STORMWATER MANAGEMENT PLAN REPORT

for

MONTANASPRUIT UPGRADE

Prepared for:
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For
City of Tshwane Metropolitan Municipality

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LIST OF ABBREVIATIONS

ARI	Average Return Interval
CoT	City of Tshwane
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EMP	Environmental Management Plan
FLDL	First Land Developments Limited
NEMA	National Environmental Management Act
SEF	Strategic Environmental Focus (Pty) Ltd

1. INTRODUCTION

The City of Tshwane Roads and Stormwater Department wishes to implement measures to alleviate flooding of properties along the Montana Spruit in Doornpoort, northern Tshwane in the Gauteng province. The location and project is described in chapter 2.

Environmental authorisation is required as the proposed development triggers a number of listed activities in terms of the regulations of the National Environmental Management Act, Act, 1998 (Act 107 of 1998), as amended [NEMA], and the Environmental Impact Assessment Regulations. A water use licence is required in terms of the National Water Act, 1998 (Act 36 of 1998) as a number of water uses defined in the act are affected.

A Basic Assessment process was initiated in 2008 and after following the legislated process a Basic Assessment Report was submitted to the Gauteng Department of Agriculture and Rural Development [GDARD] in December 2009. After reviewing the application GDARD requested additional information including clarification of the stormwater management plan.

Strategic Environmental Focus (Pty) Ltd (SEF) was appointed by TGM Consulting to collate the relevant project information and compile a response to the GDARD request for a detailed stormwater master plan.

1.1. PURPOSE OF THIS REPORT

The purpose of this report is to respond to the request by GDARD that a detailed stormwater management plan address the following:

- A description of the expected stormwater volume and catchment area;
- Clear description and depiction on a plan of the methods of collection and transportation of stormwater accumulating upstream of the Montana Spruit and final disposal at the northern end of the proposed construction;
- A description of proposed mitigation measures for possible erosion caused by hydraulic action of the modified channel;
- An indication of the anticipated volume and velocity of the flow after channelisation and deepening of the stream;
- Description of the methods to minimize the load (silt, litter and debris) within the modified spruit and how it will be managed; and
- Description of how the modified spruit will take into account possible future developments on both sides of the spruit.

This report attempts to provide clarity on each of the above items by extracting the relevant information from existing engineering reports and design documents which are also attached for reference.

STRUCTURE OF THE REPORT

The report structure is based on the issues raised by GDARD requiring clarification as follows:

- CHAPTER 1 INTRODUCTION
- CHAPTER 2 DESCRIPTION OF PROPOSED
- CHAPTER 3 STW MASTER PLAN CHARACTERISTICS
  - 3.1 Stormwater Volume and Catchment Area

- 3.2 Stormwater Flow - Upstream, within the Project Area and Downstream
- 0 *Source Montana Spruit Improvements Project *Preliminary Design Report 2007*

Table 3: Future State Flood peaks

Return Period	SDF Method	Alternative Rational Method	Rational Method	Empirical Method	RMF	Selected peak flood
2	6.09	30.92	35.00		314.6	33
5	21.38	52.16	47.51			50
10	35.58	68.23	59.96	26.6		64
20	51.65	84.29	73.78	36.1		79
50	**75.63**	**105.53**	**95.40**	**50.0**		**100**
100	**95.78**	**121.60**	**116.80**	**63.3**		**119**
200	117.16	137.67				138

**Source Montana Spruit Improvements Project Preliminary Design Report 2007*

1.1.1. Breedt Street Sub-catchment Calculated Peak Flows

Flooding along Breedt Street, especially at the intersection with Tsamma Street is problematic. The upgrading of the stormwater system along Breedt Street will result in additional catch pits along Breedt Street connecting to an underground stormwater pipe that will be upgraded with a larger diameter pipe from the existing 525mm diameter. The discharge into the Montana Spruit at the Tsamma Street crossing will remain.

The flooding along Breedt Street is aggravated by surface runoff from the N1. The preliminary Design report states that the proposed cut off drain along the N1 is anticipated to eliminate flooding along Breedt Street entirely.

- Proposed Mitigation Measures for Erosion
- 3.4 Anticipated Volume and Velocity of the Flow after ConstructionAnticipated Volume and Velocity of the Flow after
- 3.5 Minimisation Methods and Management of Silt, Litter and Debris
- 3.6 Consideration of Future Developments

- Chapter 0
-
- CONCLUSION AND RECOMMENDATIONS

1. LEVEL OF STUDY

The level of this study is limited to literature research focussed on the project documentation developed and prepared on behalf of the City of Tshawne by the project engineers IR Consulting Engineers. Where appropriate, schematics are prepared to interpret and illustrate the design parameters and intent.

2. REFERENCE MATETIAL

This report is informed by the Draft version of the "*Montana Spruit Improvements Project Preliminary Design Report*" dated 21 September 2007 and updated drawings prepared by IR Consulting Engineers for Section 1 of the Montana Spruit.

2. DESCRIPTION OF PROPOSED PROJECT

2.1. LOCATION

The proposed development is located along the Montana Spruit in Doornpoort, northern Tshwane in the Gauteng province see Figure 1. It traverses a number of properties and is treated as a linear development. The affected properties of the Montana Spruit Channelisation Improvement Project (Section 1) include Portions 28 to 42, 134, 135, and 137 and the remainder of the Farm Doornpoort 295 JR, Tshwane, Gauteng see Figure 2.

A large scale site layout plan is included in Annexure A: Site Layout showing the combined layout of the proposed project covering the study areas of two adjacent sections (Section 1 and Section 2) each with a different applicant and environmental application process.

In response to comments received in the public participation process the proposed project was extended upstream to address stormwater discharge that enters the spruit from the retirement village property portion 257 of the farm Hartebeesfontein 324-JR. This was included based on direct consultation between the project engineer on behalf of the City of Tshwane and the retirement village management.

The co-ordinates of the site are:

- Starting point of the activity 25.662006 S 28.263414 E
- End point of the activity 25.651536 S 28.262900 E

3. GENERAL PROJECT DESCRIPTION

The proposed interventions include:

- Channelisation of Montana Spruit by changing the existing channel through excavating, shaping and widening. This will provide enough space to meet flood conveyance targets, increase vegetation in the channel, improve habitat conditions, and improve water quality in the stream;
- Vertical re-alignment of the crossing of Tsamma Road over the Montana Spruit; and
- Improvement of stormwater management on Breed Street.

The project characteristics are discussed in chapter 3 where the points raised in GDARD's correspondence are addressed.

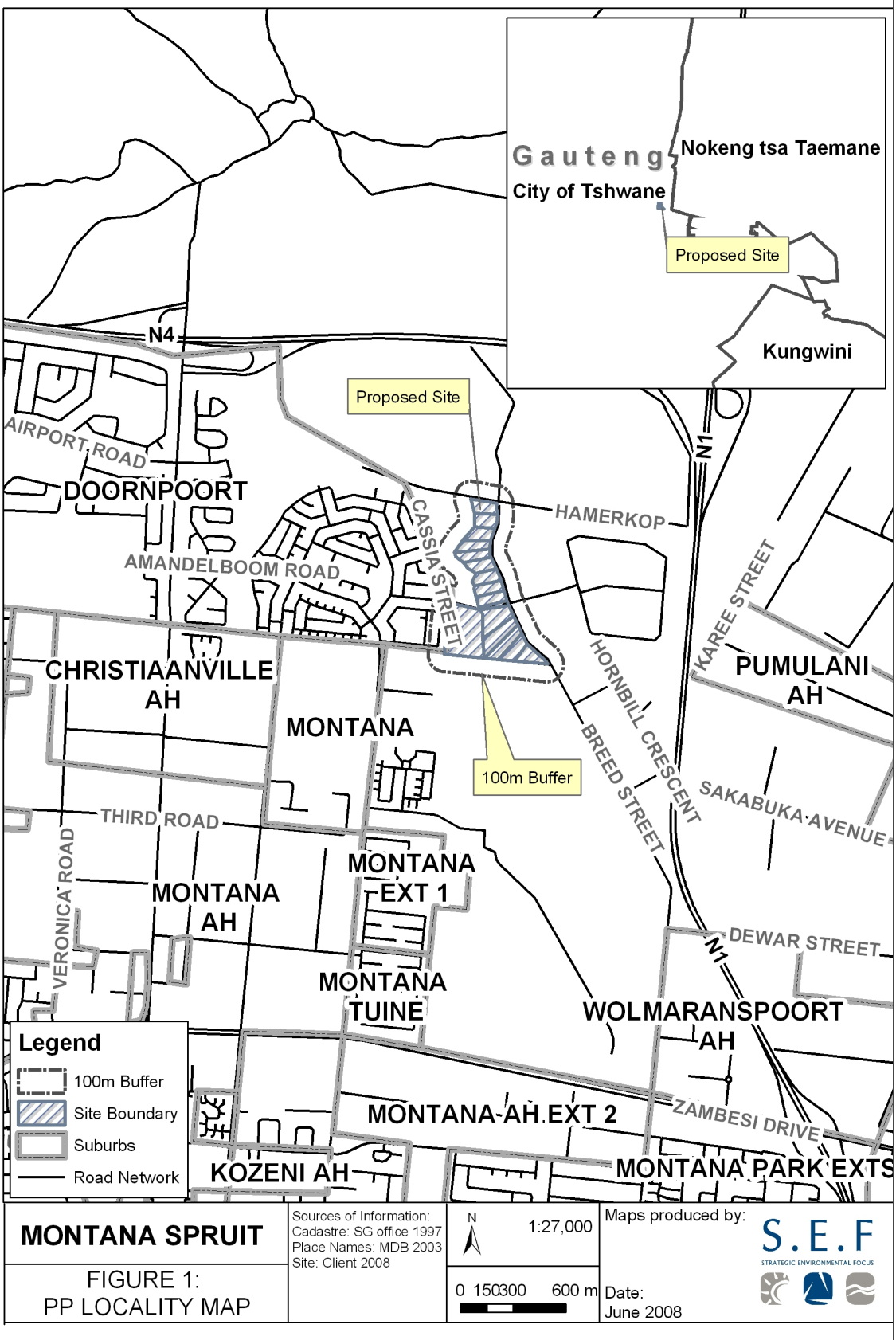

Figure 1: Locality Map

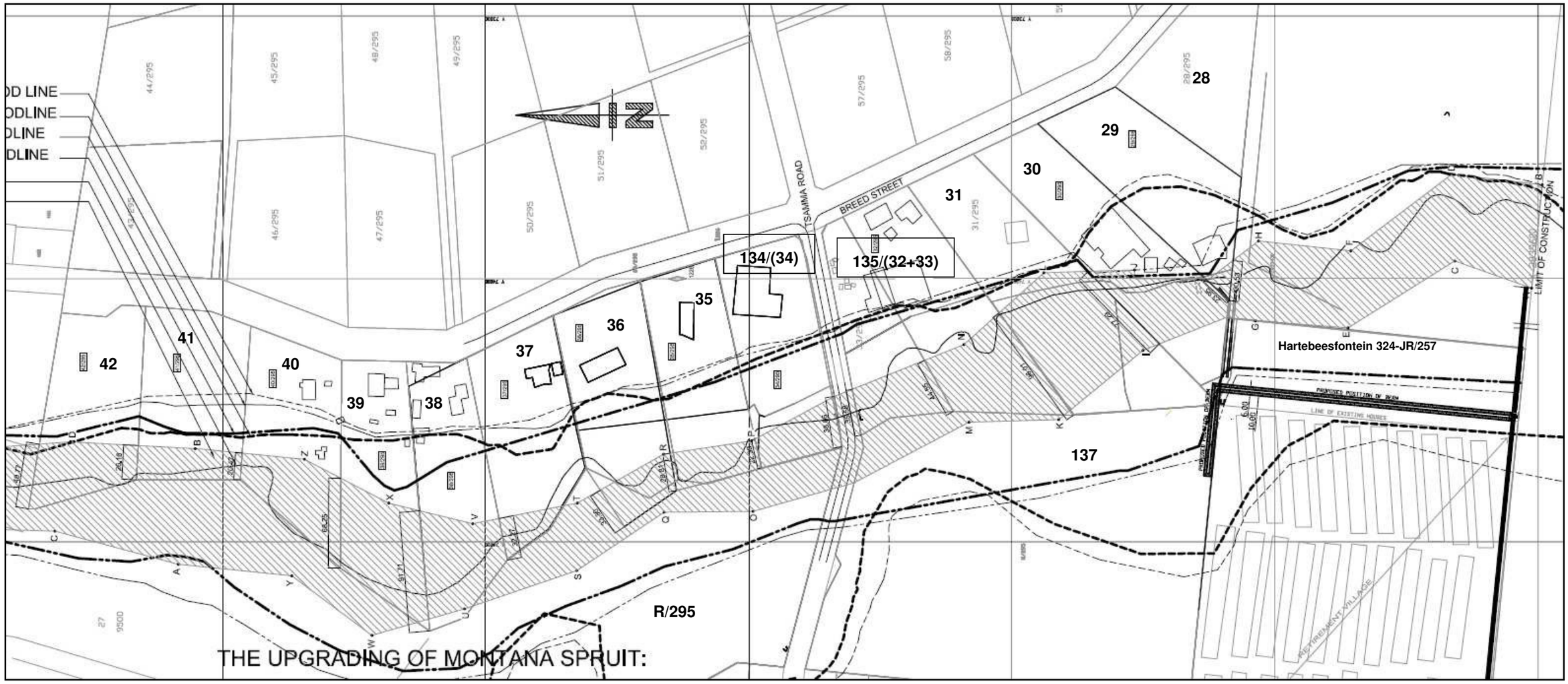

Figure 2: Site Layout

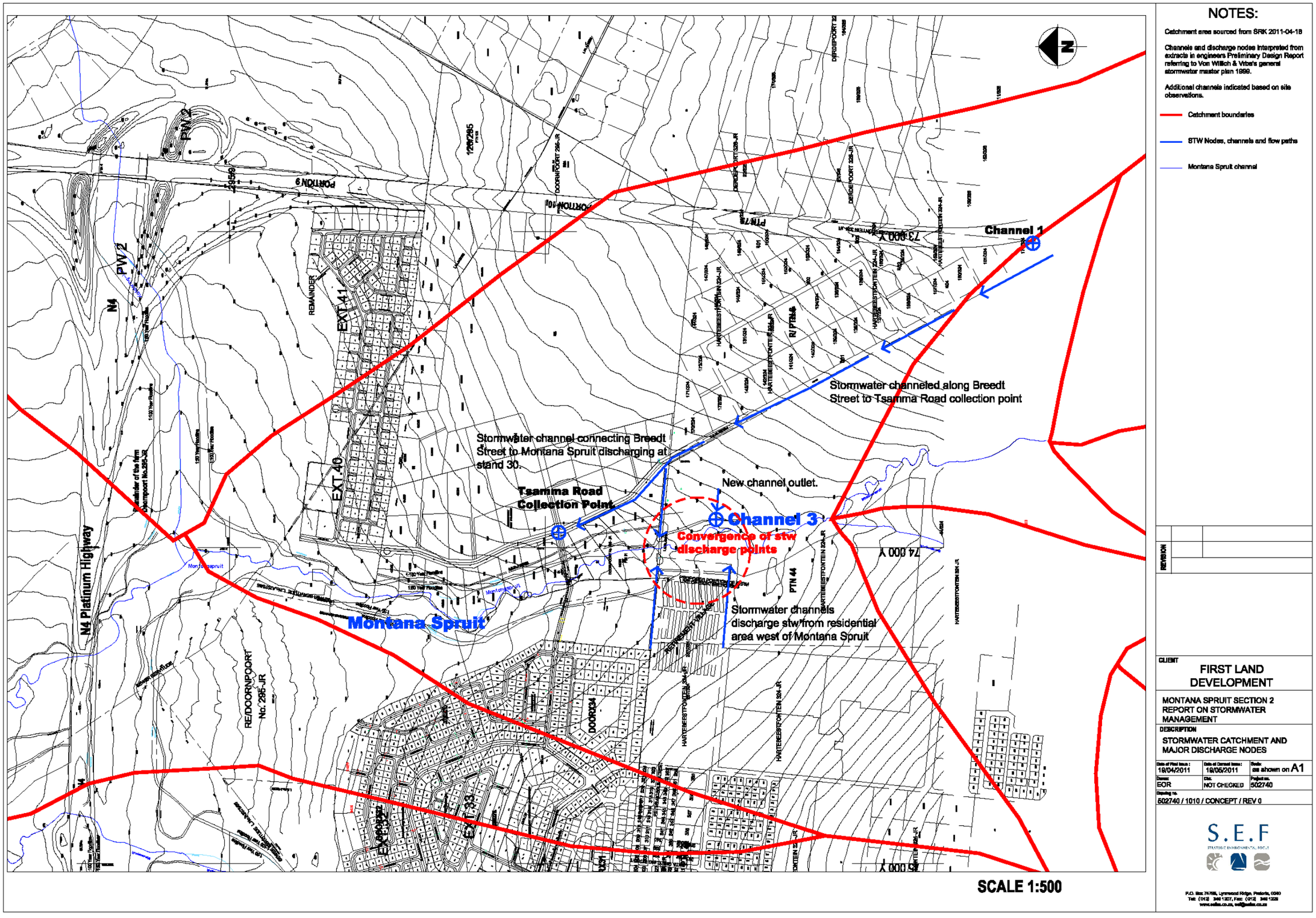

Figure 3: Stormwater Schematic

3. STW MASTER PLAN CHARACTERISTICS

3.1. Stormwater Volume and Catchment Area

The catchment for the project has an overall dimension of 15 km in length by 3 km wide. The Montana Spruit catchment is defined by a mountainous range in the south but eventually slopes towards the north at about 2%. The longest watercourse to the end of the project is about 5.1 km. The maximum elevation in the catchment is about 1372 m and the lowest is 1223 m. The elevation difference is 149 m.

The Preliminary Design Report states that Von Willich & Vrba prepared a general stormwater master plan for area in 1999. Unfortunately the drawing referred to in the report was unavailable at the time of concluding this report. A schematic identifies the approximate positions of the nodes referred to see Figure 3. The following extracts from the Preliminary Design Report describe the drainage characteristics affecting stormwater discharge into Montana Spruit:

- *According to this master plan there are four major water drainage nodes in the area.*
- *Three of these nodes are found upstream of the Tsamma Road.*
- *At the first major node the stormwater flows directly into the steam.*
- *In the other three nodes the stormwater leads to the Montana Spruit by means of an artificial channel, designed to accommodate the 1:50 year stormwater flow.*
- *Of the two collecting channels upstream of Tsamma Road the first which is referred to as **Channel-1** in the master plan drawing, is found about 1.8 km south of the road. This channel runs along the National Road (N1) for one kilometre and crosses Breed Street as shown in the master plan drawing toward the Spruit. Part of this channel, which runs from Breed Street to the Spruit, has been constructed.*
- *The second, which is referred to as **Channel-3** in the master plan drawing, is only half a kilometre south of Tsamma Road. This channel has not yet been constructed.*
- *Channel-2 runs from node No. 801 to node No. 797, as shown in the master plan drawing, along N1 and then diverted to east toward the Montana Spruit. This channel is also not constructed.*
- *The stormwater drainage along Breed Street was designed to be a pipe system to accommodate a 1:25-year return period peak flow. Right at the junction of Tsamma and Breed Streets there is a collecting node.*

In addition to the nodes described in the Von Willich & Vrba master plan the Stormwater Schematic see Figure 3 indicates the positions of additional channels that discharge into the Montana Spruit south of Tsamma Street; two from either side of the Retirement Village in the west and one from a new development further upstream.

The volumes are discussed under section 3.2 below.

3.2. Stormwater Flow - Upstream, within the Project Area and Downstream

The section of the Montana Spruit under consideration collects flows from three main sources:

- The Montana Spruit catchment through:
  - In stream flow from the Montana Spruit upstream;
  - Discharge from a number of stormwater pipes and channels; and

- Surface runoff from the adjacent properties;
- Redirected runoff along Breedt Street intercepted by the N1; and
- Discharge of flood water from Breedt Street due to incomplete and inadequate stormwater conveyance capacity along Breed Street;

The input parameters used to model the hydrology reflected the same three sources: the Montana Spruit catchment area (including runoff from adjacent properties); stormwater from Breedt Street; and stormwater originating from the N1. The values are included in Table 1 below.

Table 1: Input parameters selected for the Rational Method

	Montana Spruit stormwater	N1 stormwater	Breed Street stormwater
Catchment area	9.9 km2	0, 681 km2	071km2
Slope	1.65 %	1, 627 %	1.25 %
C (coefficient)	0.404	0, 656	0, 705
Time of concentration	66 minutes	39, 3 minutes	33 minutes

**Source Montana Spruit Improvements Project Preliminary Design Report 2007*

The 1:50 and 1:100 year return period has been adopted for the determination of design peak flows for the Montana Spruit flooding problems. The 1:25 year return period has been adopted for the determination of design peak flows for Breed Street flood problems. The 1:50 year return period has been adopted for the determination of the design peak flows for the N1 cut-off channel.

3.2.1. Montana Spruit Catchment Calculated Peak Flows

The results of the flood peak flow calculations for the Montana Spruit catchment (present and future states flood peak) for the various methods utilised are shown in Table 2 and

Table 3 below: The calculated peaks flows for each average return period and method are provided. Peak flows for the 50 and 100 year return periods are highlighted in bold text. The selected peak flows are reflected in the last column in each table.

Table 2: Present State Flood peaks

Return Period	SDF Method	Alternative Rational Method	Rational Method	Empirical Method	RMF	Selected peak flood
2	6.09	22.54	25.51		314.6	24
5	21.38	38.02	34.64			36
10	35.58	49.74	43.71	25.4		47
20	51.65	61.45	53.78	34.5		58
50	**75.63**	**76.93**	**69.55**	**47.9**		**73**
100	**95.78**	**88.65**	**85.14**	**60.6**		**87**
200	117.16	100.36				100

**Source Montana Spruit Improvements Project Preliminary Design Report 2007*

Table 3: Future State Flood peaks

Return Period	SDF Method	Alternative Rational Method	Rational Method	Empirical Method	RMF	Selected peak flood
2	6.09	30.92	35.00		314.6	33
5	21.38	52.16	47.51			50
10	35.58	68.23	59.96	26.6		64
20	51.65	84.29	73.78	36.1		79
50	**75.63**	**105.53**	**95.40**	**50.0**		**100**
100	**95.78**	**121.60**	**116.80**	**63.3**		**119**
200	117.16	137.67				138

**Source Montana Spruit Improvements Project Preliminary Design Report 2007*

3.2.2. Breedt Street Sub-catchment Calculated Peak Flows

Flooding along Breedt Street, especially at the intersection with Tsamma Street is problematic. The upgrading of the stormwater system along Breedt Street will result in additional catch pits along Breedt Street connecting to an underground stormwater pipe that will be upgraded with a larger diameter pipe from the existing 525mm diameter. The discharge into the Montana Spruit at the Tsamma Street crossing will remain.

The flooding along Breedt Street is aggravated by surface runoff from the N1. The preliminary Design report states that the proposed cut off drain along the N1 is anticipated to eliminate flooding along Breedt Street entirely.

3.3. Proposed Mitigation Measures for Erosion

The design proposes to widen the existing channel while retaining the current alignment. It is further proposed to retain the current invert level of the spruit bottom and to protect it from scouring by installing an “armorflex” lining. The newly shaped banks of the stream will be re-vegetated with indigenous plant species that naturally occur along the spruit. The establishment of vegetation is essential to prevent erosion of the channel and banks.

A floodplain rehabilitation plan has been prepared that includes detailed specifications and methods for the implementation of the rehabilitation of the floodplain. This rehabilitation plan will be submitted to GDARD as a separate report.

The Montana Spruit Channel Improvements Preliminary Design Report highlights that the hydraulic analysis indicates a high velocity of flows of between 3, 0 – 5, 0 m/s which implies that flows are critical and super critical. The properties that are expected to be affected and the proposed protection measures are indicate in Table 4 below.

3.4. Anticipated Volume and Velocity of the Flow after Construction

The hydraulic model of present and future peak flows are provided in Table 2 and

Table 3. The future flows presented in

Table 3 takes into account the proposed interventions to enlarge the flow area and thereby contain the flooded area during 1:50 and 1:100.

A comparison of the selected peak flood values of the two tables indicate an increase in peak flow for the modified channel. The peak flood for the 1:50 event will increase to 100 while that of the 1:100 event will increase to 119.

The flow velocities of the modified channel are expected to be high such that embankment protection is required to prevent erosion see Table 4.

Table 4: Proposed embankment protection from high velocity in channel

ERF NO	CROSS – SECTION NO	FRAUD NO.	VEL CHAL M/S	EXTEND OF EMBANKMENT PROTECTION
30, 31, 32	12, 13, 14	0, 99 1, 0 0,93	1, 93 2, 49 3, 24	Extensive gabion wall + mattress approx. 2,0m high
33, 34	7.4	1, 15	2, 35	Gabion wall approx. 2,0 m high
37, 38	2	1, 0	1, 77	Gabion walls approx. 2, 0m high
Old Age Home	14, 16, 3	0, 99	2, 31	Earthwall lined with (2, 0m high) concrete blocks

**Source Montana Spruit Improvements Project Preliminary Design Report 2007*

The widening of the channel cross section will reduce the floodlines for recurrence periods of 1:50 and 1:100 years.

3.5. Minimisation Methods and Management of Silt, Litter and Debris

Discussions with local residents and observations along the upper section of the spruit suggest that sediment washed downstream during flood events is comprised of building materials and exposed soils most likely originating from upstream building sites. The potential for erosion of the channel is high due to the soil characteristics and the high flow velocities anticipated along certain sections of the Montana Spruit.

Erosion of the channel would result in an increased silt load that would be deposited lower downstream where flow velocities decrease. This can be mitigated by providing erosion protection along the channel.

The channel bottom will be protected from erosion by the installation of an “armorflex” lining, while vegetation will be established to cover the wider channel.

Local residents, specifically those upstream of Tsamma Street have expressed their frustrations with the deposition of silt, litter and debris on their properties during flood events.

The proposed design for Section 1 (CoT application) does not currently provide for the management of silt, litter and debris entering the project area from upstream sources. It is however recommended that silt and litter traps be included in the design. These may be located at the outlet points of the main stormwater pipes and channels that discharge stormwater into the spruit.

The potential to construct a larger combined attenuation and sediment trap exists between the Montana Spruit and the Retirement Village, since three main stormwater outlets

discharge into the spruit at this point. The construction of this feature can run concurrently with the channelisation of the Montana Spruit or as a separate project.

3.6. Consideration of Future Developments

The hydraulic calculations and models were developed for two land use scenarios a present state and a future developed state The Preliminary Design Report states that the future fully developed state has been determined using the following assumptions:

- *50% of the vacant properties along Zambezi road and the corner of Breed and Zambezi Road will be developed as business areas and the other 50% as residential areas;*
- *Vacant land elsewhere will be developed as residential;*
- *Areas which are not shown on the cadastral map (provided by SRK) as stands will remain as they are; and*
- *All vacant stands to the west and north of Zambezi road will be developed.*

The modified floodlines reflect the anticipated flows and peak floods associated with a future developed scenario.

4. CONCLUSION AND RECOMMENDATIONS

The proposed modification of the Montana Spruit upsteam of the N4 highway will reduce floodlines thereby avoiding flooding of houses and outbuildings of residents along Breedt Street. The channel section will be widened and increase the capacity of the spruit to accommodate increased flows during flood events.

The proposed volumes discharging into Section 2 remain unchanged from the existing values. The proposed flow velocity discharging from Section 1 into Section 2 increases from the existing velocities by 0.11 m/s for the 50 year ARI and 0.18 m/s for the 100 ARI.

The proposed flow velocity discharging from Section 2 at the N4 highway **decreases** compared to the existing velocities by 0.7 m/s for the 50 year ARI and by 0.7 m/s for the 100 year ARI. Section 2 therefore mitigates the slight increase in flow velocity discharge proposed for Section1 upstream.

The construction process will change more than the hydraulic characteristics of the spruit. The ecological systems will also be transformed in the short and long term. In the short term the works area will stripped of vegetation and topsoil. The subsoil will be excavated and shaped to form the wider open channel. The pools and small wetlands occurring along the spruit will be transformed and in places removed. Implementation of a rehabilitation plan is essential to restore a semblance of these ecosystems and habitats as soon as possible after construction.

The modification of the spruit is part a response to increased peak flows resulting from increased urban development within the upstream catchment which has also resulted in increased silt and debris being washed down into the section under consideration. The capacity of the spruit to intercept silt and promote the deposition of sediments in accessible areas is required. A management programme to remove excess silt is required.

It is therefore recommended that:

- Should the application receive approval form the competent environmental authority that a water use license be obtained prior to the commencement of construction;
- The approval and construction of the proposed channels along the N1 and implementation of the stormwater capacity upgrade along Breedt Street be undertaken;
- Silt traps and attenuation features be located at the main outlets of the channels discharging into the spruit upstream of Tsamma Street;
- Silt traps be constructed early in the construction programme to trap silt washed down during the construction phase and earlier establishment of vegetation within the disturbed areas;
- Construction of the channel take place and be completed in sections to avoid the entire stretch being exposed to erosion;
- The recommendations in the rehabilitation plan be implemented including that the:
    - The attenuation features within and outside of the widened channel be constructed to increase the attenuation capacity during shorter interval floods and promote wetland habitats;
    - The raised weirs within the “armorflex” lined channel be constructed to provide in-stream aquatic refuges and wetlands;

- The management programme set out in the Environmental Management Plan for the project be implemented;
- The ecological management plan incorporating water quality monitoring during and after construction be implemented;
- The modified channel and stormwater inlets must be inspected on a monthly basis or after a heavy storm during the first 12 months after construction for signs of erosion which must be repaired as soon as practically possible before the next heavy rainfall event by means of a permanent and ecologically sympathetic solution;
- The silt traps and widened channel must be inspected monthly during the first 12 months after construction for signs of excessive sediment and debris build up which must be removed as soon as practically possible without damaging vegetation cover and to restore their capacity before the next heavy rainfall event; and
- Monitoring of the channel and silt traps and remedial action must be undertaken at least twice a year for another five years: once before the commencement of the rainy season; and the second time at the end of the rainy season.

5. REFERENCES

IR Consulting Engineers (2007). 'CB 357 / 2006: Montana Spruit Channel Improvements – Preliminary Design Report', Draft.

6. ANNEXURES

ANNEXURE A: SITE LAYOUT

ANNEXURE B: STORMWATER SCHEMATIC

NOTES:

Catchment area sourced from SRK 2011-04-18

Channels and discharge nodes interpreted from extracts in engineers Preliminary Design Report referring to Von Willich & Vrba's general stormwater master plan 1999.

Additional channels indicated based on site observations.

Catchment boundaries

STW Nodes, channels and flow paths

Montana Spruit channel

Channel 1

Stormwater channeled along Breedt Street to Tsamma Road collection point

Stormwater channel connecting Breedt Street to Montana Spruit discharging at stand 30.

Tsamma Road Collection Point

New channel outlet.

Channel 3

Convergence of stw discharge points

Stormwater channels discharge stw from residential area west of Montana Spruit

Montana Spruit

N4 Platinum Highway

SCALE 1:500

REVISION			

CLIENT
CITY OF TSHWANE

MONTANA SPRUIT SECTION 1
REPORT ON STORMWATER MANAGEMENT

DESCRIPTION
STORMWATER CATCHMENT AND MAJOR DISCHARGE NODES

Date of First Issue :	Date of Current Issue :	Scale:
19/04/2011	19/05/2011	as shown on A1
Drawn: EOR	Chk. NOT CHECKED	Project no. 504041
Drawing no. 504041 / 1010 / CONCEPT / REV 0		

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