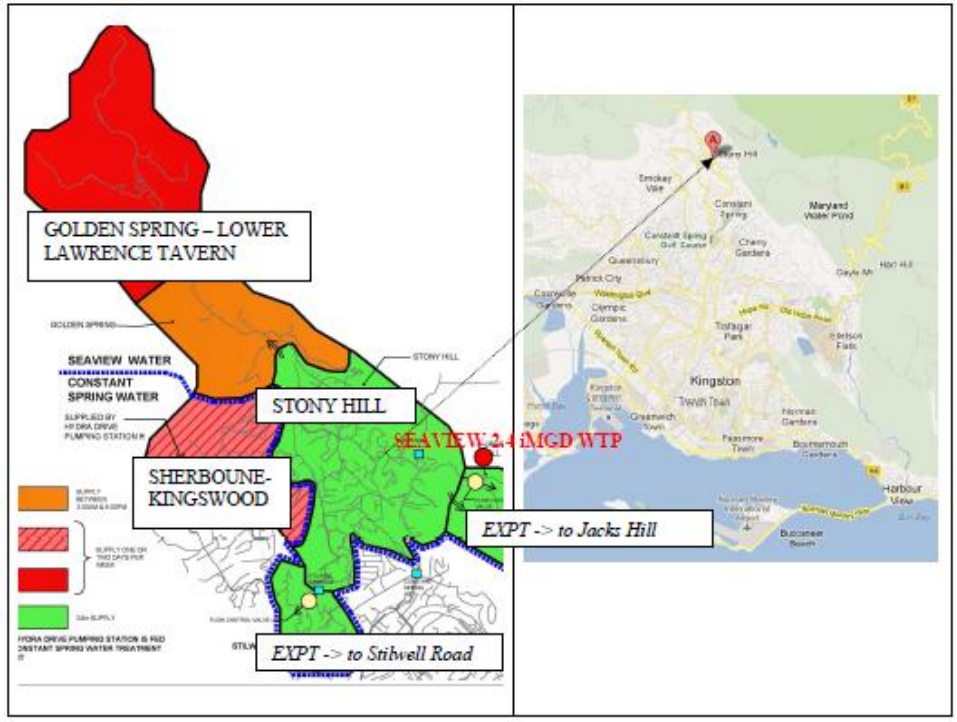
OPTIMIZING WATER RESOURCE DEVELOPMENT

- The Stony Hill (Jamaica) Experience



PRESENTATION TO

CARIBBEAN WATER AND WASTEWATER ASSOCIATION 2016

(October 25, 2016)

ACKNOWLEDGEMENTS

The Presenter wishes to express the sincere appreciation of the NWC for the invaluable contributions made by the following entities to the success of the 'Stony Hill Project' and whose work have been incorporated into this document:-

- **Vinci Construction Grands Projet,**

and their consortium partner

Water Management International,

and

- **FiWi Corporation Ltd**

OPTIMIZING WATER RESOURCE DEVELOPMENT

NATIONAL WATER COMMISSION
Water is life

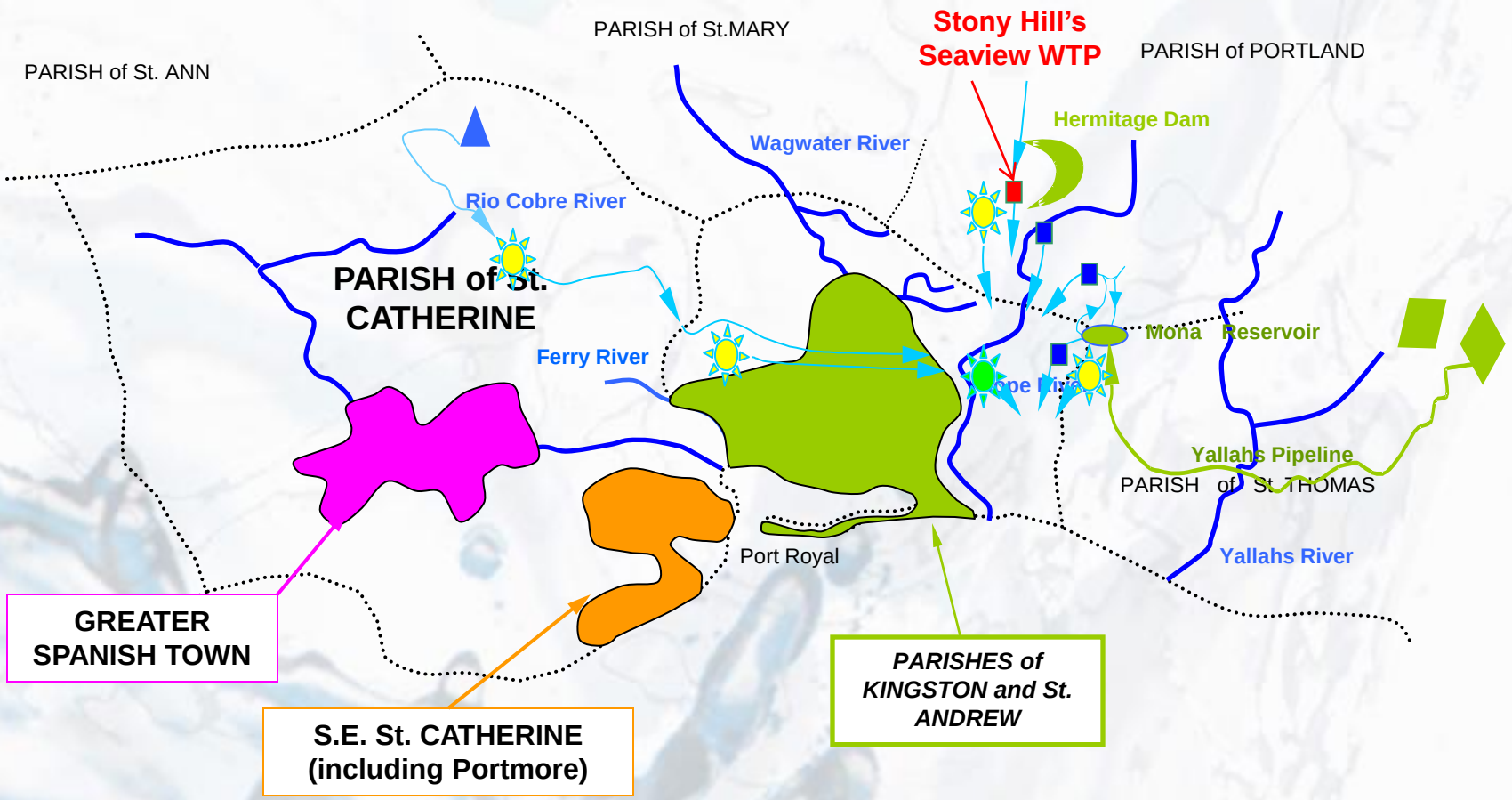
INTRODUCTION

- The usually preferred first choice option of developing new resource to correct potable water supply deficit should always be carefully interrogated again option alternative
- Paramount importance to ensure efficient use of natural and financial resources, particularly in times of drought and climate uncertainty.
- Opportunities oftentimes exist for optimization of operating costs, meaningful reduction in non-revenue water, increase of billed revenue and collections, improvement in staff capacity, customer service and public image.
- The NWC's experiences in the Greater Stony Hill, a suburb of Kingston, has provided insight into successful methods for optimizing the development of water resources to be adopted and deployed by a water utility
- Technical notes were also formulated setting out a plan of action to meet future demands as well as to ensure sustainability of the enterprise's operational efficiency gains.

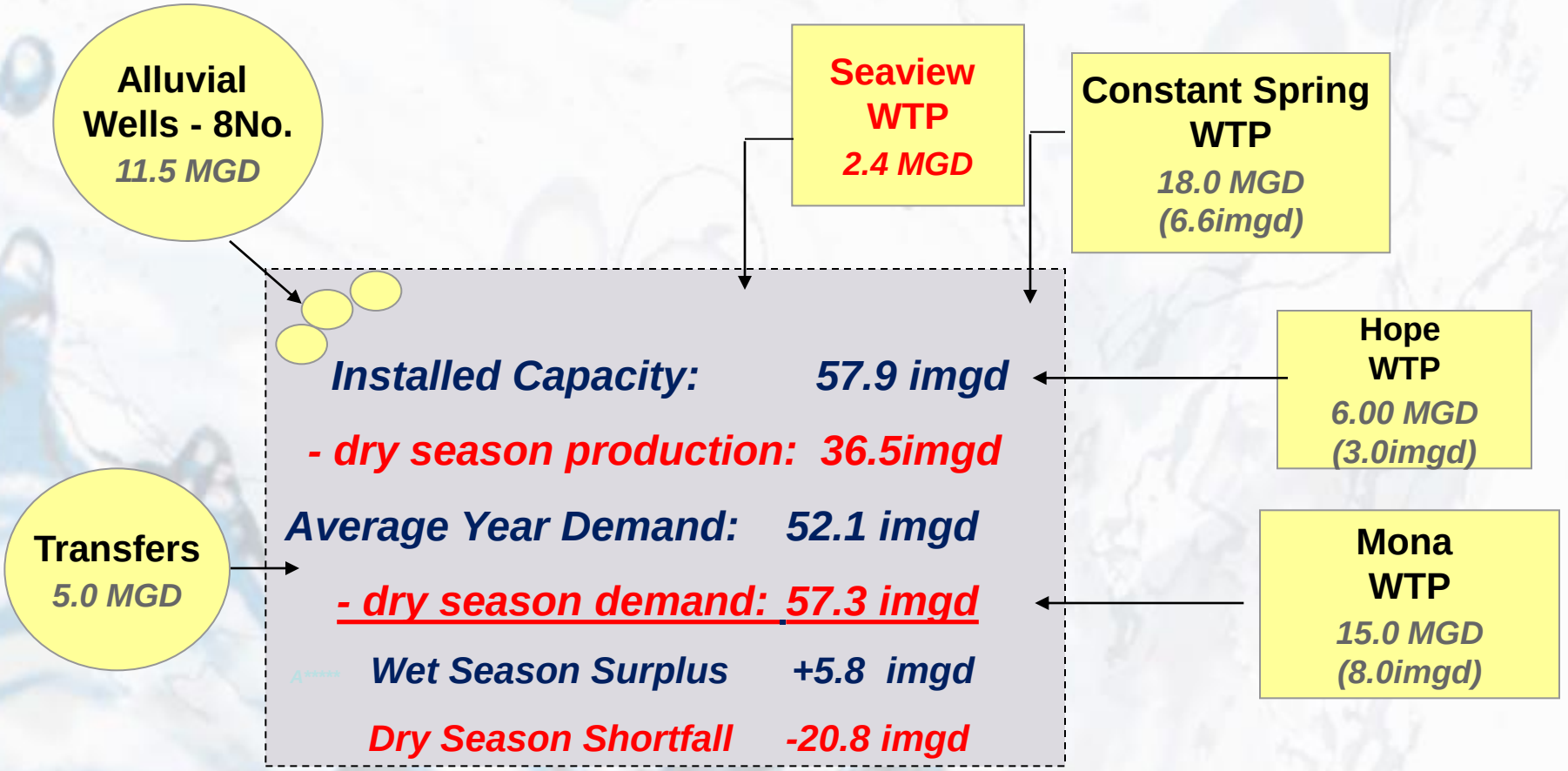
THE NATIONAL WATER COMMISSION (JAMAICA) AT A GLANCE
- Overview of Water and Wastewater Operations

National Population (2016)	2.799 Million
Number of:- Water Supply Facilities Wastewater Facilities	≈ 1,000 ≈ 75
Population connected to Potable Water System ***- Urban Population connected / served*** ***- Rural Population connected / served*** Population connected to Central W/water System	≈73% (Target = 85%) ***90%*** ***45%*** ≈25% (Target: All Major Towns)
Monthly Volume of Water Produced (Daily Ave.)	180 imgpd (0.82M m^3/day)
No. of Customers / Accounts (**Meter Coverage**)	470,000 (**72%**)
Annual Operating Revenue **(Average Sale Price of 1 Gallon of Water)**	Jm$26 Billion **(Jm$0.40)**
Annual Operating Expenditure **(Average Cost for Production of 1 Gallon of Water)**	Jm$21 Billion **(Jm$0.32)**
Annual Average Energy Consumption **(2014/15 Cost)**	160 Million kWh **(Jm$4.44B)**
Ave. Annual Capital Expenditure (2008/9 - 2015/16) ***- Potable Water / Wastewater*** ***- Urban / Rural***	Jm$6.0B / US$61.0M **≈ 70% / 30%** **≈ 70% / 30%**
Condition of Operating Assets	Under maintained / 'Aged'
Required Ave. Annual Capital Investment (2015-30)	Jm$26B / US$220 M

Water Supply Facilities in Kingston and Saint Andrew



Kng. & St Andrew - Water Demand vs Supply



SEAVIEW WTP SUPPLY ZONE - Characteristics

Demographics

- Yr 2010 Population: *28,069 persons*
- Geography: *Mountainous, hills and valleys (with elevations ranging from 540m to 230m)*
- Socio-economic: *Semi-urban, mixed income*

Potable Water Facilities

- Production Source: *Surface Water TP = 2.1imgd*
- Pipelines: *100 km gravity network from 25 - 300mm dia.*
- Storage: *5No.of 0.1 to 0.5 img*
- Pressure Control: *25No. PRVs*
- *Accounts: Commercial /Domestic*

SEAVIEW WATER TREATMENT PLANT SUPPLY ZONE

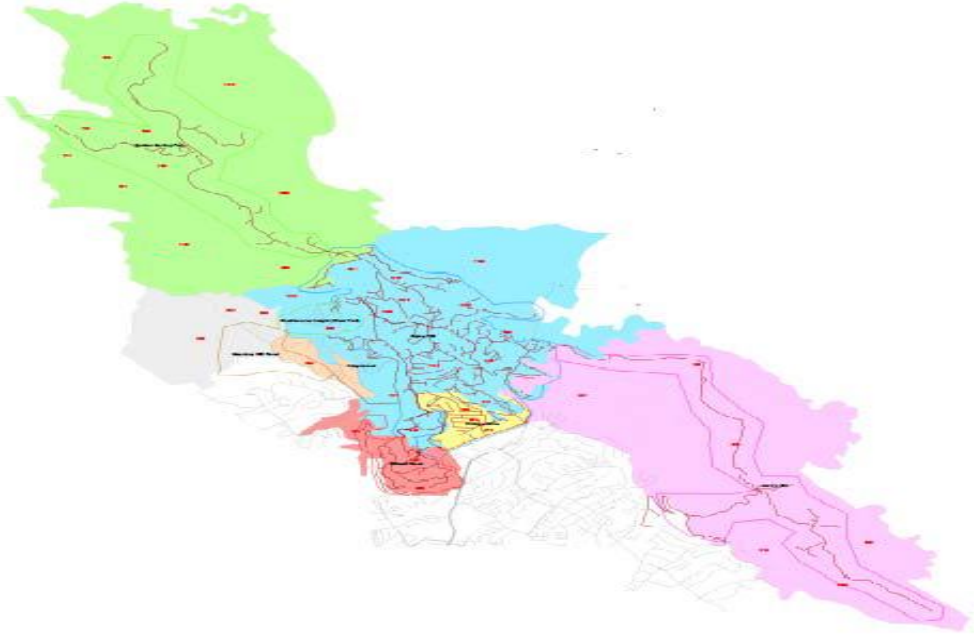
NATIONAL WATER COMMISSION
Water is life

SEAVIEW WTP

DEMAND IN SEAVIEW SUPPLY SUB-ZONES

Yr 2010 Pop. = 28,069 / Demand = 1.5imgd

- Stony Hill (13,113 Persons / 0.6imgd)
- Golden Spring / Halls Green (9,234 / 0.4impd)
- Stillwell Road / Long Lane (1,702 Per. / 0.1imgd)
- Jacks Hill (4,020 Persons / 0.2 imgd)
- Sherbourne Heights / Kingswood (5,334 / 0.2imgd)



SEAVIEW WATER TREATMENT PLANT - DAILY OUTFLOW

- 1.7imgd (80% of daily production) for 16 hours / day

- 0.4 imgd (20% of daily production) for 24 hours / day

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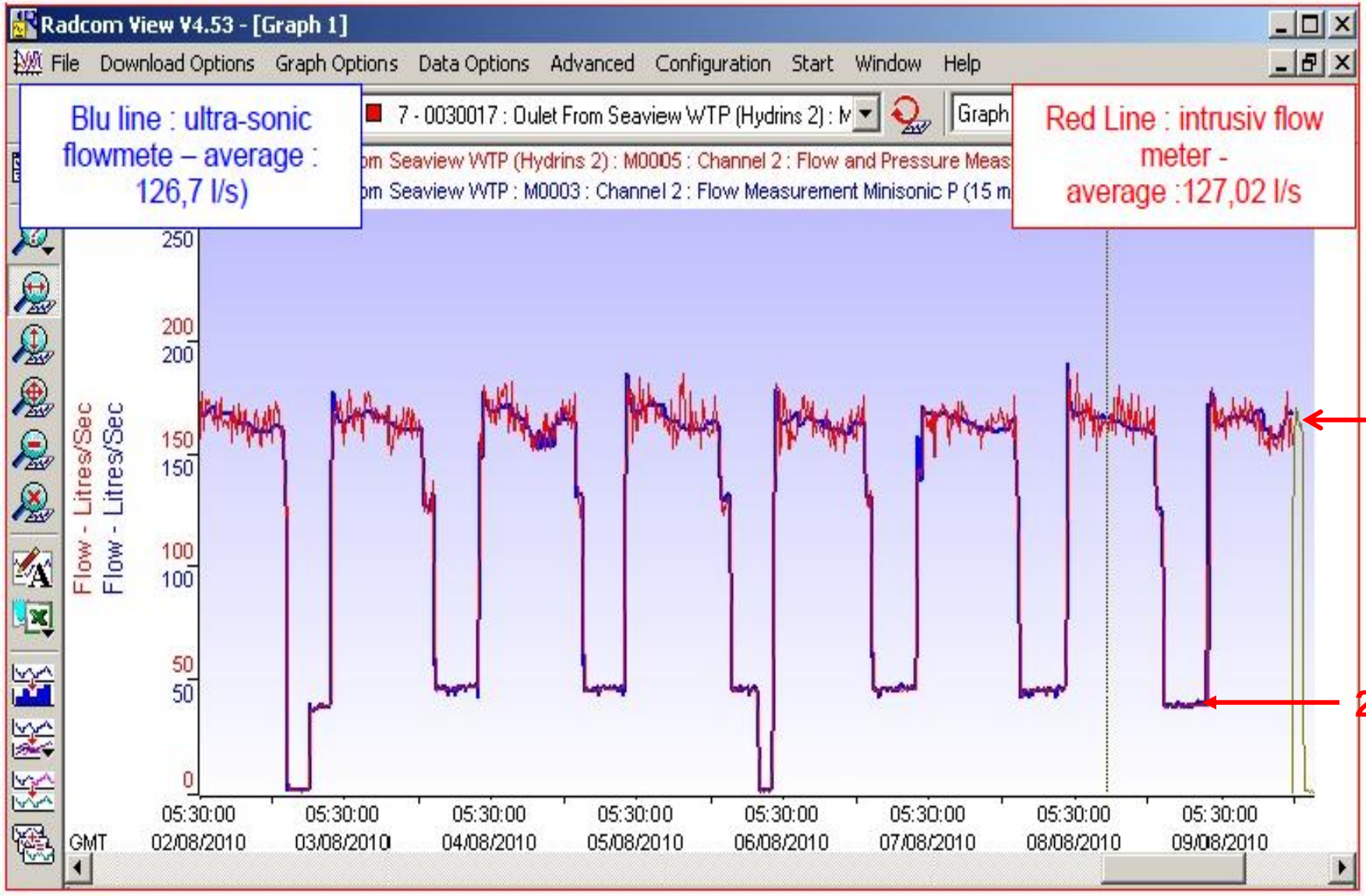

VALVE REGULATION SCHEDULE -

Customers supplied between 16 hours per day & 1 day per week

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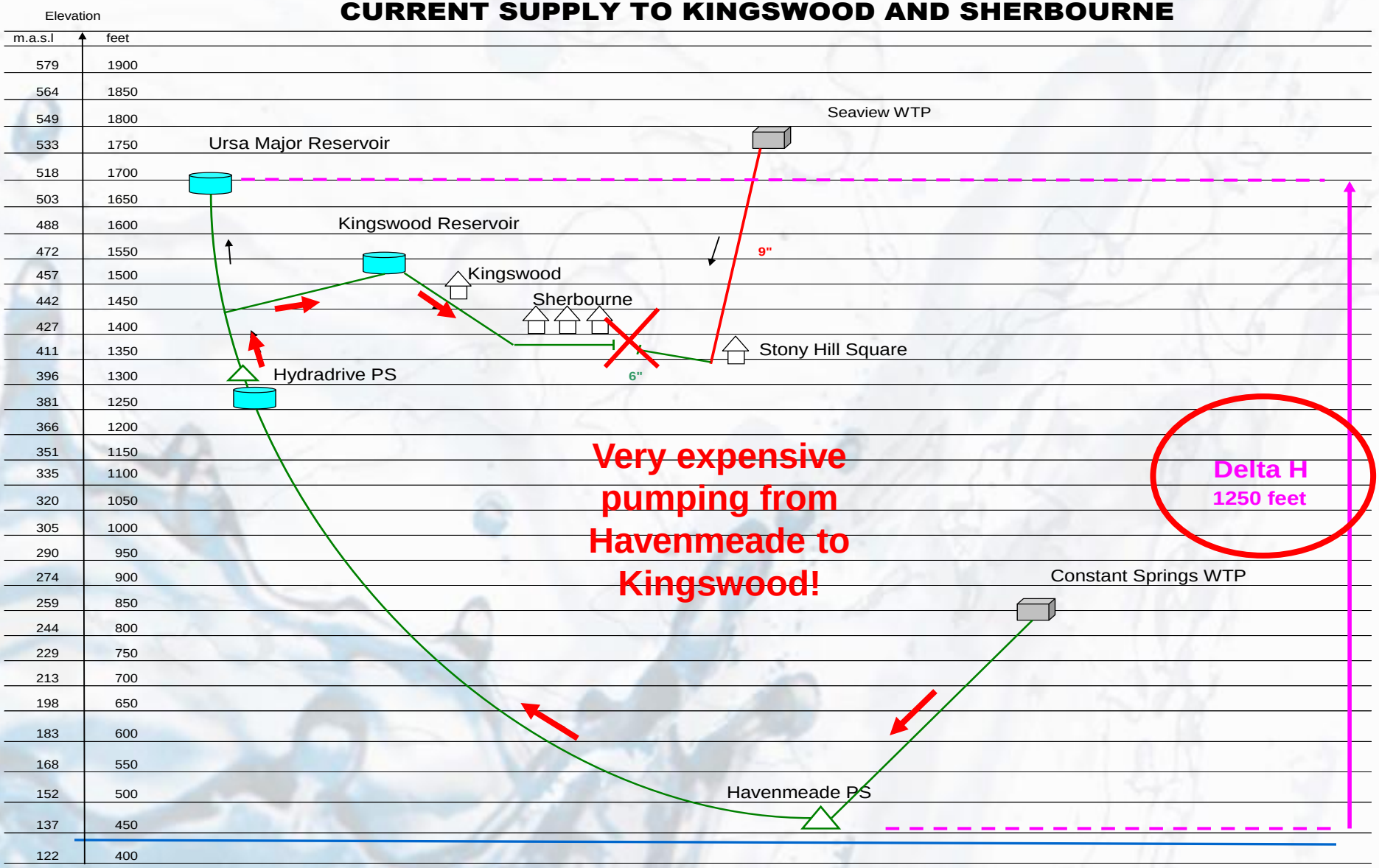
In order to supply the current area that is entirely fed by the Seaview WTP, the NWC has established a weekly schedule of closing and opening valves.

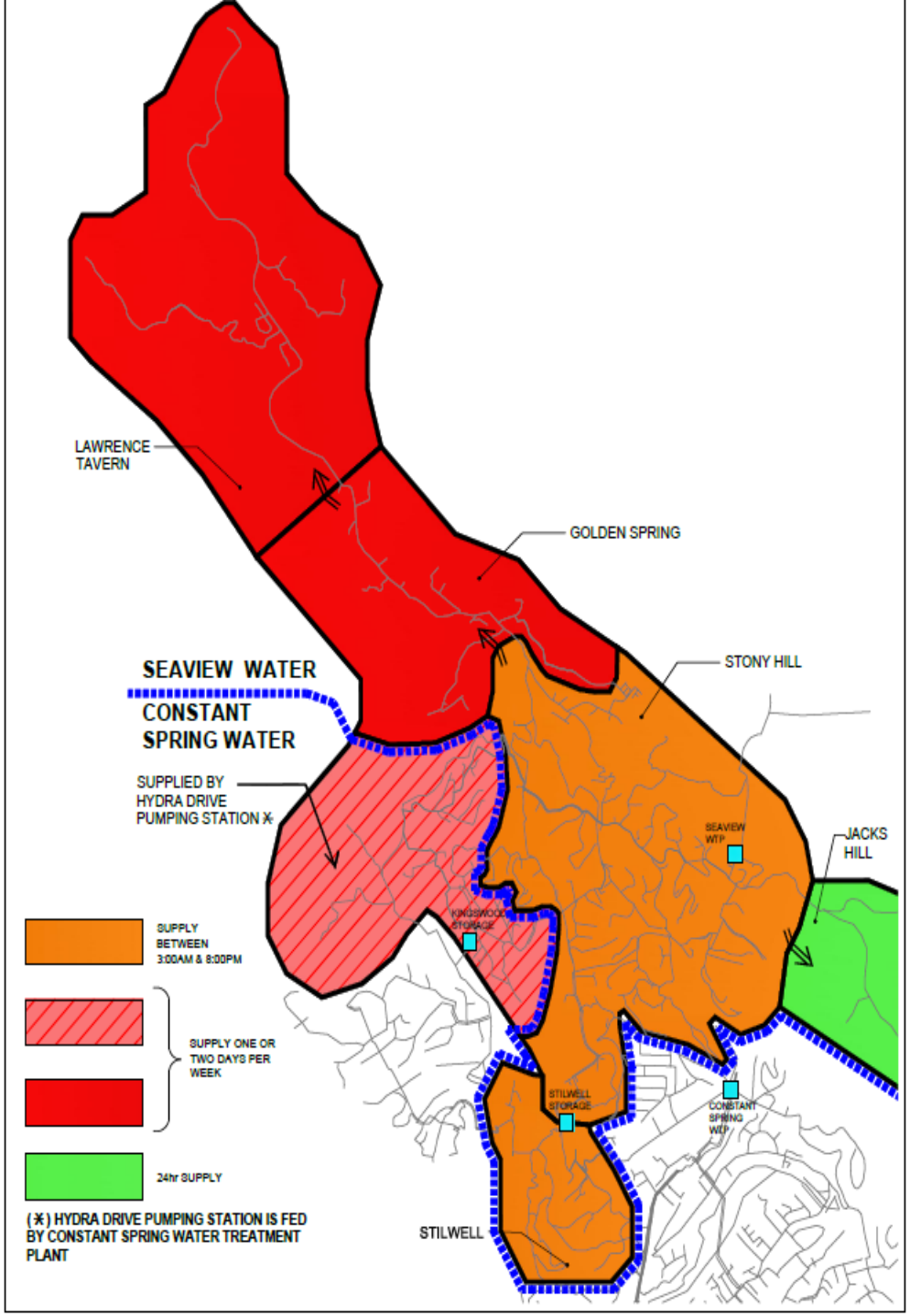
No	V. SIZE	PLACE NAME	DAY	SCHEDULE	COMMENT
0	9"	Seaview Road - Main 9" to Stony Hill	Everyday	Close 8:00PM - Open 3:00 AM	To fill up Seaview WTP Tanks
1	6"	Seaview Road - Main 6" from 9" to Jack's Hill	Everyday	Close 8:00PM - Open 3:00 AM	To fill up Seaview WTP Tanks
2	4"	Lipscombe Drive - Hill Side Av	Once or twice by week	Close 3 hours	To send water to Hill Side Av. when complaints
3	4"	Old Golden Spring Road-Mannings Hill Road	Everyday	Close 5:00PM - Open 4:00 AM next day	To send water to high part of Sheirbourne Heigh East
4	4"	Panton Road-Old Stony Hill Road	Wednesday-Saturday	Close 8:00 AM - Open 5:00 PM	To stop water in Panton Road and Christopher Av. (low area) in order to send more water on Old Stony Road
5	6"	Stony Hill Main Road to Golden Sring	Everyday	Regulated (3 turns open) 4:00AM - Open 8:00 AM	To send less water in Golden Spring, and keep more water in Stony Hill
6	4"	Stock Farm Road -Stony Hill Main Road	Monday-Wednesday	Open 4:00 AM - Close 5:00 PM	To feed Stock Farm Road - Valve 6" on Stony Hill Main Road is closed at the same time
7	6"	Stony Hill Main Road - Clanhope Av	Monday-Wednesday	Close 4:00 AM - Open 5:00 PM	To feed Stock Farm Road - Valve 6" on Stock Farm Road is open at the same time
8	6"	Stony Hill Main Road - Clarck Hill	Thursday	Close 8:00 AM - Open 3:00 PM	To send water to Clark Hill
9	6"	Stony Hill Main Road - Lawrence Tavern Road	Tuesday-Friday-Sunday	Close 8:00 AM - Open 4:00 AM Next Day	To send water to Lawrence Tavern Road
10	6"	Stony Hill Main Road - Shantel H. Hall's Green	Saturday	Close 8:00 AM - Open 3:00 PM	To send water to Hall Green
10	6"	Stony Hill Main Road - Shantel H. Hall's Green	Thursday	Close 3:00 PM - Open 8:00 PM	To send water to Hall Green

Transfer of Demand (Sherbourne / Kingswood) to adjacent Supply Zone + Sub optimal Energy Usage



Water Supply Service characterised by:-

- Very low level of reliability
- Regulated supply all year
- Supply inadequate to meet 24-hr. demand (incl. NRW)
- Nightly lock offs bet. 8 pm & 3 am
- High (73%) NRW levels
- Unbalanced Pressure Zones

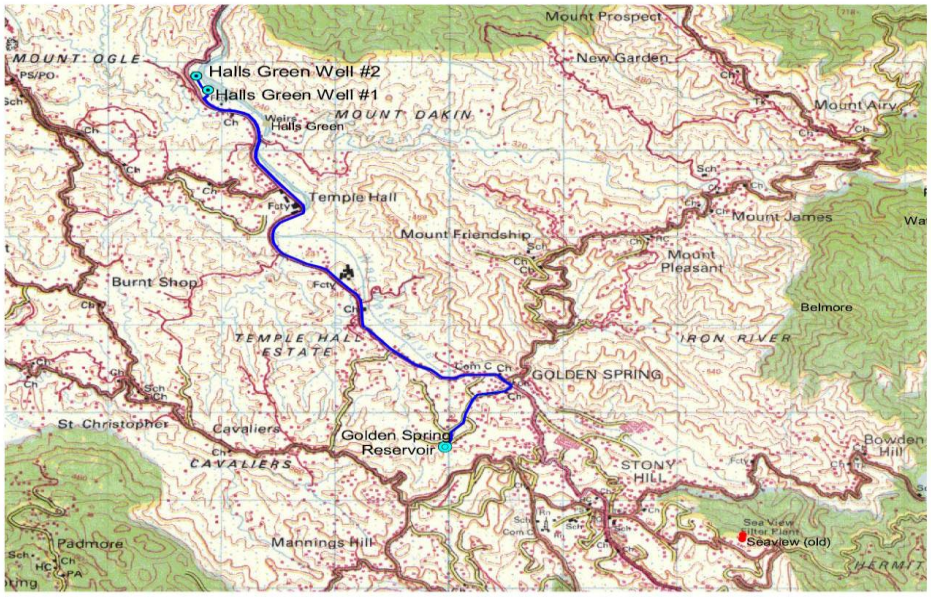


Initial Proposals for Improved Service Coverage

- Halls Green / Temple Hall / Golden Spring W-S

- Sub-zone Population = 9,234 persons
- Demand = 277,020igpd / 52.5m^3/hr
- Construction & Development of 2 No. Well - 20m @ 610 / 406mm
- Supply and installation of 6.0km of 150/100mm pipeline
- Supply and erection of 1No. Storage Tank 400m^3
- Proposed Cost ±US$3.0M.
- Sustained Yield of borehole = 12m^3/hr or 63,000igpd **i.e. 23% of Demand**

A4 - HALLS GREEN WELLS



NOT FINANCIALLY VIABLE

Refurbishment of Seaview Water Treatment Plant

- Secure the design capacity of the plant and increased its reliable output from 2.1 to 2.4imgd by improving its hydraulics

- Improved hydraulics of the ‘old plan’t to increase the production capacity to 1.8 MGD at 300 NTU
- secure production capacity of the ‘new plant’ at 0.6 MGD at 300 NTU
- Minimize the water loss during production (leaks, excessive backwash, clear water tank overflow)
- Optimization of flow pacing with control valves
- New alum dosing equipment
- Replacement of weir troughs
- Replacement of filter media, valves, blowers, valves, backwash facilities, hydro-pnuematic tanks & compressors and water level control syphon
- Remedial work to chlorination system, turbidity & pH intrumentation, leaking tankage and electrical installations

Settling tank old plant with new weirs

Steps for Formulation of Network Improvements

- *Survey of all facilities; preparation of an inventory and condition assessment report, 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
- **Measurement Campaigns (*18 No. instantaneous and 17 No. extended, 5-day - logged data field measurements)***
  1. 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.*

Element	Unit	Quantity
Pipe	km	99,8
PRV's	u	25
Storage	u	5
Valves	u	341
Hydrant	u	111
Reducers	u	23
Blank flanged	u	50
Air Valves	u	6
Leaks	u	81

	MATERIAL						
DN (inch)	AC	AC / PVC	CI	DI	GI	PVC	Total lenght (m)
0,5						34	34
1					213	551	764
1,25			71			614	685
1,5			626		177	1615	2 418
2	73		880		2037	4814	7 805
3			8936		336	1247	10 519
4	1336	146	36021	817	47	5806	44 173
5			6				6
6			22790			1122	23 912
9			9571				9 571
12			96				96
Total lenght (m)	1 410	146	78 997	817	2 811	15 803	99 984

Steps for Formulation of Network Improvements

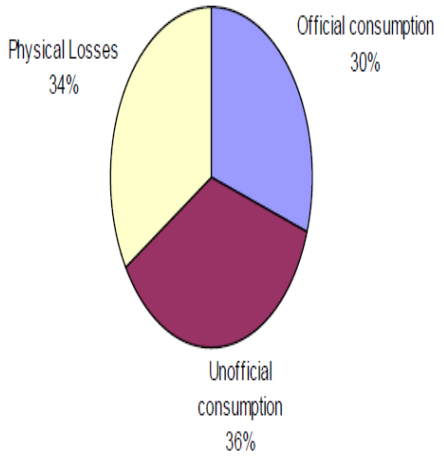
- Identification of Valve Regulation and System Operating Regimes
- Leak Investigation & Detection
- Customer / Consumer Surveys to determine:
  1. source of supply,
  2. demographics,
  3. customer meter condition,
  4. socio / economic categories
  5. nature /size of property
- Analysis of Current and Future water demand
- Preparation of a Hydraulic Network Model
- Design of 14 No. network pressure zones / District Metered Areas

Results of Water Treatment Plant Refurbishing & Findings of Network Audit

- The NRW levels (obtained by comparing Water-into-Supply and billed consumption) was approximately 73%
- Physical and Commercial Losses were estimated at 34% and 36% of Water into Supply (WIS) respectively.
- 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).
- 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.

	Water into Supply		Billed Consumption		UFW
	l/s	iMGD	l/s	iMGD	%
Production Seaview	128,7	2,44			
Into the current system					
Stony Hill	64,2	1,22	19,4	0,37	70%
Golden Spring	8,3	0,16	2,5	0,05	70%
Jacks Hill	11,2	0,21	1,5	0,03	87%
Stilwell	15,3	0,29	3,8	0,07	75%
Total 1	99,0	1,88	27,2	0,52	73%

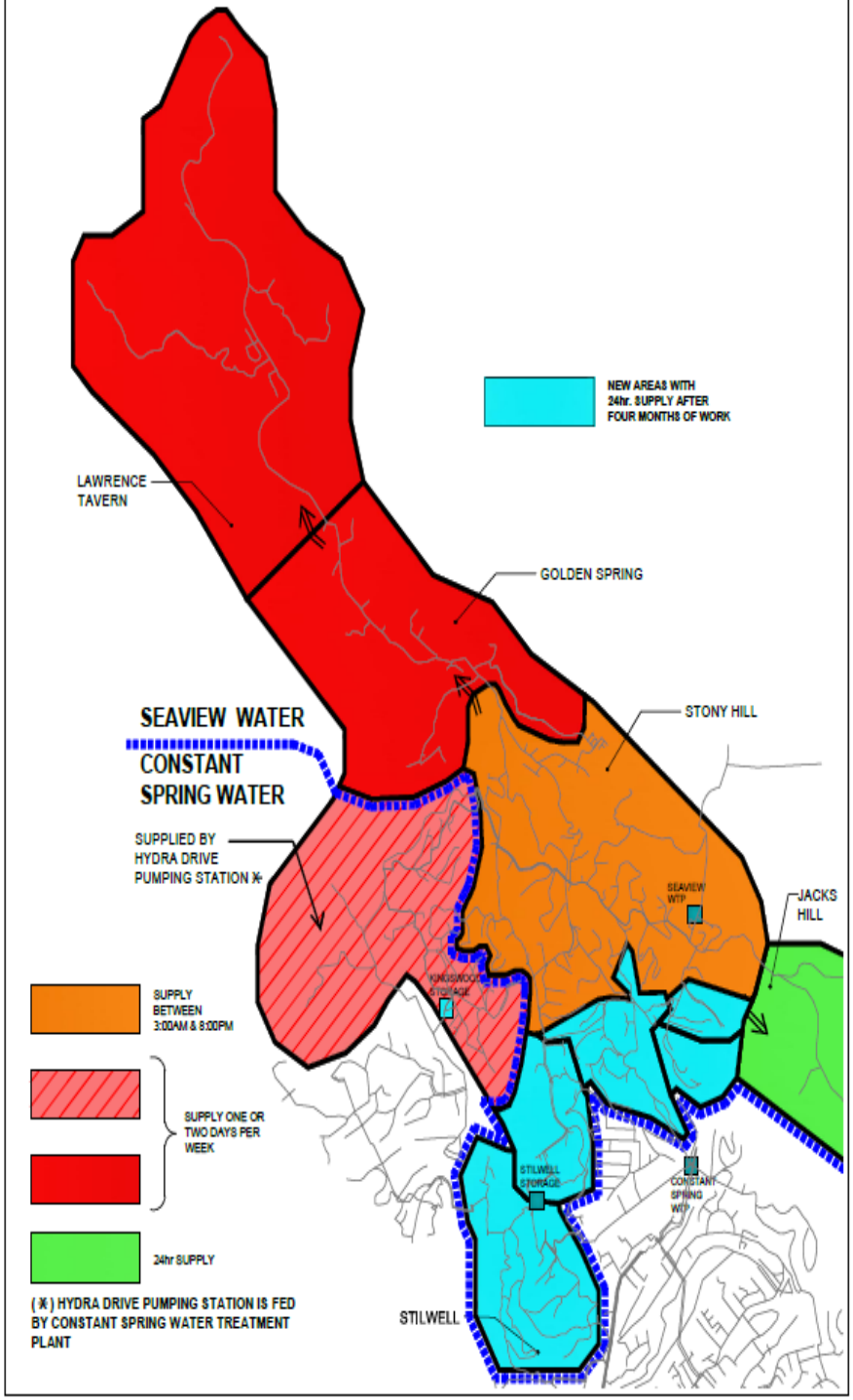
	Current water into supply In Stony Hill Area	
	(l/s)	%
Official consumption	19,4	30,2%
Unofficial consumption	23,1	36,0%
Physical Losses	21,7	33,8%
Total	64,2	100,0%



EARLY ACHIEVEMENTS

- Stilwell Road's demand 0.1imgd transferred to the Constant Spring WTP
- Reduction in water loss from overflowing clearwell and filter tank at Seaview WTP
- Improved pressure management in sections of the distribution network

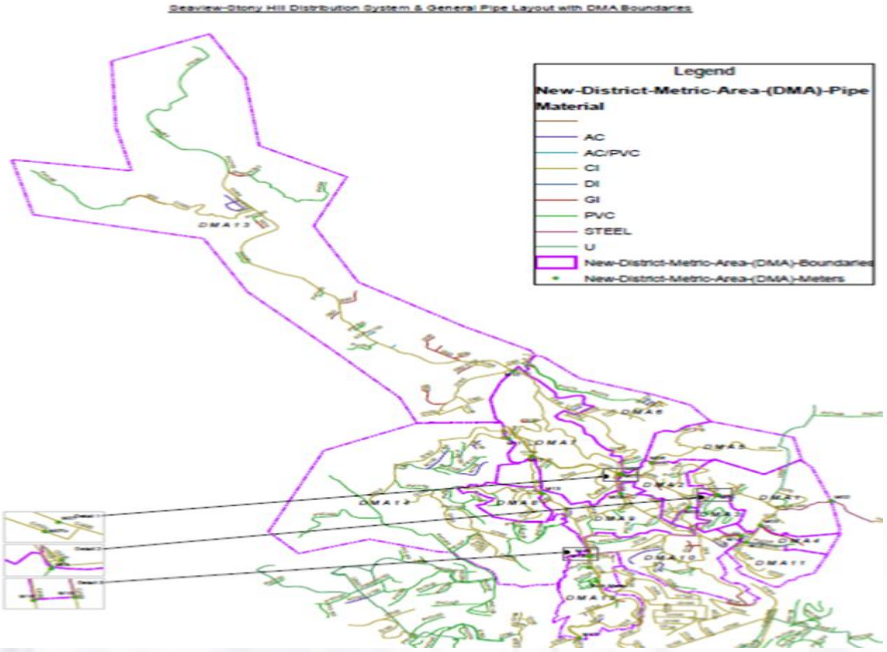
Several additional communities received 24hr / 7-day supply



Stage 1 PROGRAMME OF WORKS FOR SYSTEM IMPROVEMENTS

- Detection and repair of leaks
  - detection and repair of approx. 213No. leaks
- Upgrade Service Connections
  - Replacement of old GS/PVC service connections with HDPE pipes
- Valve replacement
  - 137 No. gate and 5 No. air valves
- Pressure management
  - Refurbishment / construction of 29 pressure reducing / flow control stations
- Establishing District Metered Areas (DMA)
  - 19 No. DMAs with GSM/SMS loggers and Central Receiving Sta.

Works costing US$5.0M & completed in 13 months



STAGE 2 - Improvements to the Distribution Network

Reinforcement of Distribution Network

A. **Pipelines**

1. 1,620m of 300mm main - Seaview WTP to Stony Hill Square
2. 1,360m of 150mm main - Stony Hill Square to Sherbourne Height
3. 950m of 150mm main - Wireless Station Road to Kingswood Reservoir
4. 625m of 150mm main - Golden Spring Road to Lawrence Tavern
5. 420m of 100mm main - Stockfarm Road.
6. 160m of 150mm- UpperBrooks Level Road

STAGE 2 - Improvements to the Distribution Network

B. Lawrence Tavern Storage Tank

- Glass-fused Bolted Steel
- Circular
- Capacity - 400m^3
- Low Water Level - 272m amsl
- Top Water Level - 277m amsl
- Top Inlet - with float valve
- Bottom Outlet - with checkvalve
- Overflow and Washout

Cost = US$2.5 Million

Time for designs, procurement and construction = 13 months

Regularization of Consumer Service Connections / Supply Points

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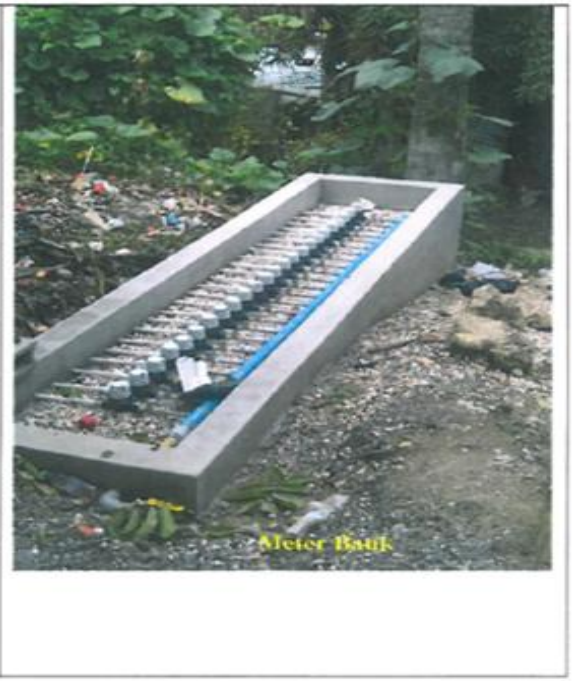
1	Number of Properties Surveyed	2,356
2	Number of delinquent customers regularized	107 Inactive Accounts found with water
3	Number of demand / reminder letters	683 (60% responded positively)
4	Number of accounts updated on Customer Accounting System (mailing address, owner/occupier	909 Accounts amendments
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

Social Intervention Programme for Informal Communities

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

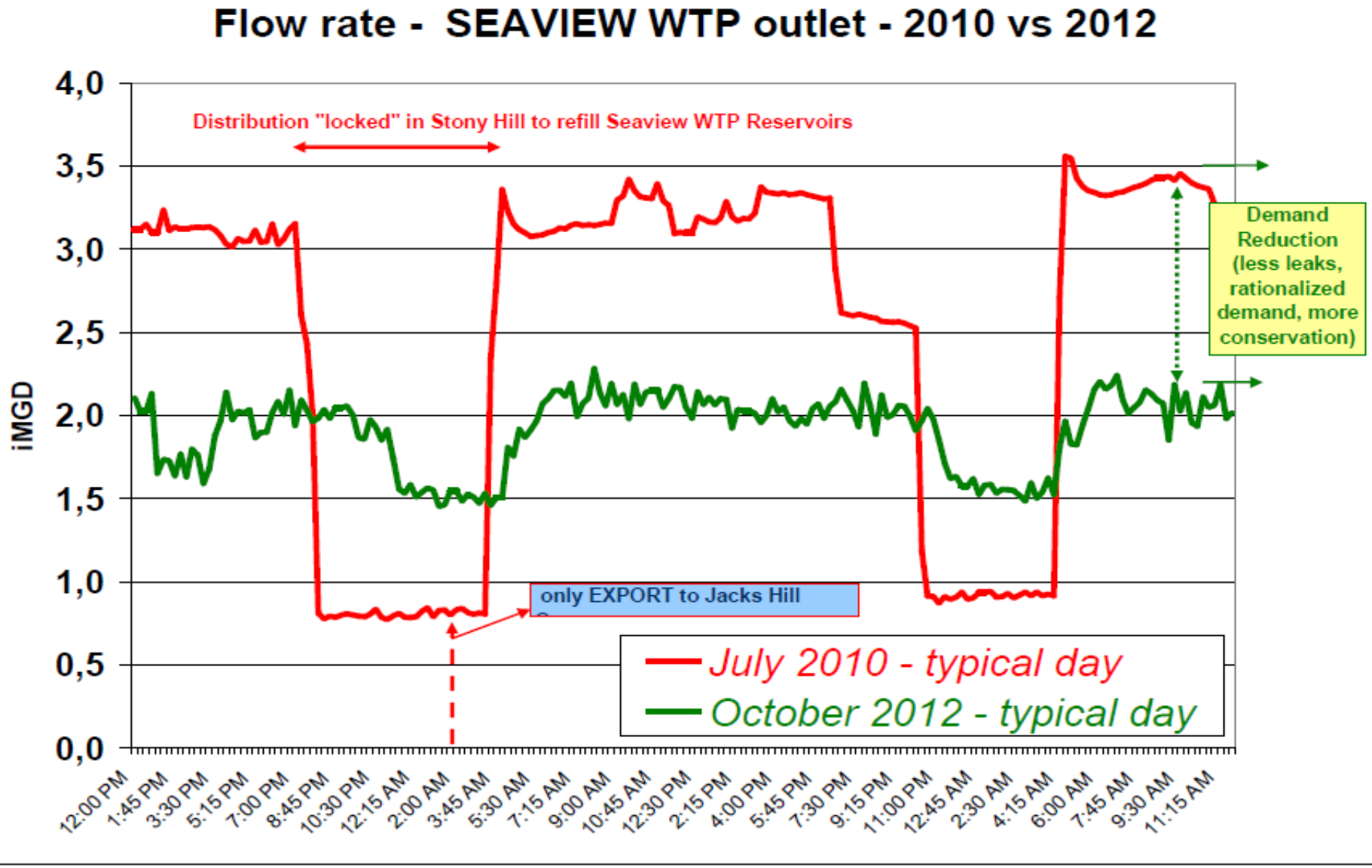


Commercial Loss Reduction Programme

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

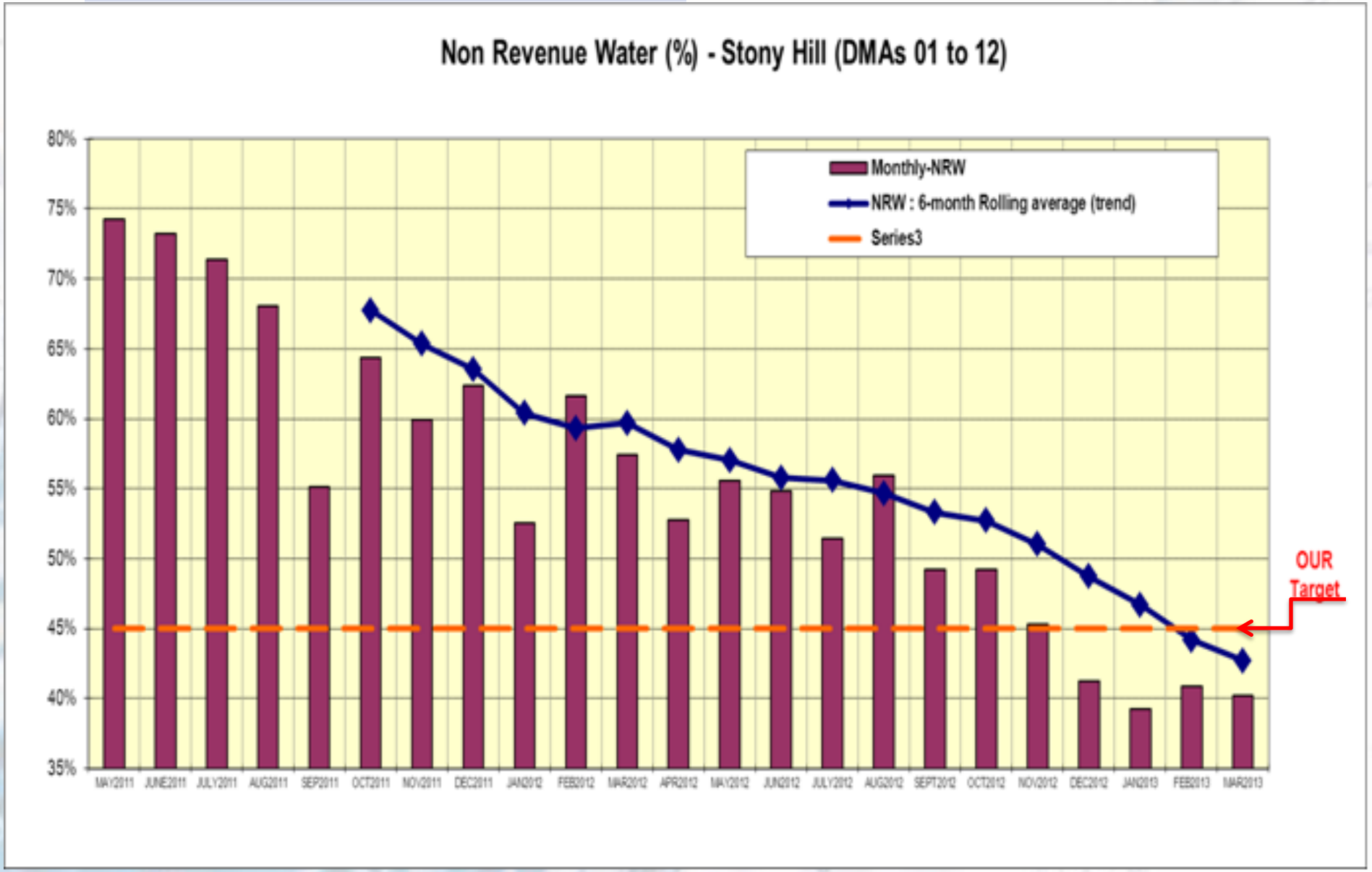
IMPACT OF STAGE 2 PROGRAME OF WORKS

SEAVIEW WTP OUTFLOW MODULATED TO 100% (2.4 IMGD) FOR 24 HOURS per DAY



IMPACT OF STAGE 2 PROGRAMME OF WORKS

- NRW has been reduced from 73% to 40%



SUBSTANTIAL REDUCTION IN ENERGY CONSUMPTION

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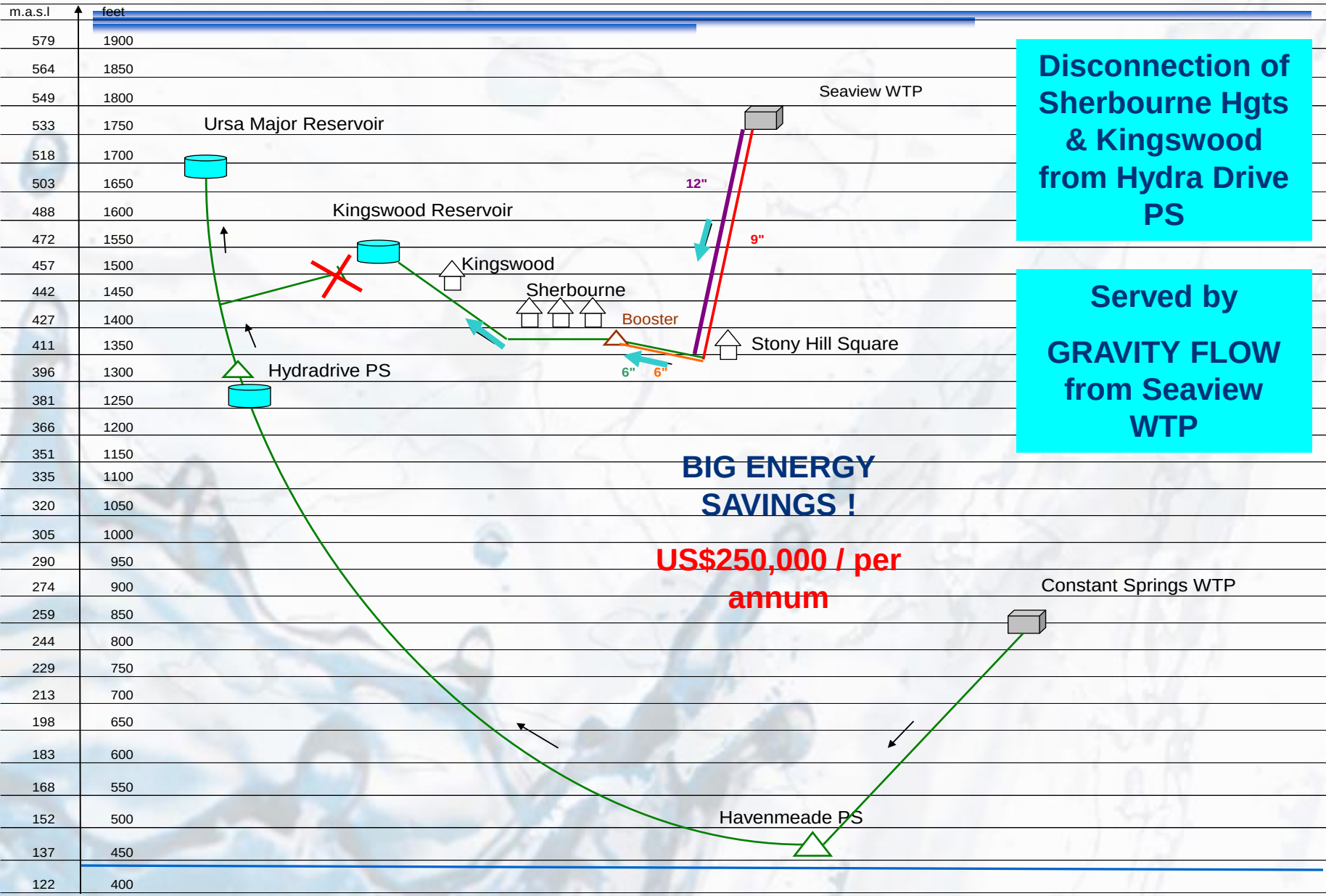
FUTURE SUPPLY TO KINGSWOOD AND SHERBOURNE



Disconnection of Sherbourne Hgts & Kingswood from Hydra Drive PS

Served by

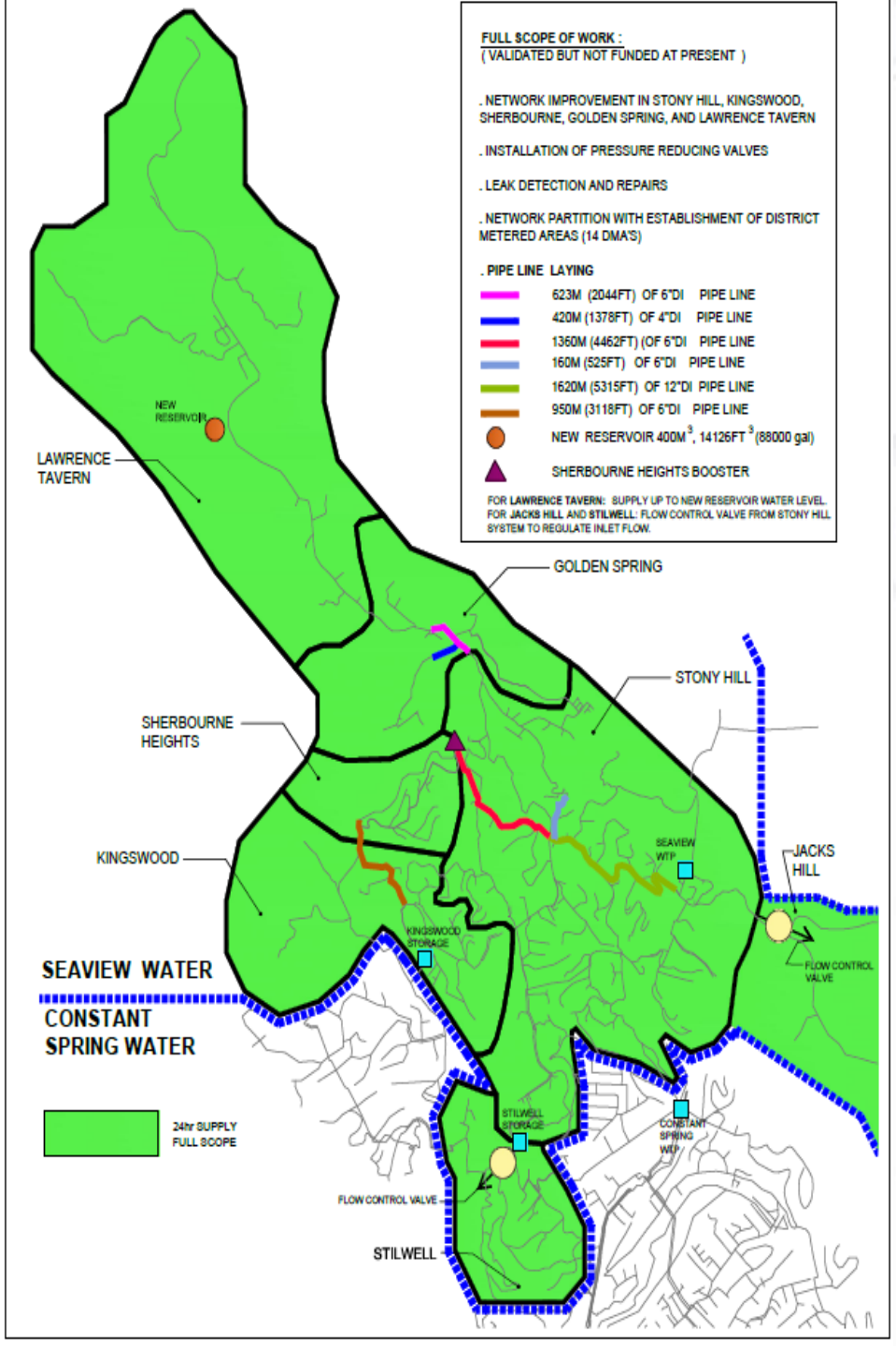
GRAVITY FLOW from Seaview WTP

BIG ENERGY SAVINGS !

US$250,000 / per annum

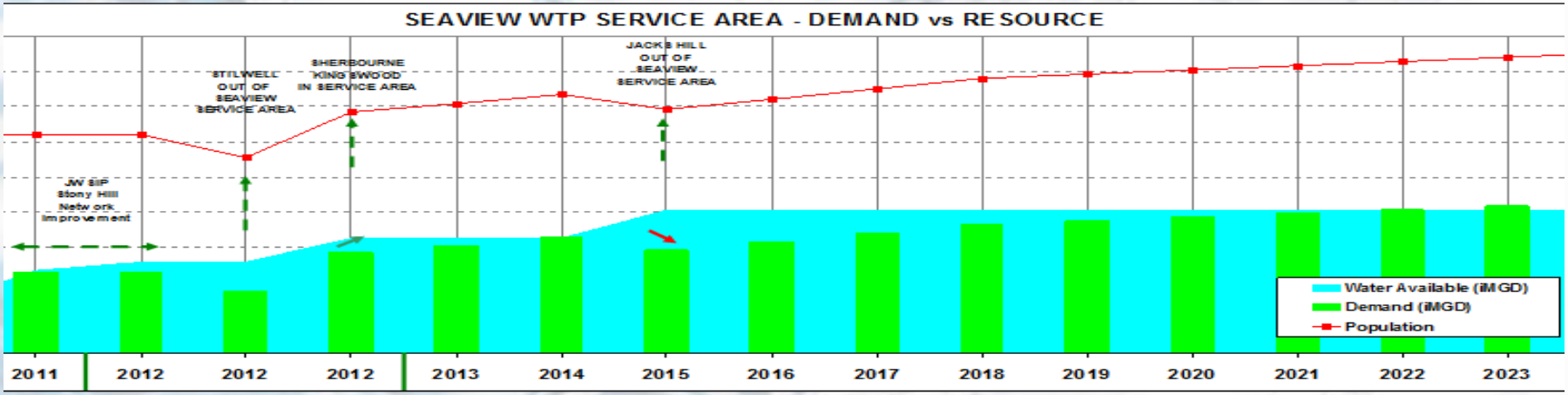
POST PROJECT ACHIEVEMENTS

- 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
- 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 73% to 40%
- Energy consumption has been reduced by US$250,000 / per annum
-



Sustainability and Future Plan of Action

- Minimal additional resource expected to be available for development in the general locale to supply the Seaview Sub-zone
- Medium-term projections suggest that the Jack Hill sub-zone will need to be transfer to the Constant Spring WTP service zone to meet the expected growth in demand
- The NWC must maintain the human and financial resources necessary to sustain the NRW at levels below 40%
-



OPTIMIZING WATER RESOURCE DEVELOPMENT

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SPECIFIC FINDINGS & CONCLUSIONS

- Without the development of any new sources of supply, 24hr/7day supply has been implemented to an area which for decades suffered from a severely regulated supply.

- This has been via a systematic interrogation of the various components of a supply network and development of an appropriate plan of action to minimize waste and increase system efficiencies, viz:-
    i. Restoration of treatment plant production capacity (+0.2imgd)
    ii. Reconfiguration of the supply zones to exclude Stilwell Road (-0.1 imgd) and return Sherbourne Heights / Kingswood (+0.2imgd) and optimize energy usage;
    iii. Pressure management and control of leakage (+0.078imgd)
    iv. Implementation of measures related to customer's commercial operations and social intervention (+0.083imgd)
    v. Reinforcement of the Transmission and Distribution Network to improve its hydraulic efficiency

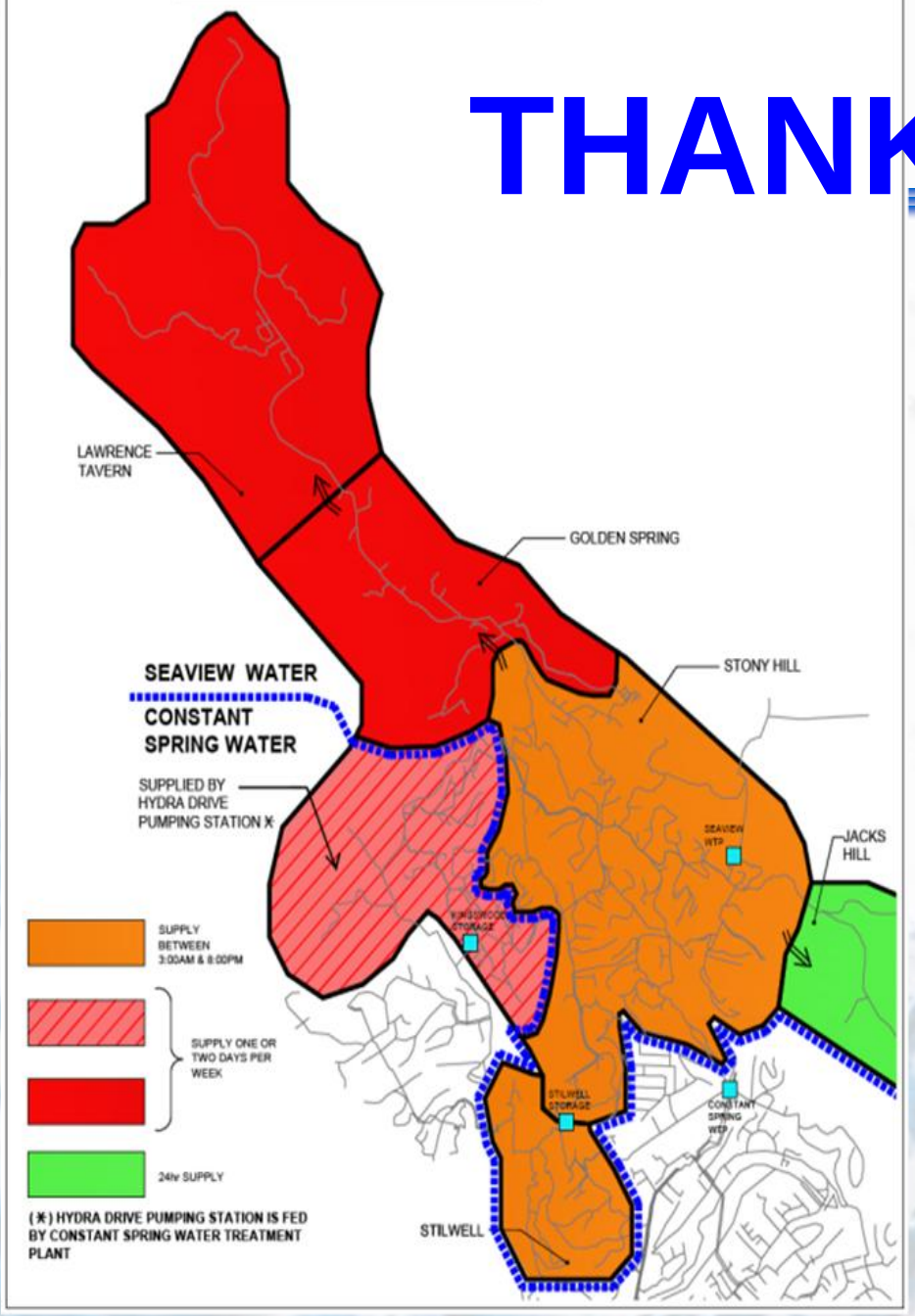
GENERAL FINDINGS & CONCLUSION

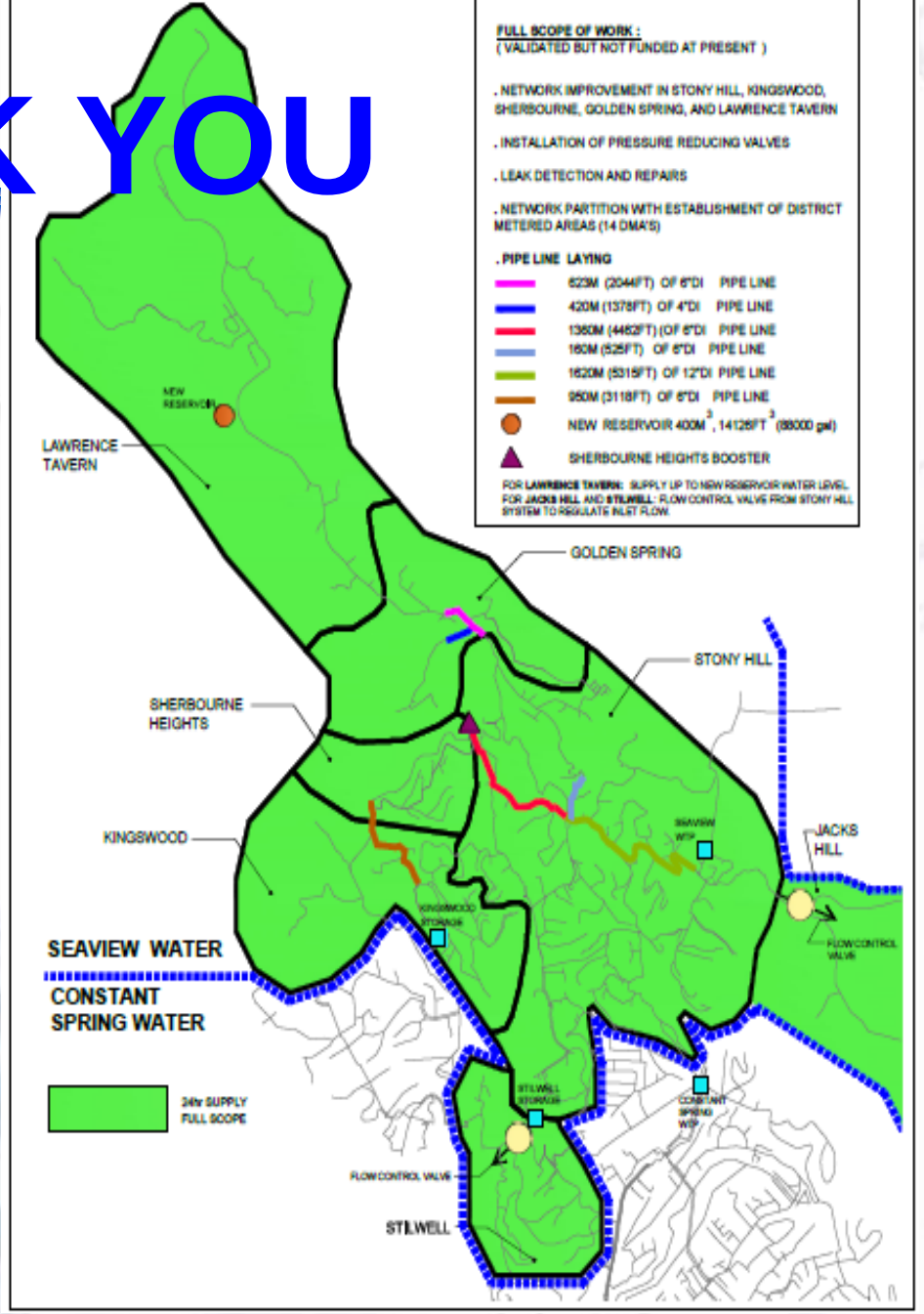
- The usual ‘first choice’ solution of developing and introducing additional water resources to meet supply shortfalls was not the optimal solution.

- 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.

- The allocation of sufficient resources to a team assigned to and dedicated to the commercial and technical operations in the Seaview supply zone will determine the sustainability of the satisfactory service levels which were achieved.

THANK YOU





Pre-project Situation

Post-project Achievements