OPTIMIZING WATER RESOURCE DEVELOPMENT
- The Stony Hill (Jamaica) Experience

Introduction

National Water Commission at a Glance

The National Water Commission (NWC) of Jamaica is the public entity charged with developing and operating water supply and wastewater facilities throughout the island nation. The mountainous terrain and dispersed nature of populated areas militates against centralized and extensively interconnected water supply and wastewater system. As a result the NWC currently lists among the capital assets that it owns and operates, approximately:-

- 1,000 water supply facilities
- 160 groundwater wells
- 116 river sources
- 147 Springs

These facilities produce and distribute 180 million imperial gallons per day through over 10,000km of transmission and distribution pipelines to 73% of Jamaica's population.

Despite the fact that the water supply facilities serving the major metropolitan area of Kingston and Saint Andrew consists of the larger (6 - 20 imgd) production plants - and has a fairly comprehensive network, the service reliability in certain supply zones has been inadequate and perennially there is a shortfall with respect to the demand.

Greater Stony Hill Water Supply - Facilities and Status

Greater Stony Hill, a suburban, mixed income community in the mountains north of Kingston with a population of approximately 27,000 persons, is one such water supply zone (the highest elevation of the KSA network) which has been plagued by intermittent service levels over the last 35 years.

The production, transmission, distribution and storage Facilities serving the Stony Hill Supply Sub-zone comprise:-

1. the Seaview treatment plant (542m amsl) with a rated capacity of 2.1imgd,
2. 100km of transmission / distribution mains raining ion size from 12" to 1"
3. 5 No Storage Tanks ranging in size from 0.1 to 0.5 million imperial gallons
4. 25 No. Pressure Reducing Stations

The areas included in the Supply zone can be further divided into the following sub-zones:-

SUPPLY SUB ZONE	Yr 2010 POPULATION
Stony Hill (*excluding Sherbourne Heights & Kingswood since 1992*)*	12,000
Golding Spring and Temple Hall / Halls Green	6,750
Jack's Hill	2,025
Stilwell Road	1,800
TOTAL	22,575 persons

**The 2010 population of Sherbourne Heights & Kingswood was 4,500 persons.*

In 2012, the Seaview water treatment plant (WTP) had 80% of its output restricted to a maximum of 16 hours daily. With output into the distribution network restricted to 20% of the plant capacity, the remainder being used to replenish the clear water storage at the plant in order to be able to meet the daily peak demand. Approximately 80% of the community was subjected to system regulations with supply being limited to between a maximum of 16 hours per day to one day per week days - See Figure No 1. This had resulted from:- i) the natural growth in demand, ii) a high level of non-revenue water, particularly the technical / physical losses due to the aged condition of the pipelines, as well as iii) inadequate pressure control. To mitigate the shortfall in the supply area, the eastern section comprising the communities of Kingswood and Sherbourne Heights was transferred to the adjoining Constant Spring WTP supply zone. This resulted in only intermittent supply being possible and required water to be pumped a very high energy cost from the lower elevations of the Constant Spring WTP system - see Figure No. 2,

FIGURE No. 1

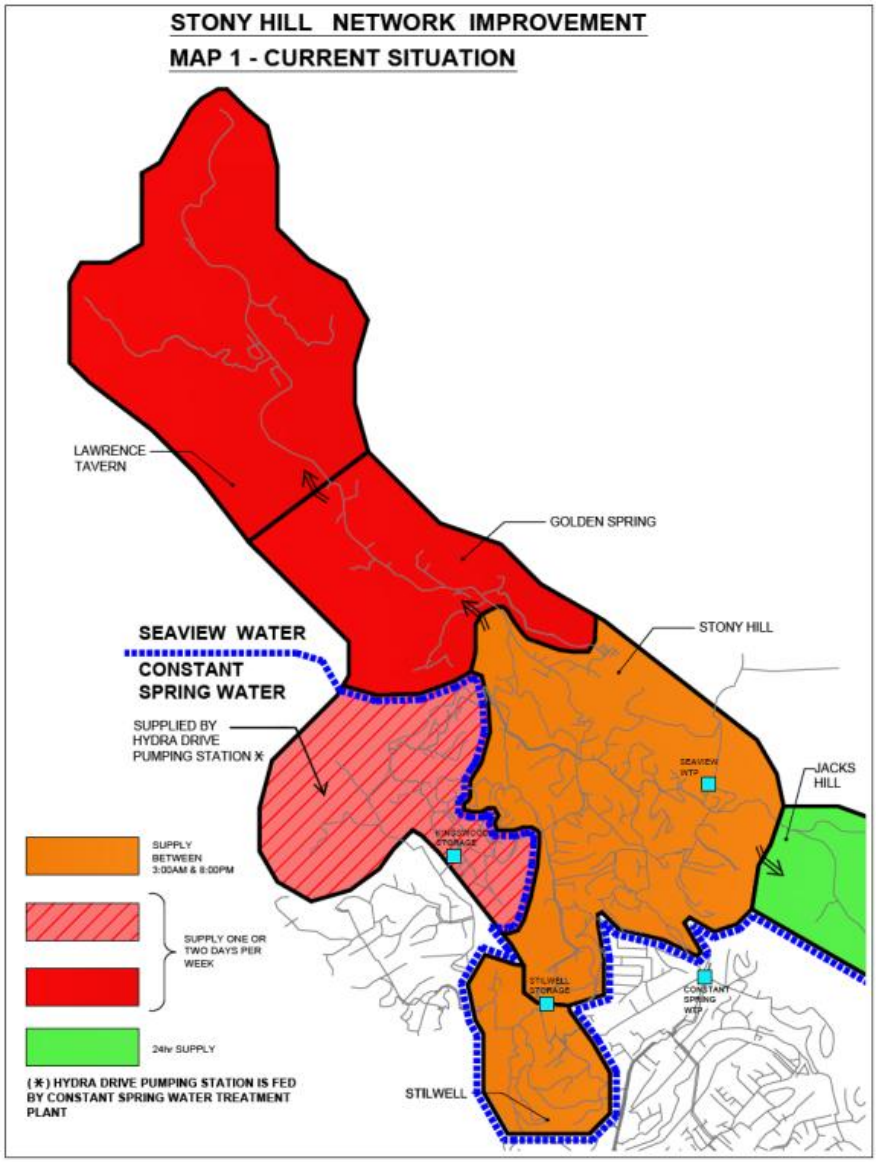
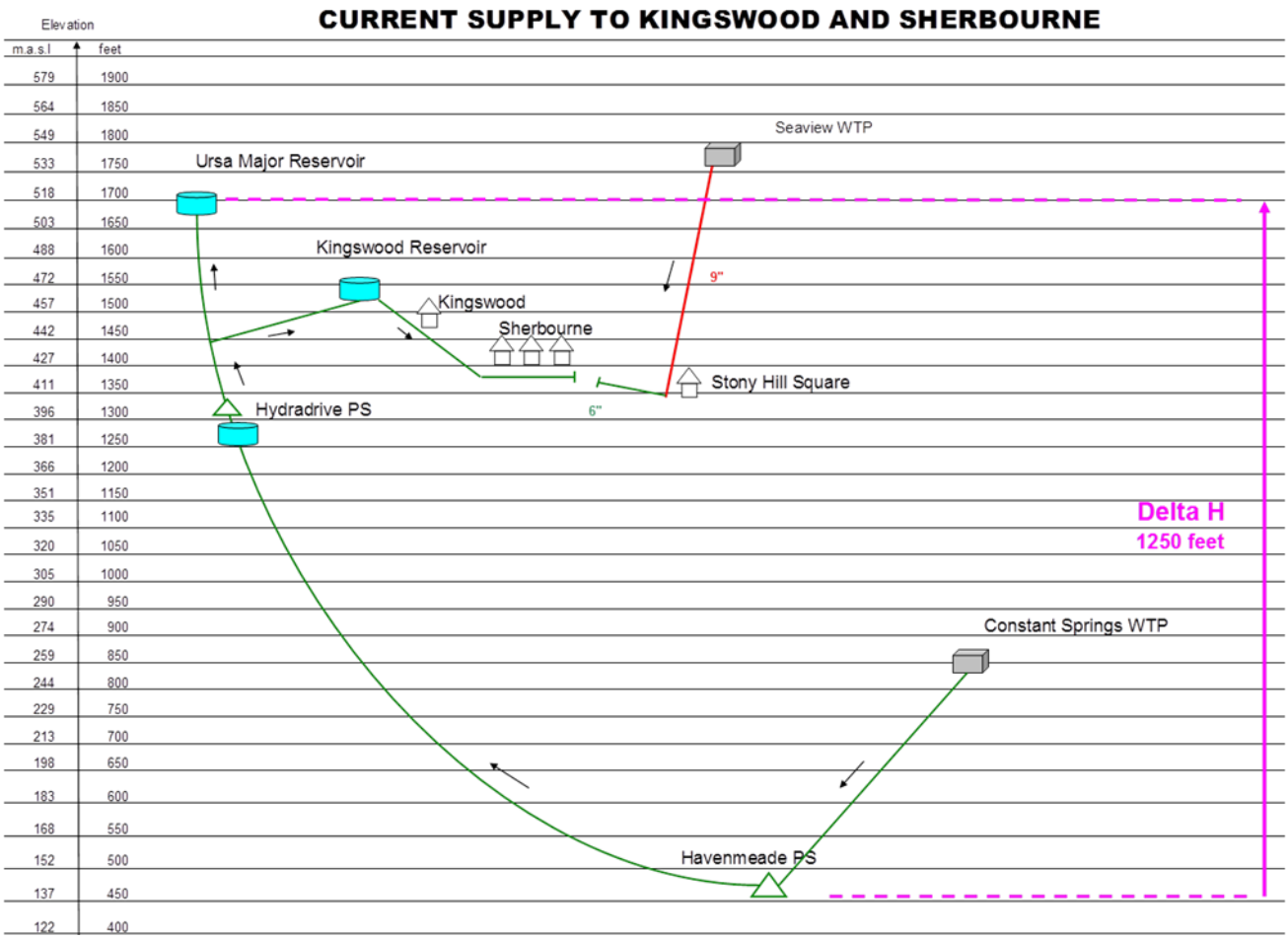


FIGURE No. 2



Initial Proposal for Increasing Service Coverage

The first option which was considered for improving service (particularly for the communities of the Halls Green / Temple Hall) to the Seaview WTP supply zone was to introduce an additional source by sinking two shallow (< 20 metres) wells in the alluvial flood plains of the major (Wag Water) river which flows through the northern section of the supply zone. However the lithologic character of the site limited the reliable yield to <65,000 imp gal / day and this was not considered to be financially viable for its utilization as a source of supply. Developing an infiltration gallery through the gravel deposits adjoining the river was considered as an option, however the early results of work being done to refurbish the Seaview WTP and improve its distribution network suggested that optimizing use of the available water resources could yield a more sustainable solution.

Proposals for Rehabilitation of the Seaview Water Supply Service Zone

Refurbishing of the Seaview Water Treatment Plant

The refurbishing works included:-

- Re-sanding of the rapid gravity filters;

- replacement of valves, blowers, pumps, and chemical dosing equipment; and
- refurbishing of hydropneumatic tanks, backwash facilities, leaking tankage and electrical installations.

This secured the existing design capacity of the plant and by improving its hydraulics, increase reliable output from 2.2 to 2.4 imgd.

Improvement of Distribution Network

This involved the implementation of a Network Audit through a phased programme of works, viz:-

- A survey of the condition and status of all facilities, viz:-
    1) sources of supply,
    2) treatment plant,
    3) storage tanks,
    4) pipes
    5) gate and air valves,
    6) washouts installations,
    7) pumping stations,
    8) Pressure Reducing Valves

  The information so obtained was used to prepare an inventory and condition assess report

- Measurement Campaigns

  Both instantaneous and extended (5-day) logged data field measurements:-
    1) pipe flow
    2) pressure; and
    3) tank storage level*

       * *Storage level measurements were used to identify the extent of overflow due to the lack of synchronization of valve regulation*.

- Identification of valve regulation and system operating regimes
- Leak investigation
- Customer / consumer surveys to determine:
    1) source of supply,
    2) demographics,
    3) customer meter condition,
    4) socio / economic categories
    5) nature /size of property
- formulation of Current and Future projections of the water demand
- Preparation of a Hydraulic Network Model
- Design of 14 No. network pressure zones / District Metered Areas

Findings of Water Treatment Plant Refurbishing & Network Audit

Evaluation and analysis of the network audit revealed the following:-

1) The NRW levels (obtained by comparing water into supply and billed consumption) was approximately 73%
2) Physical losses and commercial losses were estimated at 34% and 36% of Water into Supply (WIS) respectively.
3) Remedial work to the WTP and distribution network in conjunction with reconfiguration of the supply zones could result in demand being met on a 24hr / 7day, all year round (dry / rainy season) without the addition of new sources (i.e. solely from the output of the Seaview WTP).
4) Further reconfiguration would be required to meet the 2030 year demand, it being assumed that no additional water resources are available for development in the Stony Hill area.

Plan of Action for System Improvement

The findings of the WTP refurbishing & Network Audit were used to formulate an action plan, the scope of which incorporated:-

- Detection and repair of leaks
  - detection and repair of approx. 213 No. leaks
- Valve replacement
  - 137 No. gate and 5 No. air valves
- Pressure management
  - Refurbishment / construction of 29 pressure reducing / flow control installations
- Establishing Distric Metered Areas (DMA)
  - Design, Implementation and Commissioning of 19 No. District Metered Areas based on pressure zoning with GSM/SMS loggers and a Central Receiving Station
- Reinforcement of Distribution Network
  - Pipelines
    1) 1,620m of 300mm main from Seaview WTP to Stony Hill Square
    2) 1,360m of 150mm main from Stony Hill Square to Sherbourne Heights
    3) 950m of 150mm main along Wireless Sta. Rd to Kingswood reservoir
    4) 625m of 150mm main along Golden Spring Rd to Lawrence Tavern
    5) 420m of 100mm main along Stockfarm Rd.
    6) 160m of 150mm to (upper) Brooks Level Rd
  - Storage Tanks
    7) A 400m^3 reservoir at Lawrence Tavern

- Service Connection / Supply Points

  The results of the activities related to customer accounts and supply points are as follows:-

1	Number of properties surveyed	2,356 properties
2	Number of delinquent customers regularized	107 Inactive Accounts with water
3	Number of demand / reminder letters	683 (60% responded positively)

4	Number of accounts updated on Customer Accounting System (mailing address, owner/occupier	909 Accounts amendments
5	Number of properties investigated for high consumption, verification of occupancy for low consumption	432 Accounts
6	Number of re-checks of inactive accounts	458 Accounts
7	Number of regular disconnections - after 2nd request for payment	134 Accounts
8	Number of illegal connection disconnected	55 Supplies


Customer registration – NWC team

- Social Intervention

  The results of the social intervention programme in the informal communities was as follows:-

1	Number of informal customers regularized	855 customers
2	Revenues collected in the informal settlements	($700,000/ month
3	Total number of meter banks / meters	67 / 855

- Commercial Loss Reduction Programme
  The elements of this programme and the resulting effect were as follows:-

1	Installation of large (2”- 4”) meters	65
2	Increased Billed Consumption (11 months)	56% (1,355 to 2,079 $m^{3)}$

Impact

Following the completion of the above plan of action, the following were achieved:-

- 24hr /7 day water supply service was restored to Stony Hills, Sherbourne Heights, Kingswood, Golden Spring, and parts of (Lower) Lawrence Tavern and Halls Green – see Figure No. 3 (which can be compared with Figure No. 1 depicting the pre-project situation)
- pressure is regulated to acceptable levels, i.e. 20 - 80 psi,
- pipe breaks have been reduced to a fraction of the pre project levels, and
- NRW has been reduced from 75% to 40% - see Figure No. 4.
- Energy consumption has been reduced by US$250,000 / per annum - see Figure No. 5

FIGURE No. 3

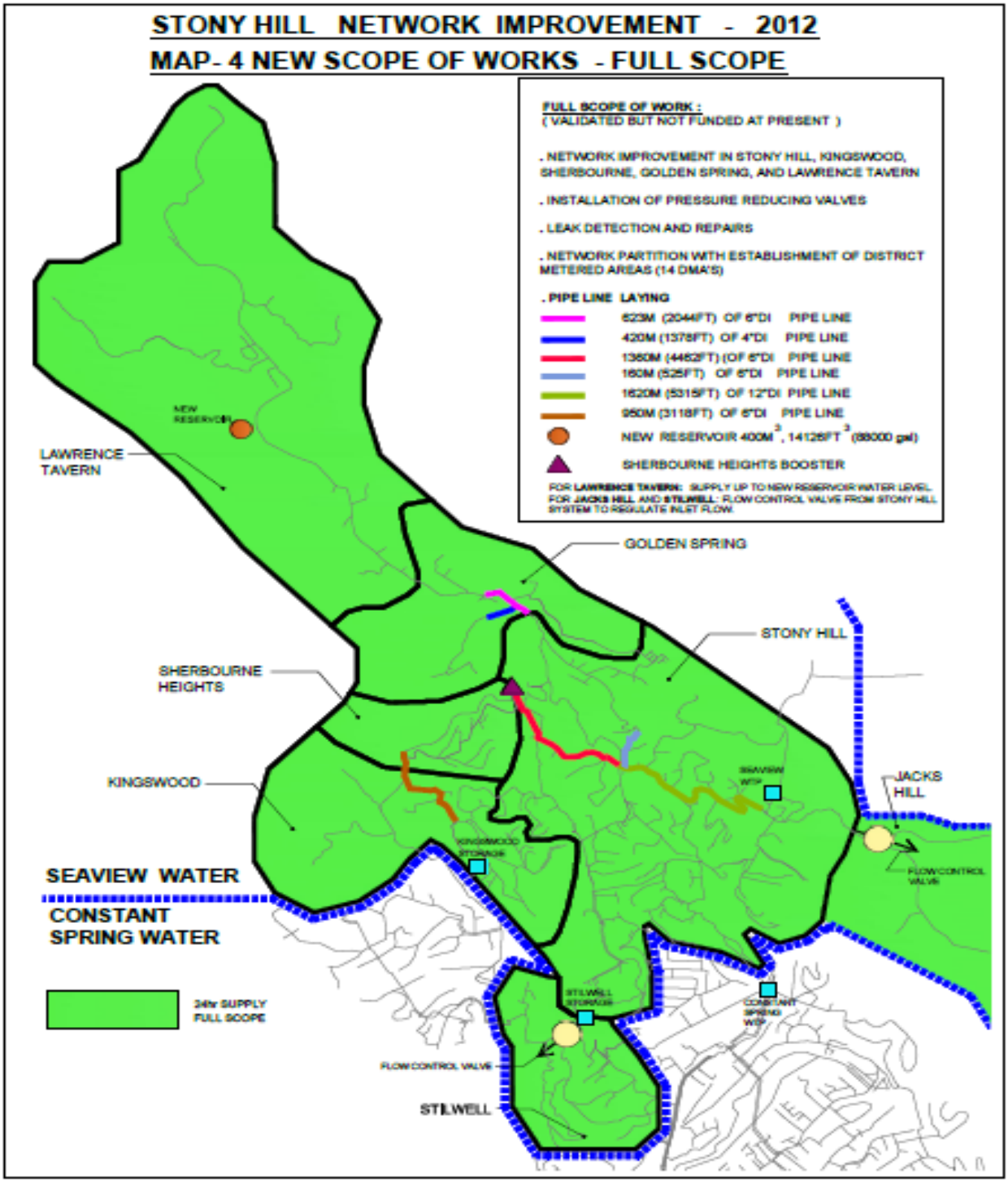

STONY HILL NETWORK IMPROVEMENT - 2012
MAP- 4 NEW SCOPE OF WORKS - FULL SCOPE
FULL SCOPE OF WORK :
(VALIDATED BUT NOT FUNDED AT PRESENT)
. NETWORK IMPROVEMENT IN STONY HILL, KINGSWOOD, SHERBOURNE, GOLDEN SPRING, AND LAWRENCE TAVERN
. INSTALLATION OF PRESSURE REDUCING VALVES
. LEAK DETECTION AND REPAIRS
. NETWORK PARTITION WITH ESTABLISHMENT OF DISTRICT METERED AREAS (14 DMA'S)
. PIPE LINE LAYING
523M (2044FT) OF 6"DI PIPE LINE
420M (1378FT) OF 4"DI PIPE LINE
1360M (4462FT) (OF 6"DI PIPE LINE
160M (525FT) OF 6"DI PIPE LINE
1620M (5315FT) OF 12"DI PIPE LINE
950M (3118FT) OF 6"DI PIPE LINE
NEW RESERVOIR 400M3, 14126FT3 (88000 gal)
SHERBOURNE HEIGHTS BOOSTER
FOR LAWRENCE TAVERN: SUPPLY UP TO NEW RESERVOIR WATER LEVEL
FOR JACKS HILL AND STILWELL: FLOW CONTROL VALVE FROM STONY HILL SYSTEM TO REGULATE INLET FLOW.
NEW RESERVOIR
LAWRENCE TAVERN
GOLDEN SPRING
STONY HILL
SHERBOURNE HEIGHTS
KINGSWOOD
SEAVIEW WTP
JACKS HILL
KINGSWOOD STORAGE
FLOW CONTROL VALVE
SEAVIEW WATER
CONSTANT SPRING WATER
STILWELL STORAGE
CONSTANT SPRING WTP
24hr SUPPLY FULL SCOPE
FLOW CONTROL VALVE
STILWELL

FIGURE No. 4

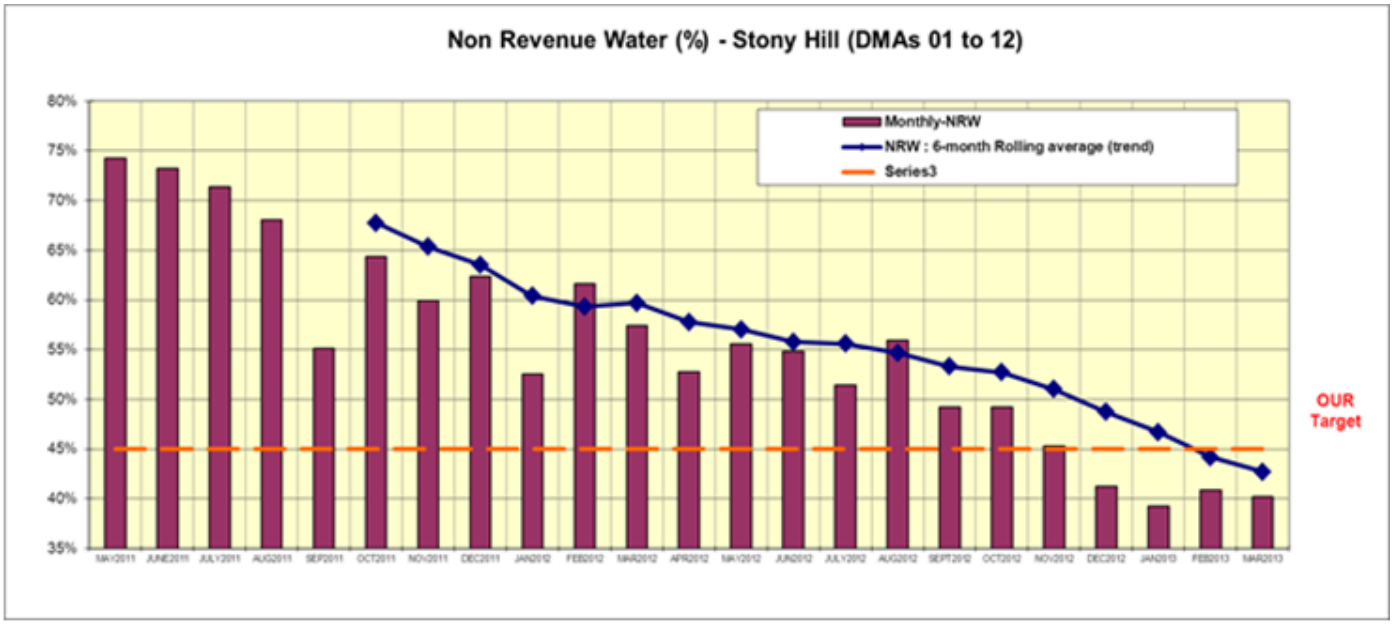
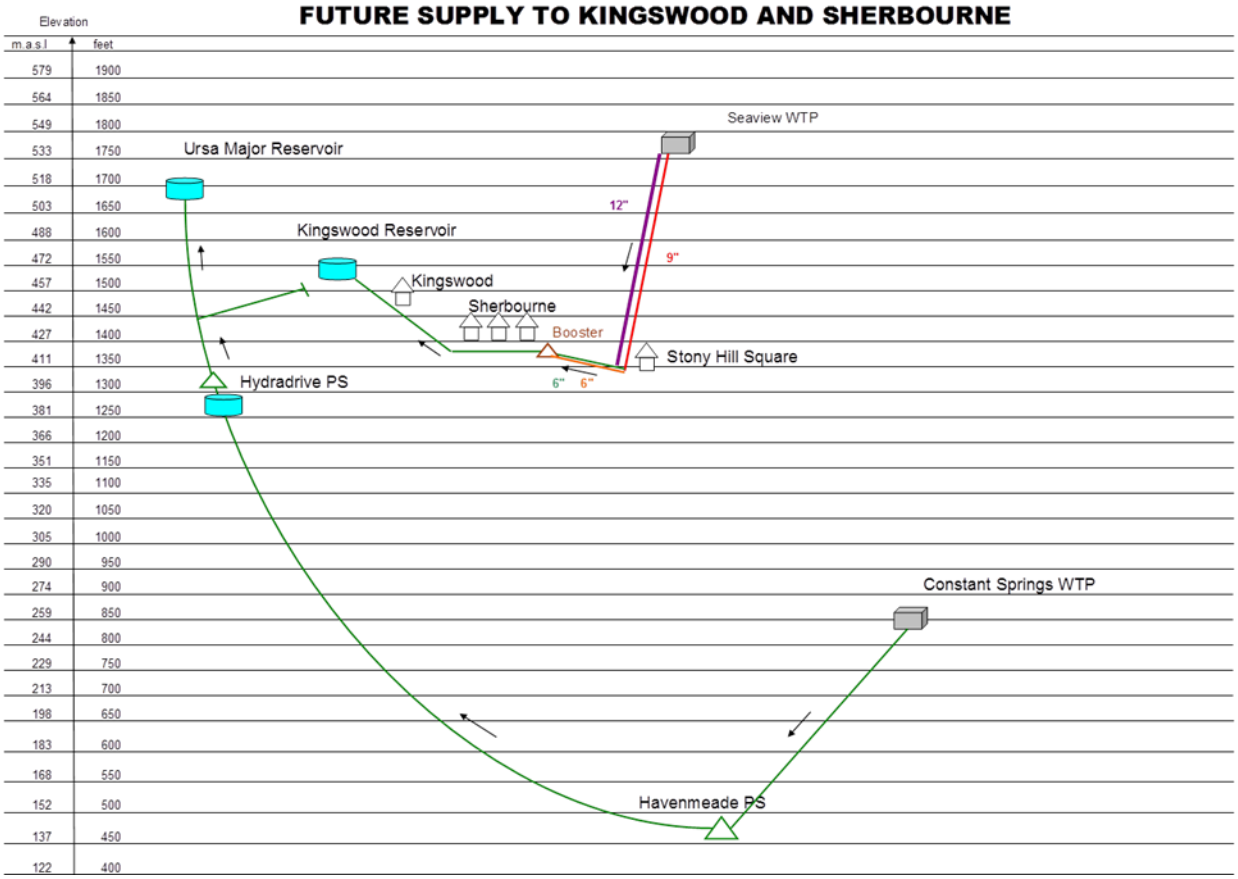


FIGURE No. 5



Conclusion

The experiences gained from the Stony Hill project strongly suggest that the usual 'first choice' solution of developing and introducing additional water resources to meet supply shortfalls was not the optimal solution. This is particularly so when society is challenged by drought and climate uncertainty. The correct selection of the means of meeting the potable water supply needs and designated service levels has been shown to be through a systematic interrogation of the various components of a supply network aimed at generating a plan of action to minimize waste and increase system efficiencies. The alternative opportunities available to a water / wastewater utility to ensure sustainable development of its limited natural, technical, and financial resources should be thoroughly examined and given due consideration in the capital investment decision making process.