Surface Water Study as part of the Integrated Waste Management Licence for the Co-disposal Facility at Kusile Coal Fired Power Station

Report Prepared for

ILISO Consulting

Report Number 467775 vers.0.4

Report Prepared by

srk consulting

July 2014

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SRK Project Number 467775 vers 0.4

July 2014

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List of Abbreviations

AD	Ash Dump
ADDD	Ash Co Disposal Facility Dirty Dam
ADDF	Ash Co Disposal Facility
BMP	Best Management Practice(s)
BPG	Best Practice Guideline(s)
D	Duration
DWA	Department of Water Affairs
E	Spatial extent
EAD	Emergency Ash Dump
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
FGD	Flue Gas Desulphurisation
GA	General Authorisation
GN	Government Notice
MAP	Mean Annual Precipitation
MAR	Mean annual Runoff
Ns	Not stated
KPS	Kusile Power Station
P	Probability
PCD	Pollution Control Dam
P&G	Provisional and General
R	Reversibility
RDF	Recommended Design Flood
RMF	Regional Maximum Flood
RWQO	Resource Water Quality Objectives
S	Severity / magnitude
SCS	Soil Conservation Services
SDD	Station Dirty Dam
SDDST	Station Dirty Dam Settling Tanks
SED	Safety Evaluation Flood
SS	Suspended Solids
Stds	Standards
SWMP	Stormwater Management Plan
TDS	Total Dissolved Salts
WMA	Water Management Area

1 Introduction and Scope of Work

SRK Consulting was appointed by Iliso Consulting to undertake a surface water specialist study for incorporation into the application for an Integrated Waste Management Licence for the construction of the facility which includes an Ash/gypsum Co-Disposal Facility, the Ash Co-Disposal Dirty Water Dam (ADDD), the Station Dirty Water Dam (SDD) and the station dirty dam settling tanks (SDD ST).

Considering the information already available and in view of the above the scope of work has been defined as summarised below:

a. Describe all the surface water **impacts** and then propose **mitigation measures** as normally required for and EIA/EMP This will be done for the construction, operational, decommissioning and closure phases;
b. A Storm Water Management Plan (SWMP) as prescribed by the Best Practice Guideline G1: Storm Water Management by DWAF, 2006. All recommendations to be in line with Regulation 704 of the NWA, 1998 and to include the following:
    - **Catchment characteristics** i.e. catchment boundaries (clean and dirty water), rainfall, water bodies (pans, dams, etc.), slope and drainage directions;
    - Determine the impact of all water retention infrastructure (dirty water dams associated with the ash co-disposal facility) on the Mean Annual Runoff (**MAR**) by simulating the life of the development over the affected streams;
    - Determine the storm water flows and volumes (1:50 & 1:100 year recurrence intervals) for **both the dirty and clean water areas together with the infrastructure engineer**. For storm water containment purposes the volumes for longer storm durations (24 hours) should also be determined;
    - **Flood lines** on all river sections that might be affected by or is in close proximity to Power Plant activities (100m).

1.1 Background

Kusile Coal-Fired Power Station is currently under construction with an anticipated output 4 800 MW, which covers approximately 2 500 ha of land on the Farm Hartebeesfontein 537 JR and the Farm Klipfontein 566 JR. in the Witbank area. Application was previously made for an environmental authorisation for a water treatment works, a wastewater treatment works, access roads, railway line, water supply pipelines, a coal stockyard, an ash disposal facility, a coal and ash conveyor system and water storage facilities. A positive environmental authorisation was received in June 2007.

This June 2007 EA was appealed and a revised EA was issued in March 2008 under the ECA. In terms of this EA, Eskom can construct the power station and operate ash disposal systems. The EA also states that Kusile Power Station will have Flue Gas Desulphurisation (FGD) technology to minimize particulate and SO2 emissions. As a result of FGD technology, gypsum shall be produced as a by-product during operation of the power station. At the time of the EIA, Eskom's intention was to dispose of ash only. Although the possibility of gypsum being generated through the FGD process and the commercial value related to it was discussed in the final EIA Report, the disposal of gypsum on the ash dump was not included. The co-disposal of gypsum with ash is therefore not authorised.

Since gypsum is considered to be a hazardous waste (classified as a medium hazardous waste), a Waste Management Licence (WML) must be applied for, to co dispose ash and gypsum as a listed activity 9, Category B of GN718 and the construction of the facility (Ash/gypsum co-disposal facility, the Ash Co-disposal facility Dirty Water Dam (ADDD), the Station Dirty Water Dam (SDD) and the station dirty dam settling tanks (SDD ST)) will trigger activity 11, Category B of GN 718. In addition to the hazardous waste that will be disposed of at Kusile, general waste including rock spoils (the concrete rock spoil and K3 spoils) produced during construction will also be temporarily stored on site.

1.2 Location and Context of Kusile Power Station

The Kusile Power Station is situated approximately 10 km north of the Kendal Power Station, and west to north-west of the New Largo Coal Field.

The construction of the Kusile Power Station is on approximately 2,500 ha on the Farms Hartbeestfontein 537 JR and Klipfontein 566 JR.

The largest town within a 30 km radius of the site is Witbank. The smaller town of Bronkhorstspruit lies approximately 20 km North West of the site.

The power station falls within the jurisdiction of the Delmas District Municipality.

A locality map is provided below in Figure 1.1.

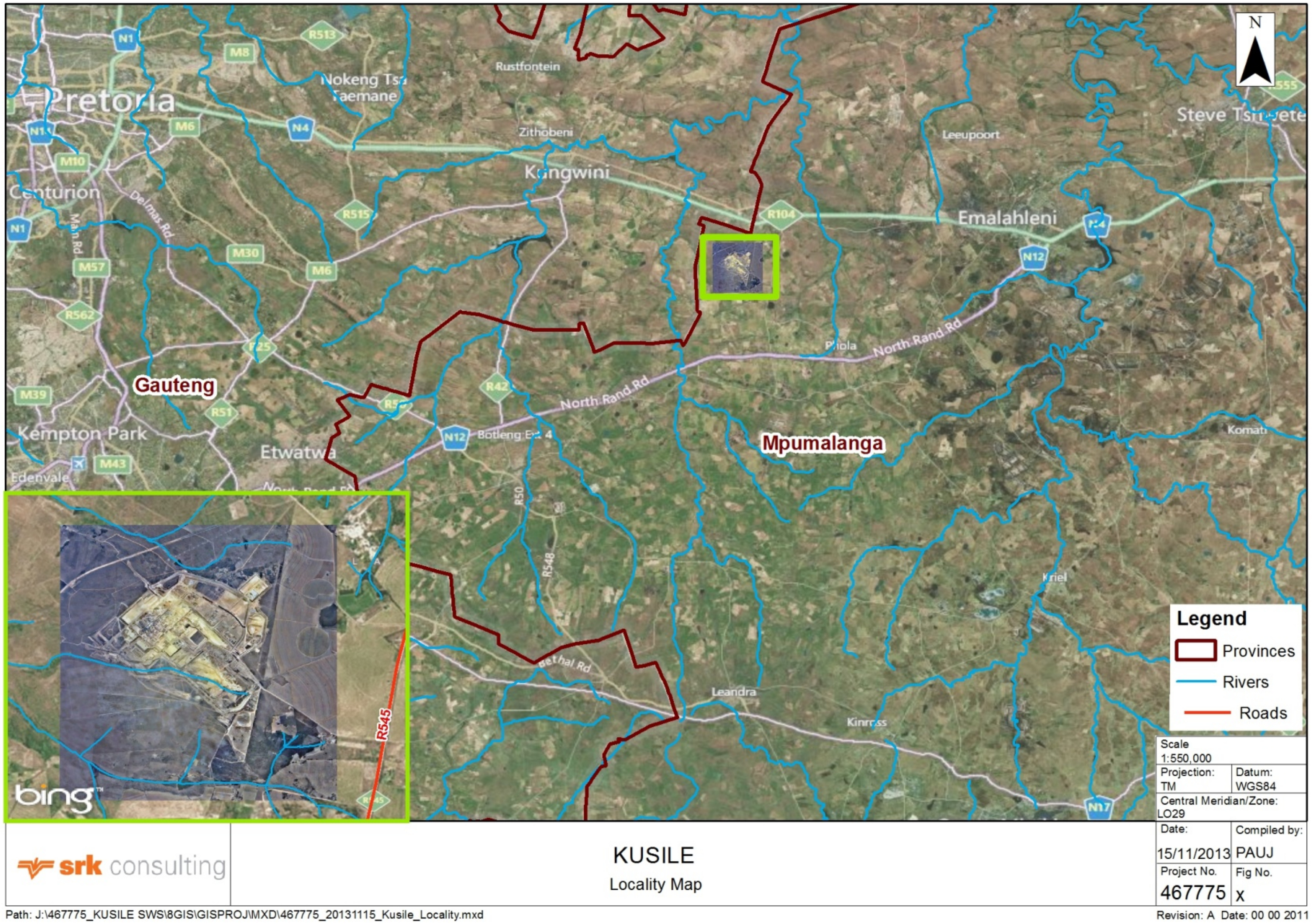

Figure 1-1: Locality of Kusile Power Station

1.3 Structure of Report

The aim of this document is to provide a risk assessment for the Kusile Power station Ash/Gypsum co-disposal facility, the Ash Co-disposal Facility Dirty Water Dam (ADDD), the Station Dirty Water Dam (SDD) and the station dirty dam settling tanks (SDD ST). In line with this, the plan is divided into five main sections, with each section providing guidance and information on particular aspects of the SWMP. The three main sections contained in this study are:

- Legislative Framework & Regulatory Requirements;
- Status Quo Assessment of Existing Control Measures;
- Risk Assessment Methodology and Predicted Risk Assessments.

1.4 Methodology

The methodology implemented to develop the Surface Water Study consists of a number of different stages. These stages include the following:

- **Collection of data:** In order to inform the study on the risk assessments at the Kusile Power Plant, data and information related to the Kusile Power Plant was collected from various sources. This data was used to develop the necessary spatial representations (maps) and database to support the Surface Water Study, as well as to determine new control measures and proposed upgrade of existing controls;
- **Assessment of relevant standards and guidelines:** During this stage relevant Eskom and related South African standards/legislation were investigated (these are listed in Table 1-2 below) in order to determine the requirements related to stormwater management and pollution control at the Kusile Power Station;
- **Site Visit and Status Quo Investigation:** A site visit was undertaken by members of the project team on 11 September 2013. The aim of this visit was to investigate the current building status of infrastructure at the Kusile Power Station and to ascertain the floodline levels which could influence the compilation of the risk assessments. Where required, data and information such as measurements related to the capacity of infrastructure was obtained from relevant collected data;
- **Determination of required control measures:** Having defined legal requirements as well as the current status quo of the existing system enabled the team to identify required additional control measures as well as remediation opportunities for existing control measures.

1.5 Legislative Framework & Regulatory Guidelines

When assessing the existing status quo of a power station building project, relevant standards and regulations need to be used for benchmarking the current control structures and the operation at the power station. The relevant legislation and guidelines that were reviewed are summarised in Table 1-2 below.

Table 1-1: Summary of Legislative Requirements and Regulatory Guidelines relevant to stormwater and pollution control

Act / Regulation	Relevance and Requirement
National Environmental Management Act, 1998 (Act No. 107 of 1998)	On water management aspects
Regulations on Dam Safety published in terms of the National Water Act (Act no 36 of 1998): Dam Safety Standards	Minimum dam spillway requirements regarding spillway capacity: Recommended Design Flood (RDD): 1:100 year routed peak

Act / Regulation	Relevance and Requirement
	flow; Recommended Safety Evaluation Flood (SED): Regional Maximum Flood (RMF)
National Environmental Management : Waste Act (Act 59 of 2009)	Licensing of waste management activity
(GN) 704 dated 4 June 1999 Regulations published in terms of the National Water Act, 1998 (Act No. 36 of 1998):	Regulating the following: Separation of “clean” and “dirty” water on a site. Stormwater control structures to handle at least a 1:100 year storm event. Containment of “dirty” water run-off up to 1:50 year storm event with 0.8 m freeboard or a 1:200 year runoff volume with no freeboard. Prevention of erosion Structures to be outside a 1:100 year flood line and/or 100 m from the river, whichever is the greatest.
Department of Water Affairs Best Practice Guideline G1- Stormwater Management Plan & A4 – Pollution Control Dams 2006	Best practice guidelines for water resource protection in the South African mining industry (Stormwater Management (Department of Water Affairs and Forestry, 2006) and Pollution Control Dams (Department of Water Affairs and Forestry, 2008))

The following approach and standards have been used for compiling the Surface Water Study:

- Clean and dirty water systems to be kept separate and be designed, constructed, maintained and operated such that these systems do not spill into each other more than once in 50 years;
- Measures to be taken to protect water resources.
    - All dirty water or substances which cause or are likely to cause pollution of a water resource through natural surface flow to be contained;
    - Pollution control dams to have a surge storage capacity (minimum required storage capacity at onset of storm event) equal to the 1:50 year runoff volume due to a 24-hour storm event plus 0.8 m freeboard;
    - All pollution control dams are to be lined with an impervious liner excepting where there is a natural clayey area that prevents polluted water from seeping into the ground water;
    - Dam spillways to handle at least the 1:100 year routed peak flow;
    - All diversions and canals to handle at least a 1:100 year storm event with no freeboard;
    - All control structures to be located outside the 1:100 year floodline and/or 100 m from the river – whichever is the greatest; and
- Clean temporary stormwater holding ponds to be decanted over a maximum period of 30 days after the storm event. d

2 Study Objectives and Work Program

2.1 Study objectives

The main objectives of the study are:

Predict risk assessments based on the information collected.

2.2 Project team

The following team undertook work for the study:

- M Braune Pr. Eng (Reviewer)
- M. Hinsch: Principal Water Quality / Resources Specialist
- J. Mathole : Hydrologist
- M. Stols: GIS Specialist
- R. Sobey: Environmental Scientist

3 Data Collection and Reviewed Documents

An important aspect of this study is to obtain all relevant information on previous and current studies undertaken for KPS, as well as compliance requirements enforced by the DWA. The documentation reviewed and spatial data obtained from the power station, and their relevance is summarised in Table 3-1 below.

Table 3-1: Summary of reviewed documents and digital data

Data List		
Name	**Description**	**Source**
Wetlands Method Statement – Kusile PS Combustion Waste Terrace (Knight Piesolt, 2013)	Wetlands method statement for the construction of the combustion Waste Terrace	Knight Piesold Consulting
Aquatic Ecological Assessment (Ecosun, Report E 457/06/B)	Wetland and Ecological Impact Assessment	Ecosun Consulting
Ash Dump and Ash Dump Dirty Dam Design Report (Panel B Consortium_ PBCJV TO#31, 2010)	Kusile Power Station Ash Dump Terrace Layer Works Design	Gibb, SSI and Knight Piesold Consulting
Ash Dump Report	Proposed Amended Layout and Construction Sequence for the Ash Dump	Gibb, SSI and Knight Piesold Consulting
Emergency Ash Dump Layer Works Design Report and Drawings (Panel B Consortium joint Venture PBC JV#19, 2008)	Emergency Ash Dump Layer Works Design Report and Drawings	Gibb, SSI and Knight Piesold Consulting
Station Dirty Dam Design Report (Panel B Consultants joint Venture PBC JV-TO #31, 2010)	Kusile Power Station Dirty Dam Design Report	Gibb, SSI and Knight Piesold Consulting
Final Kusile EMP	EMP approved in March 2008	Gibb, SSI and Knight Piesold Consulting
Ash Dump Embankment Culvert (Panel B Consultants joint Venture	Construction of the Ash Dump Embankment	Gibb, SSI and Knight Piesold Consulting

Data List		
Name	**Description**	**Source**
WMS 5452/110/014 (Rev 1), 2010)	Culvert	
Ground and Surface water monitoring report September 2013	Ground and Surface water monitoring report September 2013	Zitholele Consulting
Spatial Data		
Phase 1 and 2		Shape Files for Kusile Layout Plan showing separate phases
Site Layout		Shape Files for Kusile Layout Plan

4 Status Quo Assessment of Stormwater and Pollution Control System

It is important to obtain an understanding of the existing stormwater system during construction as well as the pollution control system of the Power Station and its operation. Relevant details are given in this section.

4.1.1 Zero liquid effluent discharge

Eskom's Kusile Power Station has implemented integrated water conservation into the organisations planning to ensure that appropriate technologies will be implemented to ensure the optimisation of the water. In order to ensure that water management is optimised Eskom has implemented a zero liquid effluent discharge philosophy at the Kusile Power Station, which will also apply to the Ash Co-disposal Facility (ADDF). This means that liquid effluents will not be discharged from the waste site, Dirty Water Dams or the Ash Dam (AD) site into the environment, but will rather be recycled and reused. An example of the recycling that is employed is that Kusile Power Station will employ a three step process at its wastewater treatment plant of 1) Pre-treatment, 2) Evaporation/Concentration, and 3) Crystallisation to treat this wastewater. This will produce a clean water stream that can be reused, which allows the power station to reduce its raw water intake by up to 3%.

4.1.2 Minimising seepage losses

The engineering of the Ash Co-disposal facility and its associated infrastructure lining for all dirty water is designed to reduce seepage losses and reduce risks on the receiving water environment.

4.1.3 Segregation of clean and dirty water systems

In accordance with the principles of Regulation 704 of the Water Act, clean storm water will be diverted around the footprint area of Ash Co-disposal facility and is to be released into the natural environment, whilst impacted storm water within the footprint area of Ash Co-disposal facility will be contained and reutilised through the ADDD and SDD.

4.2 Field Measurements and Existing Stormwater Drainage System

All the information gained for this study was received from a field study, the data received from the various sources and from SRK's own desktop study. SRK also developed and its own GIS files to properly ascertain the floodline levels and hydrological modelling.

4.3 Existing Pollution Control System

The existing pollution control system consisting mainly of the Dirty Dams are not yet in operation.

4.4 Catchment Delineation and Classification

The study area lies approximately 35km east south east of Witbank, situated in the Olifants River Catchment (Quaternary Catchment B20F). The catchments are divided into various main catchments as well as sub-catchments. The catchment size and boundaries have been determined from existing contour information and taking into account existing control systems that reroute flows in various directions. Table 4-1 below contains the details of the Quaternary Catchment B20F.

Table 4-1: Table showing the mean annual precipitation, run-off and potential evaporation per quaternary catchment (WR2005 Study_WRC).

Quaternary Catchment	Catchment Surface Area km^2	Mean Annual Rainfall (MAP) in mm	Mean Annual Run-off (MAR) in mm	MAR as % of MAP
B20F	504	661	16.7	2.5

The catchments in the Kusile Power Station Area were then classified in terms of the land use as well as condition in terms of level of pollutants. This was based on the Best Practice Guideline G1. A summary of the catchment land-use classification is given in Table 4-2 below. The relevant sections to the ash dam, is shown in bold.

Table 4-2: Catchment Land-use Classification an abstract from Department of Water Affairs and Forestry Guideline (Department of Water Affairs and Forestry, 2006)

Classification	Area	Comment
Clean	Undisturbed land area	Regional geology of agricultural practices may contaminate runoff.
	Residue deposits	Includes coal discard, slurry facilities, slime dams, waste rock dumps and sand dumps.
Moderately dirty	Unrehabilitated areas	Dissolved and suspended contaminants.
	Haul roads	Dissolved and suspended contaminants.
	Pollution control dams	Depends on contents of dam.
Dirty	Residue deposits	Includes coal discard, slurry facilities, slime dams, waste rock dumps and sand dumps.
	Unrehabilitated areas	Dissolved and suspended contaminants.
	Haul roads	Dissolved and suspended contaminants.
	Pollution control dams	Depends on contents of dam.

4.5 Hydrological Modelling

In order to determine flood peaks and runoff volumes from the above defined catchments and sub-catchments a hydrological model needed to be set up. Visual SCS and Rational methods were used to determine the Peak flows for floodline determination and rational method flood peaks were adopted for the ash co-disposal facility dirty water and clean water catchments as better correlation was observed between this method and the peak flows used for the designing of the dirty water and clean water channels. The model makes use of the following main input parameters:

i. Storm rainfall;

ii. Soil conditions;

iii. Catchment shape, slope and size; and

iv. Urbanisation, vegetation and land use.

Relevant input parameters have been calculated from the determined information and are described below.

4.5.1 Rainfall Assessment

Rainfall for the model was based on IDF (intensity-duration-frequency) curves derived for this study area by J C Smithers and R E Schulze. The estimated design rainfall depths for durations ranging from 15 minutes to 7 days and for return periods ranging from 2 to 200 years for the Kusile study area were calculated.

The 24-hour design rainfall for various return periods is given in Table 4-3 below:

Table 4-3: Design Rainfall (24 hr.)

Return Period	1:2 Year	1:5 Year	1:10 Year	1:20 Year	1:50 Year	1:100 Year
Rainfall depth (mm)	59	81	99	119	143	165

4.5.2 Catchment Details

The catchment details and land-use classification for the natural watercourse (Including diversion canal) as abstracted for the Kusile Power Plant are now summarised in Table 4-4 below. Figure 4-3: shows the locality of catchments and detailed delineation descriptions.

Table 4-4: Summary of storm water delineated catchments and classification thereof

Catchment Name	Classification	Individual Area (km^2)	Cumulative Area (km^2)
KLF	Clean	9.20	60.38
KLFS1	Clean	2.26	49.51
KLFS2	Dirty	9.77	34.86
KLFS3	Dirty	6.54	21.23
KLFS1T	Moderately Dirty	1.67	1.67
KLFS2T1	Dirty	4.05	12.84
KLFS2T2a	Dirty	3.40	3.40
KLFS2T2b	Dirty	0.54	4.0
KLFS2T2c	Dirty	0.54	6.0
KLFS2T2d	Dirty	0.86	9.66
KLFS2T2e	Dirty	1.59	1.59
KLFS2T2f	Dirty	2.8	2.80
HLF	Clean	14.63	14.63
Wilge1T1	Clean	4.75	28.95
Wilge1T2	Clean	7.28	17.50
Wilge1T3	Moderately Dirty	6.40	6.40
Wilge1T1T	Clean	6.70	6.70
Wilge1T2T	Clean	3.82	3.82

The following can be observed from the table above:

i. More than half of sub-catchments are classified as dirty. This is mainly due to the construction of the dirty water dams, ash co-disposal facility and the haul roads.

- The areas surrounding the KPS are generally clean.

- A quarry is situated to the north east corner of the power station.
- The ash co-disposal facility will be built to the south of the power station, which contributes to the dirtying of a few of the catchment areas.
- All the areas in direct contact with the power plant were also classified as dirty

ii. Only two catchments were classified as moderately dirty.
   - The moderately dirty catchment areas have a haul road which will be used to transport coal.

iii. The defined clean sub-catchments consist of the following areas:
   - Natural vegetation and farm land lies mostly to the south, west and north of the power station.
   - To the south east lies farmland with what appears to be a clean dam on the border of the catchment area.

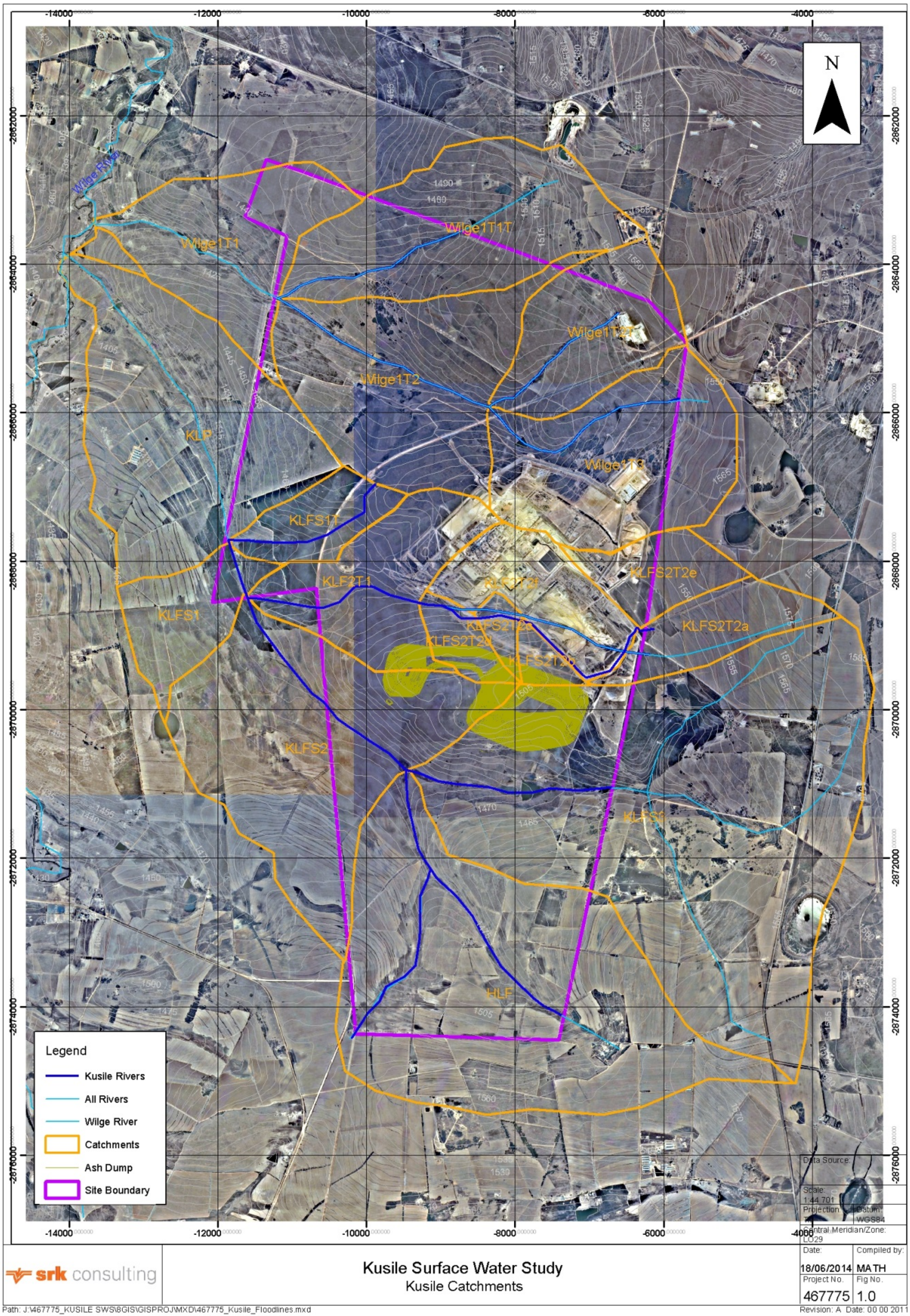

Figure 4-1: Kusile Water Catchments

4.5.3 Hydrological Model Details and Parameters

The hydrological model could now be compiled based on the catchment and input parameters derived in the above sections for both the existing drainage system as well as the possible future drainage system. The drainage systems are defined as follows:

i. At present the area is under construction and basic storm water features are in place to separate the dirty and clean water.

ii. The ash co-disposal facility embankment culvert has been constructed to direct water from a stream underneath the ash co-disposal facility to avoid contamination.

iii. Excavated clean water drains have been constructed around the ash disposal facility with culverts and culvert discharge trenches which lead to silt retention dams.

   a. The 1:100 yr./ 24 hr. clean stormwater runoff will be kept separate from the dirty water runoff from the co-disposal facility site.

   b. Runoff from fully rehabilitated areas will be managed as clean water and discharged to the streams on either side of co-disposal facility after passing through a series of retention/settling dams located around the ash co-disposal facility perimeter. These facilities will be monitored on an ongoing basis to test the water quality before discharging to the natural streams.

   c. The runoff from the incremental clean water catchments outside of the active footprint, flowing towards the active co-disposal facility will be intercepted with temporary cut-off drains. These drains will divert the flow around the ash co-disposal facility footprint, into the clean water system after passing through retention/settling dams.

iv. Within the ash co-disposal facility disposal facility temporary artificial channels to be constructed on the exposed ash surfaces to lead stormwater down the faces to the dirty water collection channels in a controlled manner thereby preventing erosion and pooling of water.

v. Dirty water concrete channels have been constructed within the ash co- disposal facility to channel away dirty stormwater and water used for the irrigation of the ash to the ADDD.

vi. The ADDD has been built to handle the capacity of a one in 50 year, 24 hr storm event.

vii. The Emergency Ash Dam (EAD) will consist of a concrete lined area of approximately 1.4 ha, sloped to fall with a concrete trapezoidal drain on two adjacent sides and a concrete rectangular channel drain on the other two sides that joins the trapezoidal drain.

viii. The Station Dirty Dam (SDD) receives all the dirty water from the power plant. Gravity pipelines flowing from the Coal Stockyard Settling Tanks (CSY ST) and the Station Dirty Dams Settling Tanks (SDD ST) will also flow to the SDD using the down gradient of the slopes running North West of the power station.

ix. The SDD is designed to contain all of the dirty water runoff from the Kusile Power Station for the 1:50 year, 24 hour duration storm event.

x. The SDD ST can handle the dirty water runoff from its inflow sources for the 1:50 year, peak instantaneous storm event including an emergency spillway to accommodate larger events.

Figure 4-2 below shows the various existing and planned infrastructure mentioned above.

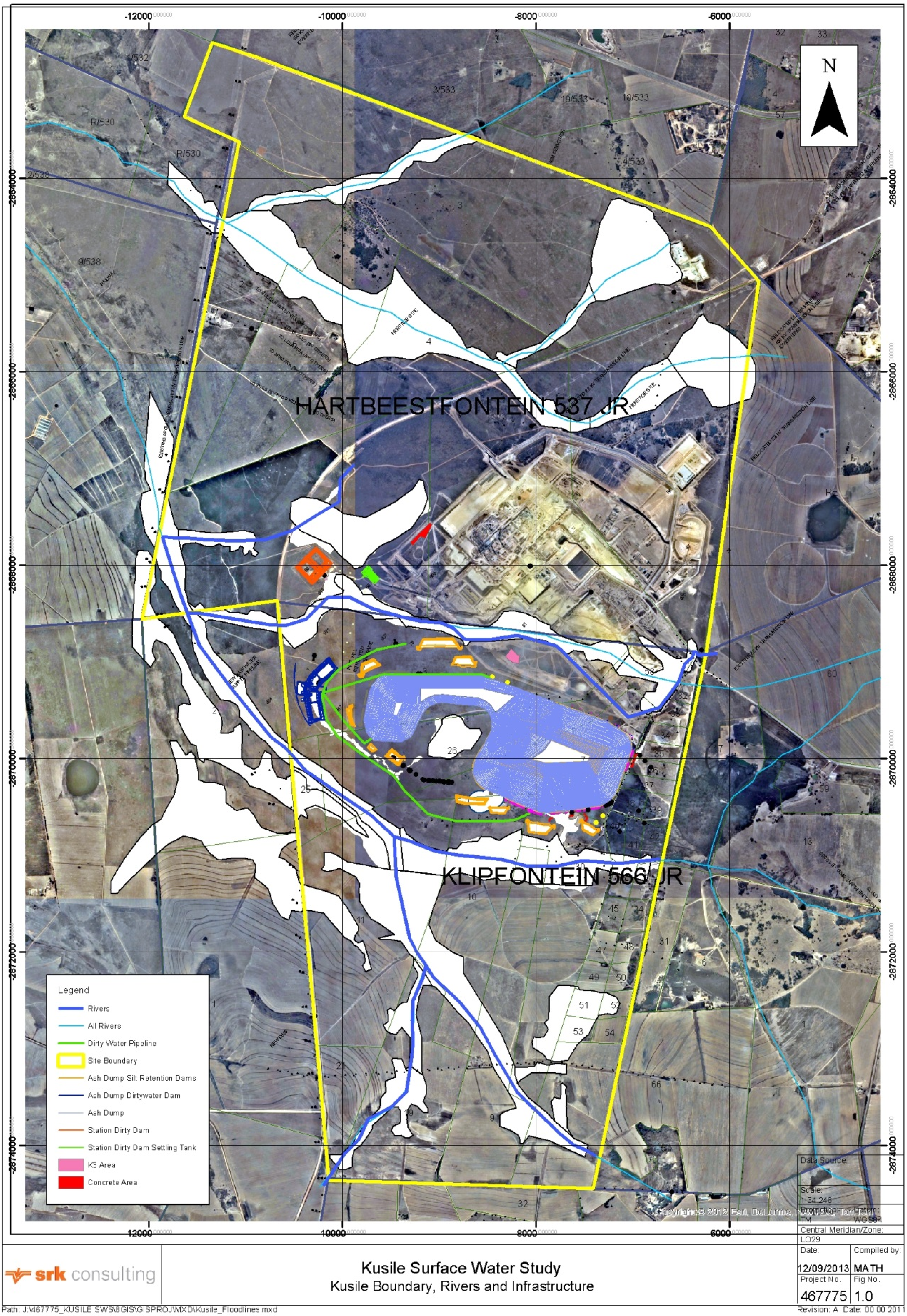

Figure 4-2: Kusile Site Boundary and Infrastructure

4.6 Assessment of current drainage system

The current drainage system is still in its infancy as the power plant is not operation as yet. Storm water diversion culverts and berms are operational around the construction of the various dirty water dams and the ash disposal facility and are compliant at this point as per the site visit conducted on the 11 of September 2013.

4.6.1 The Ash Co-disposal Facility Clean and Dirty Water Systems

The dirty and clean water collection system for the Ash Co-disposal facility were designed by Panel B Consultants Joint Venture (Panel B Consortium joint Venture PBC JV#19, 2008) The Ash Co-disposal facility clean water system was designed to handle a 1:100 year/ 24 hour storm event and the Ash Co-disposal facility dirty water was designed for a 1:50 year/24 hour duration storm.

SRK determined the Ash Co-disposal facility dirty catchment areas that will contribute the dirty water runoff and determined the peak flows that will be generated from these dirty water catchments. The dirty water canal running around the ash co-disposal facility that will collect the ash co-disposal facility dirty water were sized based on the calculated 1:50 year and 1:100 year peak flows, a minimum of 1:200 canal slope, A 2.5m base with a manning value of 0.018.

The **Table 4-5** below shows the dirty water canal sizes around the ash co-disposal facility that can handle the generated peak flows:

Table 4-5 Dirty Water Canal Sizes to accommodate the generated peak flows

Catchment Name	Area km2	Length m	1:50 Year Peak Flow	1:100 Year Peak Flow	1:50 Year Flow Depth	1:50 Year Flow Velocity	1:100 Year Flow Depth	1:100 Year Flow Velocity
AD1	0.21	355.75	3.47	4.42	0.53	2.15	0.61	2.31
AD2	0.08	181.90	2.13	2.71	0.4	1.84	0.46	1.98
AD3	0.19	303.21	3.77	5.50	0.56	2.2	0.7	2.47
AD4	0.27	635.45	3.54	5.20	0.54	2.16	0.67	2.43
AD5	0.19	424.42	2.97	3.78	0.49	2.04	0.56	2.2
AD6	0.42	636.45	5.50	7.01	0.7	2.47	0.8	2.65
AD7	0.16	440.55	2.47	3.63	0.44	1.93	0.52	2.12
AD8	0.19	324.97	3.25	4.77	0.51	2.1	0.64	2.37
AD9	0.13	428.34	2.02	2.97	0.39	1.8	0.49	2.04
AD10	0.07	176.17	1.93	2.84	0.38	1.78	0.47	2.01
AD11	0.07	335.62	1.18	1.74	0.28	1.51	0.35	1.72
AD12	0.11	377.74	1.78	2.62	0.36	1.73	0.45	1.96

A system of clean water drain will be developed to collect clean water from undeveloped area of the power station and divert the clean water from the ash co-disposal facility towards the natural watercourse. The clean water undeveloped catchment areas were determined and peak flows generated using Rational method to determine the clean water channel sizes. The channels were sized based on the calculated 1:50 year and 1:100 year peak flows, a minimum of 1:200 channel slope, a 2.5m base with a manning value of 0.018.

The details of the clean water channel sizes are given in **Table 4-6** below

Table 4-6: Clean water Cannel Sizes

Catchment Name	Area km^2	Length m	1:50 Year Peak Flow	1:100 Year Peak Flow	1:50 Year Flow Depth	1:50 Year Flow Velocity	1:100 Year Flow Depth	1:100 Year Flow Velocity
CW1	0.17	623.62	2.04	3.00	0.39	1.81	0.49	2.05
CW2	0.17	863.26	1.95	2.87	0.38	1.78	0.48	2.05

A series of clean water drains around the perimeter of the ash co-disposal facility were also designed by Panel B Consultants Joint Venture for the purpose of receiving clean storm water run-off from rehabilitated surfaces of the ash co-disposal facility. The clean water drains will discharge the clean water from the rehabilitated ash co-disposal facility to the silt retention dams before discharging to the natural stream.

The Ash co-disposal facility clean- and dirty water areas are indicated in Figure 4-3

4.6.2 The Ash Co-disposal Facility Dirty Dam Co-disposal facility

The ash co-disposal facility dirty dam was designed for a 1:50 year/ 8 day storm (Detail Design Report 5452-90-011 Rev7 by Panel B Consortium joint Venture PBC JV#19, 2008). Dirty water from the ash co-disposal facility will be collected into the dirty water canal running along the perimeter of the ash co-disposal facility. The dirty water in the canal will be transported into the ash co-disposal facility dirty dam via a system of dirty water drain pipes. The ash co-disposal facility dirty dam has a design total storage capacity of 227, 410 m3. This storage will accommodate the ash co-disposal facility dirty water, Make-up water, dust suppression water and irrigation water. The 1:150 year and 1:100 year dirty water volumes for each of the dirty water sub-catchments were determined and are given in the Table 4-8 below:

Table 4-7: Dirty Water Catchments Volumes

Catchment Name	1:50 Year Volume (10^3 m^3)	1:100 Year Volume (10^3 m^3)
AD1	9.0	11.3
AD2	3.3	4.2
AD3	5.8	8.4
AD4	5.4	8.0
AD5	6.4	8.0
AD6	14.3	18.1
AD7	3.8	5.5
AD8	8.5	12.4
AD9	3.1	4.5
AD10	4.1	6.1
AD11	3.0	4.5
AD12	3.8	5.5
CW1	4.3	6.3
CW2	5.9	8.6
Total	**70.5**	**96.6**

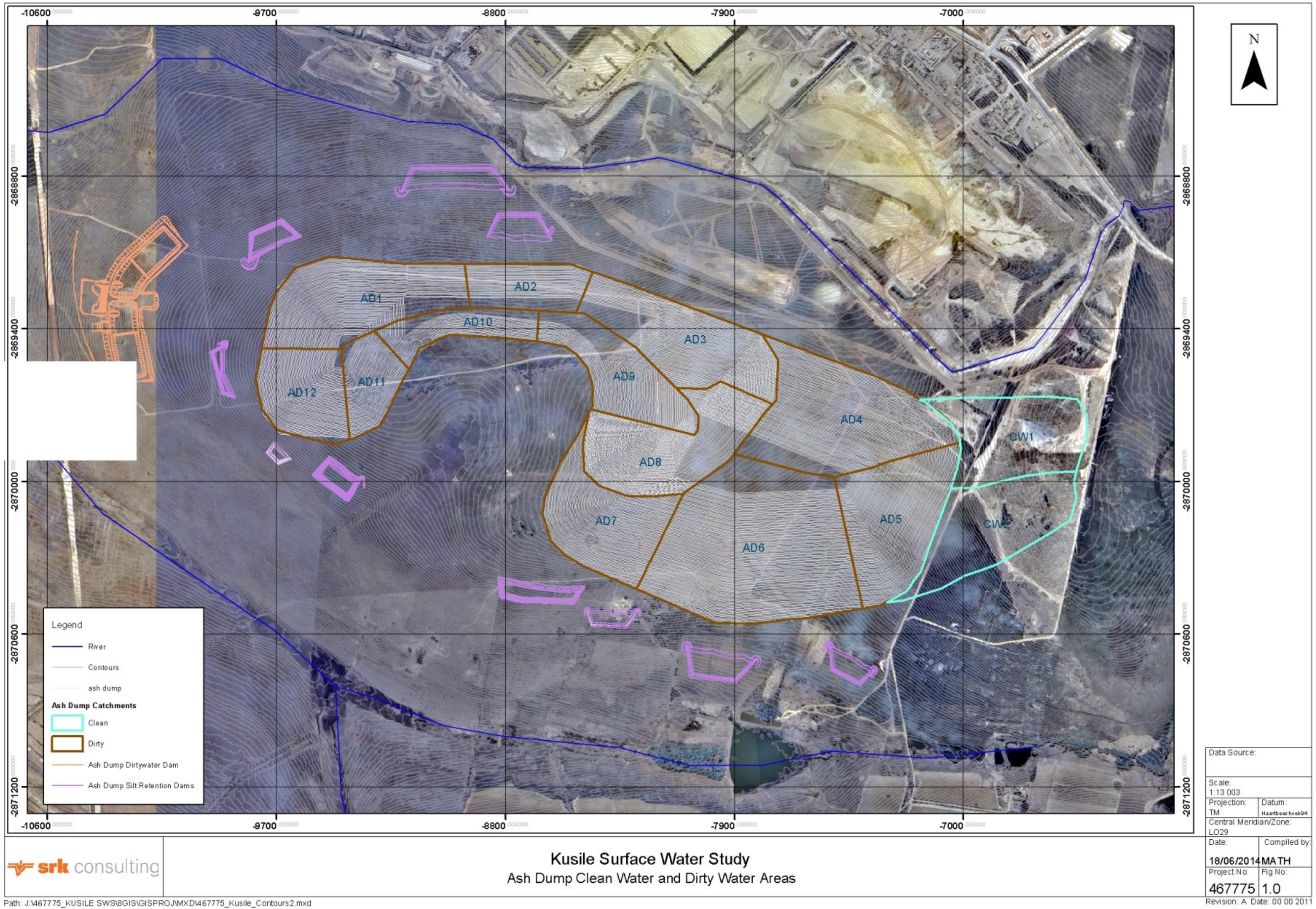

Figure 4-3: Ash Co-disposal Facility Clean Water and Dirty Water Catchments

4.7 Assessment of Current Pollution Control Dams

In addition to assessing the existing drainage system, the current dirty dams also need to be assessed .These too are in the construction phase as can be seen in Figure 4-4 below.

Figure 4-4: Construction progress on the Station Dirty Dam as of 11 September 2013

This assessment is needed though in terms of GN 704 storage facility requirements. A need therefore exists to define the future storage capacity of the holding facilities as well as the expected operating level and stormwater runoff entering the dam. The following approach has been adopted:

i. Determination of the initial storage capacity based on information from (Panel B Consortium_ PBCJV TO#31, 2010) Table 4-8 shows the various waste dirty dams and their storage capacity.

Table 4-8: Summary of the quantity of waste to be received once the dirty dams are operational.

Waste Site	Size of facility for a waste management activity	The quantity of waste to be received once operational	Type of Facility
Ash/Gypsum co-disposal facility	The footprint of the ash/gypsum co-disposal facility is approximately 250 ha	The total waste storage for the Ash/gypsum disposal facility will be 84 423 000 m3.	Ash is classified as non-hazardous waste and gypsum is classified as a moderate hazardous waste therefore, the mixture is classified as a moderate hazardous waste. The co-disposal of ash and gypsum will

Waste Site	Size of facility for a waste management activity	The quantity of waste to be received once operational	Type of Facility
			require a class H: h (LB+) waste disposal facility.
Ash Co-disposal Facility Dirty Water Dam	The ADDD will be approximately 7.01 ha.	The total waste storage volume of the ADDD will be 227 410 m3.	The dirty water collection channels from the Ash/gypsum co-disposal facility will be routed to the ADDD. The ADDD is therefore classified as a hazardous waste disposal facility.
Station Dirty Water Dam	The footprint of the SDD is approximately 5.615 ha.	The design storage capacity of each dam with the sloping floors is 181 890 m3.	The Station Dirty water Dam is classified as a hazardous waste facility.
Station Dirty Dam Settling Tank	The footprint of the Station Dirty Dam Settling Tank is approximately 0.8 ha.	The waste storage volume of the Station Dirty Dam Settling Tank will be 7 975 m3.	The Station Dirty water Dam Settling Tank is classified as a hazardous waste facility.
Rock Stockpile Areas	The footprint of the Concrete Spoil stockpile will be approximately 9.6 ha and the K3 stockpile will be approximately 4.84 ha.	The total waste storage volume of the concrete spoil stockpile and K3 stockpile will be approximately 229 500 m3 and 750 000 m3 respectively	The rock stockpile is classified as General Waste. It will primarily consist of silty soils and degradable rock not suitable for use as general backfill.

In addition to the above the required minimum “surge" volumes are applicable to the following dirty dams given below. The surge volume is defined as the spare storage capacity of the dam needed at any point in time to contain the 24-hour runoff volume from the dam catchment due to a 1:50 year storm event. Relevant details on the above are given in this section

i. The ADDD has been built to handle the capacity of a one in 50 year, 8 day storm event.

ii. The SDD ST can handle the dirty water runoff from its inflow sources for the 1:50 year, peak instantaneous storm event including an emergency spillway to accommodate larger events.

4.8 Natural Water Courses and Floodlines

The Kusile Power Plant river catchments all drain into the Wilge River. The Klipfonteinspruit and its tributaries have a total catchment area of 60.4 km^2 The upstream part of the tributary of Klipfonteinspruit that originally ran through the coal stock yard was diverted into a channel that runs on the south eastern and south western side of the coal stock yard and joins the natural river on the western side of the coal stockyard. Floodlines were determined for the Klipfonteinspruit and its tributaries including the diverted channel and the Floodline report and drawings are given as an addendum in Appendix A.

Conclusions from the Floodline report is in

5 Floodline Determination and Results

The 1:50 and 1:100-year floodlines were determined based on the HECRAS model and peak flow rates as given in the report in Appendix A: Floodline Study.

Details and certified floodlines are shown on drawing 467775/001 in the same report

From the floodline study, the following was observed:

- The existing development and infrastructure is not affected by the 1:50 year and 1:100 year floodlines. Nm
- The diverted channel running on the south eastern and south western sides of the coal stock yard can handle the 1:50 year and 1:100 year flood events.

The floodlines are shown in Figure 5-1 below.

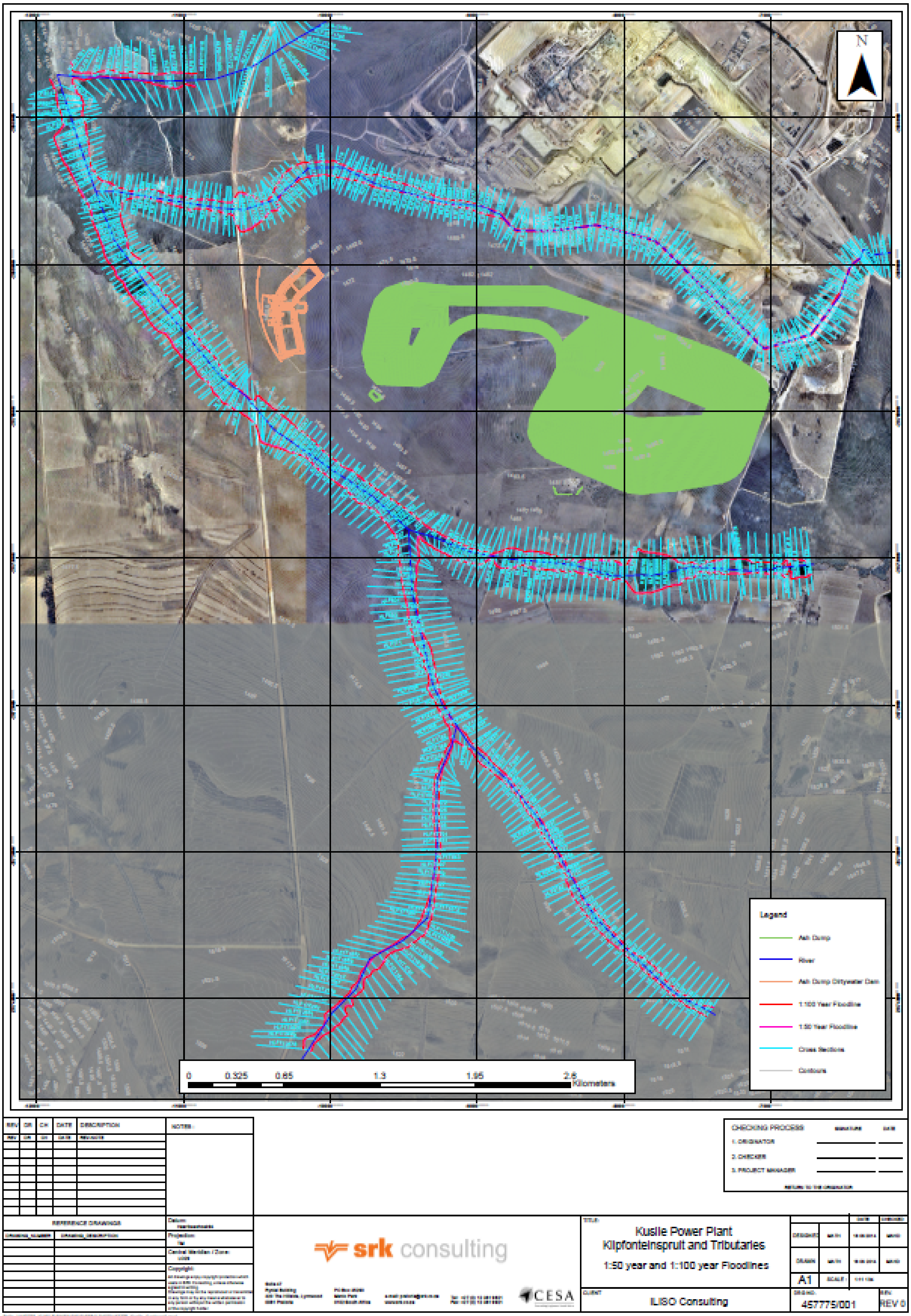

Figure 5-1: Kusile power Plant Klipfonteinspruit and Tributaries 1:50 and 1:100 year Floodlines

6 Water Quality Overview

6.1 Water Users downstream from Kusile Power Station

The land use downstream from Kusile and surrounding the power station is dominated by maize, grazed fields, coal mines and power stations. Water bodies are the only land use regarded as sensitive. The most sensitive user here is however the domestic use. The various applicable water user requirements are shown in Table 6-1. Available water quality results is evaluated against the target value for the most sensitive user for that specific parameter

Table 6-1 Various Water Quality Standards, General Limits and Guidelines for different water users

Variables	**General limit, Guidelines and Standards**							
	GA	**Stds**	**Guidelines**					
(mg/l unless otherwise specified)	**General Limit values for up to $2000m^3/d$**	**SANS241: 2011**	**Domestic use (sulfate from WHO Guideline, 2004)**	**Bathing**	**Laundry**	**Livestock watering**	**Irrigation**	**Aquatic ecosystems**
		Lifetime consumption						
pH Value @ 23°C	5.5-9.5	5.0-9.5	5.0-9.5	4.5-9.5	5.0-10	Ns	6.5-8.4	6.5 – 9.0[2]
Conductivity (mS/m @ 22°C)	70 mS/m above intake to a maximum of 150 mS/m	170	150	520	Ns	40-270	Ns	Ns

Variables	General limit, Guidelines and Standards							
	GA	Stds	Guidelines					
(mg/l unless otherwise specified)	General Limit values for up to $2000m^3/d$	SANS241: 2011 Lifetime consumption	Domestic use (sulfate from WHO Guideline, 2004)	Bathing	Laundry	Livestock watering	Irrigation	Aquatic ecosystems
Total Dissolved Solids		1200	1000	3400	1000-5000	260-1775	260[&]	<15% change from normal cycle; no change in amplitude/frequency of cycles
Calcium, Ca		Ns	150	80	1000	Ns	Ns	Ns
Magnesium, Mg		Ns	100	70	500	500-1000	Ns	Ns
Sodium, Na		200	200	Negligible effects	2000	0-2000	70[&]	Ns
Sodium as SAR							1.5 soil 2.0 crop	
Potassium as K		Ns	50	500	Ns	Ns	Ns	Ns
Sulfate, SO_4		500[&]	500	600	1000	Ns	Ns	Ns
Chloride, Cl		300	200	No effects	2000-3000	100-700	100[&]	Ns
Nitrate as N	15	11	6	20		Ns	Ns	Ns
TIN								
Fluoride, F	1	1.5	1	No effects	02-Jun	2	2	1.5

Variables	General limit, Guidelines and Standards							
	GA	Stds	Guidelines					
(mg/l unless otherwise specified)	General Limit values for up to 2000m^3/d	SANS241: 2011 Lifetime consumption	Domestic use (sulfate from WHO Guideline, 2004)	Bathing	Laundry	Livestock watering	Irrigation	Aquatic ecosystems
Free and Saline Ammonia as NH_4	6	1.5			Ns	Ns		0.015 as unionised ammonia
Aluminium as Al		0.3	Ns	Ns	5	5	5	0.01
Iron as Fe	0,3	2 (health)	1	5	10	0.02: equipment	5	0.32
		0.3 (aesthetics)				0.1: crops		
Manganese as Mn	0,1	0.5 (health)	0.4	0.1	10	0.2: equipment	0.02[&]	0.37
		0.1 (aesthetics)				5: crops		
Zinc as Zn	0,1	5	3	No effects	No effects	20	0.001	0.0036
Boron as B	1	Ns						Ns

6.2 Water Quality Assessment

Water quality information was taken from the monthly water monitoring program conducted by Zitholele Consulting and contained in the report No: 12926:9 (September 2013). As several of the sampling points are not perennial only 30 of the 47 sampling points yielded any water. The positions of the monitoring points are provided in Figure 6-1. No new sampling was undertaken for this study under this contract.

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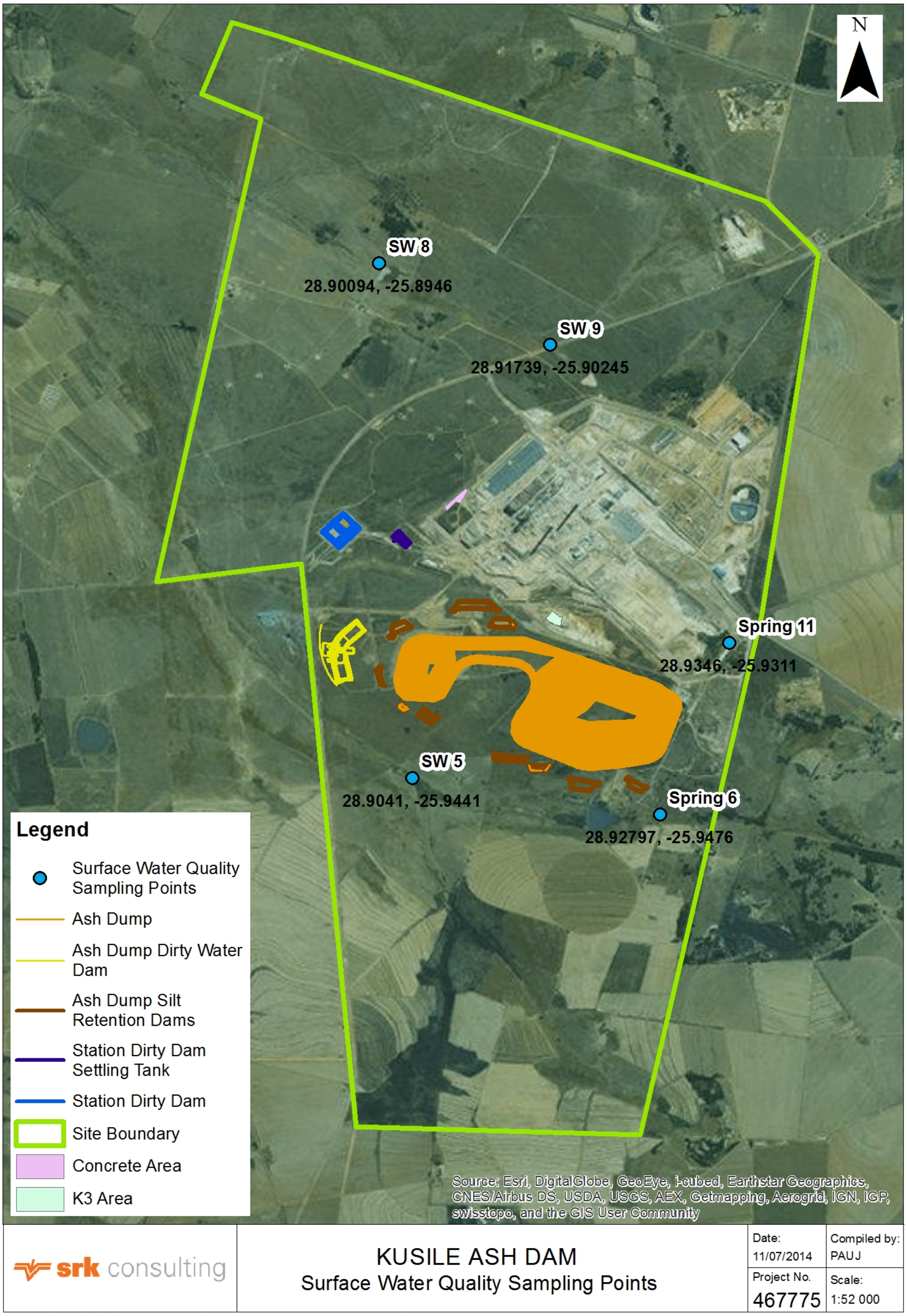

Path: J:\467775_KUSILE SWS\8GIS\GISPROJ\MXD\467775_Sampling_Points_11072014.mxd

Figure 6-1: Water Sampling Points

6.2.1 Water Quality Results

The analysis of results in this report is based on sampling taking place, on a monthly basis from the last quarter in 2008 until middle 2012. SW 8 and 9 were however only sampled twice and four times respectively and therefore the level of confidence on these samples results are lower. The significance of the surface water sampling points to the ash co-disposal facility is shown in the Table 6-2 below.

Table 6-2: Surface Water Sampling Points relevant to the Ash Co-disposal Facility

Site Name	Y co-ord	X co-ord	Site Type
Spring 6	-25.94760	28.92797	Spring to the south of the Ash co-disposal facility. Water quality of this spring could be an indication of the groundwater quality
SW5	-25.94410	28.90410	Surface water point upstream of the Ash co-disposal facility in the Klipfontein Spruit after confluence with the Holfontein spruit
Spring 11	-25.93110	28.93460	Spring to the north of the Ash co-disposal facility. Water quality of this spring could be an indication of the groundwater quality
SW 8	-25.8946	28.90094	Surface water point north to the dam in a small un named tributary of the Klipfontein Spruit (Regarded as downstream of activities)
SW 9	-25.90245	28.91739	Surface water point north to the dam in a small un named tributary of the Klipfontein Spruit (Regarded as downstream of activities)

Table 6-3: Summary of the Surface Water Quality Results taken between 2008 and 2012 of relevant surface points

Sample ID	pH	EC (mS/m)	Dissolved Solids (mg/L)	Suspended Solids (mg/L0)	Turbidity (NTU)
Spring 6					
Max	7.80	84.0	680.0	32.80	22.80
Med	7.3	54.0	383.0	5.20	5.13
Min	7.3	1.29	67.0	0.8	1.46
Number of samples	44	44	44	36	32
Spring 11					
Max	9.28	39.0	248.0	408.0	392.0
Med	6.96	7.2	48.0	11.0	10.5
Min	6.11	6.0	36.0	0.2	0.53
Number of samples	36	36	36	34	27
SW8*					
Max	7.7	11	84	150	389
Med	[redacted]		[redacted]		
Min	7.3	1.06	73	84	62
Number of samples	2	2	2	2	2
SW5					
Max	8.03	38	240	142	22.8

Sample ID		pH	EC (mS/m)	Dissolved Solids (mg/L)	Suspended Solids (mg/L0)	Turbidity (NTU)
Med		7.98	34	32	32	5.13
Min		7.6	9	74	8.2	1.46
Number of samples		44	44	44	44	44
SW9**						
Max		8.03	38	240	142	188
Med		7.98	34	226		39
Min		7.6	9	74	32	36.7
Number of samples		4	4	4	4	4
*Water Quality Guidelines	Ideal	6.0-9.0	0-70	0-450	No Guideline Value	0-1
	Marginal/No Health effect	4-6,9-11	71-150	450-1000		1-5
	Unacceptable	<4, >11	>300	>1000		>5

* *Only two samples were taken during the monitoring period and therefore the reliability of this data is low*

***Only four samples were taken during the monitoring period and therefore the reliability of this data is low*

*** (Department of Water Affairs and Forestry, 1996)

1. Colour coding is used to denote whether values measured comply with the South African Water Quality Guidelines (DWAF, 1996).
2. Where the lab gives results concentrations as µg/l and the South African Water Quality Guidelines (DWAF, 1996) gives concentrations as mg/l, the guideline values were converted to µg/l

6.2.2 Turbidity

All 5 surface water sites showed high levels of turbidity. Turbidity levels at monitoring site SW 5, are classified as having marginal / no health effects whilst SW8, SW9 and both spring water points being classified as unacceptable for domestic use (according to the SAWQG). The turbidity and the suspended solids are normally correlated and therefore no discussion on suspended solids is further given

Turbidity in surface water sites over time is shown in Figure 6-2 below. The graph shows that:

- Turbidity levels in surface water are cyclical;
- Turbidity levels spike early in the rainy season, which is expected as surface water systems flush after the first high rainfall events;
- The graph also indicates that the water quality is deteriorating, as progressively more sites show elevated levels of turbidity, which might be due to increased construction activities in the area.

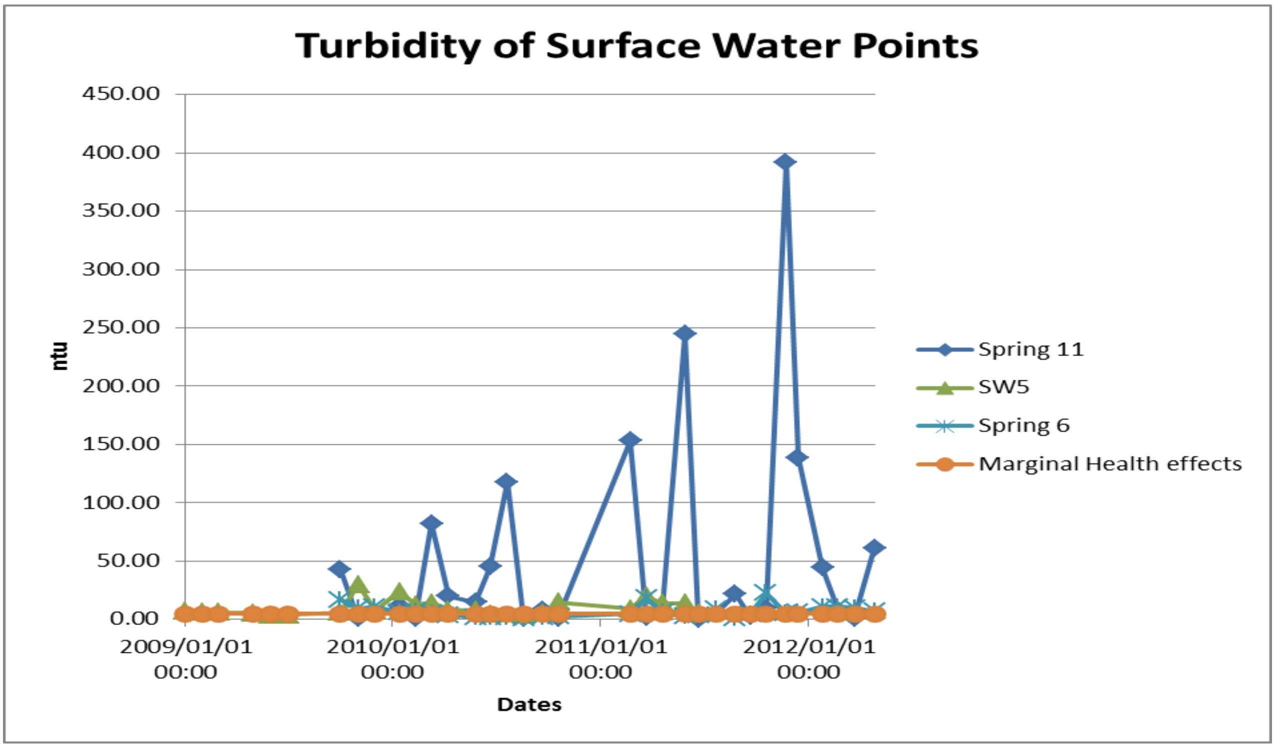

Figure 6-2: Turbidity of surface water points compared to Marginal health effects for domestic water use

6.2.3 Electrical Conductivity (EC)

The total dissolved solids (TDS) are a measure of the quantity of various inorganic salts dissolved in water. The TDS concentration is directly proportional to the electrical conductivity (EC) of water. Since EC is much easier to measure than TDS, it is routinely used as an estimate of the TDS concentration. Therefore only the EC will be discussed here. The trends of the SW5, Springs 6 and 11's conductivity can be seen in Figure 6-3 below.

For the period sampled, only spring 6 has occasionally exceeded the ideal limit for domestic use as can be seen in Figure 6-3.

Spring 11 shows a very blow conductivity compared to the Spring 6 and SW 5. No upward trend (which at this time and stage can be expected, is detected. These sampling points all present good background values before activities have started. Insufficient sampling has taken place at SW8 and SW 9. However, the few samples taken all were within the ideal range for domestic use.

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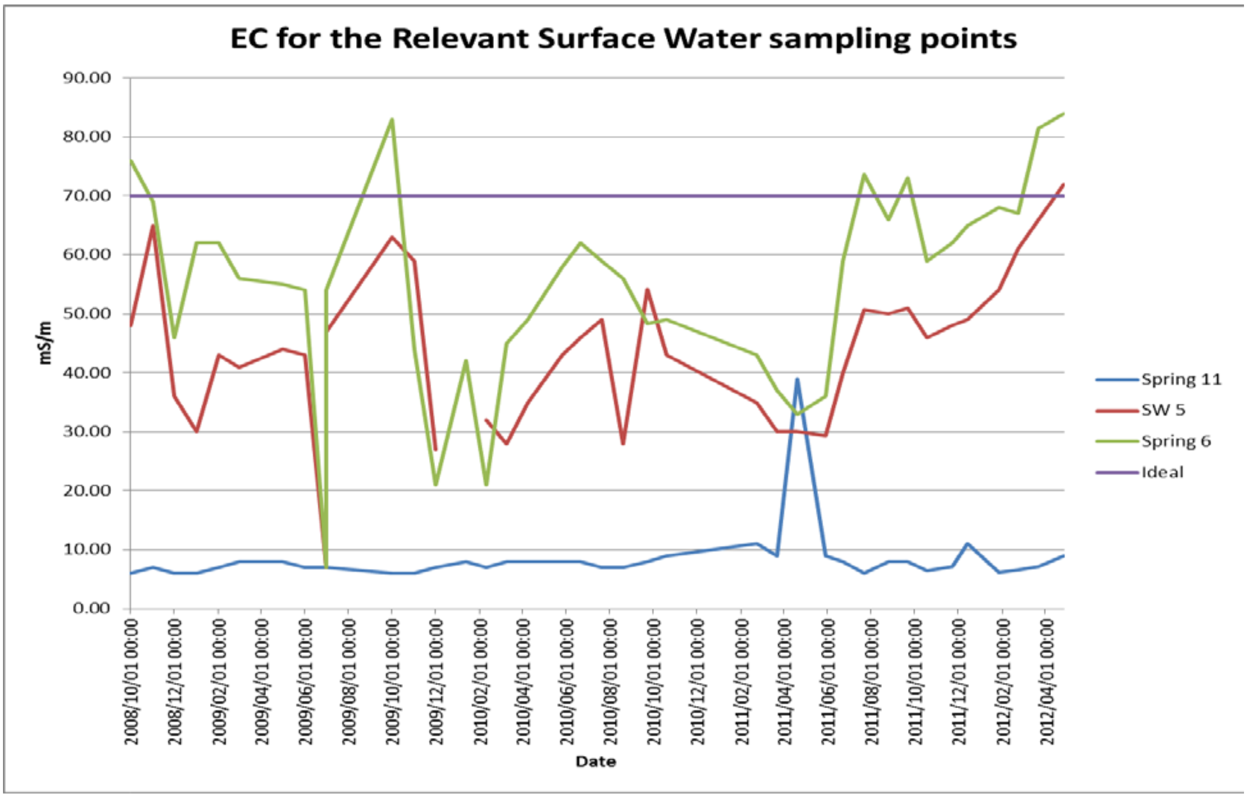


Figure 6-3: Electrical Conductivity trends for sampling done (2008- 2012)

Notes: SW 8 and 9 is not included due to lack of data

6.2.4 pH

pH values for all three sampling points were mostly all within the ideal range for domestic use with Spring 11 only on one occasion having an increased pH which still fell within the No effect range. No conclusion could be drawn as to why this reading was so different due to a lack of verified field data of that time.

Not enough sampling has taken place at SW8 and SW 9. However, the few samples taken all were within the ideal range for domestic use.

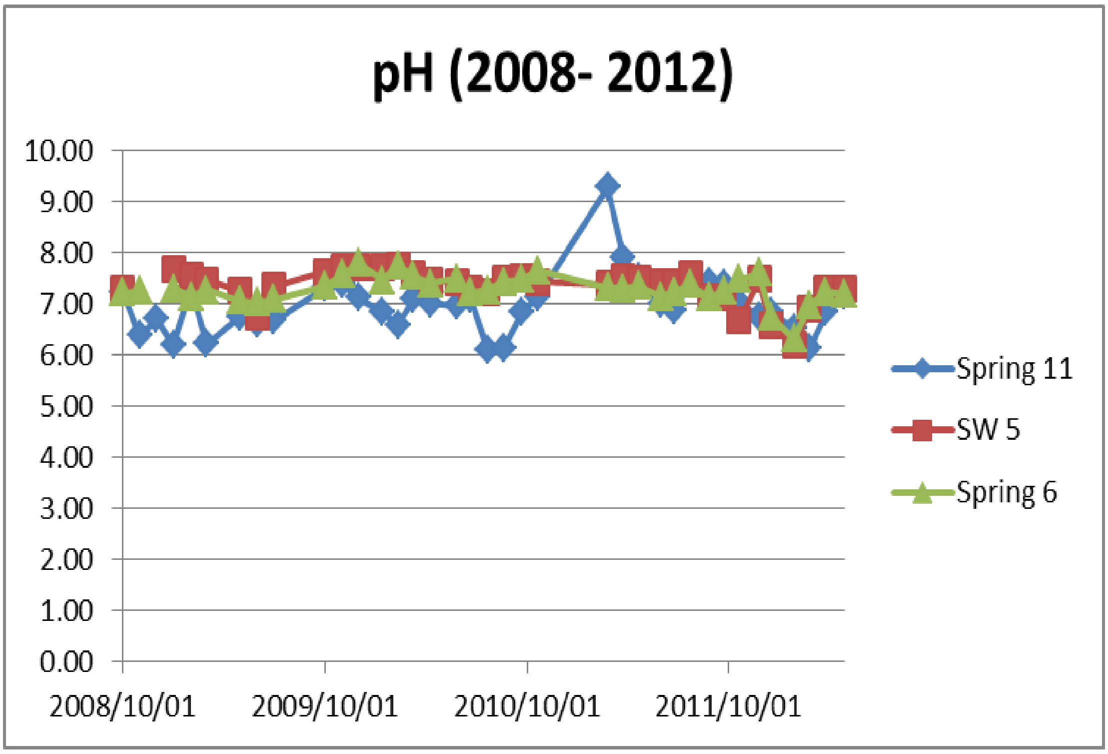


Figure 6-4: pH trends for SW5, Spring 6 and 11

6.2.5 Macro-constituents

The analysis results for macro-constituents measured in surface water samples are show in Table 5-4 below. The median value is indicated.

The surface water sites of relevance to this ash co-disposal facility are within the ideal water quality range according to the SAWQG for Domestic Use with the exception of:

- SW 5 with a calcium concentration (59.05 mg/l) within the ***marginal to no health effects*** range and spring 6 with a calcium concentration of (80.2) which falls just within the ***unacceptable level.***
- Sulfate on levels in spring 6 exceeds the ideal level for domestic use and falls within ***the marginal/ no health effects range***
- All other parameters are within the ideal range

Table 6-4: Summary of the macro constituents of surface water quality (median values0

Sample ID		Potassium (K) mg/l	Sodium (N) mg/l	Chloride (Cl) mg/l	Fluoride (F) mg/l	Nitrate(NO_3) mg/l	Sulfate (SO_4) mg/l	Calcium (Ca) mg/l	Magnesium (Mg) mg/l	Ammonia As N mg/l
Spring 6		2.4	6.1	3.9	0.2	0.5	234	80.2	13.8	<2.5
Spring 11		1.0	5.2	2.9	0.00	1.6	4.2	5.5	2.5	<2.5
SW5		2.3	8.3	4.6	0.3	0.2	167	59.1	12.1	<2.5
SW 8		3	7.3	4.05	0.26	0.1	9.64	7.1	3.7	
SW 9		3.42	14.20	8.66	0.26	0.18	60.64	27.10	15.80	<2.50
Water Quality	Ideal	0-50	0-100	0-100	0-1.0	0-6	0-200	0-32	0-50	0-1
	Marginal/No Health effects	50-100	100-200	200-600	1.0-1.5	6-10	200-400	32-80	50-100	1-10
	Unacceptable	>100	>200	>1200	>1.5	>10	>400	>80	>100	>10

Table Notes:

1. Colour coding is used to denote whether values measured comply with the South African Water Quality Guidelines (DWAF, 1996).
2. Where the lab gives results concentrations as µg/l and the South African Water Quality Guidelines (DWAF, 1996) gives concentrations as mg/l, the guideline values were converted to µg/l
3. The median value has been
3. Method for using for analysis's detection level is higher than the ideal water quality limit
4. SW8 maximum values are reflected since only 2 samples were taken over the period

6.2.6 Micro-constituents

Only aluminium manganese and iron have been sampled on a regular basis in the surfaces water points and therefore only these constituents are discussed below

Aluminium

The analysis results for aluminium measured in surface water samples are shown in Table 6-5 below Maximum Aluminium concentrations at, SW 5, SW8 and SW 9 and Spring 6 and Spring 11 all are unacceptable for use for human health. Since these are maximum values they may not be a true reflection of the real aluminium concentration of the surface water since the median values, except for Spring 6, is significant lower than the maximum level. The potential for erroneous conversions of measuring units may also be the reason for the discrepancy. Analysis of results was based on data supplied by the client.

Spring 11's median value indicates that use for domestic consumption may have marginal to no health effect. However SW5 has a median value which is unacceptable for human consumption have marginal to no health effects. According to the SAWQG the aluminium concentrations of the remaining sites are unacceptable for domestic water use, According to samples taken previously the following trends can be seen with the aluminium concentrations:

- Aluminium concentrations seem to be cyclical, with spikes during the rainy seasons.
- Trends indicate a drop in aluminium levels during the dry seasons over time,
- Water quality with regards to aluminium concentrations seems to be stable over time; and
- There is a strong correlation between aluminium concentrations found in sediment samples and aluminium concentrations found in water samples. (Zitholele Consulting, 2013)

Table 6-5: Aluminium Concentrations as measured between 2008 and 2012 in the various surface sampling points

Sample ID		pH	Aluminium Max(mg/l)	Aluminium Med(mg/l)	Aluminium (Min)
Spring 6		**7.3**	32.20	<0.03	<0.03
Spring 11		**6.96**	2.64	0.36	<0.03
SW5		**7.98**	65.70	7.45	0.03
SW8		**7.7**	251	0.47	1.5
SW 9		**7.8**	186	[redacted]	0.26
Water Quality Guidelines	Ideal	0-1.0mg/l			
	Marginal/No Health effects	1 -2.5			
	Unacceptable	>2			

Aluminium oxide and hydroxide are amphoteric, that is, they are insoluble in water around neutral pH, but dissolve under strongly acidic or strongly alkaline conditions. As such, the interactions of aluminium are strongly influenced by pH, the chemistry of the aluminium hydroxide and the nature of available organic and inorganic complexing ligands. This being demonstrated, since the concentration of aluminium is lower in the Springs where the pH is closer to being neutral

6.2.6.1 Iron

The surface water sites show concentrations within the marginal to no health effects range with SW 5 having the highest concentration (20.0mg/l). According to samples taken previously the following trends can be seen with the iron concentrations:

- There are minor elevations of iron concentrations during rainy seasons over time;
- The iron concentration trend seems stable over time; and
- There is a strong correlation between iron concentrations in the sediment samples and iron concentrations found in water samples. (Zitholele Consulting, 2013)

The concentration of dissolved iron in water is dependent on the pH, redox potential, turbidity, suspended matter, the concentration of aluminium and the occurrence of several heavy metals, notably manganese. The natural cycling of iron may also result in the co precipitation of trace metals such as arsenic, copper, cadmium and lead.

Table 6-6: Iron Concentrations as measured between 2008 and 2012 in the various surface sampling points

Sample ID		Max(mg/l)	Med(mg/l)	Min(mg/l)
Spring 6		4.99	0.09	<0.03
Spring 11		11.18	3.06	0.0
SW5		20.0	0.3	<1.0
SW 8		4.14	[redacted]	1.43
SW 9		3.33	0.70	0.34
Water Quality Guidelines	Ideal	0.1 -0.03	Very slight effects on taste and marginal other aesthetic effects Deposits in plumbing with associated problems may begin to occur. No health effects; the water is generally well tolerated	
	Marginal/No Health effects	0.03-30		
	Unacceptable	30-100	Long-term health effects gradually increase	

6.2.6.2 Manganese

Surface water sites, SW 8, and Spring 11 have concentrations within the marginal to no health effects range with SW 5 having the highest concentration. According to samples taken previously the following trends can be seen with the Manganese concentrations:

- Manganese concentrations fluctuate over time during wet and dry seasons;
- Manganese concentrations have no definite cyclical trend as seen with turbidity levels;
- There is an upward trend in manganese concentrations over time, thus deteriorating water quality; Manganese concentrations however, are mostly under the unacceptable threshold as far as water quality for domestic use goes.
- The median for spring 6 and SW 5 would indicate that the high values shown as maximums were possibly just spikes since the minimum is also particularly low

Table 6-7: Manganese Concentrations as measured between 2008 and 2012 in the various surface sampling points

Sample ID	Max(mg/l)	Med(mg/l)	Min(mg/l)
Spring 6	132	0.05	<0.03
Spring 11	1.43	0.04	<0.03
SW 8	103	[redacted]	0.01
SW 9	139	0.01	0
SW5	332	0.09	<1.0

Water Quality Guidelines	Ideal	0-0.5	No health or aesthetic effects; marginal aesthetic problems occasionally found in the 0.02 -0.05 mg/l
	Marginal/No Health effects	0.05-20	
	Unacceptable	>20	Domestic use unlikely due to extreme aesthetic effects. Chronic toxicity: at high concentrations, possible acute effects

1. Colour coding is used to denote whether values measured comply with the South African Water Quality Guidelines (DWAF, 1996).
2. Where the lab gives results concentrations as µg/l and the South African Water Quality Guidelines (DWAF, 1996) gives concentrations as mg/l, the guideline values were converted to µg/l.

Insufficient sampling of the other micro constituents was done over the sampling period. It is therefore not possible to make meaningful conclusions in terms of trends.

The water quality measured to date indicates that the water user requirements are being met and only aluminum and manganese showing elevated levels and falling within the unacceptable level for domestic water use. It is assumed that the higher levels are normal background levels since no activity as yet has taken place which could have increased these values

6.3 Water Quality Monitoring Program

The list of monitoring points relating to the ash disposal facility and associated infrastructure are summarised in Table 6-2. Additional to the sampling of the natural surface water points (which is sufficient for determining the impact of upstream activities and also the impact of the ash co-disposal facility on down stream activities), the sampling program should be extended to also include the following once the infrastructure has been built and commissioned.

- Ash Co-Disposal Facility Site Retention Dams;
- Ash Co-Disposal Facility Dirty water Dam;
- Station Dirty Dam; and
- Station Dirty Dam Settling Tank

Sampling frequency should be as per the Kusile Water Use Licence issued by the Department of Water Affairs

6.3.1 Water Sampling Monitoring

Kusile to ensure that all their sampling procedures and methods are complying with the Water Use Licence

This will ensure that the data obtained can be confidently used to interpret water chemistry thus facilitating meaningful water modelling, risk assessment and the choice of suitable remedial measures.

7 Potential Environmental Risks and Mitigation Measures

For the purpose of this assessment the Ash co-disposal facility Disposal Facility is defined as the Ash Co-disposal facility, Ash Co-disposal facility Site Retention Dams, Ash Co-disposal Facility Dirty water Dam, Station Dirty Dam and Station Dirty Dam Settling Tank

This section identifies activities associated with the development and operation of the Dirty Dams and the Ash Co-disposal facility Disposal Facility that potentially can have an impact on the receiving surface water environment, for each major component of Ash Co-disposal facility development, being the construction, operational, closure and decommissioning phases. The general activities that are common to construction of an Ash Co-disposal facility and associated infrastructure are the following:

- Establishment of site access road and perimeter fencing;
- Establishment of contractors camp and lay-down areas;
- Removal of the vegetation;
- Removal and stockpiling of the topsoil;
- Earthworks and excavation of foundations for infrastructure e.g. roads, culverts, etc.;
- Provision of stormwater management measures;
- Construction of concrete structures;
- Phased construction of Ash Co-disposal facility basic infrastructure;
- Rehabilitation of disturbed areas after general site construction is completed;
- Operation of the Ash Co-disposal facility, on-going revegetation of slide slopes, maintenance and monitoring;
- Decommissioning and Closure of the Ash Co-disposal facility system once design capacity is reached;
- Rehabilitation of Ash Co-disposal facility top surface once decommissioning is completed; and
- Post Closure including maintenance and monitoring.

Following the results from the water quality results taken in September 2013 and the historical data submitted by the water monitoring program there appears to be a deterioration of water quality over time as construction continues on the Kusile Power Plant. The high levels of aluminium and iron in the sediment samples contributes to higher concentrations being passed on into the water, combined with increased turbidity especially during the wet seasons.

The risks to surface water quality have already started with construction and mitigation measures will need to be applied to minimise the effects thereof. Table 7-1 below details the environmental risks with their associated mitigation measures.

A floodline study was undertaken to assess the placement of the infrastructure in relation to surface water bodies. The report is attached as Appendix A: Floodline Study Report.

Table 7-1: Environmental Risks and Mitigation Measures

Environmental Risk	Mitigation Measure/s
Construction Phase List of activities associated with construction phase: Construction of Ash Co-disposal facility Disposal Facility; Construction of Ash Co-disposal facility Dirty Dam; Construction of Station Dirty Dam; Construction of Station Dirty Dam Settling Tank;	

Environmental Risk	Mitigation Measure/s
Construction of Emergency Ash Dump Area; Construction of the flue gas desulphurisation wastewater treatment plant; Construction of clean water diversions; and Construction of Spoil Areas – Concrete Spoil Stockpile and the K3 Stockpile	
Increase in turbidity of surface water during construction caused by an increase in runoff from the cleared and stripped areas or from topsoil stockpiles which is high in suspended solids (Aluminium, Manganese, and Iron).	The runoff from the upstream clean water catchment is to be diverted away dirty water dams and ash dump disposal facility. Temporary surface water ditches are to be constructed on the upstream boundary of the ash dump, which will meet regulation 704 requirements regarding the separation of clean and dirty water runoff. All clean water runoff will therefore be diverted away from the cleared area.
Accidental spillages of hazardous substances from construction vehicles used during the site clearing and grubbing.	Management measures regarding the maintenance of all Power Plant vehicles must be undertaken. This will ensure that any spillages or leakages of fuel and oil are reduced.
Reduction of catchment yield as a result of the footprint areas of the dirty water dams and the Ash Dump Disposal Facility. The footprint areas will no longer form part of the natural downstream catchment thereby potentially resulting in a decrease of runoff downstream	The loss of catchment area as a result of the dirty water dams and the Ash Dump Disposal Facility and other associated infrastructure cannot be mitigated. The only way to mitigate the above mentioned impacts is to not proceed with the Power Plant which has already started. Therefore the impact rating for pre and post mitigation measures will remain unchanged.
Increase of surface runoff and potentially contaminated water that needs to be maintained in the areas where site clearing and grubbing occur.	Within the cleared area along the downstream boundary of the Ash Dump Disposal Facility, temporary ditches are to be constructed along with temporary excavated storage areas. All dirty water runoff will then be captured and contained within the temporary storage facility.
Excess storage of rainfall within the dirty water dams and settling tanks during the construction phase.	During the period of construction of the dirty water dams and settling tanks, high storm events could result in excessive ponding within the dirty water dams and settling tanks. Depending on the extent of the ponding this water could either be allowed to remain and evaporate naturally or it could be pumped out.
Separation of clean water runoff upstream of the dirty water dams and settling tanks. Water upstream of the dirty water dams and settling tanks is considered clean and will have to be separated from the dirty water area. Dirty water Spillages from the dirty water dams and settling tanks into the environment must be managed.	Based on Reg 704 requirements regarding stormwater management it is noted that all clean and dirty water must be separated. Therefore clean water emanating from upstream of the dirty water dams and settling tanks will be diverted away and discharged to the nearby watercourse or environment. The clean water diversion will be sized to accommodate the 1:50 year storm event.
	The dirty water dams will also have a minimum freeboard from spillway to crest of 0.8 m as per Reg 704 requirements.
Operation Phase List of activities associated with operation phase: Dumping of ash/gypsum into the ash dump disposal facility; The dirty water collection channels from the ash dump disposal facility will be routed to the Ash dump dirty dam; Ash and gypsum will be delivered by conveyor to a radial stacker near the ash/gypsum disposal facility, for subsequent loading, hauling and placement into paddocks; The Emergency Ash Dump (EAD) will be used occasionally for the temporary storage of quenched ash for periods of up to 24 hours, before being removed for permanent disposal on the appropriately licensed waste disposal facility; All potentially contaminated water on the Kusile Power Station will be managed in the Station Dirty Dam; Stormwater management infrastructure operation, monitoring and maintenance; Air and Water Quality Monitoring (surface & groundwater); The Station Dirty Water Dam Settling Tanks (SDD ST) will receive gravity discharges of dirty water from the power station terrace.	
Spillages from the dirty dams and wastewater treatment	A monitoring program for structural maintenance of the

Environmental Risk	Mitigation Measure/s
plant.	dirty dams and wastewater treatment plant needs to develop and maintenance on leakages or spills should be carried out immediately.
Inadequate removal of silt will result in a steady decrease in the storage capacity of the SDD ST.	The SDD ST will consist of two equal capacity concrete basins that clarify contaminated water from the power station terrace before it travels by gravity pipeline to the SDD. The two compartments will allow for occasional maintenance and inspection access (preferably during the dry season) without interrupting the functionality of the SDD ST under normal circumstances.
Maintenance of upstream clean water controls.	Upstream clean water controls should be maintained regularly by site monitoring, to ensure no blockages by vegetation or debris occur. Also to ensure berm walls that has collapsed or have been damaged be repaired
Increase in volume of contaminated water that needs to be managed on the Kusile Power Station footprint.	A stormwater management maintenance program needs to be maintained regularly to ensure that the stormwater system is functioning sufficiently.
Closure Phase List of activities associated with closure phase: Demolishing and removal of infrastructure, dirty dams, etc.; Final rehabilitation and revegetation of top surface of Ash Dump; Post-Closure Water Quality Monitoring (surface & groundwater); Removal of clean water diversion.	
Seepage of water out of the Ash Dump into the environment.	A monitoring program of ground and surface water needs to be implemented and maintenance on any seepage needs to be carried out immediately if detected.
Accidental spillages of hazardous substances from decommissioning vehicles used during the closure phase of the power station.	Management measures regarding the maintenance of all power plant vehicles must be undertaken. This will ensure that any spillages or leakages of fuel and oil are reduced.

8 Methodology

A quantitative risk assessment methodology will be used for the risk assessment. This method makes use of the basic risk assessment approach of deriving an expression for risk from the product of likelihood and consequences. It works by attributing absolute values to likelihood (probability) and consequences. The methodology is summarised in Figure 8-1.

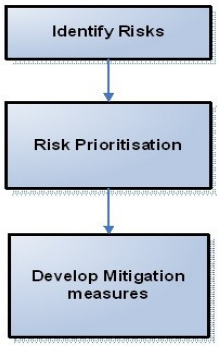


Figure 8-1: Summary of quantitative risk assessment methodology

The main objective of the risk assessment is to identify the negative impacts that can be avoided and/or mitigated and the benefits of the positive impacts during the construction and operation phases of the co-disposal facility on the environment.

8.1 Phase 1: Identification of Risks

All the risks associated with the project (positive and negative) have been determined.

8.2 Phase 2: Quantitative Risk Assessment

The risk assessment will involve the quantification of the risks associated with the project. The potential significance of potential environmental risks identified has been determined using the significance rating as described below. The terminology has been taken from the Guideline Documentation on EIA Regulations as follows:

Severity / magnitude;
Reversibility;
Duration of impact; and
Spatial extent.

Table 8-1: Consequence and probability ranking

Severity / magnitude(S)	**Reversibility (R)**	**Duration (D)**	**Spatial extent (E)**	**Probability (P)**
5 – Very high / don't know	1 – Reversible (regenerates naturally)	5 – Permanent	5 – International	5 – Definite / don't know
4 – High		4 – Long term (impact ceases after operational life)	4 – National	4 – High probability
3 – Moderate	3 – Recoverable (needs human input)	3 – Medium term (5 – 15 years)	3 – Regional	3 – Medium probability
2 – Low		2 – Short term (0 – 5 years)	2 – Local	2 – Low probability-
1 – Minor	5 – Irreversible	1 - Immediate	1 – Site only	1 – Improbable

Severity / magnitude(S)	Reversibility (R)	Duration (D)	Spatial extent (E)	Probability (P)
0 - None				0 - None

The maximum value which can be obtained is 100 significance points. The risks have been rated as High, Moderate or Low significance by combining the consequence of the impact and the probability of occurrence:

Consequence = severity + reversibility + duration + spatial scale
Consequence X Probability = Significance

- More than 60 significance points indicate **High** environmental significance;
- Between 30 and 60 significance points indicate **Moderate** environmental significance;
- Less than 30 significance points indicate **Low** environmental significance.

o

9 Results of the Risk Assessment

9.1 Construction Phase

9.1.1 Surface water quality

Surface water quality in the catchment may be impacted upon during site clearing and construction of the Ash Dump and its associated infrastructure.

- Sedimentation caused by an increase in runoff from the cleared areas or from topsoil stockpiles which is high in suspended solids;
- Poor lateral drainage of access roads and Ash Dump base preparation where stormwater may pond alongside roads and preliminary construction berms;
- Soil compaction, causing an increase in runoff during rainstorm events increasing turbidity in the surface water.

The boundaries of the study area for the Ash Dump are situated within the catchment of the Klipfonteinspruit and its tributaries. The overall topography is generally flattish with undulating hills with local drainage lines within the Ash Dump footprint area. Water will tend to drain into the non-perennial tributaries of the Klipfonteinspruit. Therefore the probability that contaminated runoff will reach the Klipfonteinspruit and eventually the Wilge River via surface water drainage channels during the construction phase is considered probable, if not appropriately mitigated. The primary impact will be contained to the immediate area of the Ash Dump and its associated infrastructure. Although the impact will be of short duration during a storm event and sometime thereafter it will continue throughout the project thus the impact is considered for the duration of the project. Should the impact materialise it will deteriorate the functionality of the surface water which could make it unfit for use by any other water users. This may be the case during the dry winter months when the site drainage courses are dry and the water reaching the water courses will be the only source. The site is however located in a summer rainfall season with very low precipitation taking place during the winter months The potential impact will further be easily reversible since the Water Act requires that appropriate clean and dirty water segregation. The overall impact has been rated as having a **MODERATE** significance in Table 8-1. The probability that the impact may occur remains likely, particularly associated with the need to divert existing water courses around the Ash Dump footprint, and therefore the significance will not be reduced to a lower significance but the significance rating will be reduced from 56 to 36.

Catchment yield loss will occur with the construction of the Ash dump and associated infrastructure. These risks cannot be mitigated and is rated as **HIGH** as depicted in Table 8-1 below.

9.1.2 Accidental spillages of hazardous substances

The Ash Dump development increases the probability of localised accidental spillages of hydrocarbons (diesel, oils etc.) from earthmoving and construction equipment and transport of equipment and personnel to and from the site of hazardous substances. The impact will be contained to the site only and will be of a short duration as spillages can usually be remediated immediately.

Spillages and runoff from the construction camp construction activities:

Spillages at the construction camp will be contained to site and will be remediated continuously for the duration of construction. The contaminated runoff will be contained and reused as necessary e.g. for dust suppression. The potential intensity should this impact occur will be **MODERATE** as it may impact on the water quality. However all spillages will be contained to site but will probably reoccur for the duration of the construction phase. The impact has been rated as having a **LOW** significance once mitigated.

The probability that spillages and runoff from the bunded area within the contractors lay-down and vehicle maintenance areas will result in the contamination of surface water is unlikely. Contaminated water will be contained on site; spillages are expected to be remediated immediately therefore the risk will be for a short duration although the risk is considered for the duration of the construction phase.

9.1.3 Stormwater management

Stormwater management is one of the key issues that must be addressed in the surface water assessment. Due to the land clearing of vegetation and topsoil for construction purposes, construction of access roads, construction camps and the Ash Dump area and associated infrastructure, the compaction of soil, contaminated runoff from these areas will definitely increase resulting in an increase of the volume of contaminated water that needs to be handled on the Kusile Power Plant footprint. This is confirmed by the increases in turbidity, aluminium and iron concentrations in the surface water monitoring results. This water will be concentrated and either flow away in the tributaries or pond until it evaporates. The impact may not just be contained to site but could potentially enter the surface water system. This impact will occur throughout the life time of the project. The impact was rated as having an overall significance of **MODERATE** and cannot be mitigated to a lower significance as set out in the Table 9-1 below.

Table 9-1: Summary of Environmental Significance Ratings of impacts on surface water during Construction

Construction Phase														
	Rating Before Mitigation Measures							Rating After Mitigation Measures						
Risk	S	R	D	E	C	P	Significance =C*P	S	R	D	E	C	P	Significance =C*P
Increase in turbidity of surface water during construction caused by an increase in runoff from the cleared and stripped areas or from topsoil stockpiles which is high in suspended solids (Aluminium and Iron).	4	3	4	3	14	4	56 - Moderate	3	3	4	2	12	3	36 - Moderate
Accidental spillages of hazardous substances from construction vehicles used during the site clearing and grubbing.	4	3	3	2	12	3	36 - Moderate	3	3	2	1	9	2	18 – Low
Reduction of catchment yield as a result of the footprint areas of the dirty water dams and the Ash Dump Disposal Facility and	3	3	4	3	13	5	65 - High	3	3	4	3	13	5	65 - High

Construction Phase														
	Rating Before Mitigation Measures							Rating After Mitigation Measures						
Risk	S	R	D	E	C	P	Significance =C*P	S	R	D	E	C	P	Significance =C*P
associated infrastructure. The footprint areas will no longer form part of the natural downstream catchment thereby potentially resulting in a decrease of runoff downstream														
Increase of surface runoff and potentially contaminated water that needs to be maintained in the areas where site clearing and grubbing occur.	4	3	4	3	14	4	56 - Moderate	3	3	4	2	12	3	36 - Moderate
Excess storage of rainfall within the dirty water dams and settling tanks during the construction phase.	2	3	2	1	8	2	16 - Low	1	3	1	1	6	2	12 - Low
Separation of clean water runoff upstream of the dirty water dams and settling tanks. Water upstream of the dirty water dams and settling tanks is considered clean and will have to be separated from the dirty water area. Dirty water Spillages from the dirty water dams and settling tanks into the environment must be managed.	4	3	4	3	14	4	56 - Moderate	3	3	4	2	12	3	36 - Moderate

9.2 Operation Phase

9.2.1 Measures implemented to manage surface water

During normal operations of the Ash Dump and associated infrastructure the affected water will be contained in the ADDD. Clean stormwater will be diverted away from the Ash Dump and associated infrastructural operational areas by cut-off channels and diversion berms designed to handle the 1:50 year storm event.

Contaminated runoff water, generated during rainstorm events, on the operational footprint area will be contained in specifically designed structures to enable sedimentation and desilting of the runoff. The quality of the return water will be monitored on a regular basis and re-cycled as process water make-up.

Water containment facilities (SDD ST, SDD, and ADDD) will be designed, constructed, operated and maintained to have a minimum freeboard of 0.8 metres above full supply level and all other water systems related thereto shall be operated in such a manner that it is at all times capable of handling the 1:50 year flood-event on top of its mean operating level.

The Ash Dump Disposal Facility will be engineered to be fully compliant with Regulation 704 in terms of clean and dirty water segregation.

Groundwater and surface water quality, and quantity, monitoring systems have already been established for Ash Dump Disposal Facility.

The SDD ST will consist of two equal capacity concrete basins that clarify contaminated water from the power station terrace before it travels by gravity pipeline to the SDD. The two compartments will allow for occasional maintenance and inspection access (preferably during the dry season) without interrupting the functionality of the SDD ST under normal circumstances there by mitigating the risk of silt build-up. This will have a mitigated significance of **LOW** as depicted in Table below.

9.2.2 Surface water quality

Surface water quality may be impacted upon during the operational phase by the Ash Dump activities and associated infrastructure, if not adequately mitigated and managed. The probability that the impact will manifest in an impact with a moderate potential intensity, meaning a reduction in the functionality of the surface water which makes it unfit for use by any other water user, is possible but unlikely, because the Ash Dump has been designed according to the principles indicated above. The activity and therefore the impact will occur during the life of the project but will be contained to site. Therefore, impacts associated with spillages on surface water quality were rated as having a **LOW** significance once mitigated as depicted in the summary Table 9-2 below.

The risk of sedimentation and increase in turbidity due to soil erosion and runoff from Ash Dump and cleared areas will continue from the construction phase and therefore has been addressed in the construction phase.

Spillages generated from Ash Dump and the dirty water systems as well as the runoff from these systems can have an impact on the surface water. The potential impact will occur for the duration while the Ash Dump is in development and subsequently when the Ash Dump is decommissioned and closed. The primary impact will be contained on site and will have a moderate intensity potential should the impact manifest with a probability of being moderate likelihood. Therefore the risk was rated as **MODERATE** if unmitigated but **LOW** once mitigated as depicted in Table 9-2 below.

The impact of pollution due to spillages of hazardous substances or leaks from vehicles and equipment during incidents or maintenance is carried over from the construction phase and therefore has been addressed in the construction phase.

9.2.3 Stormwater management

Should the Kusile Power Station footprint receive significant rainfall over a period of time, there is the potential for the stormwater systems and the clean and dirty water segregation system to be inundated with excess volumes of water. Should the maintenance of the stormwater systems be in place, the mitigated effect of increased volumes of contaminated water having to be handled by the Kusile Power Station footprint would be rated as LOW as depicted in the table below. Sufficient maintenance of upstream clean water controls will also reduce the risk of non-compliance in terms of dirty and clean water separation and will have a significance rating of LOW once mitigated

Table 9-2: Summary of Environmental Significance Ratings of impacts on surface water during Operation

Operation Phase														
	Rating Before Mitigation Measures							Rating After Mitigation Measures						
Risk	S	R	D	E	C	P	Significance =C*P	S	R	D	E	C	P	Significance =C*P
Spillages from the dirty dams and wastewater treatment plant.	4	3	4	3	14	3	42 - Moderate	3	3	2	1	9	2	18 - Low
Inadequate removal of silt will result in a steady decrease in the storage capacity of the SDD ST.	2	3	1	2	8	3	24 - Low	1	3	1	1	6	2	12 – Low
Maintenance of upstream clean water controls.	4	3	2	2	11	3	33 - Moderate	2	3	2	1	8	2	16 - Low
Increase in volume of contaminated water that needs to be managed on the Kusile Power Station footprint.	4	3	4	3	14	3	42 - Moderate	3	3	2	1	9	2	18 - Low

9.3 Closure and decommissioning phase

During the closure and decommissioning phase of the Ash Dump and associated infrastructure, all additional infrastructures will be removed and the footprint area rehabilitated as with the Ash Dump being revegetated to manage on-going dust generation and erosion.

The surface water quality could possibly be further impacted by the closure and decommissioning activities due to spillages of hazardous substances (e.g. hydrocarbons and oils) from earthmoving equipment and sedimentation and increase in turbidity due to the disturbance of soils.

Seepage of water from the Ash Dump could occur although once mitigated the risk will have a significance of LOW as depicted in Table 9-3 below.

Table 9-3: Summary of Environmental Significance Ratings of impacts on surface water during Closure

Decommissioning and Closure Phase														
	Rating Before Mitigation Measures							Rating After Mitigation Measures						
Risk	S	R	D	E	C	P	Significance =C*P	S	R	D	E	C	P	Significanc e =C*P
Seepage of water out of the Ash Dump into the environment.	4	3	4	3	14	3	42 - Moderate	3	3	2	1	9	2	18 - Low
Accidental spillages of hazardous	4	3	3	2	12	3	36 - Moderate	3	3	2	1	9	2	18 – Low

Decommissioning and Closure Phase														
	Rating Before Mitigation Measures							Rating After Mitigation Measures						
Risk	S	R	D	E	C	P	Significance =C*P	S	R	D	E	C	P	Significanc e =C*P
substances from decommissioning vehicles used during the closure phase of the power station.														

10 Conclusion

The following can be concluded from the study:

Many of the water related environmental impacts are considered as moderate significance, in the absence of appropriate mitigation measures. There is the risk of spillage of ash and gypsum into the surface water system both from the Ash Dump itself and from the dirty water dams and wastewater treatment plant. Once mitigated though, these risks are significantly reduced.

Of concern is the increase in turbidity and suspended solids in the surface water monitoring. The mitigation measures will need to be implemented immediately during the current construction phase and managed during operation to maintain acceptable water quality levels.

Although the identified construction and operational risks associated with Ash Dump and its associated infrastructure may be considered to be significant on an individual basis, because the Ash Dump will be subject to specific legislative specifications, these impacts can be mitigated and managed.

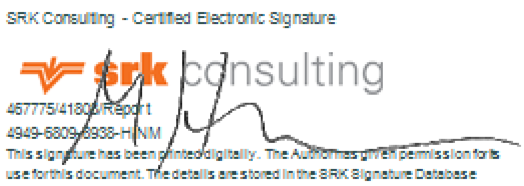
Expected Mitigation and Management Measures to protect surface water resources:

- The Ash Dump system is to be operated to ensure that the accumulation of water in the dirty dams and wastewater treatment plant does not present a stability risk and that drainage of dirty dams accommodates the 1:50 year flood event;
- All dirty dams are to be operated to ensure that the 1:50 year flood event is contained plus free-board at full operating level of 0.8 m
- The Ash dump and associated infrastructure will be provided with formal engineered drainage and seepage collection systems appropriate to the collection of impacted waters for reuse purposes;
- The Ash Dump system will be compliant to Regulation 704 in diverting clean water from the upper catchment area around the site to the natural environment, and containing dirty water within the Ash Dump water management system;
- A monitoring program for structural maintenance of the dirty dams and wastewater treatment plant needs to developed and an maintenance on leakages or spills should be carried out immediately;
- A stormwater management maintenance program needs to be maintained regularly to ensure that the stormwater system is functioning sufficiently;
- A monitoring program of ground and surface water needs to be implemented and maintenance on any seepage needs to be carried out immediately if detected.

It is expected that consideration will also be given to the on-going updates to the National Waste Management Strategy including the Waste Classification Regulations, Waste Information System

Regulations and National Norms and Standard and Standard for the Disposal of Waste to Solid waste management services.

Prepared by



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All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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Appendices

Appendix A: Floodline Study Report

Kusile Power Plant

1:50 & 1:100 Year Floodlines

Report Prepared for

ILISO Consulting

Report Number 467775/1

Report Prepared by

srk consulting

June 2014

Kusile Power Plant

1:50 & 1:100 Year Floodlines

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SRK Project Number 467775

June 2014

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Executive Summary

The purpose of this study was to carry out the 1:50 and 1:100 year floodline study for the Klipfonteinspruit and its tributary situated south of the CDF (Current Design Facility) where it approaches and crosses the new D686 tarred road. During the EMP development phase, floodline determination along the remainder of the tributary was not considered necessary as the floodline were estimated to be in excess of 100m downhill from the nearest infrastructure related to the CDF. DWA has however requested the determination of the 1:100 year floodlines around the CDF and this are required for the impact assessment phase of the project. In view of this, Iliso Consulting appointed SRK to conduct a 1:50 and 1:100 year floodline study for the remainder of the Klipfonteinspruit tributary south of the CDF.

The report covers the 1:50 and 1:100-year floodlines for the Klipfonteinspruit and its tributaries.

Summary of principal objectives

The principal objective of this project is to conduct the 1:50 and 1:100 year floodline in order to assess if the any part of the Kusile Power Station infrastructure is not situated within the 1:50 and 1:100 year floodlines.

Outline of work programme

The floodlines were determined based on the existing watercourse condition, future land-use flood peaks and survey available at the time of study. The data that was used consisted of the Surveyor 0.5m contours supplied by the client and the 24 hour rainfall.

Recommendations

- Development layout planning to take into account the position of the 100-year floodline.
- The positioned of the CDF and its infrastructure to be outside of the 1:100 year floodplain as shown on Drawing 467775/001.

Action Points

- No new development to encroach onto the 1:50-year floodplain
- All future floor levels to be above the 1:100-year flood level.
- The floodlines be revised should watercourse and/or control structures be modified in the future.

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Disclaimer

The opinions expressed in this Report have been based on the survey data information supplied to SRK Consulting (South Africa) (Pty) Ltd (SRK) by ILISO Consulting (ILISO). The opinions in this Report are provided in response to a specific request from ILISO to do so. SRK has exercised all due care in reviewing the supplied information. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information and does not accept any consequential liability arising from commercial decisions or actions resulting from them. Opinions presented in this report apply to the site conditions and features as they existed at the time of SRK's investigations, and those reasonably foreseeable. These opinions do not necessarily apply to conditions and features that may arise after the date of this Report, about which SRK had no prior knowledge nor had the opportunity to evaluate.

1 Introduction and Scope of Report

Kusile Coal-Fired Power Station is currently under construction and has an anticipated output 4 800 MW, covers approximately 2 500 ha of land on the Farm Hartebeesfontein 537 JR and the Farm Klipfontein 566 JR in the Witbank area. Floodlines form part of the surface water impacts that are normally required for the EIA/EMP for the construction, operational, decommissioning and post closure phases. Floodlines were previously (Kusile Stream Diversion & Dewatering EMP by Panel B Consultants Joint Venture)determined for the tributary of Klipfonteinspruit that was running through the Coal Stork Yard area prior to being diverted to a channel that runs against the Plant Boundary. ILISO Consulting saw the need to conduct floodline study for the tributary of Klipfonteinspruit that was diverted on the upstream and Klipfonteinspruit running on the southern side of the power plant activities. Floodlines are determined as part of Regulation 704 to ensure that all developments situated closer to the rivers are not at risk of being flooded during a 1:50 year and 1:100 year flood events.

Brief details are given below.

2 Background and Brief

2.1 Background of the project

Kusile power station is in construction and floodlines are required to ensure that the power station infrastructure and new developments are not situated within the 1:50 year and 1:100 year floodlines. In view of this, SRK Consulting (SRK) was appointed by Iliso Consulting to carry out a floodline study on the above site. Regulation 704 of the national water Act, 2008 requires that any development associated with the power station must not be placed within the 1:100 year floodline.

Nature of the brief

The aim of this study is to conduct the 1:50 and 1:100 year floodline study for two of the streams running in close proximity of power station activities (Klipfonteinspruit running on the southern side of the power station activities and the channelized tributary running on the eastern side of the Coal Stockyard until it confluences with Klipfonteinspruit on the western side at ± 4km downstream of the Coal Stockyard). Additional floodlines were determined for additional tributaries of Klipfonteinspruit and the floodlines are indicated on Drawing 467775/001 forming part of this report. Relevant details are given in this report.

3 Program Objectives and Work Program

3.1 Program objectives

The project objectives are as follows:

- Data Collection;
- Data Verification;
- Model Setup;
- Flood Hydrology Calculations;
- Hydraulic Modelling to obtain 1:50 year and 1:100 year floodlines;
- Summary Reports and maps showing Floodlines; and
- Reviewing of the Report and Floodlines.

3.2 Purpose of the Report

This report provides with the findings of the floodline study and gives recommendations to Iliso Consulting for current and future power station developments.

4 Description of Study Area and Watercourses

The Kusile Power Plant river catchments all drain into the Wilge River. The Klipfonteinspruit and its tributaries have a total catchment area of 60.4 km^2. The diverted stream including the non-diverted part of the stream on the downstream has a total catchment area 12.8 km^2. The area covered by the catchments is mostly rural and undeveloped covered largely by grass and very few trees. The study area is shown in Figure 4-1 below.

srk consulting	**Kusile Power Station Floodlines** Kusile Power Station Study Area	Project No. 467775

Figure 4-1: **Kusile Power Station Study Area**

The main watercourse (Klipfonteinspruit) is a well-defined channel that consists of a few road crossings while the tributaries are shallow and overgrown with grass. There is currently no development on both the river banks as the power station is still in construction. The river segment lengths are in Table 4-1 below.

Table 4-1: River Segment Length

Rivers situated within the Kusile Boundary			
River Name	**River Segment**	**Individual Segment Length (km)**	**Cumulative Length (km)**
Klipfonteinspruit Tributary	KLFS2T2	3.9	3.
Klipfonteinspruit Tributary	KLFS2T1	2.5	6.4
Klipfonteinspruit	KLFS3	3.3	6.8
Klipfonteinspruit	KLFS2	4.0	10.8

5 Topographical Details

The general topography was determined using 0.5m contours. From these 0.5m contours, the cross sectional profile and the profile of the road crossings were determined.

6 HECRAS Model Compilation

The 0.5m contour was entered into the HECRAS (Version 4.0) model. All “natural cross sections” were abstracted from the DEM (digital elevation model). The HECRAS model main parameters are summarised in Table 6-1 below.

Table 6-1: HECRAS Model Main Parameters

Parameter	Average Value/Selection	Reason
Manning ‘n’	0.035 (main flow channel)	Defined channel with vegetation
	0.0300 (floodplains)	Moderate vegetation (mainly grass) and thick vegetation and developments
Boundary conditions	Normal flow depth	Control structures present
Flow regime	Mixed flow	Slope and cross section changes requiring super and sub-critical flow regimes

The HECRAS model cross-sections were named in accordance with the defined River Referencing System (RRS). Further details of the HECRAS model parameter files are given in Appendix A**.**

7 Flood Hydrology

In order to obtain realistic and integrated flood peak data for the Kusile study area, the catchment area draining into the tributary of Klipfonteinspruit (KLFS2T) was sub divided into the upstream sub-catchments contributing to the diverted channels and downstream sub-catchment that drains into the natural stream. The Rational and Alternative Rational methods built into the Utility Programs for Drainage Software (UPD) were then compiled for the main Klipfonteinspruit. The Peak Flows for the subdivided catchments were determined using Visual SCS as the program was designed to model smaller catchments accurately <30 $km^{2.}$ The catchments commanded by the study area are given in Table 7-3. Based on the hydrological parameters used in the hydrological methods for the Kusile study area, peak flow rates for the catchment conditions are give in Table 7-1 below.

Table 7-1: Summary of Flood Peaks (Future Development Condition)

River Segment & Chainage	Peak Flow Rates (m³/s)	
	1:50	1:100
KLFS2	359	427
KLFS3	326	387
KLFS2T1	101	131
KLFS2T2a	27	35
KLFS2T2b	31	41
KLFS2T2c	41	53
KLFS2T2d	44	58

7.1 Rainfall Data

Rainfall for the model was based on IDF (intensity-duration-frequency) curves derived for this study area by J C Smithers and R E Schulze. The Rainfall station 0514537 which is the closest to the study area with reliable and most recent data was used. The estimated design rainfall depths for durations ranging from 15 minutes to 7 days and for return periods ranging from 2 to 200 years for the Kusile study area were calculated. The calculated 1 day rainfall depths for selected return period are as shown in Table 7-2 below.

Table 7-2: 1-day Rainfall Depths

Return Period	1:2 Year	1:5 Year	1:10 Year	1:20 Year	1:50 Year	1:100 Year
Rainfall depth (mm)	59	81.4	98.5	116.5	142.9	165

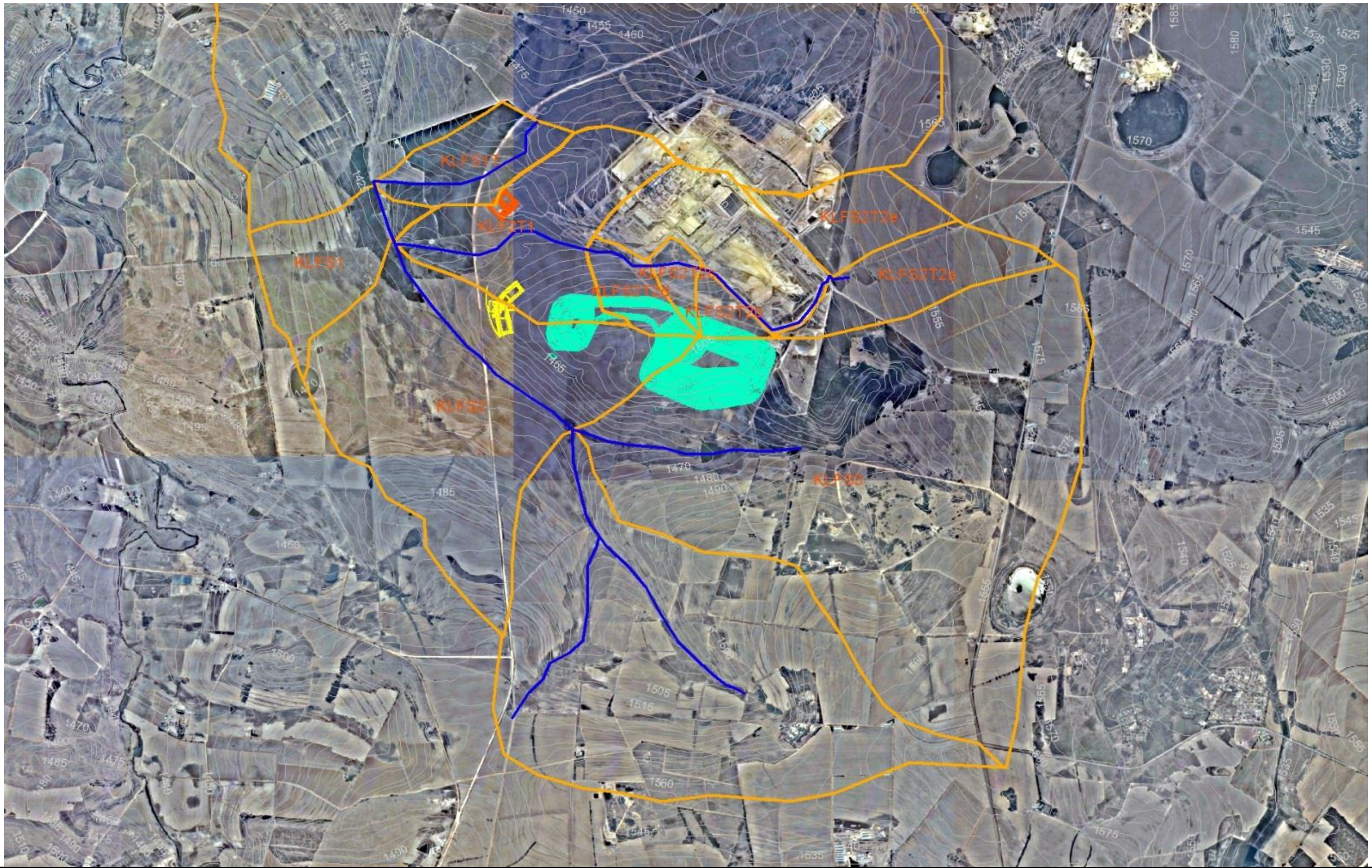
7.2 Catchment Data

The catchment of the watercourse consists mainly of grass and very few trees. The catchment areas commanded by the river segments are summarised Table 7-3 below.

Table 7-3: Summary of Catchment Area

River Segment	Catchment Area (km²)
KLFS2	49.5
KLFS3	34.9
KLFS2T1	12.8
KLFS2T2a	3.4
KLFS2T2b	4.0
KLFS2T2c	6.0
KLFS2T2d	6.9

The catchments of the study area are as shown in Figure 7-1 below.



srk consulting	**Kusile Power Station Floodlines** Kusile Catchments Areas	Project No. 467775

Figure 7-1: Kusile Catchments Areas

8 Floodline Determination and Results

The 1:50 and 1:100-year floodlines were determined based on the HECRAS model and peak flow rates as given in Table 7-1 above for existing watercourse conditions.

Details and certified floodlines are shown on drawing 467775/001 in Appendix B.

The HECRAS model output data is given in Appendix A**.**

From the floodline study, the following was observed:

- The existing development and infrastructure is not affected by the 1:50 year and 1:100 year floodlines.
- The diverted channel running on the south eastern and south western sides of the coal stock yard can handle the 1:50 year and 1:100 year flood events.
- The 1:50 and the 1:100 year average flood depths and average flood velocities along the floodplains are shown below in Table 8-1 and Table 8-2, respectively.

Table 8-1: Summary of Average flood depths along floodplains

Chainage	Average Flood depths (m)			
	1:50 Year		1:100 Year	
	Hydr depth L	Hydr depth R	Hydr depth L	Hydr depth R
KLFS2	0.75	0.76	0.82	0.83
KLFS3	0.35	0.40	0.39	0.44
KLFS2T1	0.27	0.27	0.33	0.33
KLFS2T2a	0.97	0.97	1.10	1.10
KLFS2T2b	1.04	1.04	1.19	1.19
KLFS2T2c	1.26	1.26	1.42	1.42
KLFS2T2d	1.30	1.30	1.48	1.48

Table 8-2: Summary of Average flood velocity along floodplains

Chainage	Average Flood velocity (m^3/s)			
	1:50 Year		1:100 Year	
	Vel Left	Vel Right	Vel Left	Vel Right
KLFS2	1.95	2.01	2.08	2.14
KLFS3	1.53	1.63	1.66	1.83
KLFS2T1	1.14	1.15	1.28	1.27
KLFS2T2a	4.69	4.69	5.03	5.03
KLFS2T2b	4.87	4.87	5.24	5.24
KLFS2T2c	4.83	4.83	5.16	5.16
KLFS2T2d	4.92	4.92	5.28	5.28

9 Legal and Council Requirements

The **1:100-year** floodline is required in terms of the National Water Act, Act 36 of 1998, Chapter 14 Part 3 as given below.

144. *For the purposes of ensuring that all persons who might be affected have access to information regarding potential flood hazards, no person may establish a township unless the layout plan shows, in a form acceptable to the local authority concerned, lines indicating the maximum level likely to be reached by flood waters on average once in every 100 years.*

10 Conclusions

The following is concluded:

- The existing development and infrastructure at Kusile Power Station is situated outside the 1:50 and 1:100 year floodlines.
- The diverted channel can handle the 1:50 year and 1:100 year flood events.

11 Recommendations

The following is recommended:

- The floodline data to be used for layout planning and township applications.
- No new development to encroach onto the 1:50-year floodplain
- All future floor levels to be above the 1:100-year flood level.
- The floodlines be revised should watercourse and/or control structures be modified in the future.

Prepared by

J. Mathole

Reviewed by

D. Mahlangu, Director

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

Appendices

Appendix A: Hecras Output Model

HecRas Output Table																
Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF2T6330	6330	50yr	26.8	1533.64	1534.04	1534.11	1534.26	0.021009	1.41	2.29	0.76	0.16	0.06	14.22	70.46	1.28
KLF2T6330	6330	100yr	35.1	1533.64	1534.09	1534.18	1534.34	0.020991	1.56	2.49	0.94	0.18	0.09	17.47	77.89	1.31
KLF2T6287	6287	50yr	26.8	1532.02	1532.29	1532.42	1532.74	0.070732	0.56	2.98	0.5	0.02	0.01	9.04	49.62	2.15
KLF2T6287	6287	100yr	35.1	1532.02	1532.33	1532.49	1532.86	0.065102	0.96	3.23	0.94	0.04	0.04	11.06	53.17	2.13
KLF2T6257	6257	50yr	26.8	1531.5	1531.98	1531.99	1532.14	0.01308	0.56	1.8	0.74	0.06	0.09	15.33	54.65	1.01
KLF2T6257	6257	100yr	35.1	1531.5	1532.06	1532.06	1532.23	0.010328	0.69	1.85	0.81	0.09	0.12	20.07	62.73	0.93
KLF2T6229	6229	50yr	26.8	1531.07	1531.53	1531.59	1531.74	0.017142	1.27	2.29	1.07	0.16	0.12	14.57	64.01	1.19
KLF2T6229	6229	100yr	35.1	1531.07	1531.57	1531.64	1531.83	0.019354	1.43	2.59	1.28	0.17	0.15	17.18	70.2	1.28
KLF2T6208	6208	50yr	26.8	1530.81	1531.23	1531.25	1531.38	0.015287	1.27	1.91	0.75	0.17	0.08	16.71	77.19	1.09
KLF2T6208	6208	100yr	35.1	1530.81	1531.27	1531.3	1531.45	0.015074	1.43	2.07	0.89	0.21	0.1	20.19	80.75	1.1
KLF2T6111	6111	50yr	26.8	1530.34	1530.42	1530.45	1530.55	0.012349	1.62	0.39	0.46	0.28	0.04	18.85	131.37	0.67
KLF2T6111	6111	100yr	35.1	1530.34	1530.46	1530.5	1530.59	0.012562	1.73	0.65	0.61	0.31	0.06	24.7	162.31	0.77
KLF2T6072	6072	50yr	26.8	1529.36	1529.46	1529.5	1529.59	0.033257	0.95	1.09	1.66	0.06	0.14	16.82	131.16	1.26
KLF2T6072	6072	100yr	35.1	1529.36	1529.48	1529.53	1529.64	0.03341	1.13	1.31	1.83	0.08	0.16	19.97	133.45	1.32
KLF2T6056	6056	50yr	26.8	1528.57	1528.71	1528.75	1528.85	0.04359	0.49	1.49	1.64	0.02	0.11	16.53	148.3	1.51
KLF2T6056	6056	100yr	35.1	1528.57	1528.73	1528.78	1528.9	0.043728	0.64	1.68	1.82	0.03	0.13	19.45	149.36	1.56
KLF2T6043	6043	50yr	26.8	1528.18	1527.9	1528	1528.18	0.040849			2.33		0.2	11.52	56.4	0
KLF2T6043	6043	100yr	35.1	1528.18	1527.95	1528.07	1528.26	0.037668			2.45		0.24	14.3	60.75	0
KLF2T6013	6013	50yr	26.8	1527.37	1527.32	1527.32	1527.4	0.017725			1.28		0.16	20.86	133.47	0
KLF2T6013	6013	100yr	35.1	1527.37	1527.34	1527.35	1527.45	0.020467			1.49		0.18	23.58	134.71	0
KLF2T5978	5978	50yr	26.8	1526.36	1526.37	1526.42	1526.54	0.043909	1.19	0.35	1.84	0.06	0.13	14.86	127.05	1.05
KLF2T5978	5978	100yr	35.1	1526.36	1526.4	1526.46	1526.58	0.036656	1.23	0.79	1.9	0.07	0.16	19.09	136.27	1.21
KLF2T5940	5940	50yr	26.8	1524.72	1524.47	1524.58	1524.8	0.038931			2.54		0.24	10.57	43.73	0
KLF2T5940	5940	100yr	35.1	1524.72	1524.53	1524.64	1524.87	0.045391			2.58		0.22	13.61	61.7	0
KLF2T5895	5895	50yr	26.8	1523	1521.29	1521.29	1521.49	0.012761			1.97		0.39	13.61	35.24	0
KLF2T5895	5895	100yr	35.1	1523	1521.37	1521.37	1521.6	0.012039			2.11		0.45	16.63	37.13	0
KLF2T5857	5857	50yr	26.8	1521.61	1518.2	1518.2	1518.38	0.01272			1.9		0.37	14.13	38.71	0
KLF2T5857	5857	100yr	35.1	1521.61	1518.28	1518.28	1518.49	0.012386			2.03		0.41	17.27	41.79	0

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF2T5801	5801	50yr	26.8	1519.31	1512.03	1512.03	1512.24	0.0123			2.03		0.42	13.18	31.76	0
KLF2T5801	5801	100yr	35.1	1519.31	1512.11	1512.11	1512.36	0.011676			2.2		0.49	15.94	32.69	0
KLF2T5754	5754	50yr	26.8	1517.37	1511.34	1507.9	1511.34	0.000005			0.13		2.55	209.09	82.06	0
KLF2T5754	5754	100yr	35.1	1517.37	1511.49	1508.01	1511.49	0.000006			0.16		2.67	221.98	83.12	0
KLF2T5710	5710	50yr	26.8	1516.73	1511.33		1511.34	0.000009			0.19		2.76	144.81	52.55	0
KLF2T5710	5710	100yr	35.1	1516.73	1511.49		1511.49	0.000013			0.23		2.89	153.02	52.98	0
KLF2T5665	5665	50yr	26.8	1515.93	1511.33		1511.34	0.000005			0.16		3.27	167.64	51.34	0
KLF2T5665	5665	100yr	35.1	1515.93	1511.49		1511.49	0.000008			0.2		3.4	175.65	51.63	0
KLF2T5625	5625	50yr	26.8	1515.77	1511.33		1511.33	0.000004			0.12		2.76	225.3	81.76	0
KLF2T5625	5625	100yr	35.1	1515.77	1511.49		1511.49	0.000005			0.15		2.86	238.14	83.21	0
KLF2T5578	5578	50yr	26.8	1515.51	1511.33		1511.33	0.000004			0.12		2.67	223.51	83.83	0
KLF2T5578	5578	100yr	35.1	1515.51	1511.49		1511.49	0.000005			0.15		2.8	236.59	84.54	0
KLF2T5537	5537	50yr	26.8	1515.4	1511.33		1511.33	0.000011			0.18		2.15	148.17	69.01	0
KLF2T5537	5537	100yr	35.1	1515.4	1511.49		1511.49	0.000016			0.22		2.23	159.04	71.38	0
KLF2T5495	5495	50yr	26.8	1515.21	1511.33		1511.33	0.000025			0.24		1.74	113.71	65.19	0
KLF2T5495	5495	100yr	35.1	1515.21	1511.49		1511.49	0.000034			0.28		1.83	123.94	67.58	0
KLF2T5455	5455	50yr	26.8	1514.75	1511.32		1511.33	0.000124			0.41		1.23	64.75	52.59	0
KLF2T5455	5455	100yr	35.1	1514.75	1511.47		1511.49	0.000156			0.48		1.3	73	56.12	0
KLF2T5413	5413	50yr	26.8	1514.6	1511.3		1511.32	0.000416			0.63		0.93	42.46	45.52	0
KLF2T5413	5413	100yr	35.1	1514.6	1511.45		1511.47	0.000477			0.71		1	49.43	49.22	0
KLF2T5373	5373	50yr	26.8	1514.55	1511.09		1511.27	0.007645			1.87		0.54	14.31	26.71	0
KLF2T5373	5373	100yr	35.1	1514.55	1511.23		1511.42	0.00678			1.92		0.61	18.25	29.86	0
KLF2T5343	5343	50yr	26.8	1514.23	1511.15		1511.18	0.000627			0.74		0.86	36.33	42.07	0
KLF2T5343	5343	100yr	35.1	1514.23	1511.29		1511.33	0.000709			0.83		0.94	42.36	45.12	0
KLF2T5302	5302	50yr	26.8	1513.98	1511.16		1511.17	0.000071			0.32		1.28	82.93	64.75	0
KLF2T5302	5302	100yr	35.1	1513.98	1511.3		1511.31	0.000091			0.38		1.36	92.22	67.77	0
KLF2T5260	5260	50yr	26.8	1513.46	1511.12		1511.16	0.001137			0.89		0.73	30.03	40.94	0
KLF2T5260	5260	100yr	35.1	1513.46	1511.25		1511.3	0.001234			0.98		0.8	35.65	44.61	0
KLF2T5219	5219	50yr	26.8	1512.76	1510.79	1510.79	1511.03	0.012494			2.19		0.47	12.24	25.82	0

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF2T5219	5219	100yr	35.1	1512.76	1510.9	1510.9	1511.16	0.011812			2.26		0.52	15.53	30.01	0
KLF2T5176	5176	50yr	26.8	1511.96	1509.11	1509.11	1509.33	0.012153			2.11		0.44	12.72	28.67	0
KLF2T5176	5176	100yr	35.1	1511.96	1509.2	1509.2	1509.46	0.011494			2.27		0.52	15.46	29.8	0
KLF2T5143	5143	50yr	26.8	1511.19	1508.9	1508.67	1508.96	0.002817			1.14		0.53	23.48	44.55	0
KLF2T5143	5143	100yr	35.1	1511.19	1509.01	1508.75	1509.09	0.00268			1.22		0.6	28.82	47.68	0
KLF2T5115	5115	50yr	26.8	1510.56	1508.6	1508.6	1508.82	0.012131			2.09		0.44	12.85	29.45	0
KLF2T5115	5115	100yr	35.1	1510.56	1508.69	1508.69	1508.95	0.011387			2.25		0.51	15.58	30.28	0
KLF2T5082	5082	50yr	26.8	1509.66	1508.29	1507.63	1508.32	0.00082			0.83		0.48	32.42	68.17	0
KLF2T5082	5082	100yr	35.1	1509.66	1508.35	1507.75	1508.4	0.001101			0.95		0.5	36.9	74.1	0
KLF2T5036	5036	50yr	31	1508.16	1508.13	1508.13	1508.21	0.015049	1.35		1.05	0.19	0.13	25.14	155.67	0
KLF2T5036	5036	100yr	40.6	1508.16	1508.16	1508.16	1508.26	0.015027	1.47	0.03	1.2	0.22	0.16	29.8	157.55	0.39
KLF2T4993	4993	50yr	31	1506.51	1505.64	1505.64	1505.78	0.014483	1.67			0.27		18.56	68.4	0
KLF2T4993	4993	100yr	40.6	1506.51	1505.7	1505.7	1505.86	0.013197	1.76			0.32		23.03	73.01	0
KLF2T4971	4971	50yr	31	1505.7	1505.09	1505.09	1505.22	0.014225	1.61			0.26		19.31	74.81	0
KLF2T4971	4971	100yr	40.6	1505.7	1505.05	1505.14	1505.35	0.037401	2.44			0.23		16.64	70.98	0
KLF2T4931	4931	50yr	31	1504.44	1504.02	1504.09	1504.25	0.043168	2.12			0.17		14.64	86.36	0
KLF2T4931	4931	100yr	40.6	1504.44	1504.12	1504.14	1504.26	0.017907	1.62			0.22		25.04	113.85	0
KLF2T4883	4883	50yr	31	1503.12	1503.05	1503.05	1503.14	0.016938	1.28			0.16		24.18	150.46	0
KLF2T4883	4883	100yr	40.6	1503.12	1503.06	1503.09	1503.2	0.027621	1.65			0.16		24.56	150.63	0
KLF2T4840	4840	50yr	31	1502.04	1502.14	1502.17	1502.25	0.026525	1.57	1.1	1.06	0.16	0.09	21.79	172.94	1.16
KLF2T4840	4840	100yr	40.6	1502.04	1502.19	1502.2	1502.28	0.016914	1.45	1.18	1	0.19	0.11	31.1	197.99	1
KLF2T4792	4792	50yr	31	1500.9	1501	1501.04	1501.12	0.020767	0.97	0.57	1.64	0.09	0.15	21.45	172.66	0.9
KLF2T4792	4792	100yr	40.6	1500.9	1501.01	1501.06	1501.19	0.031407	1.23	0.78	2.01	0.1	0.15	22.8	182.96	1.14
KLF2T4732	4732	50yr	31	1499.71	1499.22	1499.32	1499.53	0.035655			2.49		0.25	12.47	49.69	0
KLF2T4732	4732	100yr	40.6	1499.71	1499.32	1499.4	1499.58	0.023937			2.27		0.29	17.9	60.74	0
KLF2T4681	4681	50yr	31	1498.65	1497.82	1497.89	1498.08	0.022858			2.26		0.3	13.72	45.11	0
KLF2T4681	4681	100yr	40.6	1498.65	1497.85	1497.96	1498.21	0.029662			2.66		0.32	15.26	47.7	0
KLF2T4629	4629	50yr	31	1497.69	1496.7	1496.76	1496.93	0.020937			2.13		0.3	14.53	48.64	0
KLF2T4629	4629	100yr	40.6	1497.69	1496.79	1496.83	1497.02	0.017335			2.1		0.34	19.34	57.66	0

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF2T4582	4582	50yr	31	1496.43	1495.6	1495.6	1495.76	0.01309			1.79		0.33	17.29	52.96	0
KLF2T4582	4582	100yr	40.6	1496.43	1495.56	1495.67	1495.93	0.032418			2.7		0.3	15.06	49.38	0
KLF2T4535	4535	50yr	31	1495.24	1494.37	1494.37	1494.52	0.013857			1.74		0.3	17.78	59.46	0
KLF2T4535	4535	100yr	40.6	1495.24	1494.44	1494.44	1494.61	0.013113			1.8		0.33	22.57	69.05	0
KLF2T4487	4487	50yr	31	1493.55	1492.94	1493.1	1493.37	0.050142			2.9		0.24	10.68	43.67	0
KLF2T4487	4487	100yr	40.6	1493.55	1492.99	1493.15	1493.46	0.054086			3.03		0.25	13.4	54.4	0
KLF2T4444	4444	50yr	31	1492.29	1491.39	1491.39	1491.51	0.014721			1.53		0.23	20.28	86.74	0
KLF2T4444	4444	100yr	40.6	1492.29	1491.44	1491.44	1491.57	0.014459			1.61		0.26	25.21	98.4	0
KLF2T4399	4399	50yr	31	1490.78	1488.88	1489.17	1490.01	0.098508			4.72		0.31	6.57	21.27	0
KLF2T4399	4399	100yr	40.6	1490.78	1488.96	1489.27	1490.16	0.082703			4.85		0.37	8.36	22.73	0
KLF2T4360	4360	50yr	31	1489.51	1488.56	1488.56	1488.69	0.014543			1.6		0.25	19.4	77.33	0
KLF2T4360	4360	100yr	40.6	1489.51	1488.61	1488.62	1488.76	0.013854			1.73		0.29	23.45	79.98	0
KLF2T4317	4317	50yr	31	1488.18	1486.59	1486.59	1486.75	0.013448			1.8		0.32	17.21	53.36	0
KLF2T4317	4317	100yr	40.6	1488.18	1486.67	1486.67	1486.84	0.01313			1.86		0.34	21.86	63.6	0
KLF2T4277	4277	50yr	31	1486.68	1484.56	1484.83	1485.53	0.088462			4.36		0.3	7.11	23.73	0
KLF2T4277	4277	100yr	40.6	1486.68	1484.64	1484.93	1485.67	0.07807			4.5		0.35	9.02	26.12	0
KLF2T4245	4245	50yr	31	1485.61	1483.11	1483.11	1483.32	0.012315			2.05		0.42	15.12	36.01	0
KLF2T4245	4245	100yr	40.6	1485.61	1483.2	1483.2	1483.44	0.011726			2.2		0.49	18.43	37.91	0
KLF2T4215	4215	50yr	31	1484.61	1482	1482	1482.19	0.012378			1.93		0.37	16.09	42.94	0
KLF2T4215	4215	100yr	40.6	1484.61	1482.08	1482.08	1482.29	0.011938			2.01		0.41	20.15	48.96	0
KLF2T4184	4184	50yr	31	1483.64	1480.8	1480.97	1481.38	0.059376			3.38		0.27	9.17	34.15	0
KLF2T4184	4184	100yr	40.6	1483.64	1480.86	1481.06	1481.52	0.055261			3.6		0.31	11.28	36.17	0
KLF2T4154	4154	50yr	31	1482.78	1480.54	1480.54	1480.73	0.01248			1.91		0.37	16.21	43.99	0
KLF2T4154	4154	100yr	40.6	1482.78	1480.63	1480.63	1480.83	0.012144			2		0.4	20.31	50.56	0
KLF2T4112	4112	50yr	31	1481.69	1479.48	1479.48	1479.66	0.012706			1.9		0.36	16.3	45.24	0
KLF2T4112	4112	100yr	40.6	1481.69	1479.56	1479.56	1479.77	0.012073			2.03		0.41	20.04	48.7	0
KLF2T4053	4053	50yr	31	1479.74	1477.97	1477.97	1478.15	0.012796			1.88		0.35	16.45	46.53	0
KLF2T4053	4053	100yr	40.6	1479.74	1478.05	1478.05	1478.25	0.012172			2		0.4	20.27	50.4	0
KLF2T3991	3991	50yr	40.6	1478.04	1476.49	1476.59	1476.85	0.027913			2.64		0.33	15.36	46.99	0

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF2T3991	3991	100yr	53.1	1478.04	1476.56	1476.68	1476.98	0.028029			2.87		0.37	18.47	49.95	0
KLF2T3939	3939	50yr	40.6	1476.99	1475.4	1475.4	1475.6	0.012241			2.01		0.4	20.23	50.39	0
KLF2T3939	3939	100yr	53.1	1476.99	1475.49	1475.49	1475.72	0.011636			2.12		0.45	25.04	55.23	0
KLF2T3884	3884	50yr	40.6	1476.41	1473.92	1473.92	1474.12	0.01241			1.95		0.38	20.81	54.62	0
KLF2T3884	3884	100yr	53.1	1476.41	1474.01	1474.01	1474.23	0.011943			2.06		0.43	25.72	60.26	0
KLF2T3837	3837	50yr	40.6	1475.85	1472.79	1472.79	1472.99	0.01238			1.97		0.39	20.62	53.28	0
KLF2T3837	3837	100yr	53.1	1475.85	1472.88	1472.88	1473.1	0.011749			2.1		0.44	25.25	56.82	0
KLF2T3794	3794	50yr	40.6	1475.01	1472.03	1472.02	1472.21	0.012056			1.89		0.37	21.53	58.18	0
KLF2T3794	3794	100yr	53.1	1475.01	1472.1	1472.1	1472.32	0.012016			2.07		0.43	25.61	59.91	0
KLF2T3748	3748	50yr	40.6	1474.46	1471.46	1471.46	1471.65	0.012437			1.92		0.37	21.14	56.88	0
KLF2T3748	3748	100yr	53.1	1474.46	1471.54	1471.54	1471.76	0.012455			2.09		0.42	25.37	60.06	0
KLF2T3702	3702	50yr	40.6	1473.43	1470.57	1470.65	1470.89	0.02196			2.51		0.36	16.2	44.77	0
KLF2T3702	3702	100yr	53.1	1473.43	1470.74	1470.74	1470.98	0.011639			2.16		0.47	24.58	52.74	0
KLF2T3655	3655	50yr	40.6	1472.51	1470.18	1470.07	1470.31	0.006025			1.61		0.49	25.21	51.3	0
KLF2T3655	3655	100yr	53.1	1472.51	1470.26	1470.16	1470.42	0.006595			1.81		0.55	29.26	53.28	0
KLF2T3616	3616	50yr	40.6	1471.76	1469.8	1469.8	1469.97	0.012793			1.86		0.35	21.77	62.59	0
KLF2T3616	3616	100yr	53.1	1471.76	1469.87	1469.87	1470.07	0.012284			2.01		0.4	26.36	65.42	0
KLF2T3569	3569	50yr	40.6	1471.14	1469.05	1469.07	1469.26	0.014289			2.04		0.37	19.86	54.01	0
KLF2T3569	3569	100yr	53.1	1471.14	1469.12	1469.15	1469.37	0.014479			2.23		0.41	23.84	57.62	0
KLF2T3527	3527	50yr	40.6	1470.58	1468.45	1468.45	1468.66	0.012295			2.04		0.41	19.92	48.54	0
KLF2T3527	3527	100yr	53.1	1470.58	1468.56	1468.56	1468.77	0.011757			2.06		0.43	25.79	59.86	0
KLF2T3480	3480	50yr	40.6	1470.32	1467.88	1467.85	1468.08	0.00993			1.99		0.46	20.42	43.98	0
KLF2T3480	3480	100yr	53.1	1470.32	1467.97	1467.95	1468.21	0.010187			2.16		0.52	24.58	47.65	0
KLF2T3428	3428	50yr	40.6	1469.58	1467.29	1467.29	1467.53	0.01165			2.16		0.47	18.8	40.41	0
KLF2T3428	3428	100yr	53.1	1469.58	1467.4	1467.4	1467.66	0.011173			2.29		0.52	23.24	44.45	0
KLF2T3380	3380	50yr	40.6	1468.95	1466.53	1466.53	1466.76	0.011828			2.11		0.44	19.23	43.26	0
KLF2T3380	3380	100yr	53.1	1468.95	1466.63	1466.63	1466.89	0.011287			2.24		0.5	23.72	47.18	0
KLF2T3334	3334	50yr	40.6	1468.39	1465.91	1465.81	1466.06	0.006307			1.67		0.5	24.32	48.54	0
KLF2T3334	3334	100yr	53.1	1468.39	1465.8	1465.91	1466.2	0.020634			2.79		0.44	19.06	42.94	0

HecRas Output Table

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			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF2T3286	3286	50yr	44.3	1467.91	1465.74		1465.83	0.003438			1.31		0.55	33.94	62.16	0
KLF2T3286	3286	100yr	57.9	1467.91	1465.83	1465.62	1465.94	0.003766			1.46		0.6	39.72	66	0
KLF2T3246	3246	50yr	44.3	1467.5	1465.68		1465.72	0.001654			0.92		0.56	47.99	85.35	0
KLF2T3246	3246	100yr	57.9	1467.5	1465.76		1465.82	0.001824			1.04		0.63	55.58	88.75	0
KLF2T3200	3200	50yr	44.3	1467.17	1465.61		1465.65	0.001392			0.83		0.55	53.24	97.27	0
KLF2T3200	3200	100yr	57.9	1467.17	1465.7		1465.74	0.001549			0.95		0.61	61.23	100.04	0
KLF2T3147	3147	50yr	44.3	1467	1465.54		1465.58	0.001555			0.82		0.5	53.77	108.34	0
KLF2T3147	3147	100yr	57.9	1467	1465.61		1465.66	0.001721			0.94		0.56	61.77	110.65	0
KLF2T3098	3098	50yr	44.3	1466.51	1465.46		1465.5	0.002058			0.86		0.43	51.49	119.95	0
KLF2T3098	3098	100yr	57.9	1466.51	1465.53		1465.58	0.002245			0.98		0.49	59.35	122.22	0
KLF2T3063	3063	50yr	44.3	1465.91	1465.24	1465.24	1465.35	0.014306			1.49		0.23	29.66	129.39	0
KLF2T3063	3063	100yr	57.9	1465.91	1465.28	1465.28	1465.42	0.013922			1.64		0.27	35.23	130.43	0
KLF2T3026	3026	50yr	44.3	1463	1463.76	1464.01	1464.52	0.033262		3.86				11.48	22.57	1.73
KLF2T3026	3026	100yr	57.9	1463	1463.91	1464.15	1464.67	0.027645		3.87				14.96	25.51	1.61
KLF2T2974	2974	50yr	44.3	1461.47	1461.93	1462.11	1462.53	0.042682	1.34	3.45		0.09		13.05	39.68	1.85
KLF2T2974	2974	100yr	57.9	1461.47	1461.97	1462.21	1462.77	0.050566	1.7	3.99		0.11		14.82	41.62	2.04
KLF2T2933	2933	50yr	44.3	1460.5	1461.55	1461.56	1461.84	0.0073	1.48	2.67	1.37	0.38	0.33	20.91	38.86	0.89
KLF2T2933	2933	100yr	57.9	1460.5	1461.66	1461.68	1461.99	0.007475	1.65	2.91	1.55	0.43	0.39	25.44	42.68	0.92
KLF2T2890	2890	50yr	44.3	1460	1460.83	1460.98	1461.34	0.01868	1.37	3.2	1.02	0.17	0.11	14.7	32.64	1.33
KLF2T2890	2890	100yr	57.9	1460	1460.94	1461.11	1461.5	0.016894	1.58	3.41	1.28	0.22	0.16	18.54	36.85	1.3
KLF2T2841	2841	50yr	44.3	1459.5	1460.26	1460.29	1460.57	0.011529	0.76	2.46	0.93	0.1	0.13	18.63	39.17	1.04
KLF2T2841	2841	100yr	57.9	1459.5	1460.33	1460.41	1460.73	0.01304	1	2.83	1.15	0.13	0.17	21.47	41.65	1.13
KLF2T2790	2790	50yr	44.3	1459	1459.68	1459.72	1459.98	0.011718	1.01	2.48	1.11	0.15	0.17	18.88	41.02	1.05
KLF2T2790	2790	100yr	57.9	1459	1459.79	1459.83	1460.12	0.010451	1.18	2.64	1.28	0.2	0.23	23.66	44.73	1.02
KLF2T2737	2737	50yr	44.3	1458.5	1459.06	1459.08	1459.31	0.012875	0.34	2.28	1.15	0.03	0.17	20	47.89	1.06
KLF2T2737	2737	100yr	57.9	1458.5	1459.11	1459.18	1459.46	0.01522	0.58	2.66	1.42	0.05	0.2	22.54	49.51	1.18
KLF2T2686	2686	50yr	44.3	1457.5	1458.12	1458.22	1458.51	0.019472	0.72	2.76	0.72	0.06	0.06	16.27	39.52	1.3
KLF2T2686	2686	100yr	57.9	1457.5	1458.23	1458.33	1458.65	0.016463	1	2.9	1	0.11	0.11	20.55	43.3	1.24
KLF2T2637	2637	50yr	44.3	1457.12	1457.8	1457.8	1458.04	0.009038	1.2	2.26	1.15	0.23	0.22	21.58	47.15	0.93

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF2T2637	2637	100yr	57.9	1457.12	1457.9	1457.9	1458.17	0.008524	1.33	2.44	1.29	0.28	0.27	26.62	51.21	0.93
KLF2T2584	2584	50yr	44.3	1456	1456.75	1456.9	1457.26	0.025935		3.15				14.07	31.25	1.5
KLF2T2584	2584	100yr	57.9	1456	1456.85	1457.02	1457.42	0.025217	0.31	3.37		0.01		17.21	34.53	1.51
KLF2T2541	2541	50yr	44.3	1455	1456.22	1456.24	1456.55	0.01187	0.51	2.55		0.05		17.5	32.05	1.06
KLF2T2541	2541	100yr	57.9	1455	1456.36	1456.37	1456.71	0.009582	0.81	2.63	0.42	0.12	0.05	22.62	37.4	0.98
KLF2T2498	2498	50yr	44.3	1454.5	1455.59	1455.67	1455.97	0.0155	0.52	2.74	0.78	0.04	0.08	16.34	33.42	1.19
KLF2T2498	2498	100yr	57.9	1454.5	1455.66	1455.78	1456.16	0.017463	0.81	3.15	1.06	0.08	0.12	18.74	35.35	1.29
KLF2T2468	2468	50yr	44.3	1454.5	1455.36	1455.36	1455.64	0.010077	0.06	2.36	1.07	0	0.18	19.27	36.17	0.98
KLF2T2468	2468	100yr	57.9	1454.5	1455.48	1455.48	1455.8	0.009162	0.47	2.54	1.23	0.06	0.24	23.76	40.21	0.96
KLF2T2435	2435	50yr	67.4	1454	1454.81	1454.9	1455.23	0.013547	1.11	2.95	1.67	0.15	0.28	24.41	45.83	1.16
KLF2T2435	2435	100yr	87.6	1454	1454.92	1455.03	1455.41	0.013029	1.34	3.21	1.85	0.21	0.34	29.67	49.39	1.16
KLF2T2389	2389	50yr	67.4	1453	1454.24	1454.33	1454.64	0.011792	0.98	2.99	1.69	0.14	0.32	25.84	50.59	1.1
KLF2T2389	2389	100yr	87.6	1453	1454.33	1454.45	1454.82	0.012538	1.24	3.32	1.98	0.19	0.39	30.59	53.94	1.15
KLF2T2339	2339	50yr	67.4	1452.5	1453.62	1453.69	1453.98	0.014473		2.77	1.62		0.26	25.78	52.12	1.16
KLF2T2339	2339	100yr	87.6	1452.5	1453.72	1453.8	1454.14	0.013981	0.32	2.98	1.82	0.02	0.31	31.31	56.28	1.17
KLF2T2296	2296	50yr	67.4	1452.5	1453.18	1453.19	1453.46	0.009708	1.17	2.43	1.38	0.21	0.27	29.72	57.13	0.97
KLF2T2296	2296	100yr	87.6	1452.5	1453.27	1453.3	1453.62	0.010175	1.37	2.71	1.6	0.26	0.33	34.89	59.45	1.02
KLF2T2249	2249	50yr	67.4	1451.62	1452.34	1452.47	1452.8	0.020859	1.27	3	0.48	0.14	0.03	22.97	52.46	1.37
KLF2T2249	2249	100yr	87.6	1451.62	1452.44	1452.58	1452.96	0.019032	1.49	3.23	0.85	0.18	0.08	28.19	57	1.34
KLF2T2221	2221	50yr	67.4	1451.35	1452.06	1452.09	1452.35	0.012817	0.61	2.36	0.52	0.06	0.05	28.8	62.15	1.07
KLF2T2221	2221	100yr	87.6	1451.35	1452.17	1452.19	1452.49	0.01127	0.86	2.51	0.78	0.12	0.1	35.49	65.78	1.04
KLF2T2174	2174	50yr	67.4	1450.5	1451.29	1451.37	1451.66	0.016653	0.35	2.71	0.76	0.02	0.07	25.1	54.4	1.22
KLF2T2174	2174	100yr	87.6	1450.5	1451.37	1451.48	1451.83	0.017187	0.7	3.03	1.01	0.06	0.11	29.48	58.46	1.27
KLF2T2128	2128	50yr	67.4	1450.08	1450.83	1450.84	1451.07	0.009111	1.1	2.27	1.08	0.2	0.2	33.29	78.19	0.93
KLF2T2128	2128	100yr	87.6	1450.08	1450.91	1450.94	1451.2	0.009686	1.29	2.53	1.28	0.25	0.24	39.39	83.37	0.98
KLF2T2083	2083	50yr	67.4	1449.52	1450.14	1450.23	1450.5	0.017818	1.41	2.72	1.19	0.18	0.14	26.81	72.28	1.26
KLF2T2083	2083	100yr	87.6	1449.52	1450.22	1450.33	1450.62	0.016483	1.61	2.91	1.36	0.23	0.18	33.06	77.63	1.24
KLF2T2042	2042	50yr	67.4	1449.17	1449.81	1449.81	1450.02	0.009885	1.26	2.11	0.97	0.23	0.16	34.69	86.49	0.94
KLF2T2042	2042	100yr	87.6	1449.17	1449.9	1449.9	1450.14	0.009216	1.38	2.26	1.11	0.28	0.2	42.6	92.82	0.94

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF2T2008	2008	50yr	67.4	1448.51	1449.17	1449.28	1449.57	0.016889	1.58	2.96	1.43	0.22	0.19	26.22	68.25	1.26
KLF2T2008	2008	100yr	87.6	1448.51	1449.26	1449.39	1449.7	0.016317	1.72	3.19	1.61	0.26	0.23	32.33	75.91	1.26
KLF2T1961	1961	50yr	67.4	1447.5	1448.21	1448.35	1448.68	0.020109	1.84	3.17	1.18	0.24	0.12	23.21	55.33	1.36
KLF2T1961	1961	100yr	87.6	1447.5	1448.3	1448.46	1448.85	0.019566	2.03	3.45	1.42	0.29	0.17	28.24	60.21	1.38
KLF2T1929	1929	50yr	67.4	1447.27	1448.02	1448.02	1448.27	0.00948	1.2	2.28	1.09	0.23	0.2	31.79	67.56	0.95
KLF2T1929	1929	100yr	87.6	1447.27	1448.12	1448.12	1448.41	0.008848	1.31	2.45	1.23	0.27	0.25	39.05	73.12	0.94
KLF2T1902	1902	50yr	67.4	1447	1447.67	1447.72	1447.98	0.012736	1.25	2.56	1.3	0.19	0.2	28.49	64.87	1.09
KLF2T1902	1902	100yr	87.6	1447	1447.75	1447.82	1448.12	0.01286	1.45	2.82	1.49	0.24	0.25	34.06	68.99	1.12
KLF2T1878	1878	50yr	67.4	1446.54	1447.18	1447.29	1447.59	0.019791	1.34	2.87	0.94	0.15	0.09	24.65	63.15	1.32
KLF2T1878	1878	100yr	87.6	1446.54	1447.26	1447.4	1447.73	0.018973	1.55	3.12	1.18	0.2	0.13	30.01	68.52	1.33
KLF2T1841	1841	50yr	67.4	1446	1446.79	1446.74	1446.99	0.006819	0.83	2.04	0.99	0.17	0.21	35.65	72.56	0.81
KLF2T1841	1841	100yr	87.6	1446	1446.77	1446.84	1447.14	0.012769	1.09	2.74	1.3	0.16	0.2	34.38	71.59	1.11
KLF2T1816	1816	50yr	67.4	1446	1446.56	1446.56	1446.78	0.010218	0.66	2.12	1.08	0.09	0.18	33.16	77.98	0.96
KLF2T1816	1816	100yr	87.6	1446	1446.65	1446.65	1446.91	0.009619	0.85	2.29	1.25	0.13	0.24	40.31	82.47	0.95
KLF2T1779	1779	50yr	67.4	1445.5	1446.23	1446.06	1446.34	0.003706	0.87	1.57	0.72	0.28	0.21	46.51	87.53	0.61
KLF2T1779	1779	100yr	87.6	1445.5	1446.32	1446.16	1446.46	0.003926	0.99	1.76	0.85	0.33	0.26	54.74	93.02	0.64
KLF2T1736	1736	50yr	67.4	1445.5	1445.96		1446.11	0.007991	1.54	1.75	0.98	0.37	0.19	39.27	91.02	0.83
KLF2T1736	1736	100yr	87.6	1445.5	1446.04		1446.22	0.007896	1.55	1.94	1	0.37	0.2	46.65	94.71	0.85
KLF2T1701	1701	50yr	67.4	1444.84	1445.56	1445.56	1445.8	0.009327	1.25	2.27	0.97	0.24	0.16	31.99	69.46	0.94
KLF2T1701	1701	100yr	87.6	1444.84	1445.67	1445.67	1445.94	0.008071	1.32	2.38	0.9	0.29	0.15	41.35	89.85	0.9
KLF2T1663	1663	50yr	67.4	1444.5	1444.99	1445.07	1445.31	0.018239	1.05	2.65	1.63	0.11	0.22	28.02	80.43	1.26
KLF2T1663	1663	100yr	87.6	1444.5	1445.04	1445.16	1445.46	0.020858	1.28	3.04	1.9	0.14	0.25	32.07	84.1	1.37
KLF2T1631	1631	50yr	67.4	1444.02	1444.73	1444.71	1444.92	0.007735	1.28	2.15	1.28	0.29	0.29	37.55	88.39	0.87
KLF2T1631	1631	100yr	87.6	1444.02	1444.8	1444.8	1445.03	0.008354	1.45	2.4	1.46	0.33	0.33	44.04	93.43	0.92
KLF2T1563	1563	50yr	67.4	1443.53	1444.12	1444.12	1444.32	0.01009	1.17	2.05	0.97	0.21	0.16	35.44	92.84	0.95
KLF2T1563	1563	100yr	87.6	1443.53	1444.2	1444.2	1444.43	0.009409	1.32	2.21	1.11	0.26	0.2	43.43	98.66	0.94
KLF2T1513	1513	50yr	67.4	1443	1443.63	1443.63	1443.83	0.009673	1.32	2.16	1.15	0.26	0.21	35.96	94.33	0.94
KLF2T1513	1513	100yr	87.6	1443	1443.69	1443.71	1443.94	0.010245	1.51	2.41	1.31	0.3	0.24	42.42	99.92	0.99
KLF2T1464	1464	50yr	67.4	1442.5	1443.15	1443.08	1443.3	0.005912	0.93	1.8	1.02	0.22	0.25	41.51	93.06	0.75

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF2T1464	1464	100yr	87.6	1442.5	1443.22	1443.16	1443.41	0.006397	1.08	2.02	1.17	0.26	0.29	48.5	98.24	0.79
KLF2T1428	1428	50yr	67.4	1442.31	1442.81	1442.81	1443	0.011241	0.71	2	1.44	0.09	0.26	35.59	97.24	0.98
KLF2T1428	1428	100yr	87.6	1442.31	1442.89	1442.89	1443.11	0.010401	0.89	2.15	1.55	0.13	0.31	43.42	102.37	0.97
KLF2T1383	1383	50yr	67.4	1441.62	1442.23	1442.26	1442.47	0.012001	1.02	2.28	1.35	0.15	0.22	32.58	86.34	1.04
KLF2T1383	1383	100yr	87.6	1441.62	1442.3	1442.35	1442.59	0.012561	1.2	2.54	1.54	0.18	0.26	38.49	91.5	1.08
KLF2T1337	1337	50yr	67.4	1440.5	1441.26	1441.39	1441.7	0.024265	0.26	3.01	1.81	0.01	0.21	23.68	62.7	1.45
KLF2T1337	1337	100yr	87.6	1440.5	1441.35	1441.49	1441.83	0.021687	0.7	3.2	1.95	0.05	0.25	29.34	68.86	1.41
KLF2T1290	1290	50yr	67.4	1439.38	1440.6	1440.62	1440.9	0.011666	0.4	2.44	0.44	0.04	0.04	27.84	56.76	1.04
KLF2T1290	1290	100yr	87.6	1439.38	1440.68	1440.75	1441.06	0.012273	0.7	2.74	0.7	0.08	0.08	32.83	64.19	1.09
KLF2T1252	1252	50yr	67.4	1439	1439.82	1439.95	1440.29	0.022141	1.38	3.08		0.15		22.84	54.78	1.4
KLF2T1252	1252	100yr	87.6	1439	1439.9	1440.06	1440.44	0.021199	1.66	3.31	0.38	0.2	0.02	27.88	59.57	1.41
KLF2T1220	1220	50yr	67.4	1438.8	1439.35	1439.42	1439.64	0.015609	1.29	2.55	1.64	0.17	0.25	30.62	92.48	1.18
KLF2T1220	1220	100yr	87.6	1438.8	1439.4	1439.5	1439.76	0.017787	1.54	2.91	1.89	0.2	0.28	35.24	96.51	1.28
KLF2T1190	1190	50yr	67.4	1438	1438.68	1438.79	1439.06	0.022335	1.34	2.79	0.67	0.14	0.05	25.15	71.16	1.38
KLF2T1190	1190	100yr	87.6	1438	1438.76	1438.88	1439.19	0.019814	1.52	2.97	0.95	0.18	0.09	31.32	77.43	1.34
KLF2T1150	1150	50yr	67.4	1437	1438.41	1437.99	1438.46	0.001156	0.82	1.21	0.75	0.62	0.54	69.66	95.75	0.37
KLF2T1150	1150	100yr	87.6	1437	1438.67	1438.08	1438.71	0.000793	0.78	1.16	0.74	0.76	0.7	96.34	108.65	0.32
KLF2T1101	1101	50yr	67.4	1436.47	1438.43		1438.44	0.000046	0.25	0.34	0.2	1.12	0.83	235.3	180.82	0.08
KLF2T1101	1101	100yr	87.6	1436.47	1438.69		1438.69	0.000046	0.27	0.38	0.23	1.27	0.99	283.21	193.26	0.08
KLF2T1056	1056	50yr	67.4	1435.51	1438.43		1438.44	0.000011	0.15	0.22	0.13	1.67	1.33	396.55	221.06	0.04
KLF2T1056	1056	100yr	87.6	1435.51	1438.69		1438.69	0.000013	0.18	0.25	0.15	1.82	1.43	454.93	235.82	0.05
KLF2T1014	1014	50yr	67.4	1435	1438.44		1438.44	0.000005	0.11	0.16	0.09	1.91	1.46	531.33	251.86	0.03
KLF2T1014	1014	100yr	87.6	1435	1438.69		1438.69	0.000006	0.13	0.19	0.11	2.01	1.6	597.64	266.79	0.03
KLF2T993	993	50yr	67.4	1434.68	1438.44	1435.32	1438.44	0.000004	0.1	0.15	0.1	2.09	1.88	596.98	269.78	0.03
KLF2T993	993	100yr	87.6	1434.68	1438.69	1435.4	1438.69	0.000005	0.12	0.18	0.11	2.21	2.02	667.9	284.7	0.03
KLF2T973	973		Culvert													
KLF2T938	938	50yr	67.4	1434	1434.7	1434.7	1434.92	0.008445	1.22	2.22	1.26	0.25	0.26	35.25	82.41	0.9
KLF2T938	938	100yr	87.6	1434	1434.79	1434.79	1435.04	0.008379	1.39	2.42	1.42	0.31	0.32	42.61	87.66	0.92
KLF2T916	916	50yr	67.4	1433.73	1434.26	1434.36	1434.62	0.020394	1.93	2.85	1.23	0.26	0.13	26.45	74.05	1.34

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF2T916	916	100yr	87.6	1433.73	1434.34	1434.45	1434.75	0.019156	2.09	3.07	1.44	0.31	0.17	32.35	78.84	1.33
KLF2T892	892	50yr	67.4	1433.36	1434.02	1434.03	1434.25	0.00994	1.56	2.32	1.17	0.32	0.21	33.35	77.51	0.97
KLF2T892	892	100yr	87.6	1433.36	1434.1	1434.12	1434.38	0.010366	1.73	2.57	1.34	0.36	0.25	39.48	82.28	1.01
KLF2T845	845	50yr	67.4	1432.51	1433.19	1433.31	1433.6	0.018724	1.66	2.97	1.31	0.22	0.15	24.88	62.44	1.31
KLF2T845	845	100yr	87.6	1432.51	1433.28	1433.41	1433.74	0.01706	1.86	3.16	1.5	0.28	0.2	30.9	67.26	1.28
KLF2T806	806	50yr	67.4	1432	1432.93	1432.93	1433.19	0.008537	1.02	2.29	0.89	0.19	0.16	32.24	69.96	0.91
KLF2T806	806	100yr	87.6	1432	1433.05	1433.05	1433.32	0.007704	1.19	2.42	1.05	0.26	0.21	40.61	77.52	0.89
KLF2T770	770	50yr	67.4	1431.5	1432.43	1432.51	1432.79	0.013101	0.83	2.68	0.91	0.1	0.12	26.38	58.69	1.11
KLF2T770	770	100yr	87.6	1431.5	1432.53	1432.63	1432.95	0.012988	1.09	2.94	1.13	0.15	0.16	32.12	65.42	1.14
KLF2T734	734	50yr	67.4	1431	1432.09	1432.15	1432.4	0.008849	1.41	2.84	1.31	0.3	0.27	31.56	71.17	0.98
KLF2T734	734	100yr	87.6	1431	1432.17	1432.26	1432.54	0.009712	1.66	3.16	1.5	0.36	0.31	37.34	76.06	1.04
KLF2T697	697	50yr	67.4	1430.5	1431.3	1431.49	1431.87	0.022146	1.34	3.43	1.11	0.14	0.11	21.45	54.73	1.44
KLF2T697	697	100yr	87.6	1430.5	1431.41	1431.6	1432.01	0.019413	1.6	3.59	1.35	0.2	0.16	27.66	63.12	1.39
KLF2T652	652	50yr	67.4	1430.41	1431.02	1431.02	1431.25	0.009529	1.16	2.21	1.33	0.21	0.26	33.42	76.04	0.94
KLF2T652	652	100yr	87.6	1430.41	1431.11	1431.11	1431.38	0.009174	1.29	2.4	1.46	0.26	0.31	40.62	81.71	0.95
KLF2T603	603	50yr	67.4	1429.5	1430.23	1430.34	1430.62	0.017453	1.75	2.95	1.37	0.25	0.17	26.29	68.24	1.27
KLF2T603	603	100yr	87.6	1429.5	1430.31	1430.44	1430.76	0.017351	1.97	3.21	1.57	0.3	0.21	31.77	72.97	1.3
KLF2T570	570	50yr	67.4	1429	1429.78	1429.86	1430.12	0.012543	1.72	2.89	1.49	0.31	0.25	28.28	64.14	1.12
KLF2T570	570	100yr	87.6	1429	1429.87	1429.97	1430.27	0.012339	1.88	3.12	1.66	0.36	0.3	34.58	70.23	1.13
KLF2T543	543	50yr	67.4	1428.34	1429.14	1429.31	1429.68	0.019769	1.86	3.45	1.38	0.25	0.16	22.29	51.49	1.39
KLF2T543	543	100yr	87.6	1428.34	1429.24	1429.43	1429.84	0.018369	2.07	3.68	1.6	0.31	0.21	27.79	56.68	1.37
KLF2T504	504	50yr	67.4	1427.5	1428.64	1428.74	1429.05	0.012197	1.68	3.03	1.23	0.31	0.19	25.62	50.98	1.12
KLF2T504	504	100yr	87.6	1427.5	1428.74	1428.86	1429.22	0.012503	1.87	3.33	1.49	0.36	0.25	30.89	55.48	1.15
KLF2T466	466	50yr	67.4	1427.5	1428.19	1428.27	1428.55	0.013282	1.7	2.86	1.66	0.29	0.29	27.18	58.93	1.14
KLF2T466	466	100yr	87.6	1427.5	1428.27	1428.38	1428.7	0.013891	1.9	3.17	1.88	0.34	0.33	32.26	63.03	1.19
KLF2T423	423	50yr	67.4	1427	1427.57	1427.65	1427.91	0.01658	1.66	2.73	1.53	0.24	0.21	26.99	66.91	1.22
KLF2T423	423	100yr	87.6	1427	1427.64	1427.75	1428.06	0.016502	1.84	3	1.73	0.28	0.26	32.32	70.62	1.25
KLF2T380	380	50yr	67.4	1426	1426.76	1426.87	1427.17	0.017342	0.95	2.97	1.84	0.1	0.27	25.15	59.82	1.27
KLF2T380	380	100yr	87.6	1426	1426.85	1426.98	1427.32	0.016915	1.19	3.22	2.06	0.14	0.33	30.49	64.3	1.28

HecRas Output Table

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			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF2T338	338	50yr	67.4	1425	1426.17	1426.26	1426.57	0.012089	1.29	2.92	1.31	0.21	0.21	25.88	53.04	1.1
KLF2T338	338	100yr	87.6	1425	1426.27	1426.38	1426.73	0.011849	1.49	3.17	1.52	0.26	0.27	31.76	58.49	1.12
KLF2T296	296	50yr	67.4	1424.5	1425.63	1425.73	1426.05	0.012256	1.18	2.99	1.4	0.18	0.23	24.87	48.16	1.12
KLF2T296	296	100yr	87.6	1424.5	1425.74	1425.86	1426.23	0.011957	1.4	3.24	1.61	0.24	0.29	30.52	53.25	1.13
KLF2T262	262	50yr	67.4	1424	1425.19	1425.3	1425.66	0.010977	1.21	3.11	0.92	0.21	0.13	23.87	43.93	1.08
KLF2T262	262	100yr	87.6	1424	1425.32	1425.45	1425.84	0.010598	1.42	3.36	1.2	0.27	0.21	29.97	51.12	1.09
KLF2T224	224	50yr	67.4	1423.5	1424.52	1424.72	1425.11	0.018566	1.77	3.8	1.8	0.24	0.25	22.71	55.54	1.38
KLF2T224	224	100yr	87.6	1423.5	1424.6	1424.83	1425.29	0.019782	2.02	4.19	2.09	0.28	0.3	27.38	61.29	1.45
KLF2T193	193	50yr	67.4	1423.34	1423.77	1423.92	1424.2	0.044141	2.05	3.35	2.55	0.15	0.22	24.45	109.77	1.86
KLF2T193	193	100yr	87.6	1423.34	1423.81	1423.97	1424.33	0.046242	2.32	3.7	2.83	0.18	0.25	28.9	114.57	1.94
KLF2T154	154	50yr	67.4	1422.13	1422.52	1422.6	1422.81	0.030436	2.43	1.95		0.27		28.35	109.12	1.41
KLF2T154	154	100yr	87.6	1422.13	1422.57	1422.67	1422.92	0.029854	2.68	2.18	0.15	0.32	0	33.47	110.84	1.44
KLF2T115	115	50yr	67.4	1422.05	1422.27	1422.26	1422.39	0.010417	1.58	1.06	1.11	0.32	0.19	45.34	162.98	0.81
KLF2T115	115	100yr	87.6	1422.05	1422.31	1422.31	1422.46	0.012021	1.82	1.28	1.3	0.35	0.21	51.12	164.52	0.9
KLF2T71	71	50yr	67.4	1421.41	1421.83	1421.83	1421.96	0.01175	1.31	1.96	1.71	0.22	0.33	43.84	165.01	0.99
KLF2T71	71	100yr	87.6	1421.41	1422.23	1421.88	1422.26	0.000914	0.66	0.87	0.77	0.54	0.66	122.73	208.67	0.31
KLF2T31	31	50yr	67.4	1420.94	1421.37	1421.37	1421.53	0.010923	1.08	1.84	1.86	0.17	0.39	40.61	137.65	0.95
KLF2T31	31	100yr	87.6	1420.94	1422.23		1422.24	0.000177	0.43	0.51	0.5	0.96	1.21	186.96	173.34	0.15
KLF1T2190	2190	50yr	67.4	1475.91	1476.41	1476.57	1476.9	0.028615	1.44	3.17	1.4	0.13	0.12	23	72.07	1.56
KLF1T2190	2190	100yr	87.6	1475.91	1476.48	1476.66	1477.05	0.028623	1.66	3.48	1.65	0.16	0.16	27.75	77.98	1.6
KLF1T2150	2150	50yr	67.4	1474.85	1475.33	1475.45	1475.75	0.027961	1.36	2.98	1.65	0.12	0.16	24.72	81.94	1.52
KLF1T2150	2150	100yr	87.6	1474.85	1475.38	1475.54	1475.88	0.028294	1.63	3.28	1.84	0.16	0.19	29.57	87.39	1.57
KLF1T2079	2079	50yr	67.4	1473.17	1473.61	1473.69	1473.91	0.02281	0.13	2.53	1.77	0	0.21	28.59	93.36	1.35
KLF1T2079	2079	100yr	87.6	1473.17	1473.67	1473.76	1474.02	0.022849	0.51	2.79	1.92	0.03	0.24	34.01	99.4	1.39
KLF1T2023	2023	50yr	67.4	1471.83	1472.26	1472.36	1472.58	0.025171		2.55	1.6		0.17	27.87	94.98	1.41
KLF1T2023	2023	100yr	87.6	1471.83	1472.32	1472.44	1472.69	0.025303		2.78	1.79		0.2	33.39	101.05	1.44
KLF1T1971	1971	50yr	67.4	1469.12	1469.49	1469.72	1470.34	0.081161		4.12	1.95		0.09	17.02	68.66	2.46
KLF1T1971	1971	100yr	87.6	1469.12	1469.55	1469.81	1470.49	0.075217		4.38	2.3		0.13	21.01	73.73	2.43
KLF1T1851	1851	50yr	67.4	1466.41	1466.93	1466.94	1467.13	0.01199	0.8	2.05	0.95	0.1	0.13	34.73	101.5	1.01
KLF1T1851	1851	100yr	87.6	1466.41	1466.99	1467.03	1467.24	0.012516	0.97	2.29	1.1	0.13	0.16	41.03	108.4	1.05

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF1T1792	1792	50yr	67.4	1464.85	1465.16	1465.34	1465.75	0.061859	0.77	3.49	2.02	0.03	0.12	20.18	84.58	2.13
KLF1T1792	1792	100yr	87.6	1464.85	1465.21	1465.41	1465.88	0.05467	1.09	3.71	2.22	0.05	0.15	24.95	89.75	2.07
KLF1T1715	1715	50yr	67.4	1461.92	1462.48	1462.57	1462.82	0.024239	1.14	2.63		0.1		26.3	81.17	1.4
KLF1T1715	1715	100yr	87.6	1461.92	1462.53	1462.66	1462.96	0.026148	1.41	2.95	0.15	0.13	0	30.7	85.8	1.48
KLF1T1670	1670	50yr	67.4	1460.55	1460.9	1461.05	1461.39	0.044647	0.84	3.15	1.75	0.04	0.12	22.07	85.17	1.84
KLF1T1670	1670	100yr	87.6	1460.55	1460.95	1461.13	1461.52	0.041063	1.16	3.39	1.92	0.07	0.15	27.08	91.92	1.81
KLF1T1637	1637	50yr	67.4	1459.29	1459.74	1459.86	1460.14	0.030706	0.89	2.84	1.08	0.06	0.08	24.78	92.85	1.56
KLF1T1637	1637	100yr	87.6	1459.29	1459.78	1459.94	1460.28	0.032762	1.22	3.19	1.3	0.09	0.1	29.17	98.72	1.64
KLF1T1584	1584	50yr	67.4	1456.93	1455.52	1455.52	1455.66	0.013464	1.7			0.29		39.68	135.97	0
KLF1T1584	1584	100yr	87.6	1456.93	1455.58	1455.58	1455.74	0.013108	1.81			0.33		48.39	147.71	0
KLF1T1528	1528	50yr	67.4	1454.63	1452.1	1452.1	1452.24	0.013976	1.66			0.27		40.59	148.18	0
KLF1T1528	1528	100yr	87.6	1454.63	1452.15	1452.15	1452.32	0.013179	1.8			0.32		48.6	150.09	0
KLF1T1498	1498	50yr	67.4	1453.91	1449.5	1449.69	1450.57	0.279096	4.57			0.13		14.76	111.43	0
KLF1T1498	1498	100yr	87.6	1453.91	1449.53	1449.75	1450.71	0.278271	4.81			0.14		18.2	126.63	0
KLF1T1412	1412	50yr	67.4	1451.18	1447.33	1447.33	1447.49	0.013313	1.73			0.3		38.93	128.25	0
KLF1T1412	1412	100yr	87.6	1451.18	1447.4	1447.4	1447.57	0.012657	1.85			0.35		47.24	135.14	0
KLF1T1349	1349	50yr	67.4	1449.26	1446.63	1446.64	1446.82	0.014539	1.92			0.33		35.16	105.94	0
KLF1T1349	1349	100yr	87.6	1449.26	1446.69	1446.71	1446.91	0.014891	2.06			0.36		42.51	117.06	0
KLF1T1281	1281	50yr	67.4	1447.35	1445.85	1445.59	1445.92	0.002877	1.14			0.51		59.22	115.58	0
KLF1T1281	1281	100yr	87.6	1447.35	1445.95	1445.68	1446.03	0.003208	1.22			0.52		71.81	137.14	0
KLF1T1226	1226	50yr	67.4	1446.08	1445.48	1445.48	1445.64	0.013525	1.8			0.32		37.47	117.77	0
KLF1T1226	1226	100yr	87.6	1446.08	1445.55	1445.55	1445.73	0.01306	1.91			0.36		45.97	129.14	0
KLF1T1172	1172	50yr	67.4	1445.15	1444.77	1444.78	1444.91	0.016114	1.61			0.24		41.82	177.59	0
KLF1T1172	1172	100yr	87.6	1445.15	1444.81	1444.83	1444.98	0.01786	1.83			0.26		47.97	182.46	0
KLF1T1090	1090	50yr	67.4	1443.45	1443.38	1443.4	1443.53	0.019215	1.69			0.22		39.92	180.67	0
KLF1T1090	1090	100yr	87.6	1443.45	1443.43	1443.45	1443.59	0.017365	1.75			0.25		50.16	200.09	0
KLF1T1016	1016	50yr	67.4	1441.9	1442	1442.03	1442.16	0.018529	1.78	0.79	0.41	0.25	0.03	38.51	172.12	0.94
KLF1T1016	1016	100yr	87.6	1441.9	1442.04	1442.08	1442.24	0.020109	1.98	1.09	0.67	0.27	0.05	45.2	182.64	1.05
KLF1T946	946	50yr	67.4	1440.03	1440.57	1440.67	1440.88	0.018416	1.16	2.74	1.35	0.13	0.16	32.42	142.61	1.27

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF1T946	946	100yr	87.6	1440.03	1440.63	1440.73	1440.95	0.017316	1.37	2.87	1.48	0.17	0.2	40.91	152.89	1.26
KLF1T868	868	50yr	67.4	1437.59	1438.01	1438.19	1438.6	0.051094	1.92	3.5		0.13		20.27	74.49	1.99
KLF1T868	868	100yr	87.6	1437.59	1438.06	1438.27	1438.76	0.050445	2.16	3.8		0.16		24.47	79.8	2.02
KLF1T797	797	50yr	67.4	1436.05	1436.49	1436.52	1436.69	0.014919	1.54	2.11	0.23	0.23	0.01	34.98	112.48	1.1
KLF1T797	797	100yr	87.6	1436.05	1436.55	1436.59	1436.79	0.015503	1.72	2.35	0.49	0.27	0.04	41.08	117.88	1.15
KLF1T746	746	50yr	67.4	1434.59	1434.99	1435.14	1435.47	0.041499	2.05	3.22	0.62	0.17	0.03	22.78	86.49	1.8
KLF1T746	746	100yr	87.6	1434.59	1435.05	1435.22	1435.58	0.037437	2.16	3.43	1.01	0.19	0.06	28.3	94.48	1.76
KLF1T654	654	50yr	67.4	1432.1	1432.68	1432.78	1433.04	0.017868	1.72	2.83	1.47	0.24	0.19	26.62	69.42	1.27
KLF1T654	654	100yr	87.6	1432.1	1432.75	1432.87	1433.19	0.018857	1.97	3.15	1.7	0.28	0.23	31.31	72.9	1.33
KLF1T567	567	50yr	67.4	1429.84	1430.49	1430.65	1431.01	0.03129		3.19				21.11	52.96	1.61
KLF1T567	567	100yr	87.6	1429.84	1430.58	1430.75	1431.16	0.029223		3.37				26.03	57.34	1.59
KLF1T503	503	50yr	67.4	1428	1428.79	1428.93	1429.29	0.023348		3.14				21.46	44.29	1.44
KLF1T503	503	100yr	87.6	1428	1428.88	1429.05	1429.47	0.024055		3.41				25.72	48.03	1.49
KLF1T441	441	50yr	67.4	1425.5	1426.57	1426.86	1427.5	0.035407		4.27				15.78	27.94	1.81
KLF1T441	441	100yr	87.6	1425.5	1426.7	1427.02	1427.71	0.032906	0.64	4.45	0.44	0.03	0.02	19.72	32.71	1.78
KLF1T365	365	50yr	67.4	1424.37	1425.07	1425.16	1425.46	0.018006		2.77				24.3	49.71	1.27
KLF1T365	365	100yr	87.6	1424.37	1425.14	1425.27	1425.64	0.019693		3.12				28.12	51.7	1.35
KLF1T271	271	50yr	67.4	1421	1421.78	1422.08	1422.78	0.049549	1.16	4.43		0.06		15.46	38.13	2.08
KLF1T271	271	100yr	87.6	1421	1421.88	1422.2	1422.95	0.043308	1.65	4.62		0.12		19.7	43.78	2
KLF1T182	182	50yr	67.4	1418	1418.65	1418.8	1419.15	0.03145		3.15				21.43	55.15	1.61
KLF1T182	182	100yr	87.6	1418	1418.71	1418.91	1419.35	0.035256		3.55				24.68	57.71	1.73
KLF1T91	91	50yr	67.4	1415.68	1416.27	1416.38	1416.66	0.023496	1.24	2.81		0.12		24.84	69.92	1.4
KLF1T91	91	100yr	87.6	1415.68	1416.35	1416.47	1416.79	0.021973	1.45	3.01		0.16		30.45	75.12	1.39
KLF6824	6824	50yr	126.7	1478.5	1479.49	1479.23	1479.65	0.003022	1.09	1.78	0.88	0.46	0.34	74.7	88.82	0.58
KLF6824	6824	100yr	157.8	1478.5	1479.59	1479.33	1479.78	0.003323	1.23	1.99	0.93	0.52	0.34	83.6	91.88	0.62
KLF6788	6788	50yr	126.7	1478.5	1479.48		1479.55	0.001408	0.67	1.23	0.67	0.4	0.4	104.57	111.91	0.4
KLF6788	6788	100yr	157.8	1478.5	1479.58		1479.68	0.00155	0.74	1.38	0.73	0.43	0.42	116.29	113.57	0.42
KLF6742	6742	50yr	126.7	1478.5	1479.41		1479.48	0.001572	0.64	1.24	0.71	0.35	0.4	103.72	119.12	0.42
KLF6742	6742	100yr	157.8	1478.5	1479.5		1479.6	0.00175	0.58	1.4	0.67	0.27	0.34	115.14	123.67	0.45

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			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF6704	6704	50yr	126.7	1478.5	1479.11	1479.11	1479.34	0.011084	1.09	2.15	0.96	0.17	0.14	60.09	134.35	0.99
KLF6704	6704	100yr	157.8	1478.5	1479.19	1479.19	1479.45	0.010422	1.2	2.3	1.03	0.21	0.17	70.41	138.6	0.98
KLF6664	6664	50yr	126.7	1476.5	1477.31	1477.63	1478.39	0.062337	3.3	4.69	2.26	0.17	0.14	28	77.45	2.29
KLF6664	6664	100yr	157.8	1476.5	1477.39	1477.67	1478.55	0.055987	2.83	4.92	2.47	0.21	0.18	34.14	81.9	2.23
KLF6629	6629	50yr	126.7	1474.76	1475.44	1475.75	1476.46	0.046912	2.15	4.56	1.97	0.16	0.14	29.05	68.62	2.05
KLF6629	6629	100yr	157.8	1474.76	1475.5	1475.85	1476.72	0.047718	1.93	4.98	2.27	0.14	0.17	33.68	75.74	2.11
KLF6585	6585	50yr	126.7	1474.24	1475.17	1475.2	1475.58	0.009379	1.25	2.87	1.54	0.24	0.33	46.71	66.69	1
KLF6585	6585	100yr	157.8	1474.24	1475.31	1475.33	1475.75	0.00863	1.37	3.03	1.72	0.3	0.41	55.63	70	0.98
KLF6533	6533	50yr	126.7	1473.89	1474.74	1474.76	1475.11	0.010084	1.5	2.77	1.24	0.3	0.23	47.92	74.27	1.02
KLF6533	6533	100yr	157.8	1473.89	1474.85	1474.88	1475.27	0.009323	1.61	2.93	1.36	0.36	0.28	56.97	78.57	1
KLF6464	6464	50yr	126.7	1473	1473.72	1473.84	1474.24	0.015954	2.09	3.27	1.97	0.35	0.32	40.96	68.84	1.26
KLF6464	6464	100yr	157.8	1473	1473.81	1473.96	1474.42	0.01633	2.26	3.58	2.18	0.39	0.37	46.91	71.01	1.3
KLF6411	6411	50yr	126.7	1472.5	1473.22	1473.23	1473.56	0.010054	1.66	2.68	1.73	0.35	0.37	50.73	83.47	1.01
KLF6411	6411	100yr	157.8	1472.5	1473.33	1473.34	1473.7	0.009292	1.73	2.84	1.83	0.4	0.43	60.25	87.55	0.99
KLF6352	6352	50yr	126.7	1472	1472.84	1472.72	1473.03	0.005114	1.17	2.13	1.62	0.35	0.56	69.09	107.94	0.74
KLF6352	6352	100yr	157.8	1472	1472.94	1472.81	1473.15	0.005267	1.29	2.31	1.76	0.39	0.62	79.43	112.58	0.76
KLF6341	6341	50yr	126.7	1471.93	1472.66	1472.66	1472.94	0.009957	1.6	2.61	2.12	0.33	0.51	56.27	105.49	1
KLF6341	6341	100yr	157.8	1471.93	1472.76	1472.76	1473.06	0.009672	1.74	2.8	2.23	0.39	0.56	66.34	112.17	1.01
KLF6324	6324	50yr	126.7	1471.5	1472.1	1472.27	1472.67	0.022533	1.85	3.5	2.03	0.22	0.26	40.16	89.85	1.46
KLF6324	6324	100yr	157.8	1471.5	1472.19	1472.37	1472.8	0.020933	2.04	3.69	2.24	0.28	0.32	47.84	93.87	1.44
KLF6265	6265	50yr	126.7	1471	1471.76	1471.76	1472.03	0.009711	1.65	2.43	1.79	0.36	0.4	57.77	111.26	0.97
KLF6265	6265	100yr	157.8	1471	1471.85	1471.85	1472.15	0.009374	1.77	2.6	1.96	0.41	0.47	67.43	114.43	0.98
KLF6218	6218	50yr	126.7	1469.5	1470.63	1470.83	1471.27	0.026486	2.65	4	2.07	0.34	0.24	38.56	92.78	1.6
KLF6218	6218	100yr	157.8	1469.5	1470.7	1470.92	1471.41	0.02573	2.89	4.24	2.26	0.4	0.28	45.59	98.38	1.61
KLF6159	6159	50yr	126.7	1467.76	1469.34	1469.59	1470.09	0.015809	1.63	4.09	1.59	0.24	0.23	37.52	72.85	1.33
KLF6159	6159	100yr	157.8	1467.76	1469.44	1469.71	1470.25	0.015603	1.88	4.35	1.81	0.3	0.29	45.46	81.49	1.34
KLF6119	6119	50yr	126.7	1466.5	1468.67	1468.99	1469.53	0.012057	1.61	4.48	1.48	0.29	0.26	38.22	71.85	1.21
KLF6119	6119	100yr	157.8	1466.5	1468.79	1469.1	1469.69	0.01222	1.86	4.75	1.68	0.36	0.31	47.1	83.19	1.24
KLF6070	6070	50yr	126.7	1466	1467.18	1467.67	1468.53	0.036327		5.16				24.57	33.41	1.92
KLF6070	6070	100yr	157.8	1466	1467.34	1467.85	1468.74	0.031574		5.25				30.08	35.88	1.83

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF6022	6022	50yr	126.7	1466	1467.31	1467.33	1467.62	0.006329	1.53	3.02	1.66	0.44	0.5	59.46	97.77	0.87
KLF6022	6022	100yr	157.8	1466	1467.35	1467.43	1467.76	0.008057	1.79	3.49	1.96	0.46	0.53	64.05	100.39	0.99
KLF5972	5972	50yr	126.7	1465.67	1466.34	1466.54	1466.98	0.030494	2.82	3.93	1.84	0.34	0.18	37.59	92.71	1.68
KLF5972	5972	100yr	157.8	1465.67	1466.44	1466.63	1467.07	0.02496	2.83	3.97	1.96	0.39	0.23	47.14	101.28	1.57
KLF5915	5915	50yr	126.7	1465.5	1466.49	1466.1	1466.54	0.001651	1.08	1.08	1.08	0.71	0.72	117.04	163.69	0.41
KLF5915	5915	100yr	157.8	1465.5	1466.57	1466.18	1466.65	0.001835	1.2	1.23	1.17	0.77	0.75	131.61	171.04	0.44
KLF5853	5853	50yr	126.7	1465.5	1466.45		1466.48	0.000636	0.56	0.81	0.75	0.55	0.84	169.17	205.18	0.27
KLF5853	5853	100yr	157.8	1465.5	1466.53		1466.57	0.000735	0.64	0.92	0.85	0.59	0.91	186.24	209.6	0.29
KLF5800	5800	50yr	126.7	1465.5	1466.42		1466.44	0.000558	0.57	0.74	0.55	0.62	0.59	186.21	239.59	0.25
KLF5800	5800	100yr	157.8	1465.5	1466.5		1466.53	0.000638	0.65	0.84	0.64	0.68	0.67	205.13	241.91	0.27
KLF5751	5751	50yr	126.7	1465.5	1466.39		1466.42	0.000508	0.54	0.7	0.56	0.61	0.65	199.03	262	0.24
KLF5751	5751	100yr	157.8	1465.5	1466.47		1466.5	0.000581	0.62	0.79	0.64	0.68	0.72	218.85	263.41	0.26
KLF5700	5700	50yr	126.7	1465.5	1466.36		1466.39	0.000632	0.55	0.75	0.55	0.53	0.54	189.22	276.94	0.26
KLF5700	5700	100yr	157.8	1465.5	1466.43		1466.46	0.000716	0.63	0.85	0.63	0.6	0.59	208.9	278.58	0.28
KLF5615	5615	50yr	126.7	1464.89	1466.1	1466.1	1466.24	0.00989	0.37	1.87	1.14	0.04	0.2	82.33	291.84	0.92
KLF5615	5615	100yr	157.8	1464.89	1466.14	1466.14	1466.3	0.009904	0.54	1.99	1.3	0.07	0.25	95	293.19	0.93
KLF5566	5566	50yr	126.7	1460.25	1460.55	1460.92	1464.15	0.752504	2.56	8.48	4.49	0.03	0.06	15.27	104.81	6.79
KLF5566	5566	100yr	157.8	1460.25	1460.58	1461.01	1464.38	0.628446	3.41	8.73	4.78	0.05	0.08	18.6	108.47	6.4
KLF5517	5517	50yr	126.7	1459	1459.94	1460.13	1460.47	0.019304	1.69	3.89	2.66	0.22	0.43	42.39	89.92	1.41
KLF5517	5517	100yr	157.8	1459	1460.03	1460.22	1460.62	0.02016	1.83	4.28	2.69	0.24	0.43	51.02	108.48	1.47
KLF5481	5481	50yr	126.7	1458.5	1459.79	1459.79	1460.04	0.008157	1.84	3.06	1.79	0.48	0.46	62.37	120.93	0.96
KLF5481	5481	100yr	157.8	1458.5	1459.88	1459.88	1460.15	0.00802	1.94	3.21	1.92	0.52	0.52	73.75	129.41	0.97
KLF5427	5427	50yr	126.7	1458.26	1459.29	1459.13	1459.45	0.004413	0.88	2.08	1.49	0.25	0.55	74.27	120.69	0.7
KLF5427	5427	100yr	157.8	1458.26	1459.43	1459.23	1459.6	0.003769	0.95	2.12	1.5	0.32	0.63	92.58	134.13	0.66
KLF5369	5369	50yr	126.7	1457.5	1458.71	1458.71	1459.1	0.007365	1.02	2.9	1.48	0.21	0.37	48.08	65.67	0.92
KLF5369	5369	100yr	157.8	1457.5	1458.86	1458.86	1459.29	0.006763	1.15	3.04	1.6	0.27	0.45	58.56	74.06	0.9
KLF5312	5312	50yr	126.7	1457	1457.65	1457.85	1458.3	0.03333	1.09	3.9	3.03	0.08	0.35	36.37	91.09	1.74
KLF5312	5312	100yr	157.8	1457	1457.7	1457.95	1458.5	0.03601	1.38	4.32	3.39	0.1	0.39	41.11	94.89	1.84
KLF5277	5277	50yr	126.7	1455.5	1457.33	1457.37	1457.66	0.009114	2.04	3.26	1.76	0.51	0.41	54.77	98.03	1

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF5277	5277	100yr	157.8	1455.5	1457.41	1457.47	1457.79	0.009554	2.22	3.51	1.97	0.56	0.47	63.27	103.3	1.04
KLF5225	5225	50yr	126.7	1455	1456.42	1456.64	1457.08	0.011969	2.49	4.16	1.48	0.57	0.26	40.21	64.57	1.19
KLF5225	5225	100yr	157.8	1455	1456.58	1456.78	1457.23	0.010683	2.48	4.26	1.57	0.61	0.31	51.62	80.49	1.15
KLF5181	5181	50yr	126.7	1454.5	1456.07	1456.17	1456.52	0.010698	2.02	3.57	2.1	0.45	0.47	47.12	77.8	1.1
KLF5181	5181	100yr	157.8	1454.5	1456.14	1456.28	1456.7	0.01251	2.38	4.02	2.34	0.51	0.5	52.38	81.34	1.21
KLF5126	5126	50yr	126.7	1454	1455.45	1455.54	1455.89	0.012237	2.1	3.93	2.38	0.43	0.52	47.17	82.33	1.18
KLF5126	5126	100yr	157.8	1454	1455.57	1455.67	1456.02	0.010989	2.08	3.99	2.48	0.46	0.6	57.79	90.15	1.14
KLF5076	5076	50yr	126.7	1454	1455.01	1454.96	1455.28	0.008106	1.54	2.58	2.15	0.37	0.61	56.75	92.37	0.92
KLF5076	5076	100yr	157.8	1454	1455	1455.08	1455.43	0.012693	1.89	3.19	2.83	0.36	0.65	55.34	87.35	1.15
KLF5031	5031	50yr	126.7	1453.5	1454.62	1454.62	1454.91	0.008133	1.59	2.77	1.96	0.39	0.53	57	97.39	0.94
KLF5031	5031	100yr	157.8	1453.5	1454.72	1454.72	1455.04	0.008033	1.78	2.95	2.1	0.46	0.59	66.72	101.86	0.95
KLF4984	4984	50yr	126.7	1453	1454.45	1454.28	1454.6	0.003687	1.39	2.28	1.56	0.57	0.68	76.56	108.89	0.66
KLF4984	4984	100yr	157.8	1453	1454.55	1454.37	1454.73	0.003779	1.5	2.44	1.7	0.62	0.76	88.53	114.29	0.68
KLF4943	4943	50yr	126.7	1452.5	1454.13	1454.13	1454.4	0.005643	1.46	2.88	1.5	0.45	0.46	63.77	107.68	0.82
KLF4943	4943	100yr	157.8	1452.5	1454.22	1454.22	1454.53	0.005841	1.61	3.07	1.68	0.5	0.54	74.18	112.95	0.85
KLF4904	4904	50yr	126.7	1452	1453.88	1453.9	1454.19	0.004961	0.97	3.04	1.52	0.27	0.52	62.58	106.65	0.79
KLF4904	4904	100yr	157.8	1452	1454	1454	1454.32	0.004751	1.14	3.13	1.67	0.35	0.62	76	113.51	0.79
KLF4849	4849	50yr	126.7	1452	1452.95	1453.16	1453.63	0.026757	2.45	4.74	3.07	0.3	0.42	38.26	89.48	1.67
KLF4849	4849	100yr	157.8	1452	1453.02	1453.25	1453.77	0.02632	2.67	4.98	3.31	0.35	0.48	45.02	94.13	1.68
KLF4795	4795	50yr	126.7	1452	1452.98	1452.8	1453.11	0.004053	0.86	1.8	1.6	0.26	0.65	79.28	130.04	0.65
KLF4795	4795	100yr	157.8	1452	1453.07	1452.89	1453.23	0.004047	0.99	1.94	1.72	0.32	0.73	91.96	134.69	0.66
KLF4753	4753	50yr	126.7	1452	1452.86		1452.97	0.002719	0.6	1.49	0.67	0.21	0.24	88.95	134.97	0.53
KLF4753	4753	100yr	157.8	1452	1452.95		1453.08	0.002855	0.73	1.64	0.78	0.26	0.29	101.53	140.28	0.56
KLF4715	4715	50yr	126.7	1452	1452.54	1452.54	1452.78	0.010066	1.46	2.22	1.35	0.29	0.26	60.95	131.64	0.96
KLF4715	4715	100yr	157.8	1452	1452.62	1452.62	1452.88	0.009775	1.62	2.38	1.48	0.34	0.3	70.88	134.65	0.97
KLF4666	4666	50yr	126.7	1449.5	1451.49	1451.71	1452.18	0.01326	1.51	4.12	2.22	0.25	0.44	40.25	72.88	1.23
KLF4666	4666	100yr	157.8	1449.5	1451.61	1451.83	1452.31	0.012397	1.7	4.27	2.38	0.31	0.51	49.9	82.83	1.21
KLF4621	4621	50yr	126.7	1448.5	1450.44	1450.84	1451.51	0.014235		4.59				27.63	21.44	1.29
KLF4621	4621	100yr	157.8	1448.5	1450.72	1451.14	1451.75	0.011027	0.9	4.56	1.23	0.13	0.21	37.49	42.72	1.17

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF4578	4578	50yr	126.7	1448.5	1450.53	1450.62	1450.93	0.006214	1.46	3.36	1.46	0.42	0.41	56.43	95.02	0.87
KLF4578	4578	100yr	157.8	1448.5	1450.51	1450.71	1451.18	0.010642	1.86	4.35	1.85	0.4	0.4	54.18	93.91	1.13
KLF4532	4532	50yr	126.7	1448.5	1449.86	1450.04	1450.44	0.019534	2.37	4.45	2.57	0.36	0.41	42.55	93.36	1.45
KLF4532	4532	100yr	157.8	1448.5	1449.96	1450.13	1450.53	0.017177	2.46	4.45	2.73	0.42	0.5	52.15	99.13	1.38
KLF4478	4478	50yr	126.7	1448	1449.26	1449.31	1449.6	0.01076	2.19	3.61	2.27	0.5	0.53	52.63	95.3	1.1
KLF4478	4478	100yr	157.8	1448	1449.34	1449.4	1449.73	0.01128	2.41	3.88	2.43	0.56	0.57	60.51	100	1.14
KLF4431	4431	50yr	126.7	1448	1449.08	1448.94	1449.26	0.004393	1.51	2.19	1.38	0.57	0.49	71.92	108.53	0.7
KLF4431	4431	100yr	157.8	1448	1449.18	1449.04	1449.38	0.004557	1.65	2.37	1.53	0.63	0.56	82.71	113.18	0.73
KLF4387	4387	50yr	126.7	1448	1448.71	1448.71	1448.98	0.009072	1.58	2.52	1.77	0.35	0.42	57.54	107.36	0.96
KLF4387	4387	100yr	157.8	1448	1448.8	1448.8	1449.11	0.00872	1.7	2.68	1.91	0.4	0.48	67.69	112.18	0.96
KLF4337	4337	50yr	126.7	1447.5	1448.19	1448.21	1448.49	0.010493	1.36	2.54	1.8	0.25	0.38	54.28	103.3	1.01
KLF4337	4337	100yr	157.8	1447.5	1448.27	1448.3	1448.62	0.010614	1.48	2.76	1.96	0.28	0.43	62.68	107.91	1.04
KLF4255	4255	50yr	126.7	1446.5	1447.3	1447.34	1447.61	0.011579	1.94	2.84	1.81	0.4	0.36	54.06	110.08	1.08
KLF4255	4255	100yr	157.8	1446.5	1447.37	1447.43	1447.73	0.011648	2.14	3.05	1.94	0.46	0.4	62.6	114.02	1.1
KLF4221	4221	50yr	126.7	1446.33	1446.97	1446.97	1447.22	0.010538	1.24	2.27	1.44	0.22	0.27	58.39	122.05	0.99
KLF4221	4221	100yr	157.8	1446.33	1447.04	1447.05	1447.34	0.010863	1.39	2.49	1.6	0.25	0.31	66.62	125.21	1.02
KLF4159	4159	50yr	126.7	1445.5	1446.15	1446.23	1446.49	0.013411	1.54	2.84	1.67	0.25	0.29	53.32	128.51	1.14
KLF4159	4159	100yr	157.8	1445.5	1446.22	1446.31	1446.6	0.013335	1.77	3.03	1.81	0.31	0.32	62.29	132.47	1.16
KLF4092	4092	50yr	126.7	1444.5	1445.33	1445.4	1445.68	0.011415	1.74	2.99	1.23	0.34	0.2	52.83	112.43	1.09
KLF4092	4092	100yr	157.8	1444.5	1445.41	1445.49	1445.8	0.011289	1.92	3.18	1.37	0.4	0.24	62.31	119.41	1.1
KLF4001	4001	50yr	325.6	1444.02	1444.9	1445.13	1445.65	0.023983	2.57	4.57	3.33	0.35	0.52	92.37	181.86	1.6
KLF4001	4001	100yr	387.3	1444.02	1444.98	1445.22	1445.76	0.022795	2.76	4.72	3.49	0.41	0.58	105.98	187.52	1.58
KLF3949	3949	50yr	325.6	1443.81	1444.94	1444.82	1445.21	0.005548	1.57	2.54	2.19	0.5	0.83	144.65	173.75	0.8
KLF3949	3949	100yr	387.3	1443.81	1445.07	1444.91	1445.35	0.005005	1.63	2.61	2.26	0.57	0.94	167.57	179.19	0.77
KLF3904	3904	50yr	325.6	1443.5	1444.78		1445	0.003353	1.42	2.23	1.57	0.63	0.73	160.04	157.31	0.64
KLF3904	3904	100yr	387.3	1443.5	1444.91		1445.16	0.003228	1.49	2.35	1.67	0.7	0.83	182.01	162.88	0.64
KLF3845	3845	50yr	325.6	1443.02	1444.6		1444.82	0.00291	1.64	2.39	1.87	0.87	1.06	163.5	146.11	0.62
KLF3845	3845	100yr	387.3	1443.02	1444.74		1444.98	0.00289	1.74	2.52	1.99	0.95	1.17	184.25	150.79	0.62
KLF3798	3798	50yr	325.6	1443	1444.14	1444.13	1444.59	0.007487	1.99	3.15	2.19	0.58	0.66	114.76	125.71	0.94
KLF3798	3798	100yr	387.3	1443	1444.26	1444.25	1444.75	0.007229	2.1	3.31	2.32	0.64	0.74	130.46	130.12	0.94

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF3737	3737	50yr	325.6	1442.5	1443.92		1444.22	0.003917	1.74	2.64	1.8	0.76	0.81	141.41	130.97	0.71
KLF3737	3737	100yr	387.3	1442.5	1444.05		1444.39	0.003971	1.85	2.82	1.93	0.83	0.88	158.63	136.07	0.72
KLF3680	3680	50yr	325.6	1442.4	1443.64		1443.96	0.005023	1.54	2.6	1.55	0.52	0.53	134.56	140.05	0.77
KLF3680	3680	100yr	387.3	1442.4	1443.75	1443.62	1444.12	0.00522	1.46	2.81	1.7	0.47	0.6	150.1	150.47	0.8
KLF3628	3628	50yr	325.6	1442	1443.36		1443.7	0.005361	2.08	2.87	1.73	0.79	0.6	133.15	141.32	0.81
KLF3628	3628	100yr	387.3	1442	1443.49		1443.85	0.00522	2.2	3.02	1.84	0.87	0.67	151.22	146.43	0.81
KLF3578	3578	50yr	325.6	1441.48	1442.93	1442.93	1443.39	0.006481	2.05	3.35	1.78	0.67	0.54	118.43	129.42	0.91
KLF3578	3578	100yr	387.3	1441.48	1443.06	1443.06	1443.55	0.006375	2.2	3.52	1.91	0.75	0.61	134.82	135.04	0.91
KLF3526	3526	50yr	325.6	1441	1442	1442.24	1442.83	0.018013	3.12	4.43	2.97	0.58	0.54	83.93	110.34	1.42
KLF3526	3526	100yr	387.3	1441	1442.11	1442.37	1443.01	0.017165	3.27	4.63	3.13	0.65	0.61	95.99	114.69	1.41
KLF3487	3487	50yr	325.6	1440.83	1442.15	1442.05	1442.53	0.005712	1.96	2.95	2.05	0.69	0.73	125.33	128.19	0.84
KLF3487	3487	100yr	387.3	1440.83	1442.29	1442.18	1442.7	0.005486	2.06	3.1	2.15	0.76	0.81	143.15	133.75	0.83
KLF3441	3441	50yr	325.6	1440.5	1441.92		1442.28	0.004944	1.97	2.95	2.08	0.77	0.84	127.31	119.33	0.79
KLF3441	3441	100yr	387.3	1440.5	1442.05		1442.46	0.004937	2.08	3.14	2.21	0.84	0.92	143.75	124.77	0.8
KLF3395	3395	50yr	325.6	1440.06	1441.49	1441.49	1441.99	0.007411	2.41	3.58	2.55	0.77	0.84	109.35	110.41	0.97
KLF3395	3395	100yr	387.3	1440.06	1441.63	1441.63	1442.17	0.007226	2.54	3.76	2.68	0.85	0.92	124.5	115.31	0.97
KLF3339	3339	50yr	325.6	1439.05	1441.27	1440.85	1441.56	0.002418	1.22	2.51	1.23	0.64	0.65	147.96	114.45	0.58
KLF3339	3339	100yr	387.3	1439.05	1441.41	1441.01	1441.75	0.002581	1.35	2.72	1.36	0.72	0.72	164.36	120.26	0.61
KLF3290	3290	50yr	325.6	1439.26	1440.86	1440.86	1441.35	0.007005	2.07	3.5	2.58	0.64	0.89	111.21	113.26	0.94
KLF3290	3290	100yr	387.3	1439.26	1440.99	1440.99	1441.53	0.006861	2.2	3.68	2.72	0.71	0.98	126.65	118.67	0.95
KLF3235	3235	50yr	325.6	1438.71	1440.39	1440.44	1440.95	0.007811	2.18	3.7	2.57	0.64	0.82	104.72	106.79	1
KLF3235	3235	100yr	387.3	1438.71	1440.52	1440.57	1441.13	0.007673	2.32	3.89	2.73	0.71	0.91	119.21	112.07	1
KLF3184	3184	50yr	325.6	1438.1	1439.81	1439.95	1440.48	0.010273	2.3	3.94	2.46	0.56	0.62	96.3	107.79	1.12
KLF3184	3184	100yr	387.3	1438.1	1439.93	1440.09	1440.66	0.010231	2.45	4.17	2.64	0.62	0.69	109.13	113.09	1.13
KLF3139	3139	50yr	325.6	1438	1439.69	1439.61	1440.08	0.004961	1.7	3.14	2.14	0.62	0.87	128.04	129.25	0.81
KLF3139	3139	100yr	387.3	1438	1439.82	1439.73	1440.25	0.0049	1.84	3.3	2.28	0.7	0.97	145.65	134.86	0.81
KLF3095	3095	50yr	325.6	1437.25	1439.74		1439.91	0.001375	0.99	1.96	1.06	0.72	0.79	194.66	147.48	0.44
KLF3095	3095	100yr	387.3	1437.25	1439.87		1440.07	0.001501	1.1	2.13	1.17	0.79	0.87	214.42	153.99	0.47
KLF3047	3047	50yr	325.6	1437.26	1439.68		1439.83	0.001777	1.41	2.46	1.72	1.01	1.36	199.95	166.94	0.51

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF3047	3047	100yr	387.3	1437.26	1439.81		1439.98	0.00188	1.51	2.63	1.86	1.07	1.46	222.37	175.05	0.53
KLF3011	3011	50yr	325.6	1437	1439.65		1439.77	0.001226	1.28	2.13	1.46	1.15	1.4	226.43	172.41	0.43
KLF3011	3011	100yr	387.3	1437	1439.78		1439.91	0.001339	1.39	2.3	1.59	1.21	1.48	249.03	179.92	0.45
KLF2980	2980	50yr	325.6	1436.71	1439.64		1439.73	0.000851	1.14	1.75	1.26	1.28	1.48	259.83	182.85	0.36
KLF2980	2980	100yr	387.3	1436.71	1439.77		1439.87	0.00095	1.25	1.91	1.38	1.34	1.55	283.63	190.31	0.38
KLF2945	2945	50yr	325.6	1436.65	1439.63		1439.7	0.000518	0.93	1.44	0.88	1.35	1.26	308.69	202.44	0.28
KLF2945	2945	100yr	387.3	1436.65	1439.76		1439.84	0.000592	1.02	1.59	0.97	1.41	1.3	334.82	211.1	0.31
KLF2922	2922	50yr	325.6	1436.5	1439.63		1439.68	0.000437	0.93	1.3	0.89	1.54	1.45	337.18	211.22	0.26
KLF2922	2922	100yr	387.3	1436.5	1439.76		1439.82	0.000501	1.02	1.43	0.98	1.6	1.51	364.4	219.09	0.28
KLF2871	2871	50yr	325.6	1436.13	1439.62		1439.66	0.000296	0.82	1.11	0.83	1.7	1.73	391.94	225.45	0.21
KLF2871	2871	100yr	387.3	1436.13	1439.75		1439.79	0.000344	0.91	1.24	0.91	1.77	1.8	420.7	232.38	0.22
KLF2804	2804	50yr	325.6	1435.65	1439.62		1439.64	0.000131	0.61	0.85	0.51	2.03	1.55	516.65	251.73	0.15
KLF2804	2804	100yr	387.3	1435.65	1439.75		1439.77	0.000158	0.69	0.96	0.58	2.1	1.62	548.61	259	0.16
KLF2768	2768	50yr	325.6	1435.5	1439.62		1439.64	0.000085	0.54	0.76	0.43	2.33	1.64	612.89	275.3	0.12
KLF2768	2768	100yr	387.3	1435.5	1439.75		1439.77	0.000103	0.61	0.85	0.48	2.4	1.71	647.89	281.91	0.13
KLF2733	2733	50yr	325.6	1435.24	1439.62	1437.04	1439.64	0.000055	0.42	0.65	0.35	2.2	1.7	730.58	325.66	0.1
KLF2733	2733	100yr	387.3	1435.24	1439.75	1437.17	1439.76	0.000068	0.47	0.74	0.4	2.27	1.75	772.03	334.31	0.11
KLF2713	2713		Culvert													
KLF2676	2676	50yr	325.6	1435	1436.93		1437.24	0.003721	1.68	3.05	1.7	0.75	0.76	148.63	153.61	0.71
KLF2676	2676	100yr	387.3	1435	1437.05		1437.39	0.003883	1.81	3.24	1.82	0.82	0.82	167.19	162.46	0.74
KLF2615	2615	50yr	325.6	1434.5	1436.52	1436.52	1436.94	0.006373	1.88	3.99	2.51	0.59	0.92	125.66	145.51	0.94
KLF2615	2615	100yr	387.3	1434.5	1436.65	1436.65	1437.09	0.006247	2	4.12	2.64	0.66	1	144.2	154.36	0.94
KLF2582	2582	50yr	325.6	1434.23	1436	1436.16	1436.68	0.00972	2.16	4.29	2.59	0.53	0.7	98.56	112.79	1.12
KLF2582	2582	100yr	387.3	1434.23	1436.15	1436.29	1436.84	0.008827	2.19	4.36	2.71	0.58	0.81	116.26	121.32	1.09
KLF2541	2541	50yr	325.6	1433.69	1435.87	1435.91	1436.34	0.006863	2.43	3.92	2.2	0.83	0.71	119.01	132.26	0.96
KLF2541	2541	100yr	387.3	1433.69	1435.99	1436.01	1436.49	0.00692	2.58	4.11	2.39	0.9	0.8	134.41	137.52	0.97
KLF2512	2512	50yr	325.6	1433.59	1435.34	1435.53	1436.02	0.016087	3.21	5.14	3.32	0.66	0.7	93.6	130.19	1.41
KLF2512	2512	100yr	387.3	1433.59	1435.43	1435.63	1436.17	0.015888	3.39	5.34	3.51	0.72	0.76	106.11	135.46	1.41
KLF2492	2492	50yr	325.6	1433.5	1435.31	1435.32	1435.74	0.007272	2.43	3.95	2.39	0.79	0.77	121.09	140.12	0.98

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF2492	2492	100yr	387.3	1433.5	1435.43	1435.44	1435.89	0.007158	2.57	4.1	2.52	0.87	0.84	137.81	146.48	0.99
KLF2453	2453	50yr	325.6	1433.23	1434.78	1434.91	1435.37	0.011574	2.85	4.16	2.73	0.71	0.67	101.64	127.34	1.19
KLF2453	2453	100yr	387.3	1433.23	1434.9	1435.02	1435.52	0.011098	3.01	4.32	2.83	0.8	0.72	116.26	132.47	1.18
KLF2415	2415	50yr	325.6	1433.14	1434.83	1434.61	1435.12	0.003713	1.83	2.62	1.34	0.86	0.54	145.2	136.3	0.69
KLF2415	2415	100yr	387.3	1433.14	1434.97	1434.73	1435.28	0.003699	1.96	2.78	1.45	0.95	0.6	163.94	141.64	0.7
KLF2391	2391	50yr	325.6	1432.97	1434.51	1434.51	1434.98	0.007432	2.34	3.38	2.01	0.73	0.58	113.66	123.56	0.95
KLF2391	2391	100yr	387.3	1432.97	1434.64	1434.64	1435.15	0.007252	2.48	3.55	2.12	0.82	0.65	129.24	128.59	0.96
KLF2348	2348	50yr	325.6	1432.69	1434.16	1434.18	1434.66	0.007534	2.13	3.4	2.07	0.63	0.61	111.43	121.4	0.96
KLF2348	2348	100yr	387.3	1432.69	1434.29	1434.31	1434.83	0.007456	2.23	3.59	2.24	0.68	0.69	126.5	127.5	0.97
KLF2297	2297	50yr	325.6	1432.5	1433.92	1433.8	1434.23	0.005353	2.31	2.97	1.57	0.92	0.52	135.88	149.09	0.82
KLF2297	2297	100yr	387.3	1432.5	1434.01	1433.91	1434.38	0.005591	2.49	3.18	1.71	1	0.57	150.91	154.12	0.85
KLF2240	2240	50yr	325.6	1431.98	1433.47	1433.47	1433.88	0.006943	1.98	3.14	1.73	0.6	0.49	124.36	153.51	0.91
KLF2240	2240	100yr	387.3	1431.98	1433.58	1433.58	1434.02	0.006705	2.1	3.28	1.88	0.68	0.57	142.26	159.51	0.91
KLF2195	2195	50yr	325.6	1431.64	1433.06	1433.11	1433.51	0.010065	2.34	3.94	2.88	0.59	0.8	113.71	148.83	1.11
KLF2195	2195	100yr	387.3	1431.64	1433.15	1433.21	1433.65	0.01025	2.51	4.16	3.08	0.64	0.87	126.9	152.64	1.13
KLF2135	2135	50yr	325.6	1431	1432.46	1432.52	1432.93	0.009135	2.57	3.76	2.02	0.73	0.51	114.89	148.66	1.06
KLF2135	2135	100yr	387.3	1431	1432.56	1432.63	1433.07	0.009056	2.73	3.94	2.17	0.8	0.57	130.15	154.39	1.07
KLF2081	2081	50yr	325.6	1430.5	1432.16	1432.14	1432.51	0.005825	2.12	3.43	1.59	0.76	0.5	136.42	164.49	0.87
KLF2081	2081	100yr	387.3	1430.5	1432.27	1432.23	1432.65	0.005741	2.26	3.56	1.72	0.85	0.56	154.95	170.58	0.88
KLF2034	2034	50yr	325.6	1430	1431.93	1431.86	1432.25	0.005059	2.05	3.52	1.81	0.8	0.67	144.62	168.74	0.83
KLF2034	2034	100yr	387.3	1430	1432.05		1432.38	0.005001	2.16	3.64	1.91	0.88	0.73	165	177.81	0.83
KLF1999	1999	50yr	325.6	1429.5	1431.65	1431.65	1432.04	0.006583	2.16	3.67	1.98	0.71	0.63	130.56	161.84	0.93
KLF1999	1999	100yr	387.3	1429.5	1431.76	1431.76	1432.17	0.006615	2.29	3.84	2.12	0.78	0.69	148.36	170.89	0.94
KLF1949	1949	50yr	325.6	1429.5	1431.11	1431.22	1431.62	0.010478	2.49	4.16	2.55	0.62	0.65	112.47	156.13	1.14
KLF1949	1949	100yr	387.3	1429.5	1431.2	1431.32	1431.76	0.010454	2.64	4.35	2.72	0.68	0.71	127.67	163.63	1.15
KLF1901	1901	50yr	325.6	1429	1430.45	1430.6	1431.01	0.015882	3.07	4.55	2.92	0.63	0.58	102.18	158.74	1.35
KLF1901	1901	100yr	387.3	1429	1430.54	1430.69	1431.14	0.016078	3.17	4.8	3.13	0.65	0.64	116.68	171.97	1.37
KLF1858	1858	50yr	325.6	1428.5	1430.29	1430.29	1430.62	0.007686	2.37	3.7	1.8	0.73	0.48	135.38	191.92	0.96
KLF1858	1858	100yr	387.3	1428.5	1430.37	1430.37	1430.74	0.007811	2.54	3.86	1.94	0.8	0.53	151.69	197.92	0.97

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			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF1823	1823	50yr	325.6	1428	1429.94	1429.99	1430.31	0.009568	2.49	4.04	1.92	0.67	0.45	129.21	202.88	1.06
KLF1823	1823	100yr	387.3	1428	1430.02	1430.08	1430.43	0.0097	2.66	4.21	2.06	0.73	0.5	145.1	209.75	1.08
KLF1784	1784	50yr	325.6	1427.5	1429.62	1429.64	1429.97	0.00794	2.32	3.81	1.89	0.69	0.51	136.18	201.98	0.98
KLF1784	1784	100yr	387.3	1427.5	1429.71	1429.73	1430.08	0.007824	2.46	3.92	2.04	0.76	0.58	154.16	207.5	0.98
KLF1746	1746	50yr	325.6	1427.5	1429.21	1429.28	1429.62	0.010132	2.17	4.07	2.71	0.52	0.72	124.11	192.01	1.1
KLF1746	1746	100yr	387.3	1427.5	1429.3	1429.37	1429.74	0.01004	2.31	4.22	2.83	0.57	0.78	141.47	202.18	1.1
KLF1702	1702	50yr	325.6	1426.5	1428.68	1428.8	1429.2	0.008765	1.43	3.82	2.44	0.31	0.69	116.19	170.04	1.04
KLF1702	1702	100yr	387.3	1426.5	1428.8	1428.91	1429.33	0.008394	1.56	3.94	2.53	0.37	0.76	136.48	187.3	1.03
KLF1659	1659	50yr	325.6	1426.91	1428.39	1428.43	1428.8	0.008334	1.81	3.47	2.36	0.46	0.68	125.15	179.78	1
KLF1659	1659	100yr	387.3	1426.91	1428.46	1428.55	1428.94	0.009064	1.97	3.75	2.57	0.49	0.73	138.36	189.26	1.05
KLF1613	1613	50yr	325.6	1426.5	1428	1428.07	1428.41	0.008683	1.67	3.69	2.61	0.4	0.77	124.98	185.12	1.03
KLF1613	1613	100yr	387.3	1426.5	1428.11	1428.16	1428.53	0.007915	1.73	3.73	2.67	0.45	0.86	147.91	202.03	1
KLF1578	1578	50yr	325.6	1426	1427.66	1427.73	1428.08	0.010289	2.13	4.06	2.67	0.5	0.7	122.65	190.57	1.12
KLF1578	1578	100yr	387.3	1426	1427.73	1427.82	1428.21	0.010841	2.33	4.31	2.87	0.55	0.75	135.95	195.85	1.16
KLF1541	1541	50yr	325.6	1426	1427.36	1427.37	1427.72	0.008422	2.18	3.52	2.35	0.6	0.67	130.23	187.12	1.01
KLF1541	1541	100yr	387.3	1426	1427.46	1427.47	1427.84	0.007977	2.25	3.62	2.46	0.66	0.75	150.38	197.54	1
KLF1505	1505	50yr	325.6	1426	1426.97	1427.03	1427.38	0.010437	2.15	3.33	2.48	0.5	0.62	120.81	183.19	1.08
KLF1505	1505	100yr	387.3	1426	1427.05	1427.12	1427.51	0.010483	2.27	3.53	2.64	0.54	0.68	136.35	191.63	1.1
KLF1474	1474	50yr	325.6	1425.5	1426.61	1426.69	1427.08	0.009317	1.5	3.2	1.67	0.32	0.37	116.54	173.12	1.03
KLF1474	1474	100yr	387.3	1425.5	1426.71	1426.79	1427.21	0.009038	1.65	3.35	1.85	0.38	0.45	133.68	181.2	1.03
KLF1442	1442	50yr	325.6	1425	1426.47	1426.47	1426.82	0.007722	2.29	3.4	1.96	0.69	0.55	132.54	183.91	0.97
KLF1442	1442	100yr	387.3	1425	1426.57	1426.56	1426.94	0.007393	2.38	3.51	2.08	0.76	0.62	152.41	193.15	0.96
KLF1407	1407	50yr	325.6	1425	1426.32	1426.19	1426.59	0.004192	1.25	2.51	1.32	0.44	0.48	153.21	189.65	0.72
KLF1407	1407	100yr	387.3	1425	1426.42		1426.73	0.004201	1.36	2.66	1.44	0.5	0.55	174.25	199.78	0.73
KLF1367	1367	50yr	325.6	1424.5	1426.01	1426.01	1426.38	0.006414	1.87	3.17	1.89	0.58	0.6	132.66	170.56	0.89
KLF1367	1367	100yr	387.3	1424.5	1426.11	1426.11	1426.51	0.00641	2.03	3.33	1.98	0.66	0.64	150.16	176.77	0.9
KLF1331	1331	50yr	325.6	1424.5	1425.67	1425.72	1426.1	0.008987	2.33	3.45	2.02	0.64	0.51	119.55	161.23	1.03
KLF1331	1331	100yr	387.3	1424.5	1425.77	1425.82	1426.24	0.008863	2.5	3.61	2.13	0.71	0.56	135.28	166.46	1.04
KLF1286	1286	50yr	325.6	1424.24	1425.28	1425.29	1425.67	0.009328	2.44	3.24	2.55	0.66	0.7	120.44	160.98	1.03
KLF1286	1286	100yr	387.3	1424.24	1425.36	1425.39	1425.81	0.009574	2.63	3.46	2.72	0.72	0.76	134	164.92	1.06

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF1246	1246	50yr	325.6	1424	1424.94	1424.95	1425.32	0.008511	2.08	2.96	1.83	0.56	0.46	125.36	172.3	0.97
KLF1246	1246	100yr	387.3	1424	1425.05	1425.05	1425.45	0.008001	2.19	3.08	1.93	0.63	0.52	143.83	178.34	0.96
KLF1214	1214	50yr	325.6	1423.58	1424.67	1424.59	1424.97	0.006728	2.32	2.8	2.08	0.78	0.66	135.2	166.28	0.88
KLF1214	1214	100yr	387.3	1423.58	1424.58	1424.68	1425.12	0.013134	3.07	3.7	2.7	0.72	0.6	121.68	162.88	1.21
KLF1185	1185	50yr	325.6	1423.36	1424.57		1424.79	0.004031	1.94	2.31	1.49	0.88	0.59	160.85	176.14	0.69
KLF1185	1185	100yr	387.3	1423.36	1424.67	1424.44	1424.92	0.004157	2.08	2.48	1.65	0.95	0.68	178.74	180.54	0.71
KLF1142	1142	50yr	325.6	1423	1424.19	1424.19	1424.54	0.007758	2.14	3.11	1.79	0.62	0.48	130.75	179.06	0.95
KLF1142	1142	100yr	387.3	1423	1424.28	1424.28	1424.67	0.007717	2.3	3.27	1.93	0.7	0.53	147.02	182.85	0.96
KLF1099	1099	50yr	325.6	1422.79	1423.62	1423.71	1424.08	0.014733	2.77	3.23	2.45	0.57	0.47	109.39	175.86	1.22
KLF1099	1099	100yr	387.3	1422.79	1423.7	1423.8	1424.21	0.014209	2.92	3.41	2.59	0.63	0.53	123.7	179.43	1.22
KLF1061	1061	50yr	325.6	1422.5	1423.45	1423.34	1423.7	0.006057	2.18	2.46	1.48	0.77	0.43	146.43	188.16	0.82
KLF1061	1061	100yr	387.3	1422.5	1423.53	1423.43	1423.83	0.006224	2.34	2.64	1.62	0.84	0.48	162.28	191.32	0.84
KLF1031	1031	50yr	325.6	1422.17	1423.14	1423.14	1423.48	0.0091	1.96	3.01	2.48	0.48	0.69	130.01	192.35	1
KLF1031	1031	100yr	387.3	1422.17	1423.23	1423.23	1423.6	0.008884	2.09	3.16	2.63	0.54	0.77	146.5	195.77	1
KLF1002	1002	50yr	325.6	1421.85	1423	1422.82	1423.22	0.00431	1.47	2.33	2	0.55	0.88	161.68	190.24	0.71
KLF1002	1002	100yr	387.3	1421.85	1423.13	1422.91	1423.36	0.003976	1.52	2.4	2.1	0.61	1	185.56	195.07	0.69
KLF963	963	50yr	325.6	1421.47	1422.55	1422.55	1422.97	0.00833	1.82	3.17	2.88	0.46	0.93	117.1	143.24	0.98
KLF963	963	100yr	387.3	1421.47	1422.66	1422.66	1423.12	0.007961	1.91	3.31	3.03	0.52	1.04	133.64	149.22	0.98
KLF921	921	50yr	325.6	1421.02	1421.99	1422.13	1422.55	0.014979	2.62	3.94	2.87	0.52	0.59	103.3	159.84	1.29
KLF921	921	100yr	387.3	1421.02	1422.06	1422.22	1422.7	0.015529	2.8	4.2	3.14	0.55	0.66	114.42	162.82	1.33
KLF861	861	50yr	325.6	1420.5	1421.72	1421.71	1422.07	0.008376	2.25	3.47	2.44	0.63	0.72	128.4	175.16	1.01
KLF861	861	100yr	387.3	1420.5	1421.9	1421.8	1422.22	0.005922	2.08	3.21	2.38	0.73	0.9	161.27	183.35	0.87
KLF802	802	50yr	359.4	1420.49	1421.57	1421.64	1422.06	0.009706	2.09	3.45	2.69	0.51	0.74	122.18	156.58	1.06
KLF802	802	100yr	426.7	1420.49	1421.74	1421.74	1422.2	0.007504	2.08	3.35	2.68	0.61	0.89	149.87	165.22	0.96
KLF763	763	50yr	359.4	1420	1421.44	1421.24	1421.73	0.004369	1.9	2.71	2.12	0.8	0.94	155.46	151.29	0.74
KLF763	763	100yr	426.7	1420	1421.56	1421.36	1421.88	0.00441	2.02	2.88	2.27	0.87	1.04	173.89	155.72	0.75
KLF739	739	50yr	359.4	1419.99	1421.18	1421.14	1421.59	0.007005	2.15	3.1	2.2	0.67	0.7	132.19	145.67	0.91
KLF739	739	100yr	426.7	1419.99	1421.31	1421.26	1421.75	0.006545	2.21	3.22	2.34	0.74	0.81	151.95	151.59	0.9
KLF710	710	50yr	359.4	1419.5	1421.13		1421.41	0.00365	1.54	2.72	2.27	0.67	1.2	160.67	148.68	0.69

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF710	710	100yr	426.7	1419.5	1421.26		1421.57	0.003625	1.64	2.86	2.41	0.74	1.32	181.29	154.63	0.7
KLF681	681	50yr	359.4	1419.5	1420.87		1421.26	0.005789	1.96	3.02	2.06	0.68	0.73	136.43	139.08	0.85
KLF681	681	100yr	426.7	1419.5	1420.99	1420.91	1421.43	0.005822	2.09	3.2	2.21	0.74	0.81	153.18	144.13	0.86
KLF652	652	50yr	359.4	1419.15	1420.81		1421.11	0.003558	1.48	2.6	1.7	0.65	0.79	158.95	146.69	0.68
KLF652	652	100yr	426.7	1419.15	1420.93		1421.27	0.003735	1.62	2.8	1.84	0.71	0.86	176.37	152.3	0.7
KLF608	608	50yr	359.4	1419	1420.77		1420.96	0.002089	1.34	2.18	1.62	0.83	1.09	197.91	165.52	0.53
KLF608	608	100yr	426.7	1419	1420.88		1421.1	0.002254	1.46	2.37	1.76	0.89	1.17	217.61	171.68	0.56
KLF571	571	50yr	359.4	1419	1420.73		1420.88	0.001571	1.27	1.9	1.32	0.95	1.01	225.17	182.18	0.46
KLF571	571	100yr	426.7	1419	1420.85		1421.02	0.001709	1.39	2.07	1.44	1.01	1.08	246.62	188.21	0.49
KLF535	535	50yr	359.4	1419	1420.7		1420.82	0.001255	1.08	1.68	1.05	0.87	0.85	247.38	198.03	0.41
KLF535	535	100yr	426.7	1419	1420.81		1420.95	0.00137	1.18	1.83	1.15	0.94	0.91	270.18	203.43	0.43
KLF500	500	50yr	359.4	1419	1420.68		1420.77	0.001017	1.1	1.5	1.02	1.06	0.94	271.82	205.38	0.37
KLF500	500	100yr	426.7	1419	1420.79		1420.9	0.001123	1.21	1.64	1.11	1.13	0.99	295.04	210.1	0.39
KLF459	459	50yr	359.4	1419	1420.65		1420.73	0.000838	0.96	1.35	0.75	1	0.7	291.38	212.62	0.33
KLF459	459	100yr	426.7	1419	1420.76		1420.85	0.000938	1.06	1.48	0.84	1.06	0.75	314.69	217.11	0.36
KLF434	434	50yr	359.4	1419	1420.63		1420.71	0.000847	1.09	1.34	0.71	1.19	0.63	297.38	221.42	0.34
KLF434	434	100yr	426.7	1419	1420.74		1420.83	0.000947	1.2	1.48	0.79	1.27	0.68	321.25	225.84	0.36
KLF385	385	50yr	359.4	1419	1420.27	1420.27	1420.59	0.010276	2.39	2.59	0.89	0.6	0.14	145.66	234.61	1.01
KLF385	385	100yr	426.7	1419	1420.35	1420.35	1420.7	0.010022	2.55	2.74	1.03	0.67	0.17	162.99	235.8	1.01
KLF342	342	50yr	359.4	1417	1417.91	1418.4	1419.6	0.049064	3.28	5.96	1.69	0.3	0.11	65.16	113.76	2.23
KLF342	342	100yr	426.7	1417	1418.01	1418.55	1419.76	0.043819	3.44	6.11	1.99	0.35	0.09	76.38	126.46	2.15
KLF301	301	50yr	359.4	1416.5	1417.83	1417.93	1418.4	0.01158	2.37	3.53	1.06	0.54	0.17	111.47	139.18	1.14
KLF301	301	100yr	426.7	1416.5	1417.91	1418.04	1418.57	0.01215	2.58	3.81	1.26	0.59	0.21	122.91	142.37	1.18
KLF261	261	50yr	359.4	1416	1417.64	1417.64	1418.05	0.008361	2.73	3.49	2.23	0.85	0.63	130.27	155.98	1
KLF261	261	100yr	426.7	1416	1417.74	1417.74	1418.2	0.008437	2.89	3.68	2.41	0.92	0.7	145.86	160.53	1.02
KLF254	254	50yr	359.4	1416	1417.5	1417.54	1417.97	0.009565	2.37	3.33	2.13	0.62	0.53	122.61	153.11	1.04
KLF254	254	100yr	426.7	1416	1417.61	1417.66	1418.12	0.009033	2.47	3.47	2.26	0.69	0.6	140.4	158.85	1.03
KLF217	217	50yr	359.4	1415.5	1417.42	1417.2	1417.67	0.003774	1.92	2.47	1.63	0.91	0.71	171.57	173.82	0.68
KLF217	217	100yr	426.7	1415.5	1417.53	1417.3	1417.81	0.003914	2.05	2.65	1.79	0.97	0.79	190.45	178.62	0.7

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF196	196	50yr	359.4	1415.5	1417.17	1417.16	1417.55	0.006947	2.16	3.14	1.92	0.69	0.58	140.13	172.66	0.91
KLF196	196	100yr	426.7	1415.5	1417.27	1417.25	1417.69	0.006907	2.29	3.3	2.1	0.75	0.66	157.82	176.88	0.92
KLF142	142	50yr	359.4	1415.5	1416.77	1416.77	1417.17	0.007297	2.26	3.12	1.69	0.71	0.46	136.48	170.81	0.93
KLF142	142	100yr	426.7	1415.5	1416.88	1416.88	1417.32	0.007205	2.38	3.29	1.85	0.77	0.53	154.66	177.23	0.94
KLF72	72	50yr	359.4	1415	1416.03	1416.12	1416.54	0.010959	1.93	3.28	1.16	0.41	0.19	118.28	162.78	1.1
KLF72	72	100yr	426.7	1415	1416.12	1416.23	1416.69	0.010935	2.17	3.48	1.23	0.49	0.21	132.94	169.33	1.11
KLF2578	2578	50yr	30.1	1521	1521.64	1521.79	1522.1	0.02619	0.93	3.17	1.14	0.07	0.1	11.59	55.09	1.51
KLF2578	2578	100yr	39.1	1521	1521.7	1521.86	1522.2	0.026201	1.2	3.42	1.33	0.11	0.12	14.81	65.32	1.53
KLF2499	2499	50yr	30.1	1519.35	1519.71	1519.77	1519.93	0.026389	1.42	2.25	0.96	0.13	0.07	15.37	80.39	1.39
KLF2499	2499	100yr	39.1	1519.35	1519.75	1519.82	1520.01	0.026786	1.6	2.47	1.12	0.16	0.09	18.4	85.68	1.43
KLF2426	2426	50yr	30.1	1517.21	1517.65	1517.75	1517.97	0.028093	1.4	2.72	1.51	0.13	0.14	13.06	57.94	1.49
KLF2426	2426	100yr	39.1	1517.21	1517.69	1517.81	1518.06	0.027422	1.57	2.93	1.7	0.15	0.17	15.94	62.25	1.5
KLF2381	2381	50yr	30.1	1515.76	1516.07	1516.18	1516.44	0.039905	1.35	2.87	1.84	0.09	0.15	11.87	56.91	1.72
KLF2381	2381	100yr	39.1	1515.76	1516.11	1516.25	1516.54	0.039825	1.53	3.14	2.04	0.11	0.17	14.3	61.25	1.76
KLF2331	2331	50yr	30.1	1514.94	1515.29	1515.29	1515.41	0.011768	0.65	1.56	0.61	0.08	0.07	20.25	88.41	0.94
KLF2331	2331	100yr	39.1	1514.94	1515.34	1515.34	1515.48	0.011553	0.76	1.71	0.76	0.1	0.1	24.44	94.71	0.95
KLF2287	2287	50yr	30.1	1514.5	1514.86	1514.8	1514.93	0.00534	0.63	1.18	0.63	0.13	0.13	28.37	112.72	0.65
KLF2287	2287	100yr	39.1	1514.5	1514.91	1514.84	1514.99	0.005542	0.71	1.31	0.71	0.15	0.15	33.73	120.89	0.68
KLF2220	2220	50yr	30.1	1514	1514.26	1514.26	1514.36	0.014591	0.41	1.44		0.03		21.04	104.17	0.99
KLF2220	2220	100yr	39.1	1514	1514.3	1514.3	1514.42	0.013687	0.57	1.55	0.03	0.06	0	25.69	111.83	0.99
KLF2139	2139	50yr	30.1	1512.37	1512.78	1512.83	1512.96	0.021016	0.77	2.06	1.3	0.06	0.14	16.74	83.73	1.25
KLF2139	2139	100yr	39.1	1512.37	1512.81	1512.87	1513.04	0.021813	0.95	2.28	1.45	0.08	0.16	19.9	89.28	1.3
KLF2067	2067	50yr	30.1	1510.02	1510.48	1510.6	1510.85	0.043797		2.7				11.17	46.46	1.76
KLF2067	2067	100yr	39.1	1510.02	1510.53	1510.67	1510.94	0.040564	0.39	2.85		0.01		13.76	53.77	1.73
KLF2012	2012	50yr	30.1	1508.41	1508.78	1508.84	1509.01	0.025404	0.85	2.17	0.85	0.06	0.06	14.63	70.53	1.36
KLF2012	2012	100yr	39.1	1508.41	1508.81	1508.9	1509.1	0.0272	1.02	2.44	1.03	0.08	0.08	17.18	76.06	1.43
KLF1940	1940	50yr	30.1	1505.41	1505.83	1506	1506.4	0.054308	1.18	3.46	1.7	0.06	0.1	9.44	42.58	2.03
KLF1940	1940	100yr	39.1	1505.41	1505.88	1506.07	1506.51	0.048753	1.44	3.67	1.87	0.09	0.13	11.89	47.66	1.97
KLF1889	1889	50yr	30.1	1503.6	1503.91	1503.99	1504.17	0.033232	0.09	2.24	0.31	0	0.01	13.45	61.68	1.51
KLF1889	1889	100yr	39.1	1503.6	1503.94	1504.05	1504.28	0.036455	0.43	2.56	0.6	0.02	0.03	15.39	64.59	1.62

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			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF1837	1837	50yr	30.1	1501.16	1501.4	1501.51	1501.76	0.069283		2.64				11.39	68.86	2.07
KLF1837	1837	100yr	39.1	1501.16	1501.44	1501.56	1501.84	0.063124		2.79				14.03	73.09	2.03
KLF1756	1756	50yr	30.1	1497.8	1498.14	1498.21	1498.38	0.027221	0.6	2.15	0.23	0.04	0.01	14.06	60.54	1.39
KLF1756	1756	100yr	39.1	1497.8	1498.18	1498.26	1498.48	0.028705	0.81	2.42	0.55	0.05	0.03	16.33	63.9	1.46
KLF1701	1701	50yr	30.1	1495.48	1495.86	1496	1496.31	0.05357	0.22	2.99		0		10.08	42	1.94
KLF1701	1701	100yr	39.1	1495.48	1495.91	1496.07	1496.44	0.048514	0.7	3.22	0.62	0.03	0.02	12.23	45.39	1.91
KLF1639	1639	50yr	30.1	1493.3	1493.67	1493.75	1493.94	0.027746		2.31	0.94		0.07	13.48	58.13	1.42
KLF1639	1639	100yr	39.1	1493.3	1493.71	1493.81	1494.04	0.030237		2.6	1.15		0.09	15.73	62.02	1.51
KLF1576	1576	50yr	30.1	1491.16	1491.42	1491.5	1491.68	0.047143	0.16	2.28		0		13.2	74.95	1.73
KLF1576	1576	100yr	39.1	1491.16	1491.45	1491.55	1491.76	0.04325	0.55	2.44		0.02		16.07	78.87	1.7
KLF1509	1509	50yr	30.1	1488.62	1488.94	1489.01	1489.18	0.030536		2.16				13.91	61.46	1.45
KLF1509	1509	100yr	39.1	1488.62	1488.98	1489.07	1489.27	0.032564		2.4				16.32	64.93	1.53
KLF1455	1455	50yr	30.1	1487.09	1487.42	1487.48	1487.63	0.026867	0.84	2.04	0.52	0.06	0.03	15.08	74.56	1.36
KLF1455	1455	100yr	39.1	1487.09	1487.46	1487.53	1487.71	0.025612	1.01	2.23	0.72	0.08	0.05	18.21	78.82	1.37
KLF1402	1402	50yr	30.1	1485.89	1486.22	1486.26	1486.41	0.019687	0.87	1.94	0.64	0.08	0.05	16.16	71.78	1.2
KLF1402	1402	100yr	39.1	1485.89	1486.26	1486.32	1486.49	0.0204	1.02	2.16	0.78	0.1	0.07	19.08	76.76	1.25
KLF1357	1357	50yr	30.1	1484.64	1485.03	1485.12	1485.31	0.030091	0.11	2.33	0.38	0	0.02	12.99	54.29	1.47
KLF1357	1357	100yr	39.1	1484.64	1485.08	1485.18	1485.41	0.02801	0.5	2.52	0.69	0.03	0.04	15.79	60.28	1.46
KLF1312	1312	50yr	30.1	1483.78	1484.2	1484.22	1484.37	0.0146	0.25	1.82	0.5	0.02	0.04	16.65	59.04	1.05
KLF1312	1312	100yr	39.1	1483.78	1484.25	1484.28	1484.46	0.015508	0.47	2.06	0.67	0.04	0.06	19.34	62.52	1.11
KLF1272	1272	50yr	30.1	1483	1483.53	1483.58	1483.76	0.015452	1	2.15	0.68	0.12	0.07	14.63	47.75	1.12
KLF1272	1272	100yr	39.1	1483	1483.6	1483.65	1483.86	0.014237	1.15	2.31	0.91	0.15	0.11	18.02	51.41	1.11
KLF1233	1233	50yr	30.1	1482.51	1483.09	1483.11	1483.31	0.010943	1.03	2.12	0.97	0.16	0.15	15.59	44.47	0.98
KLF1233	1233	100yr	39.1	1482.51	1483.19	1483.19	1483.41	0.009076	1.12	2.19	1.09	0.21	0.2	20.14	49.49	0.92
KLF1197	1197	50yr	30.1	1482	1482.61	1482.65	1482.86	0.014404	0.94	2.23	0.57	0.11	0.05	13.91	38.89	1.1
KLF1197	1197	100yr	39.1	1482	1482.66	1482.73	1482.98	0.015767	1.13	2.53	0.78	0.14	0.08	16.1	41.22	1.18
KLF1169	1169	50yr	30.1	1481.62	1482.24	1482.27	1482.48	0.012308	0.76	2.19	0.9	0.09	0.12	14.34	38.3	1.04
KLF1169	1169	100yr	39.1	1481.62	1482.33	1482.35	1482.59	0.011088	0.94	2.34	1.04	0.14	0.16	17.84	42.05	1.01
KLF1127	1127	50yr	30.1	1481	1481.56	1481.62	1481.85	0.018164		2.39	0.44		0.03	12.6	33.46	1.22

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF1127	1127	100yr	39.1	1481	1481.62	1481.71	1481.99	0.018895	0.3	2.67	0.72	0.02	0.06	14.75	35.77	1.28
KLF1094	1094	50yr	30.1	1480.5	1481.09	1481.11	1481.31	0.014182		2.11				14.29	36.95	1.08
KLF1094	1094	100yr	39.1	1480.5	1481.16	1481.19	1481.43	0.014129	0.42	2.3		0.03		17.05	39.56	1.1
KLF1049	1049	50yr	30.1	1479.5	1480.07	1480.18	1480.47	0.025018	1.09	2.81		0.09		10.87	29.94	1.44
KLF1049	1049	100yr	39.1	1479.5	1480.14	1480.27	1480.6	0.023919	1.35	3	0.08	0.13	0	13.31	32.6	1.44
KLF997	997	50yr	30.1	1478.22	1478.9	1479.01	1479.31	0.019676	1.12	2.83	0.56	0.12	0.04	10.92	26.77	1.32
KLF997	997	100yr	39.1	1478.22	1478.98	1479.12	1479.47	0.019568	1.35	3.12	0.86	0.16	0.08	13.06	29.01	1.35
KLF943	943	50yr	30.1	1477	1477.63	1477.78	1478.13	0.023783	0.85	3.12	0.83	0.07	0.07	9.82	23.83	1.45
KLF943	943	100yr	39.1	1477	1477.72	1477.9	1478.3	0.023164	1.15	3.42	1.13	0.11	0.11	11.84	26.06	1.47
KLF902	902	50yr	30.1	1476	1476.7	1476.85	1477.19	0.022808	1.1	3.11	1.1	0.1	0.1	10.06	25.44	1.42
KLF902	902	100yr	39.1	1476	1476.78	1476.96	1477.37	0.023317	1.36	3.46	1.36	0.14	0.14	12	27.59	1.47
KLF863	863	50yr	30.1	1475.4	1475.87	1475.97	1476.24	0.023776		2.67				11.29	30.2	1.39
KLF863	863	100yr	39.1	1475.4	1475.94	1476.06	1476.38	0.024609		2.94				13.31	31.56	1.44
KLF831	831	50yr	30.1	1474.65	1475.25	1475.32	1475.56	0.018515		2.44				12.33	31.18	1.24
KLF831	831	100yr	39.1	1474.65	1475.33	1475.4	1475.68	0.018159		2.64				14.83	32.96	1.25
KLF791	791	50yr	30.1	1473.5	1474.13	1474.29	1474.64	0.026565	1.45	3.21	0.88	0.14	0.07	9.79	25.95	1.52
KLF791	791	100yr	39.1	1473.5	1474.21	1474.4	1474.8	0.025035	1.7	3.47	1.17	0.18	0.11	11.95	27.96	1.52
KLF726	726	50yr	30.1	1472.33	1472.9	1472.98	1473.24	0.017066	0.91	2.6	0.94	0.1	0.1	11.95	30.37	1.22
KLF726	726	100yr	39.1	1472.33	1472.97	1473.08	1473.39	0.018138	1.12	2.92	1.17	0.13	0.13	13.98	32.31	1.29
KLF675	675	50yr	30.1	1471.03	1471.54	1471.68	1471.98	0.036869		2.95				10.2	32.56	1.68
KLF675	675	100yr	39.1	1471.03	1471.6	1471.76	1472.12	0.035001	0.54	3.19		0.03		12.29	34.37	1.68
KLF625	625	50yr	30.1	1469.97	1470.58	1470.62	1470.83	0.014377	0.36	2.22		0.03		13.59	33.62	1.1
KLF625	625	100yr	39.1	1469.97	1470.65	1470.7	1470.96	0.014964	0.62	2.48	0.34	0.06	0.02	15.84	35.69	1.15
KLF572	572	50yr	30.1	1469	1469.43	1469.54	1469.81	0.026597	0.73	2.74		0.05		11.06	32.26	1.46
KLF572	572	100yr	39.1	1469	1469.5	1469.63	1469.94	0.02493	1	2.97	0.49	0.08	0.03	13.34	34.36	1.46
KLF531	531	50yr	30.1	1468	1468.55	1468.64	1468.9	0.018545	1.06	2.64	0.68	0.11	0.06	11.75	31.18	1.27
KLF531	531	100yr	39.1	1468	1468.61	1468.74	1469.05	0.019313	1.28	2.95	0.94	0.15	0.09	13.86	33.4	1.32
KLF482	482	50yr	30.1	1467.08	1467.62	1467.72	1467.98	0.019341	1.6	2.8	1.32	0.2	0.15	11.91	33.63	1.3
KLF482	482	100yr	39.1	1467.08	1467.69	1467.81	1468.11	0.019228	1.8	3.06	1.51	0.24	0.19	14.34	35.89	1.33

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
KLF435	435	50yr	30.1	1466.08	1466.62	1466.73	1467	0.022119	1.73	2.87	1.36	0.21	0.14	11.6	34.34	1.38
KLF435	435	100yr	39.1	1466.08	1466.69	1466.82	1467.14	0.022153	1.94	3.15	1.6	0.24	0.18	13.89	36.33	1.41
KLF400	400	50yr	30.1	1465.37	1465.85	1465.94	1466.18	0.023143	0.68	2.54		0.05		11.91	35.06	1.36
KLF400	400	100yr	39.1	1465.37	1465.91	1466.02	1466.31	0.023393	0.94	2.79		0.08		14.14	37.14	1.4
KLF358	358	50yr	30.1	1464.5	1465.04	1465.12	1465.36	0.016965	1.46	2.73	1.73	0.19	0.25	12.71	35.7	1.23
KLF358	358	100yr	39.1	1464.5	1465.11	1465.21	1465.49	0.016912	1.69	2.97	1.9	0.24	0.29	15.28	37.66	1.26
KLF293	293	50yr	30.1	1462.98	1463.43	1463.57	1463.87	0.036336	2.92	2.95	0.75	0.31	0.04	10.31	34.14	1.67
KLF293	293	100yr	39.1	1462.98	1463.49	1463.65	1464.01	0.035754	3.13	3.28	1.07	0.35	0.07	12.4	36.61	1.71
KLF235	235	50yr	30.1	1461.62	1462.05	1462.12	1462.33	0.019357	2.34	2.42	1.44	0.36	0.17	13.33	41.43	1.26
KLF235	235	100yr	39.1	1461.62	1462.11	1462.2	1462.44	0.019943	2.52	2.71	1.66	0.39	0.21	15.87	44.01	1.31
KLF156	156	50yr	30.1	1460	1460.5	1460.56	1460.77	0.021056	2.35	2.28	0.63	0.34	0.05	13.04	41.08	1.28
KLF156	156	100yr	39.1	1460	1460.56	1460.64	1460.88	0.020652	2.48	2.54	0.84	0.37	0.07	15.8	45.14	1.31
KLF82	82	50yr	30.1	1458.71	1459.41	1459.42	1459.57	0.012669	1.85	1.68		0.35		17.05	53.04	0.98
KLF82	82	100yr	39.1	1458.71	1459.49	1459.49	1459.66	0.012535	1.84	1.86	0.25	0.35	0.02	21.18	63.05	1
HLF4038	4038	50yr	62.5	1500.16	1500.62	1500.69	1500.92	0.018755	1.63	2.47	0.72	0.21	0.06	26.37	74.26	1.25
HLF4038	4038	100yr	81.3	1500.16	1500.69	1500.77	1501.05	0.018732	1.82	2.73	0.96	0.25	0.1	31.25	76.96	1.28
HLF3984	3984	50yr	62.5	1498.41	1498.88	1499.06	1499.48	0.037621	2.38	3.6	1.87	0.22	0.16	18.98	57.19	1.78
HLF3984	3984	100yr	81.3	1498.41	1498.95	1499.16	1499.64	0.035606	2.58	3.89	2.19	0.26	0.21	23.08	59.98	1.78
HLF3940	3940	50yr	62.5	1496.5	1497.27	1497.5	1498.02	0.030231	1.8	3.9		0.17		16.92	37.24	1.67
HLF3940	3940	100yr	81.3	1496.5	1497.37	1497.64	1498.22	0.030027	2.12	4.2		0.22		20.73	41.31	1.7
HLF3883	3883	50yr	62.5	1495.62	1496.27	1496.36	1496.65	0.016716	1.65	2.91	1.93	0.24	0.3	23.94	55.26	1.25
HLF3883	3883	100yr	81.3	1495.62	1496.34	1496.46	1496.81	0.017607	1.89	3.24	2.19	0.28	0.35	28.11	57.74	1.31
HLF3828	3828	50yr	62.5	1494.31	1494.93	1495.09	1495.47	0.027033	2.88	3.84	2.87	0.38	0.38	19.69	46.15	1.6
HLF3828	3828	100yr	81.3	1494.31	1495.02	1495.21	1495.63	0.025515	3.06	4.11	3.07	0.44	0.44	24.12	49.45	1.59
HLF3779	3779	50yr	62.5	1492.5	1493.72	1493.94	1494.42	0.017064	2.13	4.26	2.24	0.34	0.37	19.29	36.69	1.38
HLF3779	3779	100yr	81.3	1492.5	1493.84	1494.09	1494.61	0.016974	2.34	4.58	2.5	0.4	0.44	23.8	40.83	1.4
HLF3724	3724	50yr	62.5	1492	1492.69	1492.87	1493.27	0.024582	2.28	3.54	1.14	0.29	0.1	19.48	45.03	1.51
HLF3724	3724	100yr	81.3	1492	1492.78	1492.99	1493.46	0.025062	2.53	3.92	1.44	0.33	0.14	23.24	48.15	1.56
HLF3664	3664	50yr	62.5	1490.5	1491.23	1491.42	1491.84	0.022807	1.82	3.65	2	0.22	0.25	19.16	42.46	1.48
HLF3664	3664	100yr	81.3	1490.5	1491.32	1491.54	1492.04	0.022525	2.08	3.98	2.25	0.27	0.3	23.22	45.64	1.51

HecRas Output Table

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			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
HLF3604	3604	50yr	62.5	1489.51	1490.18	1490.28	1490.59	0.017477	2.37	3.09	1.33	0.4	0.17	22.87	50.39	1.29
HLF3604	3604	100yr	81.3	1489.51	1490.26	1490.4	1490.76	0.018172	2.6	3.44	1.59	0.44	0.21	27.11	53.65	1.34
HLF3547	3547	50yr	62.5	1488.56	1489.06	1489.17	1489.46	0.02207	1.75	2.87	1.11	0.21	0.11	23.28	63.63	1.38
HLF3547	3547	100yr	81.3	1488.56	1489.13	1489.27	1489.6	0.021957	1.96	3.15	1.37	0.25	0.15	27.81	66.8	1.41
HLF3484	3484	50yr	62.5	1487.14	1487.7	1487.81	1488.1	0.020748	2.16	2.94	1.1	0.3	0.11	22.94	57.59	1.36
HLF3484	3484	100yr	81.3	1487.14	1487.77	1487.91	1488.25	0.020613	2.37	3.23	1.34	0.35	0.15	27.41	60.61	1.38
HLF3430	3430	50yr	62.5	1485.97	1486.64	1486.76	1487.07	0.017854	2.31	3.22	1.68	0.37	0.23	22.6	50.65	1.31
HLF3430	3430	100yr	81.3	1485.97	1486.73	1486.87	1487.23	0.017715	2.48	3.51	1.9	0.42	0.28	27.37	54.87	1.34
HLF3380	3380	50yr	62.5	1484.95	1485.66	1485.79	1486.12	0.020108	1.99	3.09	0.89	0.27	0.08	21.58	49.02	1.36
HLF3380	3380	100yr	81.3	1484.95	1485.75	1485.9	1486.29	0.019814	2.21	3.39	1.17	0.32	0.12	25.89	52	1.38
HLF3322	3322	50yr	62.5	1483	1484.08	1484.32	1484.82	0.023879	0.93	3.81		0.08		16.56	27.97	1.52
HLF3322	3322	100yr	81.3	1483	1484.21	1484.48	1485.04	0.022406	1.32	4.05	0.57	0.14	0.04	20.58	33.79	1.51
HLF3254	3254	50yr	62.5	1482.29	1483.21	1483.29	1483.6	0.011993	1.64	2.95	1.15	0.3	0.18	24.44	49.8	1.1
HLF3254	3254	100yr	81.3	1482.29	1483.29	1483.42	1483.78	0.013399	1.89	3.35	1.4	0.34	0.22	28.53	53.56	1.19
HLF3189	3189	50yr	62.5	1481.54	1482.05	1482.17	1482.48	0.027047	2.43	3.07	0.97	0.3	0.07	22.01	61.61	1.51
HLF3189	3189	100yr	81.3	1481.54	1482.12	1482.27	1482.61	0.025211	2.56	3.31	1.24	0.34	0.11	26.91	65.78	1.5
HLF3127	3127	50yr	62.5	1480.5	1481.09	1481.12	1481.36	0.012002	1.51	2.41	1.14	0.26	0.18	28.29	65.87	1.05
HLF3127	3127	100yr	81.3	1480.5	1481.16	1481.21	1481.49	0.012675	1.73	2.69	1.38	0.31	0.22	33.12	68.15	1.1
HLF3074	3074	50yr	62.5	1480	1480.52	1480.51	1480.73	0.009864	1.25	2.05	0.16	0.23	0.01	31.38	69.66	0.94
HLF3074	3074	100yr	81.3	1480	1480.59	1480.59	1480.86	0.010531	1.43	2.32	0.44	0.27	0.05	36.3	71.7	0.99
HLF3028	3028	50yr	62.5	1479.5	1480.03	1480.03	1480.26	0.010428	1.46	2.22	1.42	0.28	0.27	29.84	65.05	0.98
HLF3028	3028	100yr	81.3	1479.5	1480.12	1480.12	1480.4	0.010176	1.61	2.43	1.61	0.33	0.33	35.64	67.08	0.99
HLF2973	2973	50yr	62.5	1478.82	1479.48	1479.43	1479.67	0.007468	0.76	1.99	1.33	0.14	0.31	32.91	65.18	0.84
HLF2973	2973	100yr	81.3	1478.82	1479.59	1479.53	1479.81	0.006904	0.92	2.14	1.47	0.19	0.39	40	67.68	0.83
HLF2920	2920	50yr	62.5	1478	1478.95	1478.95	1479.25	0.008114	1.11	2.48	1.1	0.22	0.22	27.46	49.3	0.91
HLF2920	2920	100yr	81.3	1478	1479.08	1479.08	1479.41	0.00762	1.27	2.66	1.29	0.29	0.3	33.94	53.69	0.91
HLF2857	2857	50yr	62.5	1477.4	1478.21	1478.27	1478.6	0.012887	0.83	2.8	1.2	0.1	0.18	23.04	42.02	1.12
HLF2857	2857	100yr	81.3	1477.4	1478.31	1478.4	1478.78	0.012865	1.09	3.09	1.43	0.15	0.23	27.5	44.64	1.15
HLF2795	2795	50yr	62.5	1476.86	1477.46	1477.5	1477.75	0.013538	1.42	2.43		0.22		26.32	56.63	1.1

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			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
HLF2795	2795	100yr	81.3	1476.86	1477.53	1477.6	1477.9	0.014697	1.68	2.73		0.27		30.56	58.86	1.17
HLF2762	2762	50yr	62.5	1476.34	1476.98	1477.02	1477.29	0.014737		2.47				25.27	52.87	1.14
HLF2762	2762	100yr	81.3	1476.34	1477.08	1477.13	1477.44	0.013499	0.27	2.65	0.5	0.02	0.05	30.7	55.75	1.12
HLF2710	2710	50yr	62.5	1476	1476.54	1476.54	1476.8	0.010964	1.94	2.32	2.03	0.43	0.44	28.06	55.34	1.01
HLF2710	2710	100yr	81.3	1476	1476.64	1476.64	1476.94	0.010365	2.07	2.53	2.17	0.49	0.51	33.71	56.68	1.01
HLF2664	2664	50yr	62.5	1473.5	1474.95	1475.3	1475.96	0.027493		4.45				14.05	19.12	1.66
HLF2664	2664	100yr	81.3	1473.5	1475.13	1475.43	1476.16	0.024443	1.22	4.53		0.11		18.59	29.28	1.59
HLF2626	2626	50yr	62.5	1473	1474.42	1474.57	1475.03	0.017157		3.48				17.94	24.83	1.31
HLF2626	2626	100yr	81.3	1473	1474.53	1474.76	1475.3	0.017893	0.34	3.87	0.62	0.02	0.05	21.09	28.29	1.37
HLF2584	2584	50yr	62.5	1472	1474.22	1474.22	1474.57	0.006592	1.17	2.77	1.14	0.29	0.27	25.93	39.55	0.85
HLF2584	2584	100yr	81.3	1472	1474.37	1474.37	1474.77	0.006443	1.35	2.99	1.36	0.36	0.36	32.24	44.41	0.86
HLF2527	2527	50yr	62.5	1472	1473.31	1473.49	1473.94	0.019925		3.5	0.06		0	17.84	27.56	1.39
HLF2527	2527	100yr	81.3	1472	1473.45	1473.65	1474.16	0.018234		3.72	0.78		0.07	22.11	32.74	1.36
HLF2480	2480	50yr	62.5	1471.5	1472.94	1472.94	1473.36	0.008801	0.9	2.86	0.51	0.15	0.07	22.33	29.76	0.97
HLF2480	2480	100yr	81.3	1471.5	1473.09	1473.12	1473.58	0.008506	1.15	3.13	0.84	0.23	0.14	27.18	33.59	0.98
HLF2432	2432	50yr	62.5	1471	1472.54	1472.55	1472.92	0.00929	0.77	2.76	0.66	0.12	0.09	23.17	34.48	0.98
HLF2432	2432	100yr	81.3	1471	1472.64	1472.72	1473.14	0.010246	1.03	3.14	0.97	0.17	0.15	26.91	37.29	1.05
HLF2388	2388	50yr	62.5	1470.5	1472.21	1472.09	1472.48	0.005338	1.07	2.36	0.64	0.29	0.14	27.99	36.92	0.77
HLF2388	2388	100yr	81.3	1470.5	1472.33	1472.24	1472.67	0.005802	1.27	2.66	0.86	0.36	0.2	32.75	39.81	0.82
HLF2337	2337	50yr	62.5	1471	1471.86	1471.82	1472.13	0.008771	0.52	2.33		0.07		26.85	42.76	0.93
HLF2337	2337	100yr	81.3	1471	1471.96	1471.95	1472.31	0.009169	0.78	2.6		0.12		31.51	45	0.97
HLF2296	2296	50yr	62.5	1470.51	1471.46	1471.46	1471.78	0.008082	1.47	2.64	1.26	0.34	0.27	26.18	42.07	0.93
HLF2296	2296	100yr	81.3	1470.51	1471.6	1471.6	1471.96	0.00753	1.63	2.83	1.45	0.42	0.35	32.29	45.18	0.92
HLF2248	2248	50yr	62.5	1469	1470.48	1470.69	1471.17	0.020123	1.75	3.73	0.81	0.23	0.07	17.73	31.37	1.41
HLF2248	2248	100yr	81.3	1469	1470.61	1470.85	1471.38	0.018554	1.99	4	1.19	0.29	0.14	21.99	34.85	1.39
HLF2202	2202	50yr	62.5	1468.5	1470.26	1470.26	1470.56	0.007431	1.74	2.77	1.48	0.47	0.37	28.07	46.12	0.89
HLF2202	2202	100yr	81.3	1468.5	1470.37	1470.39	1470.73	0.00796	1.98	3.07	1.72	0.54	0.44	33.06	48.45	0.93
HLF2153	2153	50yr	62.5	1467.5	1469.55	1469.67	1470.03	0.016218	1.12	3.13	1.66	0.14	0.25	21.36	41.38	1.23
HLF2153	2153	100yr	81.3	1467.5	1469.68	1469.8	1470.2	0.014522	1.37	3.32	1.9	0.2	0.33	26.65	44.63	1.2

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
HLF2111	2111	50yr	62.5	1466.5	1468.68	1468.88	1469.32	0.016934	1.3	3.63		0.16		19.08	37.68	1.29
HLF2111	2111	100yr	81.3	1466.5	1468.79	1468.99	1469.51	0.017798	1.8	3.92		0.26		23.44	40.56	1.34
HLF2060	2060	50yr	62.5	1465.5	1467.01	1467.43	1468.3	0.020502		5.04				12.4	10.54	1.48
HLF2060	2060	100yr	81.3	1465.5	1467.38	1467.86	1468.58	0.016614		4.85				16.75	12.94	1.36
HLF2012	2012	50yr	62.5	1465.44	1467.15	1467.18	1467.59	0.005354	0.9	3.1	1.2	0.23	0.35	24.3	34.13	0.81
HLF2012	2012	100yr	81.3	1465.44	1467.18	1467.37	1467.88	0.008367	1.19	3.93	1.55	0.24	0.36	25.2	34.72	1.01
HLF1964	1964	50yr	62.5	1464.5	1465.89	1466.27	1467.01	0.03094	1.17	4.7		0.09		13.37	19.15	1.75
HLF1964	1964	100yr	81.3	1464.5	1466.09	1466.48	1467.2	0.024717	1.33	4.68	0.68	0.13	0.05	17.81	25.15	1.61
HLF1922	1922	50yr	62.5	1464.5	1465.8	1465.8	1466.12	0.009294	1.23	2.57		0.24		25.5	41.87	0.97
HLF1922	1922	100yr	81.3	1464.5	1465.86	1465.94	1466.31	0.011703	1.52	3.01		0.27		28.49	44.17	1.1
HLF1881	1881	50yr	62.5	1464	1465.16	1465.27	1465.63	0.015056	1.95	3.17		0.33		21.27	37.34	1.22
HLF1881	1881	100yr	81.3	1464	1465.31	1465.41	1465.8	0.012842	2.06	3.29	0.56	0.4	0.06	27.08	42.56	1.16
HLF1827	1827	50yr	62.5	1463.5	1464.7	1464.71	1465	0.008203	1.08	2.57	1.59	0.21	0.38	27.39	47.92	0.92
HLF1827	1827	100yr	81.3	1463.5	1464.77	1464.83	1465.17	0.009844	1.33	2.99	1.87	0.26	0.43	30.96	50.16	1.03
HLF1781	1781	50yr	62.5	1463	1464.06	1464.17	1464.49	0.014993	1.81	3.04	1.1	0.29	0.14	22.94	47.97	1.21
HLF1781	1781	100yr	81.3	1463	1464.18	1464.28	1464.64	0.013381	2.01	3.21	1.36	0.38	0.21	28.67	51.18	1.17
HLF1731	1731	50yr	62.5	1463	1463.69	1463.65	1463.91	0.008892	1.73	2.15		0.41		30.23	57.47	0.91
HLF1731	1731	100yr	81.3	1463	1463.78	1463.76	1464.05	0.009457	1.93	2.4		0.46		35.28	59.72	0.96
HLF1661	1661	50yr	62.5	1462.5	1463	1463	1463.23	0.011552	2.06	2.14		0.44		29.81	66.58	1
HLF1661	1661	100yr	81.3	1462.5	1463.09	1463.09	1463.36	0.011091	2.22	2.32		0.5		35.83	68.96	1.01
HLF1604	1604	50yr	62.5	1461.19	1461.77	1461.92	1462.25	0.026226	2.17	3.27		0.26		21.37	57.36	1.52
HLF1604	1604	100yr	81.3	1461.19	1461.84	1462.01	1462.4	0.026226	2.47	3.53		0.31		25.61	59.93	1.55
HLF1553	1553	50yr	62.5	1460	1460.8	1460.92	1461.25	0.015649	1.52	3.05	0.41	0.22	0.03	22	44.82	1.23
HLF1553	1553	100yr	81.3	1460	1460.91	1461.05	1461.43	0.015041	1.71	3.31	0.78	0.27	0.08	26.9	49.73	1.24
HLF1504	1504	50yr	62.5	1459.83	1460.45	1460.45	1460.67	0.010996	1.84	2.25		0.38		30.84	71.18	1
HLF1504	1504	100yr	81.3	1459.83	1460.54	1460.54	1460.79	0.01075	2.03	2.41		0.45		37.03	74.13	1.01
HLF1449	1449	50yr	62.5	1459	1459.85	1459.9	1460.09	0.010782	1.33	2.39		0.24		31.68	85.96	1.01
HLF1449	1449	100yr	81.3	1459	1459.92	1459.97	1460.2	0.011562	1.53	2.62		0.28		37.81	92.86	1.06
HLF1385	1385	50yr	100.7	1457	1457.66	1458.22	1459.89	0.096427		6.61				15.23	29.67	2.95
HLF1385	1385	100yr	130.8	1457	1457.82	1458.44	1460.01	0.069175		6.55				19.96	30.66	2.59

HecRas Output Table

Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
HLF1348	1348	50yr	100.7	1456	1458.14	1458.3	1458.77	0.006765	1.32	3.8	1.43	0.33	0.38	33.77	44.83	0.92
HLF1348	1348	100yr	130.8	1456	1458.37	1458.51	1458.99	0.006097	1.55	3.92	1.66	0.46	0.51	44.98	53.32	0.89
HLF1310	1310	50yr	100.7	1455.69	1457.57	1457.84	1458.43	0.011167	1.58	4.3	1.38	0.3	0.25	27.83	39.3	1.16
HLF1310	1310	100yr	130.8	1455.69	1457.76	1458.05	1458.67	0.01049	1.93	4.54	1.67	0.43	0.34	35.96	45.69	1.15
HLF1270	1270	50yr	100.7	1455.5	1457.43	1457.59	1458	0.006964	1.69	3.84	1.69	0.48	0.48	35.78	47.18	0.95
HLF1270	1270	100yr	130.8	1455.5	1457.58	1457.76	1458.25	0.007566	1.84	4.24	1.99	0.51	0.57	43.44	53.89	1
HLF1234	1234	50yr	100.7	1455.5	1457.33	1457.34	1457.74	0.005155	1.33	3.29	1.71	0.42	0.61	41.4	50.89	0.81
HLF1234	1234	100yr	130.8	1455.5	1457.52	1457.52	1457.96	0.005038	1.51	3.49	1.92	0.51	0.73	51.49	56.25	0.81
HLF1196	1196	50yr	100.7	1455.5	1456.68	1456.89	1457.4	0.015463	1.11	4.25	2.41	0.14	0.44	29.6	46.91	1.32
HLF1196	1196	100yr	130.8	1455.5	1456.81	1457.06	1457.62	0.015186	1.5	4.56	2.74	0.22	0.54	35.99	49.57	1.33
HLF1157	1157	50yr	100.7	1455	1456.24	1456.4	1456.83	0.012118		3.64	1.56		0.28	33.31	59.03	1.16
HLF1157	1157	100yr	130.8	1455	1456.35	1456.55	1457.03	0.013247		3.98	1.97		0.37	39.86	61.91	1.23
HLF1122	1122	50yr	100.7	1454.5	1455.84	1456	1456.4	0.012419	0.42	3.51	1.62	0.04	0.29	33.87	60.14	1.17
HLF1122	1122	100yr	130.8	1454.5	1456.28	1456.14	1456.54	0.003765	0.75	2.51	1.52	0.22	0.64	63.52	73.14	0.68
HLF1086	1086	50yr	100.7	1454.5	1456.08	1455.66	1456.21	0.001715	0.66	1.69	1.01	0.33	0.63	68.79	74.91	0.46
HLF1086	1086	100yr	130.8	1454.5	1456.27		1456.42	0.0017	0.81	1.84	1.15	0.46	0.76	83.31	79.47	0.47
HLF1050	1050	50yr	100.7	1454.5	1455.7	1455.7	1456.08	0.00698	1.15	2.85	1.54	0.26	0.41	39.73	55.35	0.89
HLF1050	1050	100yr	130.8	1454.5	1455.86	1455.86	1456.28	0.006621	1.36	3.06	1.75	0.35	0.52	49.11	60.39	0.89
HLF1005	1005	50yr	100.7	1454	1455.05	1455.19	1455.62	0.013649	1.68	3.49	1.68	0.28	0.28	31.76	50.54	1.21
HLF1005	1005	100yr	130.8	1454	1455.18	1455.35	1455.84	0.013388	1.95	3.8	1.97	0.36	0.37	38.47	53.72	1.23
HLF957	957	50yr	100.7	1453.72	1454.54	1454.61	1454.93	0.012858	1.2	2.81	1.03	0.18	0.14	37.01	67.11	1.12
HLF957	957	100yr	130.8	1453.72	1454.62	1454.73	1455.13	0.014537	1.48	3.23	1.36	0.22	0.2	42.26	69.06	1.21
HLF910	910	50yr	100.7	1452.5	1453.8	1453.91	1454.28	0.014807		3.23	1.93		0.33	34.13	59.8	1.22
HLF910	910	100yr	130.8	1452.5	1453.92	1454.06	1454.46	0.013845	0.47	3.44	2.14	0.04	0.4	41.96	65.13	1.21
HLF860	860	50yr	100.7	1452	1453.51	1453.51	1453.81	0.006621	1.84	2.85	1.42	0.56	0.38	45.53	71.67	0.87
HLF860	860	100yr	130.8	1452	1453.63	1453.63	1453.98	0.006883	2.04	3.12	1.66	0.63	0.47	54.33	75.7	0.9
HLF807	807	50yr	100.7	1451.5	1452.97	1453.06	1453.34	0.012078	2.23	3.44	1.87	0.48	0.37	41.46	84.81	1.13
HLF807	807	100yr	130.8	1451.5	1453.06	1453.16	1453.49	0.01274	2.49	3.74	2.15	0.54	0.43	48.9	88.27	1.18
HLF771	771	50yr	100.7	1451.5	1452.57	1452.62	1452.89	0.012424	2.21	3.09	2.18	0.46	0.45	41.54	81.89	1.12

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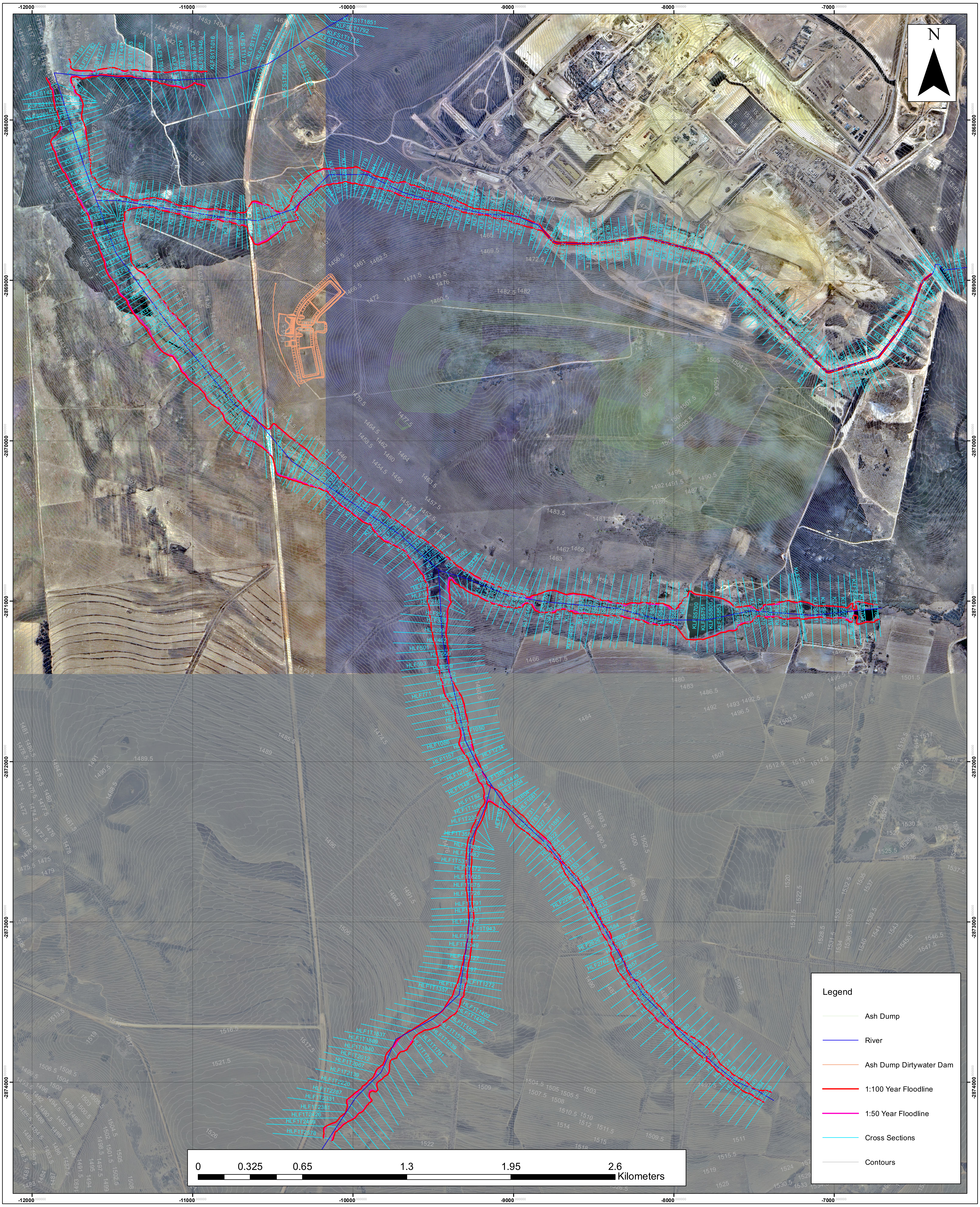
Node	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Left	Vel Chnl	Vel Right	Hydr Depth L	Hydr Depth R	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(m2)	(m)	
HLF771	771	100yr	130.8	1451.5	1452.76	1452.72	1453.04	0.007875	2.09	2.85	2.1	0.59	0.6	57.58	87.91	0.93
HLF724	724	50yr	100.7	1451	1452.34	1452.22	1452.56	0.005123	1.25	2.14	0.98	0.38	0.27	50.31	71.68	0.74
HLF724	724	100yr	130.8	1451	1452.49		1452.74	0.004883	1.38	2.32	1.14	0.46	0.34	61.04	76.07	0.74
HLF682	682	50yr	100.7	1450.5	1451.94	1451.94	1452.28	0.008363	1.21	2.68	1.67	0.25	0.41	40.86	62.07	0.94
HLF682	682	100yr	130.8	1450.5	1452.08	1452.08	1452.47	0.008101	1.4	2.91	1.85	0.32	0.49	49.38	65.79	0.95
HLF629	629	50yr	100.7	1450	1451.19	1451.3	1451.69	0.014611	1.49	3.22	1.59	0.23	0.25	33.17	56.54	1.21
HLF629	629	100yr	130.8	1450	1451.3	1451.45	1451.89	0.014071	1.7	3.5	1.87	0.28	0.33	40.12	59.87	1.22
HLF593	593	50yr	100.7	1449.5	1450.95	1450.95	1451.26	0.009862	1.09	2.49	1.59	0.19	0.33	41.81	70.26	0.98
HLF593	593	100yr	130.8	1449.5	1451.07	1451.07	1451.43	0.009559	1.27	2.73	1.75	0.25	0.39	49.93	72.64	0.99
HLF550	550	50yr	100.7	1449.5	1450.25	1450.34	1450.68	0.01812		2.93				34.4	64.98	1.28
HLF550	550	100yr	130.8	1449.5	1450.35	1450.46	1450.86	0.017666		3.19				41.01	66.84	1.3
HLF501	501	50yr	100.7	1448.5	1449.75	1449.75	1450.04	0.011136		2.38				42.23	75.14	1.02
HLF501	501	100yr	130.8	1448.5	1449.87	1449.87	1450.2	0.010317		2.56				51.13	77.29	1
HLF462	462	50yr	100.7	1448.5	1449.32	1449.34	1449.62	0.01181	0.22	2.42	0.68	0.02	0.08	41.81	78.5	1.04
HLF462	462	100yr	130.8	1448.5	1449.43	1449.45	1449.78	0.011083	0.57	2.63	0.91	0.07	0.13	50.09	80.33	1.04
HLF399	399	50yr	100.7	1447.57	1448.62	1448.63	1448.9	0.012377		2.35				42.9	84.92	1.05
HLF399	399	100yr	130.8	1447.57	1448.71	1448.74	1449.05	0.01225		2.57				50.85	87.03	1.07
HLF339	339	50yr	100.7	1447	1447.85	1447.88	1448.15	0.012506		2.46	1.19		0.18	41.87	84.29	1.07
HLF339	339	100yr	130.8	1447	1447.94	1448	1448.3	0.012586		2.68	1.39		0.23	50.17	90.19	1.09
HLF297	297	50yr	100.7	1446.5	1447.46	1447.46	1447.73	0.007828	1.54	2.56	1.33	0.38	0.3	47.76	91.77	0.91
HLF297	297	100yr	130.8	1446.5	1447.57	1447.58	1447.88	0.007801	1.73	2.77	1.51	0.45	0.37	57.85	98.35	0.93
HLF218	218	50yr	100.7	1445.5	1446.56	1446.67	1446.94	0.013267	1.87	3.11	1.52	0.32	0.25	41.73	102.95	1.16
HLF218	218	100yr	130.8	1445.5	1446.64	1446.76	1447.07	0.013699	2.06	3.39	1.8	0.37	0.31	50.1	108.08	1.2
HLF157	157	50yr	100.7	1445.5	1446.47	1446.27	1446.55	0.002932	0.74	1.42	0.97	0.26	0.4	81.5	156.52	0.54
HLF157	157	100yr	130.8	1445.5	1446.56	1446.35	1446.66	0.003068	0.86	1.58	1.1	0.32	0.46	95.84	162.84	0.57
HLF95	95	50yr	100.7	1445.5	1446.08	1446.08	1446.27	0.008278	1.07	2.06	1.21	0.21	0.25	58.46	160.85	0.88
HLF95	95	100yr	130.8	1445.5	1446.16	1446.16	1446.36	0.008205	1.26	2.23	1.32	0.27	0.29	70.75	169.61	0.89
HLF37	37	50yr	100.7	1445	1445.53	1445.56	1445.73	0.010669	1.36	2.12	0.93	0.25	0.14	56.16	183.29	0.97
HLF37	37	100yr	130.8	1445	1445.58	1445.62	1445.82	0.011278	1.54	2.35	1.17	0.29	0.19	66.44	188.03	1.02

Appendix B: Drawings



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CESA Consulting Engineers South Africa

TITLE:
Kusile Power Plant
Klipfonteinspruit and Tributaries
1:50 year and 1:100 year Floodlines

		DATE	CHECKED
DESIGNED	MATH	18 06 2014	MAHD
DRAWN	MATH	18 06 2014	MAHD
A1	SCALE :	1:11 134	

CLIENT: ILISO Consulting

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