK	OK	22.2	72.4	4,234	1,094.66	OK
15-Jan-40	19.60	1.69	17.91	41.31	1.69	57.52	OK	107.91	106.89	106.89	13.70	118.98	OK	OK	21.4	69.8	4,180	1,080.54	OK
16-Jan-40	167.40	1.69	165.71	228.91	1.69	392.92	OK	414.84	413.82	413.82	1.40	413.61	OK	OK	176.4	596.1	8,855	2,289.19	OK
17-Jan-40	182.82	1.69	181.13	245.75	1.69	425.18	OK	445.62	444.60	444.60	0.90	443.89	OK	OK	204.3	692.1	9,330	2,412.05	OK
18-Jan-40	46.25	1.69	44.56	52.86	1.69	95.73	OK	103.43	102.41	102.41	0.30	101.10	OK	OK	13.9	45.1	3,587	927.32	OK
19-Jan-40	47.81	1.69	46.12	56.22	1.69	100.65	OK	109.75	108.73	108.73	0.50	107.62	OK	OK	15.2	49.1	3,697	955.71	OK
20-Jan-40	48.20	1.69	46.51	58.81	1.69	103.63	OK	114.83	113.81	113.81	0.60	112.80	OK	OK	16.0	51.9	3,767	974.01	OK
21-Jan-40	45.55	1.69	43.86	50.26	1.69	92.42	OK	100.02	99.00	99.00	0.20	97.59	OK	OK	13.4	43.2	3,533	913.47	OK
22-Jan-40	56.80	1.69	55.11	57.01	1.69	110.42	OK	111.82	110.80	110.80	-	109.19	OK	OK	19.3	62.7	4,025	1,040.56	OK
23-Jan-40	55.50	1.69	53.81	55.71	1.69	107.82	OK	108.92	107.90	107.90	-	106.29	OK	OK	18.4	59.9	3,962	1,024.31	OK
24-Jan-40	55.20	1.69	53.51	55.41	1.69	107.22	OK	108.02	107.00	107.00	-	105.39	OK	OK	18.2	59.3	3,947	1,020.47	OK
25-Jan-40	53.70	1.69	52.01	53.81	1.69	104.12	OK	104.72	103.70	103.70	-	102.09	OK	OK	17.3	56.2	3,874	1,001.59	OK
26-Jan-40	50.00	1.69	48.31	50.11	1.69	96.72	OK	97.22	96.20	96.20	-	94.59	OK	OK	15.1	48.9	3,692	954.42	OK
27-Jan-40	50.20	1.69	48.51	50.31	1.69	97.12	OK	97.42	96.40	96.40	-	94.79	OK	OK	15.2	49.3	3,702	956.96	OK
28-Jan-40	60.40	1.69	58.71	64.11	1.69	121.12	OK	122.32	121.30	121.30	-	119.69	OK	OK	21.8	71.1	4,208	1,087.91	OK
29-Jan-40	97.68	1.69	95.99	136.29	1.69	230.58	OK	241.38	240.36	240.36	0.10	238.85	OK	OK	64.6	214.7	6,194	1,601.29	OK
30-Jan-40	133.92	1.69	132.23	180.18	1.69	310.71	OK	347.81	346.79	346.79	8.20	353.38	OK	OK	120.5	404.4	7,731	1,998.60	OK
31-Jan-40	137.28	1.69	135.59	185.59	1.69	319.49	OK	351.47	350.45	350.45	8.20	357.03	OK	OK	124.2	417.3	7,816	2,020.67	OK
01-Feb-40	120.72	1.69	119.03	165.48	1.69	282.81	OK	309.10	308.08	308.08	2.70	309.17	OK	OK	98.0	327.9	7,183	1,857.08	OK
02-Feb-40	84.98	1.69	83.29	110.30	1.69	191.90	OK	213.58	212.56	212.56	3.50	214.45	OK	OK	49.1	162.2	5,615	1,451.62	OK
03-Feb-40	81.20	1.69	79.51	96.91	1.69	174.72	OK	182.92	181.90	181.90	0.90	181.19	OK	OK	40.4	133.1	5,239	1,354.54	OK
04-Feb-40	80.50	1.69	78.81	106.01	1.69	183.12	OK	205.12	204.10	204.10	0.40	202.89	OK	OK	45.2	149.1	5,452	1,409.54	OK
05-Feb-40	77.60	1.69	75.91	134.01	1.69	208.22	OK	324.62	323.60	323.60	27.40	349.39	OK	OK	129.9	436.6	7,940	2,052.84	OK
06-Feb-40	64.30	1.69	62.61	103.91	1.69	164.82	OK	264.12	263.10	263.10	27.20	288.69	OK	OK	90.3	301.7	6,977	1,803.80	OK
07-Feb-40	67.10	1.69	65.41	84.91	1.69	148.62	OK	162.82	161.80	161.80	2.50	162.69	OK	OK	30.3	99.2	4,728	1,222.25	OK
08-Feb-40	60.30	1.69	58.61	72.91	1.69	129.82	OK	140.32	139.30	139.30	0.90	138.59	OK	OK	23.7	77.4	4,333	1,120.31	OK
09-Feb-40	54.40	1.69	52.71	57.31	1.69	108.32	OK	116.12	115.10	115.10	0.20	113.69	OK	OK	18.3	59.5	3,953	1,021.87	OK
10-Feb-40	54.30	1.69	52.61	60.41	1.69	111.32	OK	121.42	120.40	120.40	0.20	118.99	OK	OK	18.8	61.1	3,991	1,031.69	OK
11-Feb-40	63.60	1.69	61.91	87.91	1.69	148.12	OK	182.44	181.42	181.42	8.70	188.51	OK	OK	35.5	116.9	5,006	1,294.25	OK
12-Feb-40	94.40	1.69	92.71	132.44	1.69	223.46	OK	278.91	277.89	277.89	11.90	288.18	OK	OK	78.5	261.7	6,638	1,716.20	OK

13-Feb-40	67.47	1.69	65.78	122.66	1.69	186.74	OK	290.24	289.22	289.22	28.80	316.41	OK	OK	106.0	355.0	7,386	1,909.42	OK
14-Feb-40	124.98	1.69	123.29	224.64	1.69	346.24	OK	467.68	466.66	466.66	26.50	491.55	OK	OK	225.0	763.6	9,656	2,496.49	OK
15-Feb-40	126.00	1.69	124.31	196.91	1.69	319.52	OK	382.22	381.20	381.20	2.70	382.29	OK	OK	141.1	474.9	8,178	2,114.15	OK
16-Feb-40	34.08	1.69	32.39	43.49	1.69	74.18	OK	89.28	88.26	88.26	0.80	87.45	OK	OK	9.7	31.2	3,152	814.98	OK
17-Feb-40	51.90	1.69	50.21	59.61	1.69	108.12	OK	119.42	118.40	118.40	0.40	117.19	OK	OK	17.7	57.5	3,907	1,009.96	OK
18-Feb-40	48.30	1.69	46.61	55.81	1.69	100.72	OK	109.22	108.20	108.20	0.20	106.79	OK	OK	15.2	49.4	3,704	957.49	OK
19-Feb-40	46.20	1.69	44.51	53.61	1.69	96.42	OK	102.82	101.80	101.80	-	100.19	OK	OK	13.9	44.9	3,581	925.86	OK
20-Feb-40	44.00	1.69	42.31	51.31	1.69	91.92	OK	96.72	95.70	95.70	-	94.09	OK	OK	12.6	40.6	3,459	894.27	OK
21-Feb-40	43.70	1.69	42.01	52.51	1.69	92.82	OK	98.72	97.70	97.70	0.10	96.19	OK	OK	12.7	41.1	3,472	897.53	OK
22-Feb-40	49.50	1.69	47.81	64.01	1.69	110.12	OK	124.32	123.30	123.30	2.40	124.09	OK	OK	17.9	58.3	3,925	1,014.72	OK
23-Feb-40	55.00	1.69	53.31	72.21	1.69	123.82	OK	139.12	138.10	138.10	2.40	138.89	OK	OK	22.0	71.9	4,223	1,091.69	OK
24-Feb-40	44.30	1.69	42.61	58.71	1.69	99.62	OK	116.42	115.40	115.40	3.40	117.19	OK	OK	15.6	50.7	3,737	966.07	OK
25-Feb-40	47.80	1.69	46.11	61.01	1.69	105.42	OK	118.82	117.80	117.80	3.30	119.49	OK	OK	16.6	53.8	3,817	986.77	OK
26-Feb-40	46.00	1.69	44.31	57.21	1.69	99.82	OK	109.92	108.90	108.90	0.30	107.59	OK	OK	14.7	47.7	3,660	946.12	OK
27-Feb-40	91.20	1.69	89.51	118.82	1.69	206.63	OK	235.63	234.61	234.61	3.30	236.30	OK	OK	58.0	192.5	5,961	1,541.19	OK
28-Feb-40	90.65	1.69	88.96	131.46	1.69	218.72	OK	260.12	259.10	259.10	6.20	263.69	OK	OK	68.3	227.1	6,316	1,633.00	OK
29-Feb-40	53.90	1.69	52.21	81.36	1.69	131.87	OK	166.67	165.65	165.65	4.30	168.34	OK	OK	30.4	99.6	4,734	1,223.82	OK
01-Mar-40	27.79	15.34	12.45	29.75	15.34	26.87	OK	44.47	43.45	41.84	1.20	41.43	OK	OK	9.0	29.0	3,073	794.42	OK
02-Mar-40	24.99	15.34	9.65	23.45	15.34	17.77	OK	30.67	29.65	28.04	0.40	26.83	OK	OK	6.5	20.7	2,733	706.67	OK
03-Mar-40	24.36	15.34	9.02	25.32	15.34	19.01	OK	31.51	30.49	28.88	0.40	27.67	OK	OK	6.7	21.5	2,767	715.41	OK
04-Mar-40	96.46	15.34	81.12	130.02	15.34	195.81	OK	218.71	217.69	216.08	3.00	217.47	OK	OK	70.4	234.2	6,385	1,650.82	OK
05-Mar-40	139.37	15.34	124.03	192.83	15.34	301.53	OK	328.03	327.01	325.40	3.00	326.79	OK	OK	137.9	463.9	8,111	2,096.90	OK
06-Mar-40	95.62	15.34	80.28	120.18	15.34	185.13	OK	245.43	244.41	242.80	38.90	280.09	OK	OK	83.0	276.9	6,771	1,750.47	OK
07-Mar-40	71.80	15.34	56.46	76.96	15.34	118.09	OK	178.19	177.17	175.56	39.10	213.05	OK	OK	54.1	179.3	5,815	1,503.41	OK
08-Mar-40	56.28	15.34	40.94	64.04	15.34	89.65	OK	104.55	103.53	101.92	3.50	103.81	OK	OK	23.9	77.9	4,344	1,123.16	OK
09-Mar-40	56.91	15.34	41.57	67.33	15.34	93.57	OK	119.07	118.05	116.44	1.60	116.42	OK	OK	27.8	90.9	4,584	1,185.11	OK
10-Mar-40	70.77	15.34	55.43	170.22	15.34	210.32	OK	339.64	338.62	337.01	5.50	340.90	OK	OK	194.0	656.5	9,159	2,367.96	OK
11-Mar-40	122.22	15.34	106.88	270.18	15.34	361.72	OK	547.13	546.11	544.50	21.70	564.59	OK	OK	406.9	1,395.0	11,924	3,082.69	OK
12-Mar-40	84.00	15.34	68.66	131.86	15.34	185.19	OK	285.42	284.40	282.79	44.90	326.08	OK	OK	120.4	404.3	7,730	1,998.40	OK
13-Mar-40	85.80	15.34	70.46	100.72	15.34	155.85	OK	200.55	199.53	197.92	27.90	224.21	OK	OK	60.0	199.2	6,034	1,559.89	OK
14-Mar-40	87.42	15.34	72.08	114.51	15.34	171.25	OK	231.65	230.63	229.02	26.10	253.51	OK	OK	76.2	253.8	6,568	1,697.93	OK
15-Mar-40	57.96	15.34	42.62	78.02	15.34	105.30	OK	174.20	173.18	171.57	26.50	196.46	OK	OK	55.5	183.9	5,867	1,516.81	OK
16-Mar-40	120.66	15.34	105.32	158.41	15.34	248.40	OK	272.80	271.78	270.17	3.70	272.26	OK	OK	101.1	338.5	7,264	1,877.93	OK
17-Mar-40	118.50	15.34	103.16	153.80	15.34	241.63	OK	262.03	261.01	259.40	1.40	259.19	OK	OK	95.9	320.6	7,127	1,842.47	OK
18-Mar-40	98.70	15.34	83.36	123.50	15.34	191.52	OK	210.02	209.00	207.39	1.50	207.28	OK	OK	67.1	223.0	6,276	1,622.66	OK
19-Mar-40	88.20	15.34	72.86	123.46	15.34	180.99	OK	208.19	207.17	205.56	1.60	205.55	OK	OK	64.5	214.2	6,189	1,599.97	OK
20-Mar-40	65.40	15.34	50.06	84.46	15.34	119.19	OK	142.49	141.47	139.86	0.70	138.95	OK	OK	36.1	118.6	5,032	1,300.84	OK
21-Mar-40	72.06	15.34	56.72	78.02	15.34	119.41	OK	136.91	135.89	134.28	-	132.67	OK	OK	35.2	115.8	4,990	1,290.07	OK
22-Mar-40	85.25	15.34	69.92	89.52	15.34	144.10	OK	157.80	156.78	155.17	-	153.56	OK	OK	45.4	149.8	5,461	1,411.89	OK
23-Mar-40	83.00	15.34	67.66	115.46	15.34	167.79	OK	223.49	222.47	220.86	1.60	220.85	OK	OK	71.8	239.1	6,431	1,662.68	OK
24-Mar-40	61.50	15.34	46.16	88.06	15.34	118.89	OK	177.29	176.27	174.66	6.40	179.45	OK	OK	53.4	176.7	5,786	1,495.76	OK
25-Mar-40	61.00	15.34	45.66	60.56	15.34	90.89	OK	112.89	111.87	110.26	4.80	113.45	OK	OK	26.7	87.3	4,520	1,168.60	OK
26-Mar-40	56.80	15.34	41.46	95.76	15.34	121.89	OK	187.29	186.27	184.66	1.90	184.95	OK	OK	62.0	205.6	6,101	1,577.33	OK
27-Mar-40	54.10	15.34	38.76	96.06	15.34	119.49	OK	206.79	205.77	204.16	17.50	220.05	OK	OK	80.5	268.4	6,697	1,731.50	OK
28-Mar-40	48.70	15.34	33.36	56.66	15.34	74.69	OK	151.09	150.07	148.46	43.40	190.25	OK	OK	51.6	170.8	5,717	1,478.04	OK
29-Mar-40	49.60	15.34	34.26	55.16	15.34	74.09	OK	124.29	123.27	121.66	27.80	147.85	OK	OK	32.9	108.1	4,871	1,259.35	OK
30-Mar-40	58.80	15.34	43.46	61.06	15.34	89.19	OK	110.29	109.27	107.66	-	106.05	OK	OK	25.5	83.4	4,449	1,150.23	OK
31-Mar-40	48.80	15.34	33.46	49.36	15.34	67.49	OK	83.29	82.27	80.66	-	79.05	OK	OK	17.8	57.8	3,914	1,011.77	OK
01-Apr-40	39.70	15.34	24.36	36.56	15.34	45.59	OK	56.79	55.77	54.16	-	52.55	OK	OK	11.6	37.5	3,365	869.85	OK
02-Apr-40	148.82	15.34	133.48	192.81	15.34	310.96	OK	335.56	334.54	332.93	-	331.32	OK	OK	144.5	486.7	8,248	2,132.39	OK
03-Apr-40	187.11	15.34	171.77	246.03	15.34	402.47	OK	429.07	428.05	426.44	-	424.83	OK	OK	221.5	751.3	9,602	2,482.40	OK
04-Apr-40	108.01	15.34	92.67	138.49	15.34	215.83	OK	235.63	234.61	233.00	0.30	231.69	OK	OK	80.5	268.4	6,697	1,731.39	OK
05-Apr-40	91.77	15.34	76.43	116.25	15.34	177.35	OK	202.35	201.33	199.72	8.30	206.41	OK	OK	61.6	204.5	6,089	1,574.22	OK
06-Apr-40	55.16	15.34	39.82	59.65	15.34	84.14	OK	99.34	98.32	96.71	8.80	103.90	OK	OK	22.3	72.9	4,243	1,097.08	OK
07-Apr-40	52.01	15.34	36.67	62.90	15.34	84.24	OK	100.34	99.32	97.71	1.30	97.40	OK	OK	22.4	73.2	4,249	1,098.56	OK
08-Apr-40	71.33	15.34	55.99	126.54	15.34	167.20	OK	245.20	244.18	242.57	2.70	243.66	OK	OK	93.7	313.2	7,069	1,827.59	OK
09-Apr-40	64.40	15.34	49.06	109.34	15.34	143.07	OK	211.57	210.55	208.94	2.40	209.73	OK	OK	73.3	244.0	6,478	1,674.71	OK
10-Apr-40	57.89	15.34	42.55	66.75	15.34	93.97	OK	203.33	202.31	200.70	111.50	310.59	OK	OK	90.4	302.0	6,979	1,804.36	OK
11-Apr-40	45.22	15.34	29.88	47.18	15.34	61.73	OK	168.59	167.57	165.96	111.40	275.75	OK	OK	78.3	260.9	6,631	1,714.29	OK
12-Apr-40	43.40	15.34	28.06	39.06	15.34	51.79	OK	65.39	64.37	62.76	-	61.15	OK	OK	13.6	44.1	3,560	920.40	OK
13-Apr-40	43.20	15.34	27.86	40.16	15.34	52.69	OK	66.69	65.67	64.06	1.70	64.15	OK	OK	13.8	44.7	3,576	924.52	OK
14-Apr-40	43.00	15.34	27.66	44.56	15.34	56.89	OK	90.99	89.97	88.36	14.70	101.45	OK	OK	20.5	66.9	4,118	1,064.52	OK
15-Apr-40	42.80	15.34	27.46	42.96	15.34	55.09	OK	83.69	82.67	81.06	13.00	92.45	OK	OK	18.1	58.7	3,935	1,017.22	OK
16-Apr-40	42.20	15.34	26.86	37.26	15.34	48.79	OK	52.99	51.97	50.36	-	48.75	OK	OK	11.8	38.2	3,383	874.71	OK
17-Apr-40	52.60	15.34	37.26	51.56	15.34	73.49	OK	86.09	85.07	83.46	8.30	90.15	OK	OK	19.1	62.1	4,013	1,037.51	OK

18-Apr-40	53.10	15.34	37.76	52.26	15.34	74.69	OK	90.79	89.77	88.16	11.70	98.25	OK	OK	20.1	65.4	4,086	1,056.35	OK
19-Apr-40	38.70	15.34	23.36	33.66	15.34	41.69	OK	47.79	46.77	45.16	3.40	46.95	OK	OK	10.3	33.1	3,221	832.61	OK
20-Apr-40	26.50	15.34	11.16	51.26	15.34	47.09	OK	88.39	87.37	85.76	1.50	85.65	OK	OK	24.9	81.4	4,411	1,140.48	OK
21-Apr-40	25.10	15.34	9.76	49.76	15.34	44.19	OK	85.09	84.07	82.46	1.50	82.35	OK	OK	24.2	79.2	4,368	1,129.28	OK
22-Apr-40	20.70	15.34	5.36	17.56	15.34	7.59	OK	11.69	10.67	9.06	0.50	7.95	OK	OK	4.0	12.6	2,298	594.04	OK
23-Apr-40	19.60	15.34	4.26	51.86	15.34	40.79	OK	91.49	90.47	88.86	2.00	89.25	OK	OK	31.8	104.2	4,809	1,243.39	OK
24-Apr-40	18.90	15.34	3.56	114.06	15.34	102.29	OK	206.66	205.64	204.03	5.00	207.41	OK	OK	131.4	441.8	7,973	2,061.37	OK
25-Apr-40	16.30	15.34	0.96	77.26	15.34	62.89	OK	131.84	130.82	129.21	3.40	131.00	OK	OK	63.2	209.9	6,145	1,588.63	OK
26-Apr-40	14.30	15.34	-	10.70	15.34	-	Fail	12.90	11.88	10.27	0.80	9.46	OK	Fail	3.4	10.6	2,160	558.54	OK
27-Apr-40	13.10	15.34	-	9.20	15.34	-	Fail	8.50	7.48	5.87	0.20	4.46	OK	Fail	2.3	7.2	1,892	489.05	OK
28-Apr-40	11.80	15.34	-	9.10	15.34	-	Fail	16.50	15.48	13.87	10.60	22.86	OK	Fail	3.4	10.7	2,171	561.16	OK
29-Apr-40	74.30	15.34	58.96	91.46	15.34	135.09	OK	155.99	154.97	153.36	10.60	162.35	OK	OK	41.5	136.9	5,291	1,367.92	OK
30-Apr-40	87.20	15.34	71.87	116.77	15.34	173.30	OK	185.40	184.38	182.77	-	181.16	OK	OK	56.7	187.9	5,911	1,528.17	OK
01-May-40	41.18	15.34	25.85	47.15	15.34	57.66	OK	64.96	63.94	62.33	1.80	62.52	OK	OK	13.8	44.6	3,575	924.18	OK
02-May-40	22.60	15.34	7.26	17.56	15.34	9.49	OK	13.99	12.97	11.36	1.80	11.55	OK	OK	4.2	13.4	2,349	607.21	OK
03-May-40	27.00	15.34	11.66	23.46	15.34	19.79	OK	22.19	21.17	19.56	-	17.95	OK	OK	5.7	18.1	2,608	674.38	OK
04-May-40	24.80	15.34	9.46	20.26	15.34	14.39	OK	24.29	23.27	21.66	8.40	28.45	OK	OK	5.5	17.5	2,576	665.88	OK
05-May-40	92.90	15.34	77.56	112.66	15.34	174.89	OK	189.59	188.57	186.96	8.40	193.75	OK	OK	58.1	192.6	5,963	1,541.53	OK
06-May-40	93.80	15.34	78.46	112.76	15.34	175.89	OK	211.99	210.97	209.36	25.40	233.15	OK	OK	65.3	217.0	6,217	1,607.20	OK
07-May-40	22.80	15.34	7.46	15.76	15.34	7.89	OK	38.29	37.27	35.66	25.40	59.45	OK	OK	9.7	31.3	3,159	816.61	OK
08-May-40	22.20	15.34	6.86	69.96	15.34	61.49	OK	134.69	133.67	132.06	2.70	133.15	OK	OK	57.8	191.6	5,952	1,538.70	OK
09-May-40	22.30	15.34	6.96	69.96	15.34	61.59	OK	134.69	133.67	132.06	2.70	133.15	OK	OK	57.7	191.2	5,947	1,537.53	OK
10-May-40	43.80	15.34	28.46	42.86	15.34	55.99	OK	63.19	62.17	60.56	-	58.95	OK	OK	13.5	43.7	3,549	917.48	OK
11-May-40	53.40	15.34	38.06	76.36	15.34	99.09	OK	132.49	131.47	129.86	1.00	129.25	OK	OK	33.2	109.0	4,885	1,262.88	OK
12-May-40	70.60	15.34	55.26	105.56	15.34	145.49	OK	184.39	183.37	181.76	1.30	181.45	OK	OK	53.6	177.6	5,796	1,498.51	OK
13-May-40	85.00	15.34	69.66	102.26	15.34	156.59	OK	168.59	167.57	165.96	0.30	164.65	OK	OK	49.0	162.0	5,613	1,451.04	OK
14-May-40	53.50	15.34	38.16	53.86	15.34	76.69	OK	83.19	82.17	80.56	-	78.95	OK	OK	19.1	62.2	4,015	1,038.06	OK
15-May-40	32.30	1.69	30.61	39.81	1.69	68.72	OK	73.62	72.60	72.60	-	70.99	OK	OK	7.4	23.6	2,858	738.92	OK
16-May-40	61.90	1.69	60.21	80.31	1.69	138.82	OK	148.82	147.80	147.80	3.40	149.59	OK	OK	26.0	85.0	4,479	1,157.88	OK
17-May-40	164.40	1.69	162.71	220.41	1.69	381.42	OK	402.62	401.60	401.60	6.80	406.79	OK	OK	167.4	565.2	8,691	2,246.97	OK
18-May-40	152.40	1.69	150.71	201.21	1.69	350.22	OK	365.42	364.40	364.40	3.40	366.19	OK	OK	142.2	478.7	8,201	2,120.14	OK
19-May-40	50.70	1.69	49.01	61.81	1.69	109.12	OK	115.72	114.70	114.70	-	113.09	OK	OK	16.9	55.0	3,845	994.04	OK
20-May-40	31.10	1.69	29.41	36.61	1.69	64.32	OK	68.22	67.20	67.20	-	65.59	OK	OK	6.6	21.1	2,752	711.36	OK
21-May-40	30.90	1.69	29.21	36.31	1.69	63.82	OK	66.72	65.70	65.70	-	64.09	OK	OK	6.5	20.7	2,731	706.14	OK
22-May-40	33.70	1.69	32.01	40.61	1.69	70.92	OK	100.32	99.30	99.30	22.80	120.49	OK	OK	13.2	42.5	3,514	908.58	OK
23-May-40	29.30	1.69	27.61	36.21	1.69	62.12	OK	97.22	96.20	96.20	28.00	122.59	OK	OK	13.7	44.3	3,565	921.62	OK
24-May-40	26.20	1.69	24.51	39.61	1.69	62.42	OK	113.02	112.00	112.00	31.40	141.79	OK	OK	21.4	69.7	4,178	1,080.21	OK
25-May-40	25.70	1.69	24.01	39.01	1.69	61.32	OK	129.62	128.60	128.60	47.10	174.09	OK	OK	33.1	108.6	4,879	1,261.26	OK
26-May-40	25.80	1.69	24.11	30.81	1.69	53.22	OK	78.12	77.10	77.10	20.90	96.39	OK	OK	8.6	27.7	3,025	781.98	OK
27-May-40	25.20	1.69	23.51	32.71	1.69	54.52	OK	66.62	65.60	65.60	8.80	72.79	OK	OK	5.7	18.2	2,613	675.67	OK
28-May-40	144.36	1.69	142.67	229.97	1.69	370.94	OK	416.34	415.32	415.32	19.60	433.31	OK	OK	169.0	570.7	8,721	2,254.67	OK
29-May-40	149.04	1.69	147.35	232.05	1.69	377.70	OK	411.50	410.48	410.48	10.80	419.67	OK	OK	168.3	568.2	8,707	2,251.10	OK
30-May-40	53.82	1.69	52.13	77.83	1.69	128.26	OK	160.36	159.34	159.34	23.10	180.83	OK	OK	28.1	92.0	4,604	1,190.32	OK
31-May-40	53.82	1.69	52.13	77.73	1.69	128.16	OK	164.36	163.34	163.34	26.60	188.33	OK	OK	29.7	97.5	4,698	1,214.54	OK
01-Jun-40	37.40	1.69	35.71	42.01	1.69	76.02	OK	82.72	81.70	81.70	4.40	84.49	OK	OK	9.3	29.9	3,107	803.37	OK
02-Jun-40	36.20	1.69	34.51	40.81	1.69	73.62	OK	75.52	74.50	74.50	0.30	73.19	OK	OK	8.5	27.2	3,007	777.35	OK
03-Jun-40	32.00	1.69	30.31	108.75	1.69	137.37	OK	234.40	233.38	233.38	4.70	236.47	OK	OK	95.1	317.9	7,106	1,837.01	OK
04-Jun-40	25.70	1.69	24.01	102.37	1.69	124.69	OK	221.46	220.46	220.46	4.70	223.55	OK	OK	92.5	309.3	7,036	1,819.59	OK
05-Jun-40	26.10	1.69	24.41	30.51	1.69	53.22	OK	87.93	86.91	86.91	37.80	123.10	OK	OK	12.2	39.4	3,421	884.48	OK
06-Jun-40	25.90	1.69	24.21	30.21	1.69	52.72	OK	93.59	92.57	92.57	46.40	137.36	OK	OK	14.9	48.2	3,671	949.08	OK
07-Jun-40	25.90	1.69	24.21	39.11	1.69	61.62	OK	93.21	92.19	92.19	24.50	115.08	OK	OK	12.1	39.2	3,415	882.83	OK
08-Jun-40	25.70	1.69	24.01	38.81	1.69	61.12	OK	95.52	94.50	94.50	17.70	110.59	OK	OK	13.2	42.5	3,515	908.69	OK
09-Jun-40	25.30	1.69	23.61	29.41	1.69	51.32	OK	62.82	61.80	61.80	4.30	64.49	OK	OK	5.3	16.9	2,544	657.77	OK
10-Jun-40	25.30	1.69	23.61	29.31	1.69	51.22	OK	59.82	58.80	58.80	2.00	59.19	OK	OK	4.9	15.6	2,474	639.67	OK
11-Jun-40	49.70	1.69	48.01	60.81	1.69	107.12	OK	113.92	112.90	112.90	0.10	111.39	OK	OK	16.4	53.1	3,800	982.30	OK
12-Jun-40	50.60	1.69	48.91	62.11	1.69	109.32	OK	115.52	114.50	114.50	-	112.89	OK	OK	16.9	54.9	3,843	993.50	OK
13-Jun-40	26.80	1.69	25.11	33.41	1.69	56.82	OK	63.32	62.30	62.30	0.20	60.89	OK	OK	5.4	17.3	2,563	662.68	OK
14-Jun-40	22.40	1.69	20.71	28.51	1.69	47.52	OK	52.62	51.60	51.60	0.20	50.19	OK	OK	3.9	12.4	2,284	590.39	OK
15-Jun-40	9.00	1.69	7.31	12.71	1.69	18.32	OK	19.92	18.90	18.90	-	17.29	OK	OK	0.8	2.5	-	-	OK
16-Jun-40	11.80	1.69	10.11	15.51	1.69	23.92	OK	25.12	24.10	24.10	-	22.49	OK	OK	1.2	3.7	-	-	OK
17-Jun-40	7.30	1.69	5.61	14.61	1.69	18.52	OK	24.02	23.00	23.00	0.20	21.59	OK	OK	1.2	3.7	-	-	OK
18-Jun-40	8.50	1.69	6.81	15.71	1.69	20.82	OK	26.12	25.10	25.10	0.20	23.69	OK	OK	1.3	4.0	-	-	OK
19-Jun-40	12.50	1.69	10.81	17.61	1.69	26.72	OK	27.72	26.70	26.70	-	25.09	OK	OK	1.4	4.5	-	-	OK
20-Jun-40	94.10	1.69	92.41	150.91	1.69	241.62	OK	279.72	278.70	278.70	1.10	278.19	OK	OK	79.4	264.8	6,665	1,723.24	OK
21-Jun-40	95.20	1.69	93.51	151.01	1.69	242.82	OK	280.62	279.60	279.60	1.10	279.09	OK	OK	79.8	265.9	6,675	1,725.78	OK

22-Jun-40	17.10	1.69	15.41	21.11	1.69	34.82	OK	38.52	37.50	37.50	-	35.89	OK	OK	2.3	7.3	1,893	489.47	OK
23-Jun-40	14.30	1.69	12.61	17.61	1.69	28.52	OK	31.12	30.10	30.10	-	28.49	OK	OK	1.6	5.1	1,676	433.25	OK
24-Jun-40	14.40	1.69	12.71	17.61	1.69	28.62	OK	30.62	29.60	29.60	-	27.99	OK	OK	1.6	5.1	1,672	432.30	OK
25-Jun-40	14.30	1.69	12.61	17.51	1.69	28.42	OK	29.92	28.90	28.90	-	27.29	OK	OK	1.6	5.0	-	-	OK
26-Jun-40	14.20	1.69	12.51	17.31	1.69	28.12	OK	29.22	28.20	28.20	-	26.59	OK	OK	1.6	4.9	-	-	OK
27-Jun-40	41.30	1.69	39.61	52.41	1.69	90.32	OK	93.22	92.20	92.20	-	90.59	OK	OK	11.7	37.7	3,369	871.06	OK
28-Jun-40	41.90	1.69	40.21	52.91	1.69	91.42	OK	94.12	93.10	93.10	-	91.49	OK	OK	12.0	38.6	3,396	878.07	OK
29-Jun-40	14.00	1.69	12.31	17.01	1.69	27.62	OK	28.12	27.10	27.10	-	25.49	OK	OK	1.5	4.7	-	-	OK
30-Jun-40	14.20	1.69	12.51	17.11	1.69	27.92	OK	28.22	27.20	27.20	-	25.59	OK	OK	1.5	4.8	-	-	OK
01-Jul-40	14.00	1.69	12.31	16.91	1.69	27.52	OK	40.02	39.00	39.00	13.00	50.39	OK	OK	2.6	8.1	1,970	509.31	OK
02-Jul-40	14.00	1.69	12.31	16.81	1.69	27.42	OK	39.92	38.90	38.90	13.00	50.29	OK	OK	2.6	8.1	1,968	508.85	OK
03-Jul-40	13.90	1.69	12.21	18.51	1.69	29.02	OK	31.52	30.50	30.50	1.20	30.09	OK	OK	1.7	5.2	1,686	435.81	OK
04-Jul-40	13.90	1.69	12.21	18.51	1.69	29.02	OK	31.42	30.40	30.40	0.50	29.29	OK	OK	1.7	5.2	1,684	435.45	OK
05-Jul-40	13.80	1.69	12.11	16.51	1.69	26.92	OK	27.02	26.00	26.00	0.10	24.49	OK	OK	1.5	4.5	-	-	OK
06-Jul-40	13.60	1.69	11.91	16.21	1.69	26.42	OK	26.52	25.50	25.50	-	23.89	OK	OK	1.4	4.4	-	-	OK
07-Jul-40	11.70	1.69	10.01	14.31	1.69	22.62	OK	30.82	29.80	29.80	8.60	36.79	OK	OK	1.6	4.9	-	-	OK
08-Jul-40	8.90	1.69	7.21	12.11	1.69	17.62	OK	38.32	37.30	37.30	21.70	57.39	OK	OK	3.6	11.3	2,210	571.33	OK
09-Jul-40	110.70	1.69	109.01	149.61	1.69	256.92	OK	276.92	275.90	275.90	13.00	287.29	OK	OK	81.0	270.2	6,713	1,735.55	OK
10-Jul-40	112.20	1.69	110.51	150.41	1.69	259.22	OK	267.12	266.10	266.10	1.80	266.29	OK	OK	80.3	267.7	6,691	1,729.78	OK
11-Jul-40	14.90	1.69	13.21	17.31	1.69	28.82	OK	30.72	29.70	29.70	0.90	28.99	OK	OK	1.7	5.2	1,686	435.98	OK
12-Jul-40	14.20	1.69	12.51	16.61	1.69	27.42	OK	28.52	27.50	27.50	0.10	25.99	OK	OK	1.5	4.7	-	-	OK
13-Jul-40	14.30	1.69	12.61	16.61	1.69	27.52	OK	28.32	27.30	27.30	-	25.69	OK	OK	1.5	4.8	-	-	OK
14-Jul-40	13.70	1.69	12.01	31.61	1.69	41.92	OK	68.02	67.00	67.00	4.40	69.79	OK	OK	8.2	26.4	2,972	768.48	OK
15-Jul-40	12.00	1.69	10.31	36.21	1.69	44.82	OK	96.32	95.30	95.30	8.80	102.49	OK	OK	21.3	69.3	4,170	1,078.07	OK
16-Jul-40	12.40	1.69	10.71	21.01	1.69	30.02	OK	55.82	54.80	54.80	4.40	57.59	OK	OK	6.1	19.5	2,674	691.34	OK
17-Jul-40	14.40	1.69	12.71	36.51	1.69	47.52	OK	73.02	72.00	72.00	0.90	71.29	OK	OK	9.3	29.9	3,105	802.81	OK
18-Jul-40	14.50	1.69	12.81	36.81	1.69	47.92	OK	73.62	72.60	72.60	0.90	71.89	OK	OK	9.4	30.3	3,122	807.11	OK
19-Jul-40	12.30	1.69	10.61	14.61	1.69	23.52	OK	28.42	27.40	27.40	-	25.79	OK	OK	1.4	4.2	-	-	OK
20-Jul-40	12.20	1.69	10.51	21.31	1.69	30.12	OK	43.12	42.10	42.10	0.50	40.99	OK	OK	3.0	9.5	2,082	538.15	OK
21-Jul-40	14.40	1.69	12.71	24.21	1.69	35.22	OK	47.52	46.50	46.50	0.50	45.39	OK	OK	3.4	10.7	2,169	560.76	OK
22-Jul-40	25.50	1.69	23.81	32.01	1.69	54.12	OK	58.92	57.90	57.90	-	56.29	OK	OK	4.9	15.4	2,465	637.27	OK
23-Jul-40	23.80	1.69	22.11	29.61	1.69	50.02	OK	53.72	52.70	52.70	-	51.09	OK	OK	4.2	13.3	2,340	605.00	OK
24-Jul-40	12.90	1.69	11.21	14.81	1.69	24.32	OK	26.42	25.40	25.40	-	23.79	OK	OK	1.3	4.0	-	-	OK
25-Jul-40	12.80	1.69	11.11	15.11	1.69	24.52	OK	26.72	25.70	25.70	-	24.09	OK	OK	1.3	4.0	-	-	OK
26-Jul-40	10.70	1.69	9.01	13.01	1.69	20.32	OK	22.22	21.20	21.20	-	19.59	OK	OK	1.0	3.0	-	-	OK
27-Jul-40	4.70	1.69	3.01	6.51	1.69	7.82	OK	8.72	7.70	7.70	-	6.09	OK	OK	0.3	0.8	-	-	OK
28-Jul-40	6.10	1.69	4.41	7.81	1.69	10.52	OK	11.22	10.20	10.20	-	8.59	OK	OK	0.4	1.1	-	-	OK
29-Jul-40	5.60	1.69	3.91	7.31	1.69	9.52	OK	10.02	9.00	9.00	-	7.39	OK	OK	0.3	1.0	-	-	OK
30-Jul-40	5.70	1.69	4.01	7.41	1.69	9.72	OK	10.12	9.10	9.10	-	7.49	OK	OK	0.3	1.0	-	-	OK
31-Jul-40	5.60	1.69	3.91	7.21	1.69	9.42	OK	9.72	8.70	8.70	-	7.09	OK	OK	0.3	1.0	-	-	OK
01-Aug-40	24.60	1.69	22.91	31.71	1.69	52.92	OK	54.52	53.50	53.50	-	51.89	OK	OK	4.5	14.3	2,398	619.99	OK
02-Aug-40	25.30	1.69	23.61	32.31	1.69	54.22	OK	55.72	54.70	54.70	-	53.09	OK	OK	4.7	14.9	2,436	629.67	OK
03-Aug-40	6.80	1.69	5.11	8.51	1.69	11.92	OK	12.22	11.20	11.20	-	9.59	OK	OK	0.4	1.3	-	-	OK
04-Aug-40	13.20	1.69	11.51	22.71	1.69	32.52	OK	40.52	39.50	39.50	0.30	38.19	OK	OK	2.5	8.0	1,958	506.20	OK
05-Aug-40	13.50	1.69	11.81	22.71	1.69	32.82	OK	40.52	39.50	39.50	0.30	38.19	OK	OK	2.5	7.9	1,951	504.47	OK
06-Aug-40	39.50	1.69	37.81	52.61	1.69	88.72	OK	91.32	90.30	90.30	-	88.69	OK	OK	11.2	36.0	3,317	857.50	OK
07-Aug-40	42.90	1.69	41.21	56.71	1.69	96.22	OK	99.02	98.00	98.00	-	96.39	OK	OK	13.0	41.9	3,496	903.83	OK
08-Aug-40	13.30	1.69	11.61	16.01	1.69	25.92	OK	26.72	25.70	25.70	-	24.09	OK	OK	1.4	4.3	-	-	OK
09-Aug-40	10.40	1.69	8.71	20.01	1.69	27.02	OK	37.72	36.70	36.70	0.50	35.59	OK	OK	2.5	7.7	1,936	500.45	OK
10-Aug-40	8.40	1.69	6.71	17.21	1.69	22.22	OK	32.62	31.60	31.60	0.50	30.49	OK	OK	2.0	6.4	1,813	468.76	OK
11-Aug-40	40.90	1.69	39.21	53.81	1.69	91.32	OK	94.02	93.00	93.00	-	91.39	OK	OK	11.8	38.1	3,382	874.26	OK
12-Aug-40	107.45	1.69	105.76	160.06	1.69	264.12	OK	275.12	274.10	274.10	-	272.49	OK	OK	83.0	276.6	6,770	1,750.18	OK
13-Aug-40	93.17	1.69	91.48	136.38	1.69	226.16	OK	235.26	234.24	234.24	-	232.63	OK	OK	62.1	206.0	6,105	1,578.34	OK
14-Aug-40	49.98	1.69	48.29	69.99	1.69	116.58	OK	120.78	119.76	119.76	-	118.15	OK	OK	18.3	59.5	3,952	1,021.65	OK
15-Aug-40	70.98	1.69	69.29	101.29	1.69	168.88	OK	193.28	192.26	192.26	15.20	205.85	OK	OK	39.7	130.6	5,205	1,345.64	OK
16-Aug-40	45.43	1.69	43.74	61.44	1.69	103.48	OK	125.08	124.06	124.06	15.20	137.65	OK	OK	17.7	57.6	3,908	1,010.30	OK
17-Aug-40	35.10	1.69	33.41	40.11	1.69	71.82	OK	74.22	73.20	73.20	-	71.59	OK	OK	8.1	25.9	2,954	763.72	OK
18-Aug-40	34.70	1.69	33.01	41.91	1.69	73.22	OK	79.92	78.90	78.90	0.30	77.59	OK	OK	8.4	27.0	3,000	775.51	OK
19-Aug-40	33.60	1.69	31.91	52.31	1.69	82.52	OK	101.12	100.10	100.10	0.90	99.39	OK	OK	12.1	39.2	3,415	882.84	OK
20-Aug-40	34.10	1.69	32.41	50.01	1.69	80.72	OK	113.22	112.20	112.20	16.00	126.59	OK	OK	16.0	51.9	3,769	974.42	OK
21-Aug-40	36.20	1.69	34.51	63.81	1.69	96.62	OK	145.92	144.90	144.90	16.40	159.69	OK	OK	28.3	92.7	4,616	1,193.47	OK
22-Aug-40	34.30	1.69	32.61	61.81	1.69	92.72	OK	171.92	170.90	170.90	41.60	210.89	OK	OK	48.9	161.7	5,609	1,450.12	OK
23-Aug-40	27.20	1.69	25.51	29.91	1.69	53.72	OK	103.32	102.30	102.30	40.60	141.29	OK	OK	19.7	64.3	4,061	1,049.79	OK
24-Aug-40	25.00	1.69	23.31	38.91	1.69	60.52	OK	77.82	76.80	76.80	3.70	78.89	OK	OK	7.7	24.7	2,904	750.77	OK
25-Aug-40	25.40	1.69	23.71	142.21	1.69	164.22	OK	284.57	283.55	283.55	7.70	289.64	OK	OK	161.8	546.0	8,587	2,220.01	OK

26-Aug-40	27.30	1.69	25.61	132.61	1.69	156.52	OK	264.31	263.29	263.29	6.40	268.08	OK	OK	133.6	449.4	8,021	2,073.79	OK
27-Aug-40	46.40	1.69	44.71	54.31	1.69	97.32	OK	112.42	111.40	111.40	3.60	113.39	OK	OK	15.3	49.5	3,707	958.49	OK
28-Aug-40	74.10	1.69	72.41	93.51	1.69	164.22	OK	182.12	181.10	181.10	4.60	184.09	OK	OK	36.9	121.4	5,074	1,311.66	OK
29-Aug-40	85.20	1.69	83.51	110.71	1.69	192.52	OK	206.82	205.80	205.80	2.00	206.19	OK	OK	47.6	157.4	5,556	1,436.50	OK
30-Aug-40	53.30	1.69	51.61	72.11	1.69	122.02	OK	136.72	135.70	135.70	1.20	135.29	OK	OK	21.3	69.3	4,170	1,078.02	OK
31-Aug-40	24.30	1.69	22.61	32.11	1.69	53.02	OK	64.02	63.00	63.00	0.40	61.79	OK	OK	5.3	16.9	2,546	658.28	OK
01-Sep-40	18.00	15.34	2.66	11.16	15.34	-	Fail	8.30	7.28	5.67	-	4.06	OK	Fail	3.2	10.0	2,121	548.23	OK
02-Sep-40	14.50	15.34	-	88.80	15.34	73.46	Fail	161.84	160.82	159.21	4.10	161.70	OK	Fail	90.8	303.4	6,991	1,807.37	OK
03-Sep-40	20.40	15.34	5.06	132.66	15.34	122.39	OK	247.27	246.25	244.64	6.00	249.03	OK	OK	177.9	601.4	8,882	2,296.30	OK
04-Sep-40	20.30	15.34	4.96	53.46	15.34	43.09	OK	85.76	84.74	83.13	2.00	83.52	OK	OK	28.1	92.0	4,605	1,190.46	OK
05-Sep-40	14.10	15.34	-	13.70	15.34	-	Fail	34.60	33.58	31.97	19.70	50.06	OK	Fail	10.1	32.6	3,203	828.19	OK
06-Sep-40	13.70	15.34	-	14.10	15.34	-	Fail	34.50	33.48	31.87	19.70	49.96	OK	Fail	10.1	32.5	3,199	827.00	OK
07-Sep-40	13.40	15.34	-	9.40	15.34	-	Fail	14.30	13.28	11.67	1.80	11.86	OK	Fail	3.3	10.3	2,140	553.18	OK
08-Sep-40	13.00	15.34	-	6.80	15.34	-	Fail	8.30	7.28	5.67	0.50	4.56	OK	Fail	2.0	6.3	1,799	465.05	OK
09-Sep-40	13.00	15.34	-	6.70	15.34	-	Fail	6.20	5.18	3.57	0.10	2.06	OK	Fail	1.8	5.6	1,726	446.10	OK
10-Sep-40	12.90	15.34	-	6.70	15.34	-	Fail	4.70	3.68	2.07	-	0.46	OK	Fail	1.6	5.1	1,678	433.88	OK
11-Sep-40	12.90	15.34	-	6.60	15.34	-	Fail	3.50	2.48	0.87	-	-	Fail	Fail	1.6	4.9	-	-	OK
12-Sep-40	12.70	15.34	-	6.50	15.34	-	Fail	2.60	1.58	-	-	-	Fail	Fail	1.5	4.6	-	-	OK
13-Sep-40	12.20	15.34	-	6.70	15.34	-	Fail	2.20	1.18	-	-	-	Fail	Fail	1.4	4.4	-	-	OK
14-Sep-40	29.40	15.34	14.06	26.16	15.34	24.89	OK	27.99	26.97	25.36	-	23.75	OK	OK	6.6	21.1	2,748	710.47	OK
15-Sep-40	68.70	15.34	53.36	79.66	15.34	117.69	OK	127.39	126.37	124.76	3.50	126.65	OK	OK	32.7	107.3	4,859	1,256.25	OK
16-Sep-40	52.50	15.34	37.16	58.56	15.34	80.39	OK	88.69	87.67	86.06	3.50	87.95	OK	OK	20.0	65.3	4,083	1,055.54	OK
17-Sep-40	13.20	15.34	-	6.90	15.34	-	Fail	1.00	-	-	-	-	Fail	Fail	1.6	4.9	-	-	Fail
18-Sep-40	10.50	15.34	-	6.10	15.34	-	Fail	0.60	-	-	-	-	Fail	Fail	1.1	3.3	-	-	Fail
19-Sep-40	10.60	15.34	-	6.30	15.34	-	Fail	0.60	-	-	-	-	Fail	Fail	1.1	3.4	-	-	Fail
20-Sep-40	10.40	15.34	-	6.20	15.34	-	Fail	0.50	-	-	-	-	Fail	Fail	1.1	3.3	-	-	Fail
21-Sep-40	9.90	15.34	-	5.90	15.34	-	Fail	0.20	-	-	-	-	Fail	Fail	1.0	3.0	-	-	Fail
22-Sep-40	10.00	15.34	-	5.90	15.34	-	Fail	0.20	-	-	-	-	Fail	Fail	1.0	3.0	-	-	Fail
23-Sep-40	9.90	15.34	-	5.80	15.34	-	Fail	0.10	-	-	-	-	Fail	Fail	0.9	2.9	-	-	Fail
24-Sep-40	9.80	15.34	-	5.70	15.34	-	Fail	0.10	-	-	-	-	Fail	Fail	0.9	2.9	-	-	Fail
25-Sep-40	9.80	15.34	-	7.10	15.34	-	Fail	104.21	103.19	101.58	114.90	214.87	OK	Fail	61.9	205.4	6,099	1,576.77	OK
26-Sep-40	9.70	15.34	-	7.00	15.34	-	Fail	125.19	124.17	122.56	138.60	259.55	OK	Fail	87.2	291.3	6,892	1,781.68	OK
27-Sep-40	9.70	15.34	-	5.60	15.34	-	Fail	39.40	38.38	36.77	36.90	72.06	OK	Fail	10.5	33.8	3,243	838.29	OK
28-Sep-40	9.60	15.34	-	5.50	15.34	-	Fail	15.80	14.78	13.17	15.10	26.66	OK	Fail	2.6	8.1	1,966	508.29	OK
29-Sep-40	9.50	15.34	-	5.40	15.34	-	Fail	11.80	10.78	9.17	4.70	12.26	OK	Fail	1.8	5.7	1,742	450.49	OK
30-Sep-40	9.50	15.34	-	27.40	15.34	12.06	Fail	48.66	47.64	46.03	1.90	46.32	OK	Fail	13.8	44.6	3,574	923.88	OK
01-Oct-40	9.00	15.34	-	28.10	15.34	12.76	Fail	48.46	47.44	45.83	1.30	45.52	OK	Fail	13.6	43.9	3,554	918.80	OK
02-Oct-40	7.00	15.34	-	6.00	15.34	-	Fail	14.50	13.48	11.87	0.10	10.36	OK	Fail	2.1	6.5	1,818	469.91	OK
03-Oct-40	4.80	15.34	-	5.20	15.34	-	Fail	10.20	9.18	7.57	-	5.96	OK	Fail	1.1	3.5	-	-	OK
04-Oct-40	5.20	15.34	-	30.20	15.34	14.86	Fail	55.56	54.54	52.93	1.20	52.52	OK	Fail	16.2	52.5	3,784	978.21	OK
05-Oct-40	5.00	15.34	-	78.40	15.34	63.06	Fail	165.86	164.84	163.23	3.70	165.32	OK	Fail	94.9	317.3	7,102	1,835.98	OK
06-Oct-40	53.90	15.34	38.56	110.96	15.34	134.19	OK	207.79	206.77	205.16	2.60	206.15	OK	OK	79.3	264.3	6,661	1,722.02	OK
07-Oct-40	55.80	15.34	40.46	64.56	15.34	89.69	OK	99.89	98.87	97.26	0.30	95.95	OK	OK	23.1	75.3	4,293	1,109.80	OK
08-Oct-40	8.40	15.34	-	4.90	15.34	-	Fail	3.60	2.58	0.97	0.10	-	Fail	Fail	0.8	2.4	-	-	OK
09-Oct-40	8.00	15.34	-	4.90	15.34	-	Fail	3.20	2.18	0.57	0.50	-	Fail	Fail	0.7	2.2	-	-	OK
10-Oct-40	8.10	15.34	-	12.70	15.34	-	Fail	13.00	11.98	10.37	0.90	9.66	OK	Fail	2.8	8.7	2,015	520.95	OK
11-Oct-40	8.00	15.34	-	12.80	15.34	-	Fail	12.20	11.18	9.57	0.50	8.46	OK	Fail	2.6	8.3	1,982	512.29	OK
12-Oct-40	8.00	15.34	-	33.00	15.34	17.66	Fail	56.26	55.24	53.63	1.40	53.42	OK	Fail	16.5	53.7	3,812	985.57	OK
13-Oct-40	7.90	15.34	-	34.60	15.34	19.26	Fail	59.66	58.64	57.03	1.50	56.92	OK	Fail	18.0	58.5	3,929	1,015.86	OK
14-Oct-40	62.20	15.34	46.86	72.66	15.34	104.19	OK	111.39	110.37	108.76	0.20	107.35	OK	OK	27.5	90.0	4,569	1,181.23	OK
15-Oct-40	94.20	15.34	78.86	111.46	15.34	174.99	OK	277.64	276.62	275.01	109.00	382.40	OK	OK	116.0	389.3	7,628	1,972.12	OK
16-Oct-40	42.80	15.34	27.46	52.26	15.34	64.39	OK	194.73	193.71	192.10	131.30	321.79	OK	OK	108.3	362.6	7,442	1,924.07	OK
17-Oct-40	13.40	15.34	-	16.00	15.34	0.66	Fail	33.19	32.17	30.56	23.70	52.65	OK	Fail	9.6	31.0	3,145	813.01	OK
18-Oct-40	40.50	15.34	25.16	37.66	15.34	47.49	OK	68.01	66.99	65.38	20.70	84.46	OK	OK	14.0	45.2	3,590	928.01	OK
19-Oct-40	41.50	15.34	26.16	38.86	15.34	49.69	OK	74.49	73.47	71.86	19.30	89.55	OK	OK	15.7	50.8	3,741	967.12	OK
20-Oct-40	15.20	15.34	-	41.79	15.34	26.45	Fail	92.05	91.03	89.42	6.30	94.11	OK	Fail	37.5	123.6	5,105	1,319.80	OK
21-Oct-40	15.00	15.34	-	41.55	15.34	26.22	Fail	98.72	97.70	96.09	10.60	105.08	OK	Fail	42.7	140.8	5,343	1,381.36	OK
22-Oct-40	15.00	15.34	-	4.90	15.34	-	Fail	16.10	15.08	13.47	6.60	18.46	OK	Fail	3.5	10.9	2,186	565.08	OK
23-Oct-40	57.33	15.34	41.99	71.09	15.34	97.75	OK	109.85	108.83	107.22	0.10	105.71	OK	OK	26.0	84.9	4,477	1,157.32	OK
24-Oct-40	108.50	15.34	93.16	147.66	15.34	225.49	OK	244.69	243.67	242.06	3.60	244.05	OK	OK	85.9	286.7	6,854	1,771.89	OK
25-Oct-40	114.59	15.34	99.25	154.95	15.34	238.87	OK	261.17	260.15	258.54	7.10	264.03	OK	OK	94.6	316.4	7,094	1,834.05	OK
26-Oct-40	119.56	15.34	104.22	160.72	15.34	249.61	OK	270.31	269.29	267.68	6.40	272.47	OK	OK	100.8	337.5	7,256	1,875.95	OK
27-Oct-40	73.64	15.34	58.30	89.50	15.34	132.47	OK	170.97	169.95	168.34	27.30	194.03	OK	OK	46.8	154.6	5,521	1,427.33	OK
28-Oct-40	31.00	15.34	15.66	19.66	15.34	19.99	OK	50.09	49.07	47.46	25.40	71.25	OK	OK	12.0	38.6	3,397	878.11	OK
29-Oct-40	61.39	15.34	46.05	70.45	15.34	101.17	OK	115.87	114.85	113.24	2.50	114.13	OK	OK	27.6	90.3	4,575	1,182.77	OK

30-Oct-40	63.07	15.34	47.73	72.53	15.34	104.93	OK	143.23	142.21	140.60	33.30	172.29	OK	OK	36.5	120.1	5,054	1,306.58	OK
31-Oct-40	33.60	15.34	18.26	23.96	15.34	26.89	OK	61.84	60.82	59.21	33.20	90.79	OK	OK	15.0	48.5	3,679	951.17	OK
01-Nov-40	29.30	15.34	13.96	19.16	15.34	17.79	OK	30.04	29.02	27.41	3.30	29.10	OK	OK	6.7	21.4	2,765	714.89	OK
02-Nov-40	28.50	15.34	13.16	16.96	15.34	14.79	OK	155.43	154.41	152.80	152.00	303.18	OK	OK	112.8	378.3	7,552	1,952.51	OK
03-Nov-40	28.70	15.34	13.36	17.06	15.34	15.09	OK	151.75	150.73	149.12	149.20	296.71	OK	OK	107.2	359.1	7,416	1,917.18	OK
04-Nov-40	28.10	15.34	12.76	16.46	15.34	13.89	OK	18.49	17.47	15.86	-	14.25	OK	OK	5.3	16.9	2,545	658.01	OK
05-Nov-40	26.40	15.34	11.06	15.16	15.34	10.89	OK	92.29	91.27	89.66	68.00	156.05	OK	OK	42.7	140.7	5,342	1,381.20	OK
06-Nov-40	26.80	15.34	11.46	20.56	15.34	16.69	OK	103.99	102.97	101.36	68.30	168.05	OK	OK	48.7	160.9	5,599	1,447.45	OK
07-Nov-40	26.60	15.34	11.26	19.86	15.34	15.79	OK	24.49	23.47	21.86	6.10	26.35	OK	OK	5.6	17.9	2,597	671.32	OK
08-Nov-40	26.70	15.34	11.36	14.86	15.34	10.89	OK	30.09	29.07	27.46	17.30	43.15	OK	OK	7.1	22.8	2,825	730.28	OK
09-Nov-40	25.30	15.34	9.96	13.46	15.34	8.09	OK	26.89	25.87	24.26	16.10	38.75	OK	OK	6.6	21.0	2,746	710.02	OK
10-Nov-40	19.60	15.34	4.26	15.56	15.34	4.49	OK	15.79	14.77	13.16	4.20	15.75	OK	OK	4.3	13.7	2,367	611.87	OK
11-Nov-40	14.90	15.34	-	11.30	15.34	-	Fail	111.07	110.05	108.44	117.70	224.53	OK	Fail	71.1	236.5	6,407	1,656.44	OK
12-Nov-40	10.00	15.34	-	16.70	15.34	1.36	Fail	117.97	116.95	115.34	117.10	230.83	OK	Fail	77.9	259.6	6,620	1,711.44	OK
13-Nov-40	99.61	15.34	84.27	139.01	15.34	207.95	OK	251.01	249.99	248.38	11.20	257.97	OK	OK	85.1	284.0	6,831	1,766.02	OK
14-Nov-40	237.44	15.34	222.10	314.99	15.34	521.76	OK	566.53	565.51	563.90	9.30	571.59	OK	OK	351.9	1,203.4	11,323	2,927.39	OK
15-Nov-40	229.60	15.34	214.26	292.66	15.34	491.59	OK	514.13	513.11	511.50	2.80	512.69	OK	OK	311.6	1,063.3	10,843	2,803.22	OK
16-Nov-40	175.00	15.34	159.66	247.02	15.34	391.35	OK	450.24	449.22	447.61	2.50	448.50	OK	OK	227.0	770.3	9,686	2,504.20	OK
17-Nov-40	100.59	15.34	85.25	144.12	15.34	214.04	OK	266.15	265.13	263.52	2.30	264.20	OK	OK	93.8	313.4	7,071	1,828.00	OK
18-Nov-40	40.20	15.34	24.86	28.06	15.34	37.59	OK	37.69	36.67	35.06	-	33.45	OK	OK	10.0	32.3	3,192	825.32	OK
19-Nov-40	39.70	15.34	24.36	28.16	15.34	37.19	OK	38.19	37.17	35.56	-	33.95	OK	OK	9.8	31.7	3,170	819.62	OK
20-Nov-40	39.80	15.34	24.46	28.46	15.34	37.59	OK	51.39	50.37	48.76	13.40	60.55	OK	OK	11.2	36.1	3,319	858.13	OK
21-Nov-40	39.70	15.34	24.36	29.96	15.34	38.99	OK	54.89	53.87	52.26	13.60	64.25	OK	OK	11.7	37.7	3,368	870.72	OK
22-Nov-40	39.70	15.34	24.36	29.66	15.34	38.69	OK	41.79	40.77	39.16	1.20	38.75	OK	OK	10.0	32.2	3,189	824.54	OK
23-Nov-40	39.60	15.34	24.26	57.96	15.34	66.89	OK	98.56	97.54	95.93	1.90	96.22	OK	OK	23.1	75.5	4,297	1,110.85	OK
24-Nov-40	39.60	15.34	24.26	62.06	15.34	70.99	OK	107.03	106.01	104.40	2.00	104.79	OK	OK	26.6	87.1	4,518	1,167.94	OK
25-Nov-40	39.60	15.34	24.26	42.86	15.34	51.79	OK	65.99	64.97	63.36	1.00	62.75	OK	OK	13.4	43.2	3,534	913.67	OK
26-Nov-40	91.20	15.34	75.86	132.98	15.34	193.51	OK	247.80	246.78	245.17	2.70	246.26	OK	OK	84.3	281.2	6,807	1,759.87	OK
27-Nov-40	155.80	15.34	140.46	262.47	15.34	387.60	OK	530.73	529.71	528.10	6.70	533.19	OK	OK	323.9	1,105.9	10,993	2,842.09	OK
28-Nov-40	162.70	15.34	147.36	257.47	15.34	389.50	OK	514.07	513.05	511.44	5.80	515.63	OK	OK	294.8	1,004.9	10,631	2,748.35	OK
29-Nov-40	166.50	15.34	151.16	254.27	15.34	390.10	OK	510.30	509.28	507.67	12.80	518.86	OK	OK	287.6	980.0	10,538	2,724.38	OK
30-Nov-40	113.40	15.34	98.06	200.40	15.34	283.13	OK	461.44	460.42	458.81	62.90	520.10	OK	OK	299.0	1,019.6	10,685	2,762.35	OK
01-Dec-40	40.40	15.34	25.06	75.70	15.34	85.43	OK	236.59	235.57	233.96	103.60	335.95	OK	OK	148.8	501.5	8,335	2,154.88	OK
02-Dec-40	53.10	15.34	37.76	75.56	15.34	97.99	OK	170.69	169.67	168.06	52.70	219.15	OK	OK	56.5	187.1	5,903	1,526.06	OK
03-Dec-40	74.90	15.34	59.56	103.56	15.34	147.79	OK	174.00	172.98	171.37	8.40	178.16	OK	OK	48.7	161.1	5,602	1,448.17	OK
04-Dec-40	60.40	15.34	45.06	83.26	15.34	112.99	OK	137.56	136.54	134.93	3.20	136.52	OK	OK	34.5	113.5	4,955	1,281.12	OK
05-Dec-40	117.60	15.34	102.26	181.29	15.34	268.22	OK	353.87	352.85	351.24	4.50	354.12	OK	OK	154.4	520.7	8,445	2,183.41	OK
06-Dec-40	194.40	15.34	179.06	302.24	15.34	465.97	OK	626.11	625.09	623.48	8.30	630.16	OK	OK	420.1	1,440.8	12,060	3,117.78	OK
07-Dec-40	148.80	15.34	133.46	213.75	15.34	331.88	OK	467.84	466.82	465.21	66.20	529.79	OK	OK	257.6	876.1	10,133	2,619.59	OK
08-Dec-40	65.20	15.34	49.86	102.71	15.34	137.24	OK	248.78	247.76	246.15	64.40	308.94	OK	OK	110.9	371.9	7,507	1,940.89	OK
09-Dec-40	35.80	15.34	20.46	72.76	15.34	77.89	OK	147.86	146.84	145.23	9.70	153.31	OK	OK	53.0	175.3	5,770	1,491.64	OK
10-Dec-40	35.70	15.34	20.36	35.26	15.34	40.29	OK	58.00	56.98	55.37	5.40	59.16	OK	OK	11.6	37.3	3,356	867.71	OK
11-Dec-40	35.60	15.34	20.26	34.96	15.34	39.89	OK	53.15	52.13	50.52	13.70	62.61	OK	OK	10.6	34.1	3,253	841.13	OK
12-Dec-40	35.60	15.34	20.26	34.36	15.34	39.29	OK	51.23	50.21	48.60	13.50	60.48	OK	OK	10.3	33.0	3,217	831.65	OK
13-Dec-40	78.10	15.34	62.76	92.36	15.34	139.79	OK	148.76	147.74	146.13	-	144.52	OK	OK	41.3	136.2	5,282	1,365.56	OK
14-Dec-40	108.10	15.34	92.76	204.36	15.34	281.79	OK	413.07	412.05	410.44	59.90	468.72	OK	OK	228.9	776.8	9,715	2,511.59	OK
15-Dec-40	63.30	15.34	47.96	143.76	15.34	176.39	OK	304.70	303.68	302.07	60.90	361.36	OK	OK	165.8	559.6	8,661	2,239.23	OK
16-Dec-40	27.60	1.69	25.91	46.31	1.69	70.52	OK	88.30	87.28	87.28	6.40	92.07	OK	OK	9.7	31.3	3,157	816.30	OK
17-Dec-40	24.40	1.69	22.71	43.01	1.69	64.02	OK	88.43	87.41	87.41	16.70	102.50	OK	OK	10.4	33.6	3,237	836.83	OK
18-Dec-40	83.38	1.69	81.69	124.19	1.69	204.18	OK	231.48	230.46	230.46	24.70	253.55	OK	OK	55.7	184.5	5,874	1,518.52	OK
19-Dec-40	110.84	1.69	109.14	163.24	1.69	270.69	OK	311.64	310.62	310.62	35.80	344.81	OK	OK	96.2	321.8	7,137	1,845.05	OK
20-Dec-40	91.10	1.69	89.41	133.51	1.69	221.23	OK	247.43	246.41	246.41	22.40	267.20	OK	OK	63.4	210.6	6,152	1,590.60	OK
21-Dec-40	66.53	1.69	64.84	97.04	1.69	160.19	OK	175.08	174.06	174.06	-	172.45	OK	OK	34.0	111.7	4,927	1,273.82	OK
22-Dec-40	30.50	1.69	28.81	41.51	1.69	68.62	OK	80.63	79.61	79.61	3.60	81.60	OK	OK	8.0	25.7	2,946	761.65	OK
23-Dec-40	103.27	1.69	101.58	153.08	1.69	252.96	OK	294.30	293.28	293.28	30.50	322.17	OK	OK	86.3	287.9	6,864	1,774.56	OK
24-Dec-40	120.28	1.69	118.58	176.38	1.69	293.27	OK	331.02	330.00	330.00	26.90	355.29	OK	OK	108.6	363.9	7,450	1,926.12	OK
25-Dec-40	65.68	1.69	63.98	114.08	1.69	176.37	OK	222.55	221.53	221.53	23.00	242.92	OK	OK	53.4	176.8	5,787	1,496.15	OK
26-Dec-40	75.43	1.69	73.73	129.23	1.69	201.27	OK	247.45	246.43	246.43	23.00	267.82	OK	OK	64.3	213.5	6,181	1,598.06	OK
27-Dec-40	68.20	1.69	66.51	92.11	1.69	156.92	OK	173.22	172.20	172.20	-	170.59	OK	OK	33.2	109.1	4,887	1,263.36	OK
28-Dec-40	88.20	1.69	86.51	121.71	1.69	206.52	OK	223.37	222.35	222.35	0.60	221.34	OK	OK	54.0	178.7	5,809	1,501.72	OK
29-Dec-40	88.10	1.69	86.41	120.51	1.69	205.22	OK	219.34	218.32	218.32	0.60	217.31	OK	OK	52.9	175.0	5,766	1,490.82	OK
30-Dec-40	46.20	1.69	44.51	58.41	1.69	101.22	OK	111.83	110.81	110.81	0.20	109.40	OK	OK	15.1	48.9	3,690	954.10	OK
31-Dec-40	40.30	1.69	38.61	65.81	1.69	102.72	OK	131.34	130.32	130.32	6.40	135.11	OK	OK	20.0	65.0	4,078	1,054.26	OK

Appendix 6.7

WATER BALANCE SIMULATION OF THE KRUENG ACEH CATCHMENT

LULC Scenario II introduced Alternative I runs on inflow 2040 and water demand 2040 (in m^3/s)

DEMAND	Up	Down
Domestic	0.60	0.64
Non-Domestic	0.44	0.16
Water Losses	0.17	0.21
Min.Environmental Flow	2.18	1.61
Paddy Field	27.28	-

	Water Quantity														Water Quality at PDAM Tirta Daroy				
Date	Lampisang Sta			Darang Sta			Upstream	Pasie Sta			Sub Banda Aceh		Downstream	Upstream - Downstream	TSS (mg/l)	Turb (NTU)	Alum (kg/day)	Cost Alum (USD)	PDAM (Quantity & Quality)
	I_1	D_1	(I_1-D_1) R_1	I_2	D_2	$(R_1+I_2-D_2)$ R_2		I_3	$(R_2+I_3-D_{(D+ND+WL)})$ R_3	(R_3-D_{PF}) R_4	I_4	$(R_4+I_4-D_4)$ R_5			(R_2+I_3) = TSS (>2000) $0.000771*(R_2+I_3)^{2.899}$	Limit < 5 NTU $3.093*TSS^{1.017}$	5 NTU<Alum<2000 mg/l $1.2*(8.59*D_{(D+ND+WL)})^{0.35}$	(Alum*USD 0.259)	
RELIABILITY			**93.17%**			**93.44%**	**90.98%**		**99.18%**	**98.36%**		**96.99%**	**96.99%**	**90.98%**	**0.00%**	**15.30%**	**1,353,207.97**	**349,846.94**	**99.18%**
01-Jan-40	7.20	1.69	5.51	7.91	1.69	11.72	OK	20.82	19.80	19.80	2.30	20.49	OK	OK	0.8	2.4	-	-	OK
02-Jan-40	12.70	1.69	11.01	16.11	1.69	25.42	OK	33.42	32.40	32.40	0.70	31.49	OK	OK	1.3	4.1	-	-	OK
03-Jan-40	18.20	1.69	16.51	23.21	1.69	38.02	OK	45.12	44.10	44.10	0.30	42.79	OK	OK	2.2	6.8	1,854	479.43	OK
04-Jan-40	13.10	1.69	11.41	16.11	1.69	25.82	OK	32.72	31.70	31.70	0.70	30.79	OK	OK	1.3	4.0	-	-	OK
05-Jan-40	18.90	1.69	17.21	27.91	1.69	43.42	OK	84.02	83.00	83.00	14.80	96.19	OK	OK	10.0	32.2	3,188	824.09	OK
06-Jan-40	24.00	1.69	22.31	33.71	1.69	54.32	OK	97.42	96.40	96.40	15.10	109.89	OK	OK	12.0	38.8	3,403	879.71	OK
07-Jan-40	11.00	1.69	9.31	13.31	1.69	20.92	OK	29.02	28.00	28.00	1.50	27.89	OK	OK	1.1	3.4	-	-	OK
08-Jan-40	49.53	1.69	47.84	61.24	1.69	107.38	OK	114.98	113.96	113.96	0.40	112.75	OK	OK	12.3	39.9	3,436	888.34	OK
09-Jan-40	56.24	1.69	54.54	70.34	1.69	123.19	OK	134.59	133.57	133.57	0.70	132.66	OK	OK	16.1	52.2	3,775	976.02	OK
10-Jan-40	13.88	1.69	12.19	20.49	1.69	30.99	OK	49.19	48.17	48.17	2.40	48.96	OK	OK	3.0	9.5	2,082	538.25	OK
11-Jan-40	61.93	1.69	60.24	83.24	1.69	141.78	OK	162.58	161.56	161.56	1.80	161.75	OK	OK	21.7	70.8	4,200	1,085.82	OK
12-Jan-40	66.53	1.69	64.84	88.04	1.69	151.19	OK	165.99	164.97	164.97	1.30	164.66	OK	OK	23.2	75.7	4,301	1,112.00	OK
13-Jan-40	26.40	1.69	24.71	33.41	1.69	56.42	OK	66.22	65.20	65.20	1.20	64.79	OK	OK	4.3	13.6	2,356	609.22	OK
14-Jan-40	23.10	1.69	21.41	45.71	1.69	65.42	OK	115.10	114.08	114.08	13.70	126.17	OK	OK	16.7	54.0	3,822	988.10	OK
15-Jan-40	19.60	1.69	17.91	41.31	1.69	57.52	OK	107.91	106.89	106.89	13.70	118.98	OK	OK	16.1	52.1	3,773	975.36	OK
16-Jan-40	127.40	1.69	125.71	188.91	1.69	312.92	OK	334.84	333.82	333.82	1.40	333.61	OK	OK	86.8	289.9	6,881	1,778.85	OK
17-Jan-40	132.82	1.69	131.13	195.75	1.69	325.18	OK	345.62	344.60	344.60	0.90	343.89	OK	OK	92.8	310.2	7,045	1,821.48	OK
18-Jan-40	46.25	1.69	44.56	52.86	1.69	95.73	OK	103.43	102.41	102.41	0.30	101.10	OK	OK	10.4	33.6	3,238	837.06	OK
19-Jan-40	47.81	1.69	46.12	56.22	1.69	100.65	OK	109.75	108.73	108.73	0.50	107.62	OK	OK	11.4	36.7	3,337	862.68	OK
20-Jan-40	48.20	1.69	46.51	58.81	1.69	103.63	OK	114.83	113.81	113.81	0.60	112.80	OK	OK	12.0	38.7	3,401	879.20	OK
21-Jan-40	45.55	1.69	43.86	50.26	1.69	92.42	OK	100.02	99.00	99.00	0.20	97.59	OK	OK	10.0	32.2	3,189	824.55	OK
22-Jan-40	56.80	1.69	55.11	57.01	1.69	110.42	OK	111.82	110.80	110.80	-	109.19	OK	OK	14.4	46.8	3,633	939.27	OK
23-Jan-40	55.50	1.69	53.81	55.71	1.69	107.82	OK	108.92	107.90	107.90	-	106.29	OK	OK	13.8	44.7	3,576	924.60	OK
24-Jan-40	55.20	1.69	53.51	55.41	1.69	107.22	OK	108.02	107.00	107.00	-	105.39	OK	OK	13.7	44.2	3,563	921.14	OK
25-Jan-40	53.70	1.69	52.01	53.81	1.69	104.12	OK	104.72	103.70	103.70	-	102.09	OK	OK	13.0	41.9	3,497	904.07	OK
26-Jan-40	50.00	1.69	48.31	50.11	1.69	96.72	OK	97.22	96.20	96.20	-	94.59	OK	OK	11.3	36.5	3,332	861.52	OK
27-Jan-40	50.20	1.69	48.51	50.31	1.69	97.12	OK	97.42	96.40	96.40	-	94.79	OK	OK	11.4	36.8	3,341	863.81	OK
28-Jan-40	60.40	1.69	58.71	64.11	1.69	121.12	OK	122.32	121.30	121.30	-	119.69	OK	OK	16.4	53.1	3,798	982.01	OK
29-Jan-40	97.68	1.69	95.99	136.29	1.69	230.58	OK	241.38	240.36	240.36	0.10	238.85	OK	OK	48.5	160.2	5,591	1,445.41	OK
30-Jan-40	113.92	1.69	112.23	160.18	1.69	270.71	OK	307.81	306.79	306.79	8.20	313.38	OK	OK	70.9	235.9	6,401	1,654.96	OK
31-Jan-40	127.28	1.69	125.59	175.59	1.69	299.49	OK	331.47	330.45	330.45	8.20	337.03	OK	OK	82.9	276.4	6,767	1,749.41	OK
01-Feb-40	120.72	1.69	119.03	165.48	1.69	282.81	OK	309.10	308.08	308.08	2.70	309.17	OK	OK	73.5	244.7	6,484	1,676.31	OK
02-Feb-40	84.98	1.69	83.29	110.30	1.69	191.90	OK	213.58	212.56	212.56	3.50	214.45	OK	OK	36.8	121.1	5,068	1,310.32	OK
03-Feb-40	81.20	1.69	79.51	96.91	1.69	174.72	OK	182.92	181.90	181.90	0.90	181.19	OK	OK	30.3	99.3	4,729	1,222.68	OK
04-Feb-40	80.50	1.69	78.81	106.01	1.69	183.12	OK	205.12	204.10	204.10	0.40	202.89	OK	OK	33.9	111.3	4,921	1,272.33	OK
05-Feb-40	77.60	1.69	75.91	134.01	1.69	208.22	OK	294.62	293.60	293.60	27.40	319.39	OK	OK	73.1	243.2	6,470	1,672.73	OK
06-Feb-40	64.30	1.69	62.61	103.91	1.69	164.82	OK	244.12	243.10	243.10	27.20	268.69	OK	OK	53.3	176.3	5,781	1,494.64	OK
07-Feb-40	67.10	1.69	65.41	84.91	1.69	148.62	OK	162.82	161.80	161.80	2.50	162.69	OK	OK	22.7	74.1	4,267	1,103.27	OK
08-Feb-40	60.30	1.69	58.61	72.91	1.69	129.82	OK	140.32	139.30	139.30	0.90	138.59	OK	OK	17.8	57.7	3,912	1,011.26	OK
09-Feb-40	54.40	1.69	52.71	57.31	1.69	108.32	OK	116.12	115.10	115.10	0.20	113.69	OK	OK	13.7	44.4	3,568	922.40	OK
10-Feb-40	54.30	1.69	52.61	60.41	1.69	111.32	OK	121.42	120.40	120.40	0.20	118.99	OK	OK	14.1	45.6	3,602	931.27	OK
11-Feb-40	63.60	1.69	61.91	87.91	1.69	148.12	OK	182.44	181.42	181.42	8.70	188.51	OK	OK	26.7	87.2	4,519	1,168.26	OK
12-Feb-40	94.40	1.69	92.71	132.44	1.69	223.46	OK	278.91	277.89	277.89	11.90	288.18	OK	OK	58.9	195.3	5,992	1,549.15	OK

13-Feb-40	67.47	1.69	65.78	122.66	1.69	186.74	OK	270.24	269.22	269.22	28.80	296.41	OK	OK	64.4	213.9	6,185	1,599.10	OK
14-Feb-40	97.42	1.69	95.73	197.09	1.69	291.12	OK	382.57	381.55	381.55	26.50	406.43	OK	OK	119.0	399.6	7,698	1,990.16	OK
15-Feb-40	98.28	1.69	96.59	169.19	1.69	264.08	OK	326.78	325.76	325.76	2.70	326.85	OK	OK	81.2	270.7	6,717	1,736.58	OK
16-Feb-40	34.08	1.69	32.39	43.49	1.69	74.18	OK	89.28	88.26	88.26	0.80	87.45	OK	OK	7.3	23.3	2,846	735.65	OK
17-Feb-40	51.90	1.69	50.21	59.61	1.69	108.12	OK	119.42	118.40	118.40	0.40	117.19	OK	OK	13.3	42.9	3,526	911.65	OK
18-Feb-40	48.30	1.69	46.61	55.81	1.69	100.72	OK	109.22	108.20	108.20	0.20	106.79	OK	OK	11.4	36.9	3,343	864.29	OK
19-Feb-40	46.20	1.69	44.51	53.61	1.69	96.42	OK	102.82	101.80	101.80	-	100.19	OK	OK	10.4	33.5	3,233	835.74	OK
20-Feb-40	44.00	1.69	42.31	51.31	1.69	91.92	OK	96.72	95.70	95.70	-	94.09	OK	OK	9.4	30.3	3,122	807.23	OK
21-Feb-40	43.70	1.69	42.01	52.51	1.69	92.82	OK	98.72	97.70	97.70	0.10	96.19	OK	OK	9.5	30.6	3,134	810.16	OK
22-Feb-40	49.50	1.69	47.81	64.01	1.69	110.12	OK	124.32	123.30	123.30	2.40	124.09	OK	OK	13.5	43.5	3,543	915.95	OK
23-Feb-40	55.00	1.69	53.31	72.21	1.69	123.82	OK	139.12	138.10	138.10	2.40	138.89	OK	OK	16.5	53.6	3,812	985.42	OK
24-Feb-40	44.30	1.69	42.61	58.71	1.69	99.62	OK	116.42	115.40	115.40	3.40	117.19	OK	OK	11.7	37.8	3,373	872.03	OK
25-Feb-40	47.80	1.69	46.11	61.01	1.69	105.42	OK	118.82	117.80	117.80	3.30	119.49	OK	OK	12.4	40.2	3,445	890.71	OK
26-Feb-40	46.00	1.69	44.31	57.21	1.69	99.82	OK	109.92	108.90	108.90	0.30	107.59	OK	OK	11.1	35.6	3,303	854.02	OK
27-Feb-40	91.20	1.69	89.51	118.82	1.69	206.63	OK	235.63	234.61	234.61	3.30	236.30	OK	OK	43.5	143.6	5,381	1,391.17	OK
28-Feb-40	90.65	1.69	88.96	131.46	1.69	218.72	OK	260.12	259.10	259.10	6.20	263.69	OK	OK	51.2	169.5	5,702	1,474.04	OK
29-Feb-40	53.90	1.69	52.21	81.36	1.69	131.87	OK	166.67	165.65	165.65	4.30	168.34	OK	OK	22.8	74.3	4,273	1,104.69	OK
01-Mar-40	27.79	11.50	16.29	33.59	11.50	38.37	OK	55.97	54.95	53.34	1.20	52.93	OK	OK	6.8	21.6	2,774	717.09	OK
02-Mar-40	24.99	11.50	13.49	27.29	11.50	29.27	OK	42.17	41.15	39.54	0.40	38.33	OK	OK	4.9	15.5	2,467	637.88	OK
03-Mar-40	24.36	11.50	12.86	29.16	11.50	30.51	OK	43.01	41.99	40.38	0.40	39.17	OK	OK	5.0	16.0	2,498	645.77	OK
04-Mar-40	96.46	11.50	84.96	133.86	11.50	207.31	OK	230.21	229.19	227.58	3.00	228.97	OK	OK	52.8	174.8	5,764	1,490.13	OK
05-Mar-40	139.37	11.50	127.87	196.67	11.50	313.03	OK	339.53	338.51	336.90	3.00	338.29	OK	OK	103.4	346.2	7,321	1,892.79	OK
06-Mar-40	95.62	11.50	84.12	124.02	11.50	196.63	OK	256.93	255.91	254.30	38.90	291.59	OK	OK	62.3	206.7	6,112	1,580.08	OK
07-Mar-40	71.80	11.50	60.30	80.80	11.50	129.59	OK	189.69	188.67	187.06	39.10	224.55	OK	OK	40.6	133.8	5,249	1,357.06	OK
08-Mar-40	56.28	11.50	44.78	67.88	11.50	101.15	OK	116.05	115.03	113.42	3.50	115.31	OK	OK	17.9	58.2	3,921	1,013.83	OK
09-Mar-40	56.91	11.50	45.41	71.16	11.50	105.07	OK	130.57	129.55	127.94	1.60	127.93	OK	OK	20.8	67.8	4,138	1,069.75	OK
10-Mar-40	70.77	11.50	59.27	174.05	11.50	221.82	OK	291.14	290.12	288.51	5.50	292.40	OK	OK	97.7	327.0	7,176	1,855.31	OK
11-Mar-40	79.50	11.50	68.00	231.29	11.50	287.79	OK	373.19	372.17	370.56	21.70	390.65	OK	OK	165.7	559.2	8,659	2,238.64	OK
12-Mar-40	84.00	11.50	72.50	135.70	11.50	196.69	OK	266.92	265.90	264.29	44.90	307.58	OK	OK	69.5	231.2	6,356	1,643.25	OK
13-Mar-40	85.80	11.50	74.30	104.55	11.50	167.35	OK	212.05	211.03	209.42	27.90	235.71	OK	OK	45.0	148.7	5,446	1,408.05	OK
14-Mar-40	87.42	11.50	75.92	118.34	11.50	182.76	OK	243.16	242.14	240.53	26.10	265.02	OK	OK	57.1	189.4	5,928	1,532.65	OK
15-Mar-40	57.96	11.50	46.46	81.85	11.50	116.81	OK	185.71	184.69	183.08	26.50	207.96	OK	OK	41.6	137.2	5,296	1,369.16	OK
16-Mar-40	89.20	11.50	77.70	130.79	11.50	196.98	OK	221.38	220.36	218.75	3.70	220.84	OK	OK	49.5	163.8	5,634	1,456.47	OK
17-Mar-40	88.70	11.50	77.20	127.84	11.50	193.53	OK	213.93	212.91	211.30	1.40	211.09	OK	OK	47.2	156.1	5,540	1,432.21	OK
18-Mar-40	98.70	11.50	87.20	127.33	11.50	203.03	OK	221.53	220.51	218.90	1.50	218.78	OK	OK	50.3	166.4	5,666	1,464.71	OK
19-Mar-40	88.20	11.50	76.70	127.30	11.50	192.49	OK	219.69	218.67	217.06	1.60	217.05	OK	OK	48.4	159.9	5,586	1,444.23	OK
20-Mar-40	65.40	11.50	53.90	88.30	11.50	130.69	OK	153.99	152.97	151.36	0.70	150.45	OK	OK	27.0	88.5	4,542	1,174.21	OK
21-Mar-40	72.06	11.50	60.56	81.86	11.50	130.91	OK	148.41	147.39	145.78	-	144.17	OK	OK	26.4	86.4	4,504	1,164.49	OK
22-Mar-40	85.25	11.50	73.75	93.35	11.50	155.60	OK	169.30	168.28	166.67	-	165.06	OK	OK	34.0	111.8	4,930	1,274.46	OK
23-Mar-40	83.00	11.50	71.50	119.30	11.50	179.29	OK	234.99	233.97	232.36	1.60	232.35	OK	OK	53.9	178.4	5,805	1,500.83	OK
24-Mar-40	61.50	11.50	50.00	91.90	11.50	130.39	OK	188.79	187.77	186.16	6.40	190.95	OK	OK	40.0	131.9	5,222	1,350.16	OK
25-Mar-40	61.00	11.50	49.50	64.40	11.50	102.39	OK	124.39	123.37	121.76	4.80	124.95	OK	OK	20.0	65.1	4,080	1,054.85	OK
26-Mar-40	56.80	11.50	45.30	99.60	11.50	133.39	OK	198.79	197.77	196.16	1.90	196.45	OK	OK	46.5	153.5	5,507	1,423.79	OK
27-Mar-40	54.10	11.50	42.60	99.90	11.50	130.99	OK	218.29	217.27	215.66	17.50	231.55	OK	OK	60.4	200.3	6,046	1,562.96	OK
28-Mar-40	48.70	11.50	37.20	60.50	11.50	86.19	OK	162.59	161.57	159.96	43.40	201.75	OK	OK	38.7	127.5	5,161	1,334.17	OK
29-Mar-40	49.60	11.50	38.10	59.00	11.50	85.59	OK	135.79	134.77	133.16	27.80	159.35	OK	OK	24.7	80.7	4,397	1,136.76	OK
30-Mar-40	58.80	11.50	47.30	64.90	11.50	100.69	OK	121.79	120.77	119.16	-	117.55	OK	OK	19.1	62.3	4,016	1,038.26	OK
31-Mar-40	48.80	11.50	37.30	53.20	11.50	78.99	OK	94.79	93.77	92.16	-	90.55	OK	OK	13.3	43.2	3,533	913.28	OK
01-Apr-40	39.70	11.50	28.20	40.40	11.50	57.09	OK	68.29	67.27	65.66	-	64.05	OK	OK	8.7	28.0	3,037	785.18	OK
02-Apr-40	108.82	11.50	97.32	156.65	11.50	242.46	OK	267.06	266.04	264.43	-	262.82	OK	OK	68.1	226.5	6,311	1,631.62	OK
03-Apr-40	117.11	11.50	105.61	179.87	11.50	273.97	OK	300.57	299.55	297.94	-	296.33	OK	OK	84.3	281.4	6,809	1,760.40	OK
04-Apr-40	79.50	11.50	68.00	113.82	11.50	170.31	OK	190.11	189.09	187.48	0.30	186.17	OK	OK	38.8	127.8	5,166	1,335.45	OK
05-Apr-40	91.77	11.50	80.27	120.08	11.50	188.85	OK	213.85	212.83	211.22	8.30	217.91	OK	OK	46.2	152.6	5,496	1,420.98	OK
06-Apr-40	55.16	11.50	43.66	63.49	11.50	95.64	OK	110.84	109.82	108.21	8.80	115.40	OK	OK	16.8	54.4	3,830	990.29	OK
07-Apr-40	52.01	11.50	40.51	66.74	11.50	95.74	OK	111.84	110.82	109.21	1.30	108.90	OK	OK	16.8	54.6	3,836	991.63	OK
08-Apr-40	71.33	11.50	59.83	130.37	11.50	178.70	OK	256.70	255.68	254.07	2.70	255.16	OK	OK	70.3	233.8	6,381	1,649.69	OK
09-Apr-40	64.40	11.50	52.90	113.17	11.50	154.57	OK	223.07	222.05	220.44	2.40	221.23	OK	OK	55.0	182.1	5,847	1,511.69	OK
10-Apr-40	57.89	11.50	46.39	70.59	11.50	105.47	OK	214.83	213.81	212.20	111.50	322.09	OK	OK	67.8	225.4	6,300	1,628.73	OK
11-Apr-40	45.22	11.50	33.72	51.02	11.50	73.23	OK	180.09	179.07	177.46	111.40	287.25	OK	OK	58.7	194.7	5,985	1,547.42	OK
12-Apr-40	43.40	11.50	31.90	42.90	11.50	63.29	OK	76.89	75.87	74.26	-	72.65	OK	OK	10.2	32.9	3,214	830.81	OK
13-Apr-40	43.20	11.50	31.70	44.00	11.50	64.19	OK	78.19	77.17	75.56	1.70	75.65	OK	OK	10.4	33.4	3,228	834.52	OK
14-Apr-40	43.00	11.50	31.50	48.40	11.50	68.39	OK	102.49	101.47	99.86	14.70	112.95	OK	OK	15.4	49.9	3,717	960.90	OK
15-Apr-40	42.80	11.50	31.30	46.80	11.50	66.59	OK	95.19	94.17	92.56	13.00	103.95	OK	OK	13.6	43.8	3,552	918.20	OK
16-Apr-40	42.20	11.50	30.70	41.10	11.50	60.29	OK	64.49	63.47	61.86	-	60.25	OK	OK	8.9	28.5	3,054	789.56	OK

17-Apr-40	52.60	11.50	41.10	55.40	11.50	84.99	OK	97.59	96.57	94.96	8.30	101.65	OK	OK	14.3	46.4	3,622	936.52	OK
18-Apr-40	53.10	11.50	41.60	56.10	11.50	86.19	OK	102.29	101.27	99.66	11.70	109.75	OK	OK	15.1	48.8	3,688	953.53	OK
19-Apr-40	38.70	11.50	27.20	37.50	11.50	53.19	OK	59.29	58.27	56.66	3.40	58.45	OK	OK	7.7	24.7	2,907	751.56	OK
20-Apr-40	26.50	11.50	15.00	55.10	11.50	58.59	OK	99.89	98.87	97.26	1.50	97.15	OK	OK	18.7	60.8	3,982	1,029.46	OK
21-Apr-40	25.10	11.50	13.60	53.60	11.50	55.69	OK	96.59	95.57	93.96	1.50	93.85	OK	OK	18.2	59.1	3,943	1,019.35	OK
22-Apr-40	20.70	11.50	9.20	21.40	11.50	19.09	OK	23.19	22.17	20.56	0.50	19.45	OK	OK	3.0	9.4	2,074	536.21	OK
23-Apr-40	19.60	11.50	8.10	55.70	11.50	52.29	OK	102.99	101.97	100.36	2.00	100.75	OK	OK	23.8	77.8	4,341	1,122.36	OK
24-Apr-40	18.90	11.50	7.40	87.90	11.50	83.79	OK	168.16	167.14	165.53	5.00	168.92	OK	OK	60.3	200.0	6,042	1,561.95	OK
25-Apr-40	16.30	11.50	4.80	61.10	11.50	54.39	OK	123.35	122.33	120.72	3.40	122.50	OK	OK	36.3	119.5	5,046	1,304.44	OK
26-Apr-40	14.30	11.50	2.80	13.50	11.50	4.79	OK	17.69	16.67	15.06	0.80	14.25	OK	OK	2.5	7.9	1,950	504.17	OK
27-Apr-40	13.10	11.50	1.60	10.80	11.50	0.89	OK	9.39	8.37	6.76	0.20	5.35	OK	OK	1.7	5.4	1,708	441.45	OK
28-Apr-40	11.80	11.50	0.30	9.40	11.50	-	Fail	16.50	15.48	13.87	10.60	22.86	OK	Fail	2.5	8.0	1,959	506.53	OK
29-Apr-40	74.30	11.50	62.80	95.30	11.50	146.59	OK	167.49	166.47	164.86	10.60	173.85	OK	OK	31.1	102.2	4,776	1,234.76	OK
30-Apr-40	87.20	11.50	75.70	120.60	11.50	184.80	OK	196.90	195.88	194.27	-	192.66	OK	OK	42.5	140.2	5,336	1,379.41	OK
01-May-40	41.18	11.50	29.68	50.98	11.50	69.16	OK	76.46	75.44	73.83	1.80	74.02	OK	OK	10.3	33.3	3,227	834.22	OK
02-May-40	22.60	11.50	11.10	21.40	11.50	20.99	OK	25.49	24.47	22.86	1.80	23.05	OK	OK	3.2	10.0	2,120	548.10	OK
03-May-40	27.00	11.50	15.50	27.30	11.50	31.29	OK	33.69	32.67	31.06	-	29.45	OK	OK	4.3	13.5	2,355	608.73	OK
04-May-40	24.80	11.50	13.30	24.10	11.50	25.89	OK	35.79	34.77	33.16	8.40	39.95	OK	OK	4.1	13.1	2,325	601.06	OK
05-May-40	92.90	11.50	81.40	116.50	11.50	186.39	OK	201.09	200.07	198.46	8.40	205.25	OK	OK	43.6	143.7	5,382	1,391.48	OK
06-May-40	93.80	11.50	82.30	116.60	11.50	187.39	OK	223.49	222.47	220.86	25.40	244.65	OK	OK	49.0	161.9	5,612	1,450.75	OK
07-May-40	22.80	11.50	11.30	19.60	11.50	19.39	OK	49.79	48.77	47.16	25.40	70.95	OK	OK	7.3	23.4	2,851	737.12	OK
08-May-40	22.20	11.50	10.70	73.80	11.50	72.99	OK	146.19	145.17	143.56	2.70	144.65	OK	OK	43.3	143.0	5,372	1,388.92	OK
09-May-40	22.30	11.50	10.80	73.80	11.50	73.09	OK	146.19	145.17	143.56	2.70	144.65	OK	OK	43.2	142.7	5,368	1,387.86	OK
10-May-40	43.80	11.50	32.30	46.70	11.50	67.49	OK	74.69	73.67	72.06	-	70.45	OK	OK	10.1	32.6	3,203	828.17	OK
11-May-40	53.40	11.50	41.90	80.20	11.50	110.59	OK	143.99	142.97	141.36	1.00	140.75	OK	OK	24.9	81.3	4,409	1,139.95	OK
12-May-40	70.60	11.50	59.10	109.40	11.50	156.99	OK	195.89	194.87	193.26	1.30	192.95	OK	OK	40.2	132.6	5,232	1,352.65	OK
13-May-40	85.00	11.50	73.50	106.10	11.50	168.09	OK	180.09	179.07	177.46	0.30	176.15	OK	OK	36.8	120.9	5,066	1,309.79	OK
14-May-40	53.50	11.50	42.00	57.70	11.50	88.19	OK	94.69	93.67	92.06	-	90.45	OK	OK	14.3	46.4	3,624	937.01	OK
15-May-40	32.30	1.69	30.61	39.81	1.69	68.72	OK	73.62	72.60	72.60	-	70.99	OK	OK	5.5	17.6	2,580	667.00	OK
16-May-40	61.90	1.69	60.21	80.31	1.69	138.82	OK	148.82	147.80	147.80	3.40	149.59	OK	OK	19.5	63.5	4,043	1,045.17	OK
17-May-40	64.40	1.69	62.71	120.41	1.69	181.42	OK	202.62	201.60	201.60	6.80	206.79	OK	OK	35.3	116.2	4,996	1,291.72	OK
18-May-40	52.40	1.69	50.71	101.21	1.69	150.22	OK	165.42	164.40	164.40	3.40	166.19	OK	OK	25.1	81.9	4,421	1,142.89	OK
19-May-40	50.70	1.69	49.01	61.81	1.69	109.12	OK	115.72	114.70	114.70	-	113.09	OK	OK	12.7	41.0	3,471	897.28	OK
20-May-40	31.10	1.69	29.41	36.61	1.69	64.32	OK	68.22	67.20	67.20	-	65.59	OK	OK	5.0	15.8	2,484	642.11	OK
21-May-40	30.90	1.69	29.21	36.31	1.69	63.82	OK	66.72	65.70	65.70	-	64.09	OK	OK	4.9	15.4	2,465	637.40	OK
22-May-40	33.70	1.69	32.01	40.61	1.69	70.92	OK	100.32	99.30	99.30	22.80	120.49	OK	OK	9.9	31.7	3,172	820.13	OK
23-May-40	29.30	1.69	27.61	36.21	1.69	62.12	OK	97.22	96.20	96.20	28.00	122.59	OK	OK	10.3	33.1	3,218	831.91	OK
24-May-40	26.20	1.69	24.51	39.61	1.69	62.42	OK	113.02	112.00	112.00	31.40	141.79	OK	OK	16.0	52.0	3,772	975.06	OK
25-May-40	25.70	1.69	24.01	39.01	1.69	61.32	OK	129.62	128.60	128.60	47.10	174.09	OK	OK	24.8	81.0	4,404	1,138.49	OK
26-May-40	25.80	1.69	24.11	30.81	1.69	53.22	OK	78.12	77.10	77.10	20.90	96.39	OK	OK	6.5	20.7	2,730	705.86	OK
27-May-40	25.20	1.69	23.51	32.71	1.69	54.52	OK	66.62	65.60	65.60	8.80	72.79	OK	OK	4.3	13.6	2,359	609.90	OK
28-May-40	44.36	1.69	42.67	129.97	1.69	170.94	OK	216.34	215.32	215.32	19.60	233.31	OK	OK	51.0	168.8	5,694	1,471.98	OK
29-May-40	49.04	1.69	47.35	132.05	1.69	177.70	OK	211.50	210.48	210.48	10.80	219.67	OK	OK	47.0	155.4	5,532	1,430.16	OK
30-May-40	53.82	1.69	52.13	77.83	1.69	128.26	OK	160.36	159.34	159.34	23.10	180.83	OK	OK	21.1	68.7	4,156	1,074.46	OK
31-May-40	53.82	1.69	52.13	77.73	1.69	128.16	OK	164.36	163.34	163.34	26.60	188.33	OK	OK	22.3	72.7	4,241	1,096.31	OK
01-Jun-40	37.40	1.69	35.71	42.01	1.69	76.02	OK	82.72	81.70	81.70	4.40	84.49	OK	OK	7.0	22.3	2,805	725.17	OK
02-Jun-40	36.20	1.69	34.51	40.81	1.69	73.62	OK	75.52	74.50	74.50	0.30	73.19	OK	OK	6.4	20.3	2,714	701.68	OK
03-Jun-40	32.00	1.69	30.31	108.75	1.69	137.37	OK	234.40	233.38	233.38	4.70	236.47	OK	OK	71.3	237.2	6,414	1,658.19	OK
04-Jun-40	25.70	1.69	24.01	102.37	1.69	124.69	OK	221.48	220.46	220.46	4.70	223.55	OK	OK	69.4	230.8	6,353	1,642.47	OK
05-Jun-40	26.10	1.69	24.41	30.51	1.69	53.22	OK	87.93	86.91	86.91	37.80	123.10	OK	OK	9.1	29.4	3,088	798.38	OK
06-Jun-40	25.90	1.69	24.21	30.21	1.69	52.72	OK	93.59	92.57	92.57	46.40	137.36	OK	OK	11.2	35.9	3,314	856.69	OK
07-Jun-40	25.90	1.69	24.21	39.11	1.69	61.62	OK	93.21	92.19	92.19	24.50	115.08	OK	OK	9.1	29.2	3,082	796.90	OK
08-Jun-40	25.70	1.69	24.01	38.81	1.69	61.12	OK	95.52	94.50	94.50	17.70	110.59	OK	OK	9.9	31.7	3,173	820.23	OK
09-Jun-40	25.30	1.69	23.61	29.41	1.69	51.32	OK	62.82	61.80	61.80	4.30	64.49	OK	OK	4.0	12.6	2,297	593.74	OK
10-Jun-40	25.30	1.69	23.61	29.31	1.69	51.22	OK	59.82	58.80	58.80	2.00	59.19	OK	OK	3.7	11.6	2,233	577.41	OK
11-Jun-40	49.70	1.69	48.01	60.81	1.69	107.12	OK	113.92	112.90	112.90	0.10	111.39	OK	OK	12.3	39.7	3,430	886.68	OK
12-Jun-40	50.60	1.69	48.91	62.11	1.69	109.32	OK	115.52	114.50	114.50	-	112.89	OK	OK	12.7	41.0	3,469	896.79	OK
13-Jun-40	26.80	1.69	25.11	33.41	1.69	56.82	OK	63.32	62.30	62.30	0.20	60.89	OK	OK	4.1	12.9	2,314	598.17	OK
14-Jun-40	22.40	1.69	20.71	28.51	1.69	47.52	OK	52.62	51.60	51.60	0.20	50.19	OK	OK	2.9	9.3	2,061	532.92	OK
15-Jun-40	13.00	1.69	11.31	20.71	1.69	30.32	OK	36.92	35.90	35.90	-	34.29	OK	OK	1.6	5.0	-	-	OK
16-Jun-40	11.80	1.69	10.11	15.51	1.69	23.92	OK	33.12	32.10	32.10	-	30.49	OK	OK	1.3	4.2	-	-	OK
17-Jun-40	7.30	1.69	5.61	14.61	1.69	18.52	OK	24.02	23.00	23.00	0.20	21.59	OK	OK	0.9	2.8	-	-	OK
18-Jun-40	8.50	1.69	6.81	15.71	1.69	20.82	OK	26.12	25.10	25.10	0.20	23.69	OK	OK	1.0	3.0	-	-	OK
19-Jun-40	12.50	1.69	10.81	17.61	1.69	26.72	OK	27.72	26.70	26.70	-	25.09	OK	OK	1.1	3.3	-	-	OK

20-Jun-40	94.10	1.69	92.41	150.91	1.69	241.62	OK	279.72	278.70	278.70	1.10	278.19	OK	OK	59.6	197.6	6,017	1,555.49	OK
21-Jun-40	95.20	1.69	93.51	151.01	1.69	242.82	OK	280.62	279.60	279.60	1.10	279.09	OK	OK	59.8	198.5	6,026	1,557.79	OK
22-Jun-40	17.10	1.69	15.41	21.11	1.69	34.82	OK	38.52	37.50	37.50	-	35.89	OK	OK	1.7	5.4	1,709	441.82	OK
23-Jun-40	14.30	1.69	12.61	17.61	1.69	28.52	OK	31.12	30.10	30.10	-	28.49	OK	OK	1.2	3.8	-	-	OK
24-Jun-40	14.40	1.69	12.71	17.61	1.69	28.62	OK	30.62	29.60	29.60	-	27.99	OK	OK	1.2	3.8	-	-	OK
25-Jun-40	14.30	1.69	12.61	17.51	1.69	28.42	OK	29.92	28.90	28.90	-	27.29	OK	OK	1.2	3.7	-	-	OK
26-Jun-40	14.20	1.69	12.51	17.31	1.69	28.12	OK	29.22	28.20	28.20	-	26.59	OK	OK	1.2	3.6	-	-	OK
27-Jun-40	41.30	1.69	39.61	52.41	1.69	90.32	OK	93.22	92.20	92.20	-	90.59	OK	OK	8.8	28.1	3,041	786.27	OK
28-Jun-40	41.90	1.69	40.21	52.91	1.69	91.42	OK	94.12	93.10	93.10	-	91.49	OK	OK	9.0	28.8	3,066	792.59	OK
29-Jun-40	14.00	1.69	12.31	17.01	1.69	27.62	OK	28.12	27.10	27.10	-	25.49	OK	OK	1.1	3.5	-	-	OK
30-Jun-40	14.20	1.69	12.51	17.11	1.69	27.92	OK	28.22	27.20	27.20	-	25.59	OK	OK	1.2	3.6	-	-	OK
01-Jul-40	14.00	1.69	12.31	16.91	1.69	27.52	OK	40.02	39.00	39.00	13.00	50.39	OK	OK	1.9	4.8	-	-	OK
02-Jul-40	14.00	1.69	12.31	16.81	1.69	27.42	OK	39.92	38.90	38.90	13.00	50.29	OK	OK	1.9	4.9	-	-	OK
03-Jul-40	13.90	1.69	12.21	18.51	1.69	29.02	OK	31.52	30.50	30.50	1.20	30.09	OK	OK	1.3	3.9	-	-	OK
04-Jul-40	13.90	1.69	12.21	18.51	1.69	29.02	OK	31.42	30.40	30.40	0.50	29.29	OK	OK	1.2	3.9	-	-	OK
05-Jul-40	13.80	1.69	12.11	16.51	1.69	26.92	OK	27.02	26.00	26.00	0.10	24.49	OK	OK	1.1	3.4	-	-	OK
06-Jul-40	13.60	1.69	11.91	16.21	1.69	26.42	OK	26.52	25.50	25.50	-	23.89	OK	OK	1.1	3.3	-	-	OK
07-Jul-40	11.70	1.69	10.01	14.31	1.69	22.62	OK	30.82	29.80	29.80	8.60	36.79	OK	OK	1.2	3.7	-	-	OK
08-Jul-40	8.90	1.69	7.21	12.11	1.69	17.62	OK	38.32	37.30	37.30	21.70	57.39	OK	OK	2.7	8.4	1,995	515.71	OK
09-Jul-40	110.70	1.69	109.01	149.61	1.69	256.92	OK	276.92	275.90	275.90	13.00	287.29	OK	OK	60.8	201.7	6,060	1,566.61	OK
10-Jul-40	112.20	1.69	110.51	150.41	1.69	259.22	OK	267.12	266.10	266.10	1.80	266.29	OK	OK	60.2	199.8	6,039	1,561.40	OK
11-Jul-40	14.90	1.69	13.21	17.31	1.69	28.82	OK	30.72	29.70	29.70	0.90	28.99	OK	OK	1.3	3.9	-	-	OK
12-Jul-40	14.20	1.69	12.51	16.61	1.69	27.42	OK	28.52	27.50	27.50	0.10	25.99	OK	OK	1.1	3.5	-	-	OK
13-Jul-40	14.30	1.69	12.61	16.61	1.69	27.52	OK	28.32	27.30	27.30	-	25.69	OK	OK	1.1	3.6	-	-	OK
14-Jul-40	13.70	1.69	12.01	31.61	1.69	41.92	OK	68.02	67.00	67.00	4.40	69.79	OK	OK	6.2	19.7	2,683	693.68	OK
15-Jul-40	12.00	1.69	10.31	36.21	1.69	44.82	OK	96.32	95.30	95.30	8.80	102.49	OK	OK	16.0	51.7	3,764	973.13	OK
16-Jul-40	12.40	1.69	10.71	21.01	1.69	30.02	OK	55.82	54.80	54.80	4.40	57.59	OK	OK	4.6	14.5	2,414	624.04	OK
17-Jul-40	14.40	1.69	12.71	36.51	1.69	47.52	OK	73.02	72.00	72.00	0.90	71.29	OK	OK	7.0	22.3	2,803	724.67	OK
18-Jul-40	14.50	1.69	12.81	36.81	1.69	47.92	OK	73.62	72.60	72.60	0.90	71.89	OK	OK	7.1	22.6	2,818	728.55	OK
19-Jul-40	12.30	1.69	10.61	14.61	1.69	23.52	OK	28.42	27.40	27.40	-	25.79	OK	OK	1.0	3.1	-	-	OK
20-Jul-40	12.20	1.69	10.51	21.31	1.69	30.12	OK	43.12	42.10	42.10	0.50	40.99	OK	OK	2.3	7.1	1,879	485.76	OK
21-Jul-40	14.40	1.69	12.71	24.21	1.69	35.22	OK	47.52	46.50	46.50	0.50	45.39	OK	OK	2.5	8.0	1,958	506.17	OK
22-Jul-40	25.50	1.69	23.81	32.01	1.69	54.12	OK	58.92	57.90	57.90	-	56.29	OK	OK	3.6	11.5	2,225	575.24	OK
23-Jul-40	23.80	1.69	22.11	29.61	1.69	50.02	OK	53.72	52.70	52.70	-	51.09	OK	OK	3.1	9.9	2,112	546.11	OK
24-Jul-40	12.90	1.69	11.21	14.81	1.69	24.32	OK	26.42	25.40	25.40	-	23.79	OK	OK	1.0	3.0	-	-	OK
25-Jul-40	12.80	1.69	11.11	15.11	1.69	24.52	OK	26.72	25.70	25.70	-	24.09	OK	OK	1.0	3.0	-	-	OK
26-Jul-40	10.70	1.69	9.01	13.01	1.69	20.32	OK	22.22	21.20	21.20	-	19.59	OK	OK	0.7	2.2	-	-	OK
27-Jul-40	4.70	1.69	3.01	6.51	1.69	7.82	OK	8.72	7.70	7.70	-	6.09	OK	OK	0.2	0.6	-	-	OK
28-Jul-40	6.10	1.69	4.41	7.81	1.69	10.52	OK	11.22	10.20	10.20	-	8.59	OK	OK	0.3	0.8	-	-	OK
29-Jul-40	5.60	1.69	3.91	7.31	1.69	9.52	OK	10.02	9.00	9.00	-	7.39	OK	OK	0.2	0.7	-	-	OK
30-Jul-40	5.70	1.69	4.01	7.41	1.69	9.72	OK	10.12	9.10	9.10	-	7.49	OK	OK	0.3	0.8	-	-	OK
31-Jul-40	5.60	1.69	3.91	7.21	1.69	9.42	OK	9.72	8.70	8.70	-	7.09	OK	OK	0.2	0.7	-	-	OK
01-Aug-40	24.60	1.69	22.91	31.71	1.69	52.92	OK	54.52	53.50	53.50	-	51.89	OK	OK	3.4	10.7	2,165	559.64	OK
02-Aug-40	25.30	1.69	23.61	32.31	1.69	54.22	OK	55.72	54.70	54.70	-	53.09	OK	OK	3.5	11.1	2,198	568.38	OK
03-Aug-40	6.80	1.69	5.11	8.51	1.69	11.92	OK	12.22	11.20	11.20	-	9.59	OK	OK	0.3	1.0	-	-	OK
04-Aug-40	13.20	1.69	11.51	22.71	1.69	32.52	OK	40.52	39.50	39.50	0.30	38.19	OK	OK	1.9	6.0	1,767	456.92	OK
05-Aug-40	13.50	1.69	11.81	22.71	1.69	32.82	OK	40.52	39.50	39.50	0.30	38.19	OK	OK	1.9	5.9	1,761	455.37	OK
06-Aug-40	39.50	1.69	37.81	52.61	1.69	88.72	OK	91.32	90.30	90.30	-	88.69	OK	OK	8.4	26.9	2,994	774.03	OK
07-Aug-40	42.90	1.69	41.21	56.71	1.69	96.22	OK	99.02	98.00	98.00	-	96.39	OK	OK	9.7	31.3	3,156	815.85	OK
08-Aug-40	13.30	1.69	11.61	16.01	1.69	25.92	OK	26.72	25.70	25.70	-	24.09	OK	OK	1.0	3.2	-	-	OK
09-Aug-40	10.40	1.69	8.71	20.01	1.69	27.02	OK	37.72	36.70	36.70	0.50	35.59	OK	OK	1.8	5.8	1,747	451.73	OK
10-Aug-40	8.40	1.69	6.71	17.21	1.69	22.22	OK	32.62	31.60	31.60	0.50	30.49	OK	OK	1.5	4.8	-	-	OK
11-Aug-40	40.90	1.69	39.21	53.81	1.69	91.32	OK	94.02	93.00	93.00	-	91.39	OK	OK	8.9	28.4	3,052	789.16	OK
12-Aug-40	107.45	1.69	105.76	160.06	1.69	264.12	OK	275.12	274.10	274.10	-	272.49	OK	OK	62.2	206.6	6,111	1,579.81	OK
13-Aug-40	93.17	1.69	91.48	136.38	1.69	226.16	OK	235.26	234.24	234.24	-	232.63	OK	OK	46.5	153.8	5,511	1,424.71	OK
14-Aug-40	49.98	1.69	48.29	69.99	1.69	116.58	OK	120.78	119.76	119.76	-	118.15	OK	OK	13.7	44.4	3,567	922.20	OK
15-Aug-40	70.98	1.69	69.29	101.29	1.69	168.88	OK	193.28	192.26	192.26	15.20	205.85	OK	OK	29.7	97.5	4,698	1,214.66	OK
16-Aug-40	45.43	1.69	43.74	61.44	1.69	103.48	OK	125.08	124.06	124.06	15.20	137.65	OK	OK	13.3	43.0	3,527	911.95	OK
17-Aug-40	35.10	1.69	33.41	40.11	1.69	71.82	OK	74.22	73.20	73.20	-	71.59	OK	OK	6.1	19.3	2,667	689.38	OK
18-Aug-40	34.70	1.69	33.01	41.91	1.69	73.22	OK	79.92	78.90	78.90	0.30	77.59	OK	OK	6.3	20.2	2,708	700.02	OK
19-Aug-40	33.60	1.69	31.91	52.31	1.69	82.52	OK	101.12	100.10	100.10	0.90	99.39	OK	OK	9.1	29.2	3,082	796.90	OK
20-Aug-40	34.10	1.69	32.41	50.01	1.69	80.72	OK	113.22	112.20	112.20	16.00	126.59	OK	OK	12.0	38.8	3,402	879.57	OK
21-Aug-40	36.20	1.69	34.51	63.81	1.69	96.62	OK	145.92	144.90	144.90	16.40	159.69	OK	OK	21.2	69.2	4,167	1,077.29	OK
22-Aug-40	34.30	1.69	32.61	61.81	1.69	92.72	OK	171.92	170.90	170.90	41.60	210.89	OK	OK	36.7	120.7	5,063	1,308.96	OK

23-Aug-40	27.20	1.69	25.51	29.91	1.69	53.72	OK	103.32	102.30	102.30	40.60	141.29	OK	OK	14.8	48.0	3,665	947.60	OK
24-Aug-40	25.00	1.69	23.31	38.91	1.69	60.52	OK	77.82	76.80	76.80	3.70	78.89	OK	OK	5.8	18.4	2,621	677.69	OK
25-Aug-40	25.40	1.69	23.71	142.21	1.69	164.22	OK	284.57	283.55	283.55	7.70	289.64	OK	OK	121.4	407.5	7,751	2,003.91	OK
26-Aug-40	27.30	1.69	25.61	132.61	1.69	156.52	OK	264.31	263.29	263.29	6.40	268.08	OK	OK	100.2	335.4	7,241	1,871.92	OK
27-Aug-40	46.40	1.69	44.71	54.31	1.69	97.32	OK	112.42	111.40	111.40	3.60	113.39	OK	OK	11.5	37.0	3,347	865.19	OK
28-Aug-40	74.10	1.69	72.41	93.51	1.69	164.22	OK	182.12	181.10	181.10	4.60	184.09	OK	OK	27.7	90.6	4,580	1,183.98	OK
29-Aug-40	85.20	1.69	83.51	110.71	1.69	192.52	OK	206.82	205.80	205.80	2.00	206.19	OK	OK	35.7	117.5	5,016	1,296.67	OK
30-Aug-40	53.30	1.69	51.61	72.11	1.69	122.02	OK	136.72	135.70	135.70	1.20	135.29	OK	OK	16.0	51.7	3,764	973.08	OK
31-Aug-40	24.30	1.69	22.61	32.11	1.69	53.02	OK	64.02	63.00	63.00	0.40	61.79	OK	OK	4.0	12.6	2,298	594.20	OK
01-Sep-40	18.00	11.50	6.50	15.00	11.50	9.99	OK	18.29	17.27	15.66	-	14.05	OK	OK	2.4	7.5	1,914	494.87	OK
02-Sep-40	14.50	11.50	3.00	71.80	11.50	63.29	OK	131.67	130.65	129.04	4.10	131.53	OK	OK	42.3	139.5	5,326	1,377.02	OK
03-Sep-40	20.40	11.50	8.90	116.50	11.50	113.89	OK	218.77	217.75	216.14	6.00	220.53	OK	OK	96.7	323.6	7,150	1,848.51	OK
04-Sep-40	20.30	11.50	8.80	57.30	11.50	54.59	OK	97.26	96.24	94.63	2.00	95.02	OK	OK	21.1	68.7	4,156	1,074.58	OK
05-Sep-40	14.10	11.50	2.60	16.30	11.50	7.39	OK	41.99	40.97	39.36	19.70	57.45	OK	OK	7.6	24.4	2,892	747.58	OK
06-Sep-40	13.70	11.50	2.20	16.30	11.50	6.99	OK	41.49	40.47	38.86	19.70	56.95	OK	OK	7.6	24.3	2,887	746.50	OK
07-Sep-40	13.40	11.50	1.90	11.30	11.50	1.69	OK	15.99	14.97	13.36	1.80	13.55	OK	OK	2.4	7.7	1,931	499.33	OK
08-Sep-40	13.00	11.50	1.50	9.30	11.50	-	Fail	8.30	7.28	5.67	0.50	4.56	OK	Fail	1.5	4.7	-	-	OK
09-Sep-40	13.00	11.50	1.50	8.20	11.50	-	Fail	6.20	5.18	3.57	0.10	2.06	OK	Fail	1.3	4.2	-	-	OK
10-Sep-40	12.90	11.50	1.40	8.10	11.50	-	Fail	4.70	3.68	2.07	-	0.46	OK	Fail	1.2	3.8	-	-	OK
11-Sep-40	12.90	11.50	1.40	8.00	11.50	-	Fail	3.50	2.48	0.87	-	-	Fail	Fail	1.2	3.6	-	-	OK
12-Sep-40	12.70	11.50	1.20	7.70	11.50	-	Fail	2.60	1.58	-	-	-	Fail	Fail	1.1	3.4	-	-	OK
13-Sep-40	12.20	11.50	0.70	7.40	11.50	-	Fail	2.20	1.18	-	-	-	Fail	Fail	1.1	3.3	-	-	OK
14-Sep-40	29.40	11.50	17.90	30.00	11.50	36.39	OK	39.49	38.47	36.86	-	35.25	OK	OK	4.9	15.7	2,481	641.31	OK
15-Sep-40	68.70	11.50	57.20	83.50	11.50	129.19	OK	138.89	137.87	136.26	3.50	138.15	OK	OK	24.5	80.1	4,386	1,133.97	OK
16-Sep-40	52.50	11.50	41.00	62.40	11.50	91.89	OK	100.19	99.17	97.56	3.50	99.45	OK	OK	15.0	48.7	3,685	952.79	OK
17-Sep-40	13.20	11.50	1.70	8.60	11.50	-	Fail	6.00	4.98	3.37	-	1.76	OK	Fail	1.4	4.2	-	-	OK
18-Sep-40	10.50	11.50	-	6.10	11.50	-	Fail	4.60	3.58	1.97	-	0.36	OK	Fail	0.9	2.8	-	-	OK
19-Sep-40	10.60	11.50	-	6.30	11.50	-	Fail	3.60	2.58	0.97	-	-	Fail	Fail	0.9	2.8	-	-	OK
20-Sep-40	10.40	11.50	-	6.20	11.50	-	Fail	0.50	-	-	-	-	Fail	Fail	0.8	2.4	-	-	Fail
21-Sep-40	9.90	11.50	-	5.90	11.50	-	Fail	0.20	-	-	-	-	Fail	Fail	0.7	2.2	-	-	Fail
22-Sep-40	10.00	11.50	-	5.90	11.50	-	Fail	0.20	-	-	-	-	Fail	Fail	0.7	2.2	-	-	Fail
23-Sep-40	9.90	11.50	-	5.80	11.50	-	Fail	3.10	2.08	0.47	-	-	Fail	Fail	0.8	2.4	-	-	OK
24-Sep-40	9.80	11.50	-	5.70	11.50	-	Fail	2.10	1.08	-	-	-	Fail	Fail	0.7	2.2	-	-	OK
25-Sep-40	9.80	11.50	-	7.10	11.50	-	Fail	104.21	103.19	101.58	114.90	214.87	OK	Fail	46.4	153.3	5,505	1,423.28	OK
26-Sep-40	9.70	11.50	-	7.00	11.50	-	Fail	125.19	124.17	122.56	138.60	259.55	OK	Fail	65.4	217.4	6,221	1,608.25	OK
27-Sep-40	9.70	11.50	-	5.60	11.50	-	Fail	39.40	38.38	36.77	36.90	72.06	OK	Fail	7.9	25.2	2,927	756.69	OK
28-Sep-40	9.60	11.50	-	5.50	11.50	-	Fail	15.80	14.78	13.17	15.10	26.66	OK	Fail	1.9	6.0	1,775	458.81	OK
29-Sep-40	9.50	11.50	-	5.40	11.50	-	Fail	11.80	10.78	9.17	4.70	12.26	OK	Fail	1.4	4.3	-	-	OK
30-Sep-40	9.50	11.50	-	27.40	11.50	15.90	Fail	52.50	51.48	49.87	1.90	50.16	OK	Fail	10.3	33.3	3,226	833.95	OK
01-Oct-40	9.00	11.50	-	28.10	11.50	16.60	Fail	52.30	51.28	49.67	1.30	49.36	OK	Fail	10.2	32.8	3,208	829.36	OK
02-Oct-40	7.00	11.50	-	6.00	11.50	-	Fail	14.50	13.48	11.87	0.10	10.36	OK	Fail	1.5	4.8	-	-	OK
03-Oct-40	4.80	11.50	-	5.20	11.50	-	Fail	10.20	9.18	7.57	-	5.96	OK	Fail	0.8	2.6	-	-	OK
04-Oct-40	5.20	11.50	-	30.20	11.50	18.70	Fail	59.40	58.38	56.77	1.20	56.36	OK	Fail	12.1	39.2	3,415	882.99	OK
05-Oct-40	5.00	11.50	-	78.40	11.50	66.90	Fail	169.70	168.68	167.07	3.70	169.16	OK	Fail	71.2	236.8	6,410	1,657.27	OK
06-Oct-40	53.90	11.50	42.40	114.80	11.50	145.69	OK	219.29	218.27	216.66	2.60	217.65	OK	OK	59.5	197.2	6,012	1,554.40	OK
07-Oct-40	55.80	11.50	44.30	68.40	11.50	101.19	OK	111.39	110.37	108.76	0.30	107.45	OK	OK	17.3	56.2	3,875	1,001.77	OK
08-Oct-40	8.40	11.50	-	4.90	11.50	-	Fail	3.60	2.58	0.97	0.10	-	Fail	Fail	0.6	1.8	-	-	OK
09-Oct-40	8.00	11.50	-	4.90	11.50	-	Fail	3.20	2.18	0.57	0.50	-	Fail	Fail	0.5	1.7	-	-	OK
10-Oct-40	8.10	11.50	-	12.70	11.50	1.20	Fail	14.20	13.18	11.57	0.90	10.86	OK	Fail	2.1	6.5	1,819	470.24	OK
11-Oct-40	8.00	11.50	-	12.80	11.50	1.30	Fail	13.50	12.48	10.87	0.50	9.76	OK	Fail	2.0	6.2	1,789	462.42	OK
12-Oct-40	8.00	11.50	-	33.00	11.50	21.50	Fail	60.10	59.08	57.47	1.40	57.26	OK	Fail	12.4	40.0	3,441	889.63	OK
13-Oct-40	7.90	11.50	-	34.60	11.50	23.10	Fail	63.50	62.48	60.87	1.50	60.76	OK	Fail	13.5	43.7	3,547	916.98	OK
14-Oct-40	62.20	11.50	50.70	76.50	11.50	115.69	OK	122.89	121.87	120.26	0.20	118.85	OK	OK	20.6	67.2	4,124	1,066.25	OK
15-Oct-40	94.20	11.50	82.70	115.30	11.50	186.49	OK	289.14	288.12	286.51	109.00	393.90	OK	OK	87.0	290.5	6,886	1,780.15	OK
16-Oct-40	42.80	11.50	31.30	56.10	11.50	75.89	OK	206.23	205.21	203.60	131.30	333.29	OK	OK	81.2	270.8	6,718	1,736.78	OK
17-Oct-40	13.40	11.50	1.90	17.90	11.50	8.29	OK	40.82	39.80	38.19	23.70	60.28	OK	OK	7.2	23.1	2,839	733.87	OK
18-Oct-40	40.50	11.50	29.00	41.50	11.50	58.99	OK	79.51	78.49	76.88	20.70	95.97	OK	OK	10.5	33.7	3,240	837.67	OK
19-Oct-40	41.50	11.50	30.00	42.70	11.50	61.19	OK	85.99	84.97	83.36	19.30	101.05	OK	OK	11.8	37.9	3,377	872.98	OK
20-Oct-40	15.20	11.50	3.70	45.49	11.50	37.68	OK	103.28	102.26	100.65	6.30	105.34	OK	OK	28.2	92.2	4,608	1,191.33	OK
21-Oct-40	15.00	11.50	3.50	45.05	11.50	37.05	OK	109.55	108.53	106.92	10.60	115.91	OK	OK	32.0	105.1	4,823	1,246.90	OK
22-Oct-40	15.00	11.50	3.50	8.40	11.50	0.39	OK	16.49	15.47	13.86	6.60	18.85	OK	OK	2.6	8.2	1,973	510.08	OK
23-Oct-40	57.33	11.50	45.83	74.93	11.50	109.25	OK	121.35	120.33	118.72	0.10	117.21	OK	OK	19.5	63.4	4,041	1,044.66	OK
24-Oct-40	108.50	11.50	97.00	151.50	11.50	236.99	OK	256.19	255.17	253.56	3.60	255.55	OK	OK	64.4	214.0	6,187	1,599.41	OK
25-Oct-40	114.59	11.50	103.09	158.79	11.50	250.37	OK	272.67	271.65	270.04	7.10	275.53	OK	OK	71.0	236.1	6,404	1,655.52	OK

26-Oct-40	119.56	11.50	108.06	164.56	11.50	261.11	OK	281.81	280.79	279.18	6.40	283.97	OK	OK	75.6	251.9	6,550	1,693.35	OK
27-Oct-40	73.64	11.50	62.14	93.34	11.50	143.97	OK	182.47	181.45	179.84	27.30	205.53	OK	OK	35.1	115.4	4,983	1,288.39	OK
28-Oct-40	31.00	11.50	19.50	23.50	11.50	31.49	OK	61.59	60.57	58.96	25.40	82.75	OK	OK	9.0	28.8	3,066	792.64	OK
29-Oct-40	61.39	11.50	49.89	74.29	11.50	112.67	OK	127.37	126.35	124.74	2.50	125.63	OK	OK	20.7	67.4	4,130	1,067.64	OK
30-Oct-40	63.07	11.50	51.57	76.37	11.50	116.43	OK	154.73	153.71	152.10	33.30	183.79	OK	OK	27.4	89.6	4,562	1,179.39	OK
31-Oct-40	33.60	11.50	22.10	27.80	11.50	38.39	OK	73.34	72.32	70.71	33.20	102.30	OK	OK	11.2	36.2	3,321	858.58	OK
01-Nov-40	29.30	11.50	17.80	23.00	11.50	29.29	OK	41.54	40.52	38.91	3.30	40.60	OK	OK	5.0	16.0	2,496	645.31	OK
02-Nov-40	28.50	11.50	17.00	20.80	11.50	26.29	OK	166.93	165.91	164.30	152.00	314.69	OK	OK	84.6	282.4	6,817	1,762.45	OK
03-Nov-40	28.70	11.50	17.20	20.90	11.50	26.59	OK	163.25	162.23	160.62	149.20	308.21	OK	OK	80.4	268.0	6,694	1,730.56	OK
04-Nov-40	28.10	11.50	16.60	20.30	11.50	25.39	OK	29.99	28.97	27.36	-	25.75	OK	OK	4.0	12.6	2,297	593.96	OK
05-Nov-40	26.40	11.50	14.90	19.00	11.50	22.39	OK	103.79	102.77	101.16	68.00	167.55	OK	OK	32.0	105.0	4,822	1,246.75	OK
06-Nov-40	26.80	11.50	15.30	24.40	11.50	28.19	OK	115.49	114.47	112.86	68.30	179.55	OK	OK	36.5	120.1	5,054	1,306.56	OK
07-Nov-40	26.60	11.50	15.10	23.70	11.50	27.29	OK	35.99	34.97	33.36	6.10	37.85	OK	OK	4.2	13.4	2,344	605.97	OK
08-Nov-40	26.70	11.50	15.20	18.70	11.50	22.39	OK	41.59	40.57	38.96	17.30	54.65	OK	OK	5.3	17.0	2,550	659.20	OK
09-Nov-40	25.30	11.50	13.80	17.30	11.50	19.59	OK	38.39	37.37	35.76	16.10	50.25	OK	OK	4.9	15.7	2,479	640.91	OK
10-Nov-40	19.60	11.50	8.10	19.40	11.50	15.99	OK	27.29	26.27	24.66	4.20	27.25	OK	OK	3.2	10.3	2,136	552.31	OK
11-Nov-40	14.90	11.50	3.40	14.70	11.50	6.59	OK	117.67	116.65	115.04	117.70	231.12	OK	OK	53.3	176.5	5,783	1,495.20	OK
12-Nov-40	10.00	11.50	-	16.70	11.50	5.20	Fail	121.81	120.79	119.18	117.10	234.67	OK	Fail	58.4	193.8	5,975	1,544.85	OK
13-Nov-40	99.61	11.50	88.11	142.85	11.50	219.45	OK	262.51	261.49	259.88	11.20	269.47	OK	OK	63.8	212.0	6,166	1,594.12	OK
14-Nov-40	237.44	11.50	225.94	318.83	11.50	533.26	OK	578.04	577.02	575.41	9.30	583.09	OK	OK	263.9	898.2	10,221	2,642.43	OK
15-Nov-40	229.60	11.50	218.10	296.50	11.50	503.09	OK	525.64	524.62	523.01	2.80	524.19	OK	OK	233.7	793.5	9,787	2,530.35	OK
16-Nov-40	175.00	11.50	163.50	250.86	11.50	402.85	OK	461.74	460.72	459.11	2.50	460.00	OK	OK	170.2	574.9	8,743	2,260.44	OK
17-Nov-40	100.59	11.50	89.09	147.96	11.50	225.54	OK	277.65	276.63	275.02	2.30	275.71	OK	OK	70.3	233.9	6,382	1,650.06	OK
18-Nov-40	40.20	11.50	28.70	31.90	11.50	49.09	OK	49.19	48.17	46.56	-	44.95	OK	OK	7.5	24.1	2,882	744.98	OK
19-Nov-40	39.70	11.50	28.20	32.00	11.50	48.69	OK	49.69	48.67	47.06	-	45.45	OK	OK	7.4	23.6	2,862	739.83	OK
20-Nov-40	39.80	11.50	28.30	32.30	11.50	49.09	OK	62.89	61.87	60.26	13.40	72.05	OK	OK	8.4	27.0	2,996	774.60	OK
21-Nov-40	39.70	11.50	28.20	33.80	11.50	50.49	OK	66.39	65.37	63.76	13.60	75.75	OK	OK	8.8	28.1	3,040	785.97	OK
22-Nov-40	39.70	11.50	28.20	33.50	11.50	50.19	OK	53.29	52.27	50.66	1.20	50.25	OK	OK	7.5	24.1	2,879	744.28	OK
23-Nov-40	39.60	11.50	28.10	61.80	11.50	78.39	OK	110.06	109.04	107.43	1.90	107.72	OK	OK	17.4	56.4	3,879	1,002.72	OK
24-Nov-40	39.60	11.50	28.10	65.90	11.50	82.49	OK	118.53	117.51	115.90	2.00	116.29	OK	OK	20.0	65.0	4,078	1,054.25	OK
25-Nov-40	39.60	11.50	28.10	46.70	11.50	63.29	OK	77.49	76.47	74.86	1.00	74.25	OK	OK	10.0	32.2	3,190	824.73	OK
26-Nov-40	91.20	11.50	79.70	136.81	11.50	205.01	OK	259.30	258.28	256.67	2.70	257.76	OK	OK	63.2	209.9	6,145	1,588.56	OK
27-Nov-40	155.80	11.50	144.30	266.31	11.50	399.10	OK	542.23	541.21	539.60	6.70	544.69	OK	OK	242.9	825.4	9,923	2,565.44	OK
28-Nov-40	162.70	11.50	151.20	261.31	11.50	401.00	OK	525.57	524.55	522.94	5.80	527.13	OK	OK	221.1	750.0	9,596	2,480.82	OK
29-Nov-40	166.50	11.50	155.00	258.11	11.50	401.60	OK	521.80	520.78	519.17	12.80	530.36	OK	OK	215.7	731.4	9,512	2,459.19	OK
30-Nov-40	113.40	11.50	101.90	204.24	11.50	294.63	OK	472.94	471.92	470.31	62.90	531.60	OK	OK	224.2	760.9	9,645	2,493.46	OK
01-Dec-40	40.40	11.50	28.90	79.54	11.50	96.93	OK	248.10	247.08	245.47	103.60	347.46	OK	OK	111.6	374.3	7,524	1,945.12	OK
02-Dec-40	53.10	11.50	41.60	79.40	11.50	109.49	OK	182.19	181.17	179.56	52.70	230.65	OK	OK	42.3	139.6	5,328	1,377.51	OK
03-Dec-40	74.90	11.50	63.40	107.40	11.50	159.29	OK	185.50	184.48	182.87	8.40	189.66	OK	OK	36.5	120.2	5,056	1,307.20	OK
04-Dec-40	60.40	11.50	48.90	87.10	11.50	124.49	OK	149.06	148.04	146.43	3.20	148.02	OK	OK	25.9	84.7	4,473	1,156.41	OK
05-Dec-40	117.60	11.50	106.10	185.13	11.50	279.72	OK	365.37	364.35	362.74	4.50	365.63	OK	OK	115.8	388.6	7,623	1,970.87	OK
06-Dec-40	194.40	11.50	182.90	306.08	11.50	477.47	OK	637.61	636.59	634.98	8.30	641.67	OK	OK	315.1	1,075.3	10,886	2,814.29	OK
07-Dec-40	148.80	11.50	137.30	217.59	11.50	343.38	OK	479.34	478.32	476.71	66.20	541.30	OK	OK	193.2	653.9	9,146	2,364.59	OK
08-Dec-40	65.20	11.50	53.70	106.55	11.50	148.74	OK	260.28	259.26	257.65	64.40	320.44	OK	OK	83.2	277.6	6,777	1,751.96	OK
09-Dec-40	35.80	11.50	24.30	76.60	11.50	89.39	OK	159.36	158.34	156.73	9.70	164.82	OK	OK	39.7	130.8	5,208	1,346.45	OK
10-Dec-40	35.70	11.50	24.20	39.10	11.50	51.79	OK	69.50	68.48	66.87	5.40	70.66	OK	OK	8.7	27.8	3,030	783.25	OK
11-Dec-40	35.60	11.50	24.10	38.80	11.50	51.39	OK	64.65	63.63	62.02	13.70	74.11	OK	OK	7.9	25.5	2,937	759.25	OK
12-Dec-40	35.60	11.50	24.10	38.20	11.50	50.79	OK	62.73	61.71	60.10	13.50	71.99	OK	OK	7.7	24.6	2,904	750.70	OK
13-Dec-40	78.10	11.50	66.60	96.20	11.50	151.29	OK	160.26	159.24	157.63	-	156.02	OK	OK	31.0	101.7	4,768	1,232.63	OK
14-Dec-40	108.10	11.50	96.60	208.20	11.50	293.29	OK	424.57	423.55	421.94	59.90	480.23	OK	OK	171.6	579.8	8,769	2,267.11	OK
15-Dec-40	63.30	11.50	51.80	147.60	11.50	187.89	OK	316.20	315.18	313.57	60.90	372.86	OK	OK	124.3	417.7	7,818	2,021.27	OK
16-Dec-40	27.60	1.69	25.91	46.31	1.69	70.52	OK	88.30	87.28	87.28	6.40	92.07	OK	OK	7.3	23.4	2,850	736.84	OK
17-Dec-40	24.40	1.69	22.71	43.01	1.69	64.02	OK	88.43	87.41	87.41	16.70	102.50	OK	OK	7.8	25.1	2,922	755.37	OK
18-Dec-40	83.38	1.69	81.69	124.19	1.69	204.18	OK	231.48	230.46	230.46	24.70	253.55	OK	OK	41.8	137.7	5,302	1,370.70	OK
19-Dec-40	110.84	1.69	109.14	163.24	1.69	270.69	OK	311.64	310.62	310.62	35.80	344.81	OK	OK	72.2	240.2	6,442	1,665.45	OK
20-Dec-40	91.10	1.69	89.41	133.51	1.69	221.23	OK	247.43	246.41	246.41	22.40	267.20	OK	OK	47.6	157.2	5,554	1,435.77	OK
21-Dec-40	66.53	1.69	64.84	97.04	1.69	160.19	OK	175.08	174.06	174.06	-	172.45	OK	OK	25.5	83.3	4,448	1,149.83	OK
22-Dec-40	30.50	1.69	28.81	41.51	1.69	68.62	OK	80.63	79.61	79.61	3.60	81.60	OK	OK	6.0	19.2	2,659	687.51	OK
23-Dec-40	103.27	1.69	101.58	153.08	1.69	252.96	OK	294.30	293.28	293.28	30.50	322.17	OK	OK	64.7	214.9	6,196	1,601.82	OK
24-Dec-40	120.28	1.69	118.58	176.38	1.69	293.27	OK	331.02	330.00	330.00	26.90	355.29	OK	OK	81.4	271.6	6,725	1,738.63	OK
25-Dec-40	65.68	1.69	63.98	114.08	1.69	176.37	OK	222.55	221.53	221.53	23.00	242.92	OK	OK	40.1	132.0	5,224	1,350.51	OK
26-Dec-40	75.43	1.69	73.73	129.23	1.69	201.27	OK	247.45	246.43	246.43	23.00	267.82	OK	OK	48.2	159.3	5,580	1,442.51	OK
27-Dec-40	68.20	1.69	66.51	92.11	1.69	156.92	OK	173.22	172.20	172.20	-	170.59	OK	OK	24.9	81.4	4,411	1,140.38	OK
28-Dec-40	88.20	1.69	86.51	121.71	1.69	206.52	OK	223.37	222.35	222.35	0.60	221.34	OK	OK	40.5	133.4	5,243	1,355.54	OK
29-Dec-40	88.10	1.69	86.41	120.51	1.69	205.22	OK	219.34	218.32	218.32	0.60	217.31	OK	OK	39.7	130.6	5,205	1,345.70	OK
30-Dec-40	46.20	1.69	44.51	58.41	1.69	101.22	OK	111.83	110.81	110.81	0.20	109.40	OK	OK	11.3	36.5	3,331	861.23	OK
31-Dec-40	40.30	1.69	38.61	65.81	1.69	102.72	OK	131.34	130.32	130.32	6.40	135.11	OK	OK	15.0	48.5	3,681	951.64	OK

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