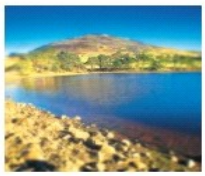




A96 Corridor Wastewater Development Option Study

12/01/2007

A96 CORRIDOR WASTEWATER DEVELOPMENT OPTION STUDY

CONTENTS

1.0 EXECUTIVE SUMMARY

This report delivers the Options for treating the foul waters from the proposed new development Along the A96 Corridor between Inverness and Nairn. The study was commissioned by the Scottish Water Development Group on behalf of The Highland Council to an agreed scope of work:

- Meet with the Client, Scottish Water and SEPA to confirm the Project needs.
- Collate and assimilate existing Data and define Baseline Data.
- Visit the proposed site and existing treatment facilities in the area to undertake asset survey.
- Develop Options by a desk top study of:

  New treatment works.

  Upgrading the existing works.

The Options generated are to treat the ultimate flows from the proposed development and so identify the total prospective costs and risk. It is acknowledged that the development is programmed to occur over a 35 year investment period in discrete phases, however at this stage, no consideration is given to treat the potential flows from the initial stage of the development.

Key to the development process has been the identification of risk associated with any given options. Certain risks have been identified that are common to all options. These are detailed in Section 4.

During Option Development and following surveys and the investigation of record drawings it became apparent that certain proposed options would not generate practical solutions and have not been brought forward to costing and conclusion. Similarly it became apparent that to ensure a comprehensive study and as part of the risk mitigation and development process, alternative solutions were identified as meriting further investigation.

The options have been evaluated on cost and risk and, in accordance with client instructions, the only consultations have been with SEPA. Options have been developed to meet the standards assumed based on the receiving water designations and associated legislation.

The PFI at Allanfearn WwTW have confirmed that the additional flows/loads would have a significant impact on the works and therefore substantial investment would be

required. Additionally the proposed flows from the central area would push the DWF at Allanfearn WwTW above the consented figure and this Works is reported as already experiencing difficulties during storm events.

The current Scottish Water sludge strategy indicates that all additional sludges from the Inverness and Nairn developments will be transported to Allanfearn WwTW for treatment. The increase solids load from additional sludges from the surrounding area would overload the sludge stream at Allanfearn WwTW which is the main reception centre for thickened sludge. The only alternative sludge centre is at Lossiemouth WwTW, which is a further 50km east of Nairn.

It is acknowledged that settlement expansions are considered for the villages of Culloden Moor/Sunnyside, Croy and Cawdor. From the baseline data received (see section 3) the additional flows and loads calculated would require these works to be extended. An indication of development potential for each of these works is detailed in section 9. It is envisaged that the final solution may be to transfer all flows from these areas to a new works to be constructed in the central area.

To develop options and to match the aspirations of the Highland Council 3 agglomerations have been assumed: Inverness East; Central and Nairn.

Inverness East has 2 options, Nairn Area 4 options and Central Area 4 options. Some of the options are interdependent e.g. the options include transferring flows to the adjacent agglomerations for treatment and discharge. Hence the selection of a transfer option from one agglomeration would necessitate the selection of a matching option in the adjacent agglomeration. For example, the selection of Inverness East option 2 would necessitate the selection of Central Area option 1A and would give the opportunity to include Nairn Area option 2. This would result in a single new asset to treat all the flows from the 3 new agglomerations.

The Options with their key components are summarised as follows:

INVERNESS EAST AREA

OPTION 1 – TRANSFER WASTEWATER TO ALLANFEARN WwTW (PFI)

Capital Cost £ 6,381,000

The wastewaters from the separate networks constructed at Inverness East and Culloden are forwarded to the site of the existing PFI at Allanfearn. The effluent is treated by a new side stream plant to 25mg/l BOD:35mg/l suspended solids prior to disinfection and discharge via the existing pumping station and outfall.

Note that this does not include any current proposal to transfer additional flow to the works from another area, such as North Kessock.

OPTION 2 – TRANSFER WASTEWATER TO A NEW WORKS IN CENTRAL AREA

Capital Cost £ 1,895,000

The wastewaters from the separate networks constructed at Inverness East and Culloden are forwarded to the site of a new works constructed at Ardersier. This works will be constructed to treat the wastewater from the central development. The capacity of this works (Central option 1A) is increased to accommodate the additional influent.

NAIRN AREA

OPTION 1 – TRANSFER WASTEWATER TO EXISTING NAIRN WwTW

Capital Cost £ 5,147,000

The wastewaters from the separate networks constructed at Nairn are forwarded via a new rising main to the existing asset at Nairn East. The effluent is treated via a low footprint plant to 20mg/l BOD:30mg/l suspended solids and UV disinfection and discharge via the existing outfall.

OPTION 2 – TRANSFER WASTEWATER TO NEW WORKS CONSTRUCTED AT ARDERSIER

Capital Cost £ 1,618,000

The wastewaters from the separate networks constructed at Nairn are forwarded via a new rising main to the new works constructed at Ardersier. This works will be constructed to treat the wastewater from the central development. The capacity of this works (Central option 1A) is increased to accommodate the additional influent.

OPTION 3 – TRANSFER WASTEWATER TO NEW WORKS WITH SEA OUTFALL

Capital Cost £ 3,907,000

The wastewaters from the separate networks constructed at Nairn are forwarded via a new rising main to a new primary treatment facility located west of Nairn for discharge to unclassified waters.

OPTION 4 – TRANSFER WASTEWATER TO NEW WORKS WITH RIVER NAIRN OUTFALL

Capital Cost £ 7,887,000

The wastewaters from the separate networks constructed at Nairn are forwarded via a new rising main to a new treatment plant at Nairn South. The effluent is treated with a membrane process to produce a very high quality effluent for discharge to the river Nairn.

CENTRAL AREA

OPTION 1A – TRANSFER WASTEWATER TO NEW WORKS CONSTRUCTED ON EXISTING ARDERSIER WwTW SITE WITH DISCHARGE VIA A LONG SEA OUTFALL, NORTH EAST OF FORT GEORGE.

Capital Cost £ 9,308,000

The wastewaters from the separate networks constructed at Tornagrain, Ardersier and Whiteness Head are forwarded via new rising mains to the site of an existing treatment works at Ardersier. The effluent is treated by a new treatment works to 20mg/l BOD:30mg/l suspended solids and discharged via a long sea outfall beyond Whiteness Head.

OPTION 1B – TRANSFER WASTEWATER TO NEW WORKS CONSTRUCTED ON EXISTING ARDERSIER WwTW SITE WITH DISCHARGE VIA A SHORT SEA OUTFALL WEST OF ARDERSIER

Capital Cost £ 7,974,000

The wastewaters from the separate networks constructed at Tornagrain, Ardersier and Whiteness Head are forwarded via new rising mains to the site of an existing treatment works at Ardersier. The effluent is treated by a new treatment works to 20mg/l BOD:30mg/l suspended solids and discharged via a short sea outfall west of Ardersier.

OPTION 2 – TRANSFER WASTEWATER TO ALLANFEARN WwTW (PFI)

Capital Cost £ 10,088,000

The wastewaters from the separate networks constructed at Tornagrain, Ardersier and Whiteness Head are forwarded via a new rising main to the site of the existing PFI at Allanfearn. The effluent is treated by a new side stream plant to 20mg/l BOD:30mg/l suspended solids with UV disinfection. The treated waters are discharged via a 1km outfall and pumping station.

OPTION 3 – TRANSFER WASTEWATER TO NEW WORKS AT FISHERTON

Capital Cost £ 7,305,000

The wastewaters from the separate networks constructed at Tornagrain, Ardersier and Whiteness Head are forwarded via new rising mains to a new works near Fisherton. The effluent is treated to 20mg/l BOD:30mg/l suspended solids with UV disinfection and discharged via a 500m outfall to the Moray Firth.

OPTION 4 – TRANSFER WASTEWATER TO NEW WORKS WITH RIVER NAIRN OUTFALL

Capital Cost £ 8,718,000

The wastewaters from the separate networks constructed at Tornagrain, Ardersier and Whiteness Head are forwarded via new rising mains to a new works at Dalcross. The effluent is treated with a membrane process to produce a very high quality effluent for discharge to the river Nairn.

2.0 OPTION DEVELOPMENT AND STRATEGY

The options have been developed to satisfy proposed development and against the following key constraints and parameters;

- Receiving waters and likely designation/classification
- The locations of the proposed development which is split into 3 agglomerations
- Existing assets, their conditions and points of discharge
- Likely discharge consents
- The Urban Wastewater Treatment Directive
- Perceived SEPA aspirations
- Existing Drainage Area Systems

To facilitate a study within the budgets and timescales, and provide an indicative cost, no investigation has been undertaken of the existing Drainage Area Networks and every option has been developed on the basis of the new separate system strategy designed and constructed by the Developer with the foul waters brought to a single pumping station for transference via a new rising main to the appropriate Option asset. However, during detailed design value opportunities may exist, dependant on selection of Options for feeding the foul waters into existing Drainage Networks and undertaking appropriate remedial work.

This report provides the Options available and is the final stage of the option study process which comprised

- Site Visit and Data Collection
- Establish Baseline Data
- Option Development: Desktop Study
- Reporting

The strategy of the study was to provide options to treat the ultimate flows from the proposed development and so identify the total prospective costs and risk to Scottish Water.

The Capital Costs have been estimated from the Biwater data base and are presented as Initial Target Costs (ITCs). The ITCs are based on the outline designs and proposals and are sensitive to the mitigation of project risks. The ITC does however include a contingency and facilitates differentiation between options. It is intended that

any Option selected is then further developed to an Agreed Target (ATC) wherein risks are identified and mitigation measures assigned as appropriate.

During the option development stage it was identified as a sub-option that a new works (Central Area Option 4) with a discharge to the river Nairn could be located on the existing site of Croy WwTW (Central Area Sub-option 4A). As the works is adjacent to the village of Croy, and planned developments would encroach closer to the site boundary, it was considered that this option was not feasible due to the significant visual impact of a new works. Therefore this option is not considered further in this report.

A further sub-option identified (Central Area Sub-option 3A), to transfer flows from Ardersier to a new works at Fisherton should this option be taken up (Central Area Option 3). This would allow the existing works to be decommissioned and reduce operating costs. This is to be considered during the detailed design stages and no further detail is given in this report.

3.0 BASELINE DATA

The options were developed from the following existing documentation and inherent Baseline data.

- EXTENDED Inverness Transport Model A96 Corridor Spreadsheet received 18th December 2006.
- EXTENDED Inverness Transport Model A96 Corridor Commitments Spreadsheet
- Council Projections Spreadsheet
- Inverness Traffic Model (Extended Model) Zoning System for A96 Corridor Drawing
- Green Framework Plots Indicating Environmental Constraints
- Inverness, Nairn and Ardersier GIS Plots

4.0 RISK

Each of the Options has been developed against a set of fundamental design assumptions taken from the Baseline documents. These assumptions form the basis of a set of risks that underpin the veracity of the proposed options. Having been identified it is now recommended that these risks are verified, managed and mitigated through the project process. Individual option risks are further identified and listed in option detail:

Design assumptions:

- **Flow:** The proposed staged development intends a diverse range of buildings including domestic housing, schools and colleges, leisure facilities, sports facilities, shopping centres, offices, industrial units etc. Whereas a flow build up for treatment works design is readily achievable from say the domestic properties, a head count and water usage estimate from the other relatively 'undefined' areas of the development is more problematic. As there has been no further verification of the flows from the development the following has been adopted in line with the drainage strategies:

  The build up of flow has consisted of wastewater contributions from household properties, as well as commercial areas, schools and industrial developments. The developer has provided information on the number of properties allowing this part of the flow contribution to be calculated using well defined methods.

  In order to estimate the flow contribution from the proposed new schools information has been used from the British Water code of practice. Flows and Loads. BW COP: 1/05. Based on an estimated number of pupils the flow contribution is calculated based on flow per capita figures.

  The sum of the household properties and the school contribution is termed the domestic contribution (PG).

  The remaining flow contributions from the commercial and industrial areas is undefined due to the unknown nature of the industry and the number of employees associated with each area. As stated above the flow contribution can only be estimated based on the total land area occupied by these commercial/industrial areas. Information on land areas, provided by The Highland Council, has therefore been used to estimate these figures.

  The sum of the above flows is termed the trade effluent (E).

  In order to take into account future deterioration of the sewer network an infiltration figure has been included, assumed to be 10% of the domestic contribution.

The summation of the domestic contribution, trade effluent and infiltration has been termed dry weather flow (DWF). The wastewater collection system is to be a separate network and storm flows from land drainage does not need to be considered. However, to take into account the expected diurnal flow pattern, the peak flow is assumed to be 3 times dry weather flow (3DWF). This is calculated using industry standard methods.

Average flow through the works is assumed to be 1.25 times the dry weather flow (1.25xDWF).

The build up of the different flow contributions and the methodology used is detailed in the Flow and Load Build Up calculation 09559_0600_O (Appendix 5).

- **Load:** Similar to the risk associated with the flow difficulty has been found in evaluating an appropriate load for sizing the treatment works. However a calculation 09559_0600_O (Appendix 5) has been adopted to provide a baseline. In this calculation the load expressed as BOD generates a population equivalent. Metcalf and Eddy provides approximations of sewage loads from low, medium and high strength sewage. Where there is lack of information available to calculate load contributions of commercial/industrial areas, it has been assumed that the sewage is medium strength. At this stage of investigation there is not sufficient information to justify assuming a strong sewage strength (potential for over-sizing) or weak strength (potential for under-sizing).

- **Network**: The proposed foul drainage network is separate. Options have been developed without the inclusion of any surface waters and minimal infiltration. There are at present no details of the foul drainage strategy for the development and options are based on a single new transfer pumping station for each development area, nominally located within the perimeter of the development, to transfer flows to the pertinent treatment facility. The pumping station will contain fixed speed pump sets sizes to accommodate diurnal flow patterns and the phased development. However, care will have to be taken during detailed design to firstly match the design of the development's drainage system and secondly reduce the opportunity for septicity in the network. No allowance has been made for storing wastewaters.

- **SEPA.** Option development has included consulting with SEPA to ascertain views on discharge contents for options. SEPA however are not able at this stage to confirm these consents. Proposals for treatment have been based on these consultations.

- **Associated projects.** No impact has been considered from other projects in the area not included in the information provided by The Highland Council, and no network capacity has been 'reserved'. Options have been developed to

comply with the regional sludge strategy of transporting sludges to other treatment facilities for disposal.

- **Consultation.** In option development it is usual to identify stakeholders and undertake consultation. This has only occurred with SEPA. It is recommended that at the next stage a Stakeholder Management Plan is developed and included as a minimum: local planning authorities, operation, public, local councils, other utilities, Scottish National Heritage, land owners, etc. This issue is further discussed in section 10.

5.0 STAKEHOLDER CONSULTATIONS – SEPA.

Generally this section describes our perception of the receiving water designations as a result of discussions with SEPA during a workshop hosted by The Highland Council on 1st December 2006.

1. SCHEME OUTLINE

The Options under investigation were described and discussed and the opinion of the SEPA representative sought as to the impact from any given SEPA policy or likely consents.

Final consent standards will be set on an individual site basis dependent upon receiving water, dilution and statutory designations. The standards proposed in this document are indicative and are subject to change upon processing through SEPA's consultation system.

2. DISCHARGES TO RIVER NAIRN

SEPA advised that the River Nairn, as a tributary of the bathing waters in the Moray Firth, will be classed as sensitive for Phosphorus and any consent would likely include a phosphate and pathogenic micro-organisms standard.

Consequently additional flow from the proposed development is considered very significant.

To give a consent, at the proposed flows and loads, SEPA will need to run a computer model of the river system. This is not an insignificant exercise and is not programmed, but should be undertaken at a later stage if an associated option is taken forward. Initial thoughts are that consent discharge standards would be extremely tight for a new treatment works consequently disinfection and ammonia removal. Due to a low dilution ratio a new works in the area is likely to have a consent of 10mg/l BOD: 25mg/l Suspended Solids: 2mg/l Ammonia: 0.5mg/l Phosphate: 10,000 Total Coliforms per 100ml: 2,000 Faecal Coliforms per 100ml.

3. DISCHARGES TO MORAY FIRTH

The Moray Firth is split between South of Fort George and beyond Fort George. South of Forth George the waters are protected areas and are subject to limited dilutions effects and it is noted that discharges from Allanfearn are subject to disinfection; therefore options which discharge here are subject to similar high standards. Discharge beyond Fort George is taken as less onerous due to greater dilution effects particularly for long outfalls.

Discharges at Nairn are subject to bathing water designations. The options are to disinfect effluent or to discharge east of Nairn beyond the bathing waters where UWWTD would facilitate primary treatment for additional separate Nairn agglomeration.

Due to the presence of Dolphins, the Moray Firth is subject to the habitats directive. SEPA have indicated that any discharges are likely to be subject to disinfection. Any option taken forward will require dispersion modelling to determine whether bathing waters will be impacted and what limits should be set to protect these waters.

4. POLICIES IN THIS AREA.

Policy for this area is in line with The Urban Wastewater Treatment Directive (UWWTD) with sensitive receiving waters requiring final effluent disinfection.

The Moray Firth is subject to the Habitats Directive, and the area around Nairn is subject to the Bathing waters Directive.

SEPA indicated that the discharge consent at Nairn may be tightened under the Revised Bathing Waters Directive 2006, which may come into force by 2008.

5. GENERAL CONSULTATIONS

During initial stages of development there may be potential for septicity in rising mains that are under capacity. This can be alleviated during detailed design and controlled planning. The remit of this report is to develop options for the final 2041 scenario; however some phasing issues are addressed in section 12.

SEPA have indicated that saline intrusion has caused problems on a number of schemes. The risk associated with saline intrusion can be mitigated by adequate consideration during the detailed design phase of a new works.

Dispersion studies for these proposals will not be included within this report. It is anticipated that this will be undertaken at a later stage when a preferred overall solution has been defined in more detail.

No consideration of surface water contamination has been taken within this report. At the time of writing there is no information available relating to make up of the industrial areas and the likely contributions to contamination.

6.0 INVERNESS EAST AREA

6.1 Option 1 – Transfer Flows to Allanfearn WwTW

6.1.1 *Introduction*

The existing works at Allanfearn receives incoming flow from Inverness and Culloden by gravity, where excess flow is diverted to a storm tank providing 3 hours retention. Screening is provided by 2 no. step screens, and grit removal is provided by a bendy channel. Screened flow enters 2 no. primary settlement tanks, and primary effluent flows onto 3 no. aeration lanes and 3 no. FST's for carbonaceous only treatment.

Final effluent from the FST's is disinfected by a UV plant prior to being pumped to the outfall in the Moray Firth. The current discharge consent is 25 mg/l BOD and 35 mg/l Suspended Solids (95%ile).

The works is a PFI concession which is due to expire in 2021. Upto that date, Catchment Ltd (the consortium running the works) are obliged to accept any additional flows from developments within their exclusive area. Therefore any assessment of the works upgrade required will also need to be undertaken by them at a future date. New infrastructure must be put in place to collect and transfer flows to the works.

The current works is operating within SEPA consents but it is widely acknowledged that there is little headroom in the existing works. In order to be capable of accepting the flows and loads indicated above the works will need to be upgraded. There are areas on the existing site for new processes but space is limited and an expansion to this works has been proposed based on low foot print technology.

In order to avoid complications associated with combining flows in the existing works, a new side stream treatment process is proposed for the anticipated additional wastewater flows in this area. The side stream technology is based on a compact plant ASP plant for BOD and solids removal, provided with a 6mm inlet screen, grit removal and UV disinfection.

It is anticipated that due to the president set on the current works, disinfection is to be a requirement of any new works or works extension. Disinfected final effluent from the side stream will be combined with the final effluent from the current works and pumped to the Moray Firth via the existing outfall. A further investigation is required to determine whether the existing final effluent pumps and outfall pipeline require upgrading.

As the detailed design aspects of the current works are not known, the works upgrade proposed is based on providing a side stream. There may be some value engineering opportunities associated with combining flows but these can only be realised during the detailed design phase.

In this section we include:

6.1.1 Introduction to Option

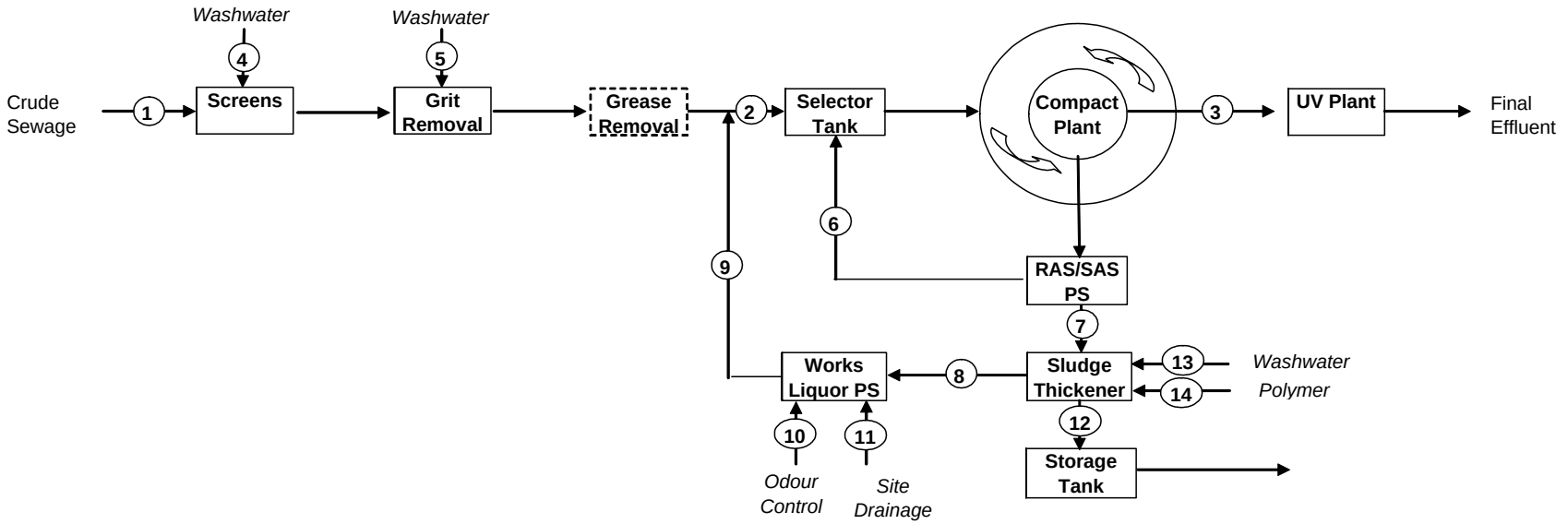
6.1.2 Specification

6.1.3 Mass Balance (Calc no. 09509_0603 Rev O)

6.1.4 Cost Summary

6.1.6 Risk Schedule

Figure 6.1 - Block diagram of proposed side stream at Allanfearn WwTW



Flows		1	2	3	4	5	6	7*	8*	9	10	11	12*	13*	14*
Average	m³/d	1688	1965	1867	86	43	982	97.6	80.1	147	2	50	18	9.6	5.3
	l/s	20	23	23	1	0.5	11			2					
Peak	m³/d	4758	5035	4937	86	43	2530	97.6	80.1	147	2	50	18	9.6	5.3
	l/s	55.1	58.6	58.6	1.0	0.5	29.3			2.0					
Loads															
BOD	kg/d	522	582	46.7	0	0			60	60					
SS	kg/d	625	705	81.7	0	0	8812	875	80	80			875		5.25
Concentration @ average flow															
BOD	mg/l	248	237	20	0	0			750	409					
SS	mg/l	296	287	35	0	0	8969	8969	1000	545			50000		1000

6.1.2 *SPECIFICATION*

REMOTE FEED PUMPING STATIONS

It is to be assumed that the new infrastructure in the Inverness East Area will be collected and transferred to a single point where a new pumping station will be constructed to transfer flows to the Allanfearn works side stream. The pumping station will comprise of 3 no. fixed speed submersible pumps to operate as duty/assist/standby, each rated at 8l/s @ 16m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 1500m of rising main.

It is to be assumed that the new infrastructure in the Culloden Area will be collected and transferred to a single point where a new pumping station will be constructed to transfer flows to the Allanfearn works side stream. The pumping station will comprise of 3 no. fixed speed submersible pumps to operate as duty/assist/standby, each rated at 8l/s @ 16m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 1000m of rising main.

INLET SCREENS

A new concrete inlet channel is to be provided to house 2 no. new Rotamat 6mm inlet screens. The screens will be provided with isolation penstocks and a bypass channel with a hand raked screen.

GRIT REMOVAL PLANT

A Hydro Grit King Separator c/w wash water grit lifting system, grit pump, Hydro series 4 grit classifier is to be provided for grit removal.

COMPACT PLANT ASP

2 No. 18m diameter compact plant, with a 12.5m diameter internal final settlement tank is proposed for secondary treatment. The FST will be provided with a scraper bridge and diffuser grids for fine bubble diffused air aeration will be installed within the aeration lane annulus.

PROCESS AIR SYSTEM

2 No Air blowers (1 duty / 1 standby) each complete with variable speed motors are to be provided to meet a maximum air demand (SOTR) of 1600 kgO2/day. Each blower will be slab mounted and provided with an acoustic enclosure, delivery pipework, valves and instrumentation.

RAS/SAS SYSTEM

Two progressive cavity (duty/standby) pumps are to be provided to return sludge from the base of the FST to the aeration lane. All process pipework valves and instrumentation will be provided, plus a tee and actuated valve and flow meter to bleed off surplus sludge to a new sludge thickener. The sludge thickener, provided with polymer dosing equipment, will produce thickened sludge of 5% dry solids. Thickened sludge is stored in a 88m3 tank prior to transfer to the sludge treatment facility at Allanfearn WwTW.

ODOUR CONTROL

An odour control unit, with duty/standby vent fans, is to be provided for treating odourous air from the inlet channel, screen, grit plant, sludge thickener, and thickened sludge storage tank.

LIQUOR RETURN PUMPING STATION

A new concrete sump is to be provided to house two no. duty/standby submersible pumps, including pipework, valves and instrumentation, to transfer screenings, grit and sludge liquors to the inlet channel.

SERVICE WATER (POTABLE) BOOSTER SET

A new potable water booster set will provide site wash water to hose points, inlet screen, grit classifier and sludge thickener. The set will incorporate duty/standby pumps, pipework and valves, accumulator vessel and instrumentation.

UV TREATMENT PLANT

A new UV treatment plant is to be provided for disinfection of final effluent prior to discharge to the Moray Firth.

6.1.3 *Cost Summary*

INVERNESS EAST - OPTION 1

Item	Description	Price
1.1	Inverness East Pumping Station	123770
1.2	Culloden Pumping Station	123770
1.3	Inverness East Transfer Rising Main	191363
1.4	Culloden Transfer Rising Main	143168
1.5	ALLANFEARN WWTW - 10,200 pe based on 2 No Compact Plants providing 25 BOD: 35 SS standard.	5529939
1.6	UV Disinfection	140438
1.7	Process Pipework to Exisitng Outfall	127575
	TOTAL	**6381000**

6.1.4 *Risk Schedule*

RISK REGISTER

A96 Corridor Option Study - Inverness Option 1 (Transfer flows to Allanfearn WwTW)

Risk No	Description of Risk	Description of Impact	Estimated Impact Costs on occurrence	Estimated Probability Likelihood of occurrence	Comments and possible mitigating measures
A	**Construction**				
a1	Incoming sewers crossing railway line	Delayed or onerous construction cost	Medium	Medium	Correct construction methods to be built into target costs. Early consultations with Scotrail
a2	Unforeseen Ground Conditions and services	Additional costs and delay.	Medium	Medium	Investigate during ATC phase.
a3	Discovery of unexpected buried structures, obstructions, services or pipework.	Additional costs and delay.	Medium	Low	Investigate during ATC phase.
B	**Stakeholders**				
b1	Land purchase	Programme delay or make option untenable	High	High	Early land owner contact
b2	Onerous consent from SEPA	Costly asset to construct (not best value solution for Scottish Water)	High	Medium	Detailed discussions with SEPA
b3	Planning constraints (set disinfection levels on existing works)	Costly asset to construct (not best value solution for Scottish Water)	High	High	Initial consultations with planners. Design for disinfection.
b4	Damage or interference to local archaelogical site	Programme delay	High	Low	Early consultations with Historic Scotland. Initiation of stakeholder management plan.
b5	Programme delay when gaining permission for road crossing for incoming sewer	Delay to programme	Medium	Low	Stakeholder management plan to be initiated
b6	Risk of septicity and odours from early development stages	Odour nuisance, cost of cheemical dosing, inhibit performance of works	Medium	Medium	Consider design of rising mains for phased development
b7	Design life beyond concession for PFI	Cost burden to Scottish Water. Impact on business strategy	Medium	Medium	Determine impact on business strategy
b8	Additional flows may breach terms of PFI contract	Additional cost for Scottish Water	High	Low	Determine conditions of PFI contract
D	**Design**				
d1	Flow and load data accuracy	Additional cost of dealing with increased requirements.	High	Medium	Verify Flow and Loads
d2	Exacerbate odour issues	Breach of planning regulations	High	Medium	Undertake odour plan
d3	Option based on reusing existing outfall which may not be big enough	Cost for new outfall	High	Low	Investigate capacity of existing outfall
d4	Risk in complying with regional sludge strategy aspirations	Additional OPEX and CAPEX at sludge centre and additional transportation costs	High	Medium	Review capacity of regional sludge centres and compare with CAPEX/OPEX balance
F	**Site Specifics**				
f1	Interfering with existing works	Protracted programme to maintain existing works during construction	High	Medium	Careful construction methodology required
f2	Push existing works beyond consent boundaries	Prosecution from SEPA	High	Low	Careful construction methodology required

6.2 Option 2 – Transfer Flows to a New Works in Central Area

6.2.1 *Introduction*

The wastewaters are collected by the separated network and forwarded to a new treatment facility to be constructed in the central area (see section 8).

This option gives a solution that requires significant transference of the wastewaters. The key issues and risks of transferring the flows to a new works in the central area are:

- Suitable watercourse for discharge.
- Capacity of new treatment works.
- Flow and load build-up.
- Prospective discharge consent (SEPA).
- Land purchase.

In addition to a new collection and transfer system, this option involves the upgrade of the carbonaceous ASP works proposed for options 1 & 3 for the central area (see sections 8.1 & 8.3) to be suitable for this additional population equivalent.

This proposed works will discharge to the Moray Firth and the addition of wastewaters from Inverness east will not have a significant impact on the works, providing sufficient provision is provided during design. The issues surrounding this option relate specifically to the collection and transfer system as highlighted above.

In this section we include:

6.1.1 Introduction to Option

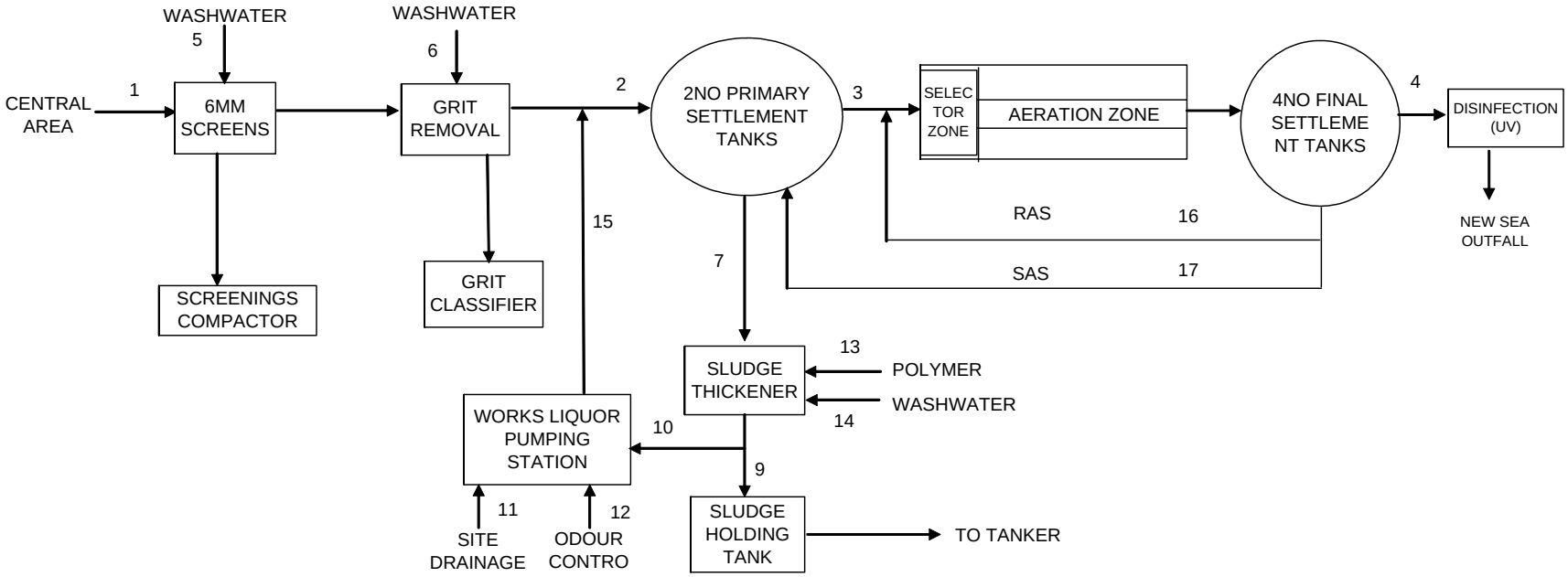
6.1.2 Specification

6.1.3 Mass Balance (Calc no. 09509_0609 Rev O)

6.1.4 Cost Summary

6.1.6 Risk Schedule

Figure 6.2 - Block diagram of proposed Enlarged Works at Ardersier



Flows		1	2	3	4	5	6	7	9	10	11	12	13	14	15	16	17
Average Flow	m³/d	4,536	4,775	4,716	4,716	86	43	59	49.4	33	50	2	15	10	109	2,374	128
	l/s	52	55	55	55	1	0.5								1.27	27	
Maximum Flow	m³/d	12,783	13,345	13,286	13,286	86	43	59	49.4	33	50	2	15	10	432	6,659	128
	l/s	148	154	154	154	1	0.5								5	77	
Loads																	
BOD	kg/d	1,236	1,335	1,335	47			#####	2,471	99					99		
SS	kg/d	1,519	1,651	-114	165			#####	2,471	132			14.83		132	17,458	939
Concentrations at average flow																	
BOD	mg/l	273	1,176	283	10					3,000					903.68		
SS	mg/l	335	1,540	-24	35			#####	#####	4,000			1,000		######	7,355	7,355

6.2.2 *SPECIFICATION*

REMOTE FEED PUMPING STATION

It is to be assumed that the new infrastructure in the Inverness East Area will be collected and transferred to a single point where a new pumping station will be constructed to transfer flows to the Culloden Pumping Station. The pumping station will comprise of 3 no. fixed speed submersible pumps to operate as duty/assist standby, each rated at 8l/s @ 16m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 1500m of rising main.

It is to be assumed that the new infrastructure in the Culloden Area will be collected and transferred to a single point where a new pumping station will be constructed to transfer flows to the Ardersier works. Flows from Inverness East will also be transferred to this pumping station. The pumping station will comprise of 3 no. fixed speed submersible pumps to operate as duty/assist standby, each rated at 8l/s @ 20m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 6000m of rising main.

INLET WORKS

Raw sewage fed to the works will be screened to 6mm by two duty/standby fine screens supplied by Rotamat. Screenings are conveyed to a screenings handling units for compaction prior to discharge to a screenings skip.

Screened sewage will be de-gritted in a grit trap, provided with grit pumps for transfer of grit to a classifier where the grit is washed and compacted prior to discharge into the grit skip.

PRIMARY TREATMENT

Two circular primary tanks are proposed in line with Scottish Water design specifications to provide initial solids and BOD removal. Each tank is provided with a scraper bridge, pipework, valves and instrumentation.
Two duty/standby progressive cavity pumps operating will automatically desludge the primary tanks and transfer consolidated sludge to the sludge thickener. The sludge thickener is suitable to thicken surplus sludge to a concentration of 5% dry solids prior to being transferred to a new 250m^3 storage tank.

SECONDARY TREATMENT

A new activated sludge plant is proposed to provide the additional BOD and solids removal required to meet likely discharge consents. Primary effluent is combined with return activated sludge (RAS) in the selector tank. Flows from the selector tank are distributed between 3 aeration lanes, each 34m long and 3m wide.

Each aeration lane is provided with fine bubble diffuser grids, air pipework and isolation valves.
The outlet from the aeration tank flows to a new FST distribution chamber which splits flows between four final settlement tanks. Each tank is provided with a scraper bridge.

RAS/SAS SYSTEM
RAS is drained from the base of each FST via a dedicated actuated valve into the RAS/SAS pumping station. Two duty/standby submersible pumps transfer RAS to the selector tank of the ASP and are provided with associated pipework, valves and instrumentation. Surplus sludge is diverted from the RAS line by an actuated valve the primary tank distribution chamber for co-settlement.

ODOUR CONTROL

An odour control unit, with duty/standby vent fans, is to be provided for treating odourous air from the inlet channel, screen, grit plant, sludge thickener, and thickened sludge storage tank.

LIQUOR RETURN PUMPING STATION

A new concrete sump is to be provided to house two no. duty/standby submersible pumps, including pipework, valves and instrumentation, to transfer screenings, grit and sludge liquors to the inlet channel.

SERVICE WATER (POTABLE) BOOSTER SET

A new potable water booster set will provide site wash water to hose points, inlet screen, grit classifier and sludge thickener. The set will incorporate duty/standby pumps, pipework and valves, accumulator vessel and instrumentation.

UV TREATMENT PLANT

A new UV treatment plant is to be provided for disinfection of final effluent prior to discharge to the Moray Firth.

6.2.3 *Cost Summary*

INVERNESS EAST - OPTION 2

Item	Description	Price
1.1	Inverness East Pumping Station	127151
1.2	Culloden Pumping Station	124053
1.3	Inverness East Transfer Rising Main	191363
1.4	Culloden Transfer Rising Main	918540
1.5	Allow Central Area Option 2 as previous minus the New Central Area Option 1	533453
	TOTAL	**1895000**

6.2.4 *Risk Schedule*

RISK REGISTER

A96 Corridor Option Study - Inverness Option 2 (Transfer flows to WwTW in central area)

Risk No	Description of Risk	Description of Impact	Estimated Impact Costs on occurrence	Estimated Probability Likelihood of occurrence	Comments and possible mitigating measures
A	**Construction**				
a1	Discovery of unexpected land contamination at transfer P.S.	Time & cost implications associated with removal.	Medium	Low	Investigate during ATC phase.
a2	Unforeseen Ground Conditions and services	Additional costs and delay.	Medium	Medium	Investigate during ATC phase.
a3	Discovery of unexpected buried structures, obstructions, services or pipework.	Additional costs and delay.	Medium	Low	Investigate during ATC phase.
B	**Stakeholders**				
b1	Planning Restrictions Noise, Buildings, cemetry, community centre	Cost and delay if constraints imposed by Local Planner.	High	Medium	Develop Stakeholder Plan, Identify and Consult early
b2	Land Owners Restricting Access	Cost and delay	High	Medium	Develop Stakeholder Plan, Identify and Consult early
b3	Power Supply Installation	Delay to Prog	High	Medium	Develop Stakeholder Plan, Identify and Consult early
b4	Risk of septicity and odours from early development stages	Odour nuisance, cost of cheemical dosing, inhibit performance of works	Medium	Medium	Consider design of rising mains for phased development
D	**Design**				
d1	Flow and load data accuracy	Additional cost of dealing with increased requirements.	High	Medium	Verify Flow and Loads
F	**Site Specifics**				
f1					

7.0 NAIRN AREA

7.1 Option 1 – Redevelop Existing Wastewater Treatment Works

7.1.1 *Introduction*

The additional wastewaters are collected by new separated networks for the new developments to the west of Nairn and to the south of Nairn, are transferred to the existing works located at East Beach in Nairn.

The current works accepts flow (pumped and gravity) from the Nairn catchment and caravan park and has a Moray Firth outfall.
Incoming flows are controlled by a modulating penstock which causes excess flows to back up over a fixed storm overflow weir and flow to a storm tank. Full flow to treatment enters the inlet works where it's screened by 2 no. J&A screens which can operate duty/assist or duty/standby. A Parkwood dewatering unit is provided for screenings handling. Screened sewage passes through a grit removal plant incorporating 1 no J&A grit trap with grit classifier.
A submersible pumping station then transfers flows to the inlet of 2 no. CAS basins for combined aeration and settlement. 2 No. Centrifugal blowers deliver process air to each basin.
4 no UV channels are on site. Final effluent from the CAS basins pass through two channels before being pumped to the balance tanks. The contents of the balance tanks is bled through the 2 more UV channels to meet the coliforms consents. The use of the balance tanks is to prevent the UV channels drying up during periods of no flow due to the operation of the CAS basins.
RAS is returned to the CAS basin inlet. SAS is transferred to the sludge treatment building.

Although this works has rarely failed SEPA consents, it is suspected that the works is highly over-loaded during the peak tourist season. There is no head room at this works to accommodate additional flows and loads. In order for this site to accept the flows and loads indicated above, the works will need a major overhaul.

Due to the land restrictions at this site a new process system will need to be chosen based on small foot print. Scottish Water has invested heavily in recently commissioned assets which would need to be re-used to avoid asset write off.

A current capital maintenance scheme is to consider repairs to the current outfall and identify head room in the works by undertaking a flow and load survey. From consultations with Scottish Water Solutions it is understood that works upgrade will be considered in more detail when there is information on the headroom available. However, it is clear that further works re-development is limited and any subsequent capital maintenance scheme will be constrained to asset renewal. Scottish Water Solutions should be made aware of early development plans so this can be taken into account.

The proposal in this option is to utilise Biologically Aerated Filtration as it is a small foot-print technology. As the detailed design aspects of the current works are not known, the works upgrade proposed is based on providing a side stream. There may be some value engineering opportunities associated with combining flows but these can only be realised during the detailed design phase.

Under this proposal the side stream plant will provide 6mm fine screening and UV disinfection. The disinfected flows from the side stream plant will be combined with the flows from the current works for discharge to the Moray Firth by gravity via the existing outfall. The existing outfall is 700mm diameter and will have sufficient capacity for the side stream plant flows. The outlet from the side stream plant will have a non-return facility to prevent problems with saline intrusion.

In this section we include:

6.1.1 Introduction to Option

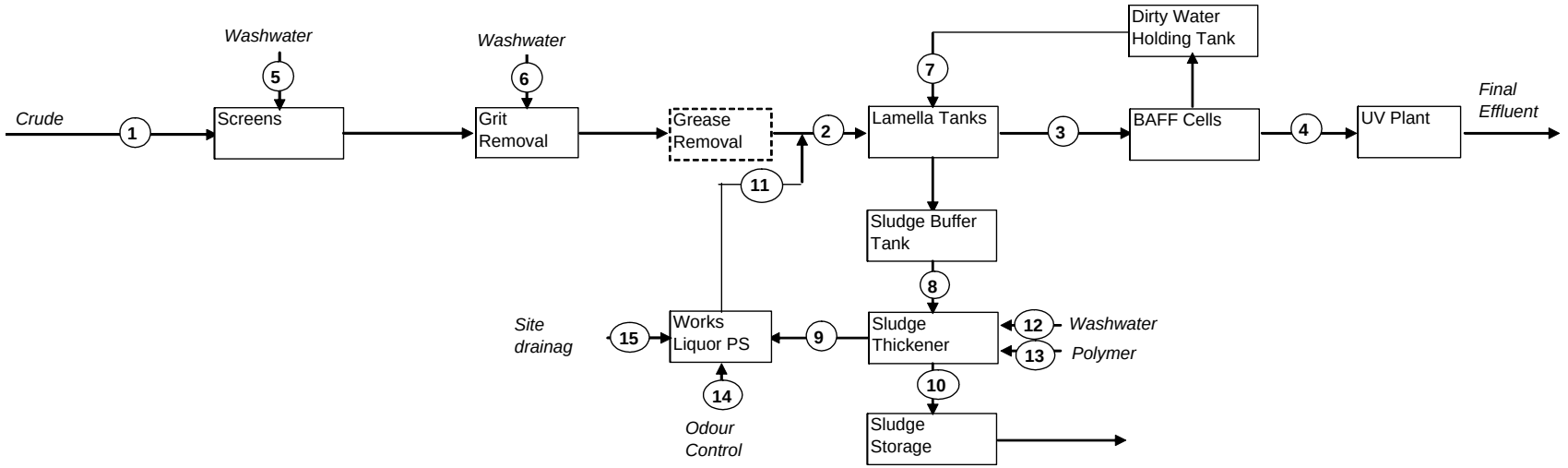
6.1.2 Specification

6.1.3 Mass Balance (Calc no. 09509_0604 Rev O)

6.1.4 Cost Summary

6.1.6 Risk Schedule

Figure 7.1 - Block diagram of Proposed Side Stream Process



FLOWS, LOADS AND CONCENTRATIONS

Flows	Units	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Average	m³/d	1136	1,348	1,455	1,323	86	43	133	36	14	22	82	9.6	6.5	2	50
	l/s	13	16	17	15	1	0.5	1.5				1				
Peak	m³/d	3,202	3,414	3,653	3,388	86	43	265	36	14	22	82	9.6	6.5	2	50
	l/s	37	40	45	40	1	0.5	5.0				1				
Loads																
BOD	kg/d	373	391	298	26	0	0	53		18		18	0			
TSS	kg/d	454	476	297	46	0	0	593	1,081	22	1081	22	0	6.5		
Concentrations @ Average Flow																
BOD	mg/l	328	290	205	20	0	0	400		1250		218	0			
TSS	mg/l	400	353	204	35	0	0	4478	30000	1500	50000	262	0	1000.0		

7.1.2 *SPECIFICATION*

REMOTE FEED PUMPING STATION

It is to be assumed that the new infrastructure in the Nairn West area will be collected and transferred to a single point where a new satellite pumping station will be constructed to transfer flows to the Nairn South Pumping Station. The pumping station will comprise of 2 no. fixed speed submersible pumps to operate as duty/standby, each rated at 5l/s @ 10m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 1500m of rising main.

It is to be assumed that the new infrastructure in the Nairn South Area will be collected and transferred to a single point where a new pumping station will be constructed to transfer flows to a new side stream at the existing Nairn works. Flows from Nairn West will also be transferred to this pumping station. The pumping station will comprise of 3 no. fixed speed submersible pumps to operate as duty/assist standby, each rated at 20l/s @ 10m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 1500m of rising main.

INLET WORKS

Raw sewage fed to the works will be screened to 6mm by two duty/standby fine screens supplied by Rotamat. Screenings are conveyed to a screenings handling units for compaction prior to discharge to a screenings skip.

Screened sewage will be de-gritted in a grit trap, provided with grit pumps for transfer of grit to a classifier where the grit is washed and compacted prior to discharge into the grit skip.

PRIMARY TREATMENT

Primary treatment is provided by 1 no. lamella sized for removal of 25% incoming BOD and 50% of the incoming suspended solids. This process has been chosen due to its low foot print only covering a surface area of 26m^2.
Primary sludge combined with secondary sludge and co-settled, is extracted from the base of the lamella and transferred to a sludge buffer tank. The sludge is then transferred to the sludge thickener by duty/standby progressive cavity pumps. The sludge thickener is suitable to thicken the sludge to 5% dry solids prior to being transferred to a storage tank.

SECONDARY TREATMENT

The secondary treatment process proposed to provide the additional BOD and solids removal required to meet likely discharge consents is a Bio-bead BAFF plant. This technology has been selected due to it's low foot print. Primary effluent is filter through a media coated with activated material to provide the biological treatment. To provide

the required treatment a foot print area of only 50m^2 is required. Two duty/standby blowers are provided to supply air to the filter.
The BAFF plant is provided with a dirty water holding tank to buffer dirty wash water prior to return to the lamella tank by duty/standby progressive cavity pumps.

ODOUR CONTROL

An odour control unit, with duty/standby vent fans, is to be provided for treating odourous air from the inlet channel, screen, grit plant, sludge thickener, and thickened sludge storage tank.

LIQUOR RETURN PUMPING STATION

A new concrete sump is to be provided to house two no. duty/standby submersible pumps, including pipework, valves and instrumentation, to transfer screenings, grit and sludge liquors to the inlet channel.

SERVICE WATER (POTABLE) BOOSTER SET

A new potable water booster set will provide site wash water to hose points, inlet screen, grit classifier and sludge thickener. The set will incorporate duty/standby pumps, pipework and valves, accumulator vessel and instrumentation.

UV TREATMENT PLANT

Final effluent from the BAFF plant flows to a new UV treatment plant is for disinfection of final effluent prior to discharge to the Moray Firth.

7.1.3 *Cost Summary*

NAIRN - OPTION 1

Item	Description	Price
1.1	Nairn Satellite Pumping Station	103715
1.2	Nairn No 1 Pumping Station	142538
1.3	Nairn Satellite PS Transfer Rising Main	178605
1.4	Nairn No 1 Pump Station Transfer Rising Main	229635
1.5	BAFF plant for 6900 p.e.	4330158
1.6	UV Disinfection	161438
	TOTAL	**5147000**

7.1.4 *Risk Schedule*

RISK REGISTER

A96 Corridor Option Study - Nairn Option 1 (Redevelop Existing Works)

Risk No	Description of Risk	Description of Impact	Estimated Impact Costs on occurrence	Estimated Probability Likelihood of occurrence	Comments and possible mitigating measures
A	**Construction**				
a1	Discovery of unexpected land contamination at transfer P.S's	Time & cost implications associated with removal.	Medium	Low	Investigate during ATC phase.
a2	Unforeseen Ground Conditions	Additional costs and delay.	Medium	Medium	Investigate during ATC phase.
a3	Discovery of unexpected buried structures, obstructions, services or pipework.	Additional costs and delay.	Medium	Medium	Investigate during ATC phase.
a4	Wrong route for incoming rising main	Delay due to consultation and access permission	Medium	Medium	Early consultation - stakeholder management plan to be initiated
B	**Stakeholders**				
b1	Land Owners Restricting Access or sale refusal	Cost and delay	High	High	Develop Stakeholder Plan, Identify and Consult early
b2	Uprated power installation	Delay to Prog	High	Low	Develop Stakeholder Plan, Identify and Consult early
b3	Planning constraints	Costly asset to construct (not best value solution for Scottish Water)	High	Medium	Initial consultations with planners. Design for disinfection.
b4	Opposition from caravan park and golf course	Delay to programme	High	High	Early consultation - stakeholder management plan to be initiated
b5	Risk of septicity and odours from early development stages	Odour nuisance, cost of cheemical dosing, inhibit performance of works	Medium	Medium	Consider design of rising mains for phased development
D	**Design**				
d1	Flow and load data accuracy	Additional cost of dealing with increased requirements.	High	Medium	Verify Flow and Loads
d2	Exacerbate odour issues	Breach of planning regulations	High	Medium	Undertake odour plan
d3	Risk in complying with regional sludge strategy aspirations	Additional OPEX and CAPEX at sludge centre and additional transportation costs	High	Medium	Review capacity of regional sludge centres and compare with CAPEX/OPEX balance
F	**Site Specifics**				
f1	Interfering with existing works	Protracted programme to maintain existing works during construction	High	Medium	Careful construction methodology required
f2	Push existing works beyond consent boundaries	Prosecution from SEPA	High	Low	Careful construction methodology required
f3	Existing sea outfall under capacity	Cost and delay	High	Low	Review capacity of existing outfall

7.2 Option 2 – Transfer Flows to New Works in Central Area

7.2.1 *Introduction*

The wastewaters are collected by the separated network and forwarded to a new treatment facility to be constructed in the central area (see section 8).

This option gives a solution that requires significant transference of the wastewaters. The key issues and risks of transferring the flows to a new works in the central area are:

- Suitable watercourse for discharge.
- Capacity of new treatment works.
- Flow and load build-up.
- Prospective discharge consent (SEPA).
- Land purchase.

In addition to a new collection and transfer system, this option involves the upgrade of the carbonaceous ASP works proposed for options 1 & 3 for the central area (see sections 8.1 & 8.3) to be suitable for this additional population equivalent.

This proposed works will discharge to the Moray Firth and the addition of wastewaters from Nairn will not have a significant impact on the works, providing sufficient provision is provided during design. The issues surrounding this option relate specifically to the collection and transfer system as highlighted above.

In this section we include:

7.2.1 Introduction to Option

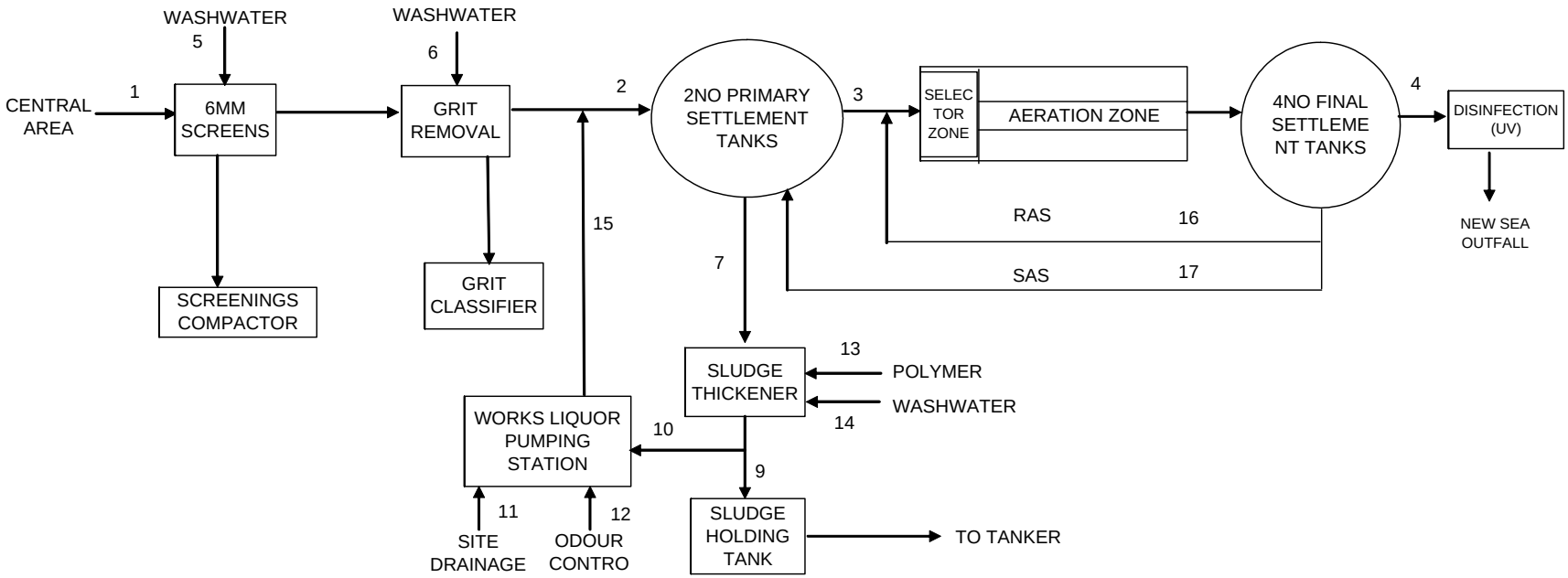
7.2.2 Specification Site

7.2.3 Mass Balance (Calc no. 09509_0608 Rev O)

7.2.4 Cost Summary

7.2.6 Risk Schedule

Figure 7.2 - Block diagram of Proposed Side Stream Process



Flows		1	2	3	4	5	6	7	9	10	11	12	13	14	15	16	17
Average Flow	m³/d	4,536	4,775	4,716	4,716	86	43	59	49.4	33	50	2	15	10	109	2,374	128
	l/s	52	55	55	55	1	0.5								1.27	27	
Maximum Flow	m³/d	12,783	13,345	13,286	13,286	86	43	59	49.4	33	50	2	15	10	432	6,659	128
	l/s	148	154	154	154	1	0.5								5	77	
Loads																	
BOD	kg/d	1,236	1,335	1,335	47					99					99		
SS	kg/d	1,519	1,651	-114	165			#####	2,471	132			14.83		132	17,458	939
Concentrations at average flow																	
BOD	mg/l	273	1,176	283	10					3,000					903.68		
SS	mg/l	335	1,540	-24	35			#####	#####	4,000			1,000		######	7,355	7,355

7.2.2 *SPECIFICATION*

REMOTE FEED PUMPING STATION

It is to be assumed that the new infrastructure in the Nairn West area will be collected and transferred to a single point where a new satellite pumping station will be constructed to transfer flows to the Nairn South Pumping Station. The pumping station will comprise of 2 no. fixed speed submersible pumps to operate as duty/standby, each rated at 5l/s @ 10m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 1500m of rising main.

It is to be assumed that the new infrastructure in the Nairn South Area will be collected and transferred to a single point where a new pumping station will be constructed to transfer flows to the Ardersier works. Flows from Nairn West will also be transferred to this pumping station. The pumping station will comprise of 3 no. fixed speed submersible pumps to operate as duty/assist standby, each rated at 20l/s @ 10m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 4500m of rising main.

INLET WORKS

Raw sewage fed to the works will be screened to 6mm by two duty/standby fine screens supplied by Rotamat. Screenings are conveyed to a screenings handling units for compaction prior to discharge to a screenings skip.

Screened sewage will be de-gritted in a grit trap, provided with grit pumps for transfer of grit to a classifier where the grit is washed and compacted prior to discharge into the grit skip.

PRIMARY TREATMENT

Two circular primary tanks are proposed in line with Scottish Water design specifications to provide initial solids and BOD removal. Each tank is provided with a scraper bridge, pipework, valves and instrumentation.
Two duty/standby progressive cavity pumps operating will automatically desludge the primary tanks and transfer consolidated sludge to the sludge thickener. The sludge thickener is suitable to thicken surplus sludge to a concentration of 5% dry solids prior to being transferred to a new 250m^3 storage tank.

SECONDARY TREATMENT

A new activated sludge plant is proposed to provide the additional BOD and solids removal required to meet likely discharge consents. Primary effluent is combined with return activated sludge (RAS) in the selector tank. Flows from the selector tank are distributed between 3 aeration lanes, each 34m long and 3m wide.

Each aeration lane is provided with fine bubble diffuser grids, air pipework and isolation valves.
The outlet from the aeration tank flows to a new FST distribution chamber which splits flows between four final settlement tanks. Each tank is provided with a scraper bridge.

RAS/SAS SYSTEM
RAS is drained from the base of each FST via a dedicated actuated valve into the RAS/SAS pumping station. Two duty/standby submersible pumps transfer RAS to the selector tank of the ASP and are provided with associated pipework, valves and instrumentation. Surplus sludge is diverted from the RAS line by an actuated valve the primary tank distribution chamber for co-settlement.

ODOUR CONTROL

An odour control unit, with duty/standby vent fans, is to be provided for treating odourous air from the inlet channel, screen, grit plant, sludge thickener, and thickened sludge storage tank.

LIQUOR RETURN PUMPING STATION

A new concrete sump is to be provided to house two no. duty/standby submersible pumps, including pipework, valves and instrumentation, to transfer screenings, grit and sludge liquors to the inlet channel.

SERVICE WATER (POTABLE) BOOSTER SET

A new potable water booster set will provide site wash water to hose points, inlet screen, grit classifier and sludge thickener. The set will incorporate duty/standby pumps, pipework and valves, accumulator vessel and instrumentation.

UV TREATMENT PLANT

A new UV treatment plant is to be provided for disinfection of final effluent prior to discharge to the Moray Firth.

7.2.3 *Cost Summary*

NAIRN - OPTION 2

Item	Description	Price
1.1	Nairn Satellite Pumping Station	103715
1.2	Nairn No 1 Pumping Station	146081
1.3	Nairn Satellite PS Transfer Rising Main	178605
1.4	Nairn No 1 Pump Station Transfer Rising Main	688905
1.5	Central Area Option No 1 new price @ 14000pe less the original 21500 plant from Central Area Option No 1	349703
1.6	UV Disinfection	150938
	TOTAL	**1618000**

7.2.4 *Risk Schedule*

RISK REGISTER

A96 Corridor Option Study - Nairn Option 2 (Transfer flows to WwTW in central area)

Risk No	Description of Risk	Description of Impact	Estimated Impact Costs on occurrence	Estimated Probability Likelihood of occurrence	Comments and possible mitigating measures
A	**Construction**				
a1	Discovery of unexpected land contamination at transfer P.S.	Time & cost implications associated with removal.	Medium	Low	Investigate during ATC phase.
a2	Unforeseen Ground Conditions	Additional costs and delay.	Medium	Medium	Investigate during ATC phase.
a3	Discovery of unexpected buried structures, obstructions, services or pipework.	Additional costs and delay.	Medium	Low	Investigate during ATC phase.
a4					
B	**Stakeholders**				
b1	Planning Restrictions Noise, Buildings, cemetry, community centre	Cost and delay if constraints imposed by Local Planner.	High	Medium	Develop Stakeholder Plan, Identify and Consult early
b2	Land Owners Restricting Access or sale refusal	Cost and delay	High	Medium	Develop Stakeholder Plan, Identify and Consult early
b3	Power Supply Installation	Delay to Prog	High	Medium	Develop Stakeholder Plan, Identify and Consult early
b4	Opposition from golf course	Delay to Prog	High	Medium	Develop Stakeholder Plan, Identify and Consult early
b5	Risk of septicity and odours from early development stages	Odour nuisance, cost of cheemical dosing, inhibit performance of works	Medium	Medium	Consider design of rising mains for phased development
D	**Design**				
d1	Flow and load data accuracy	Additional cost of dealing with increased requirements.	High	Medium	Verify Flow and Loads
F	**Site Specifics**				
f1					

7.3 Option 3 – Transfer Flows to a New Works with New Sea Outfall

7.3.1 *Introduction*

This option requires a newly constructed wastewater treatment facility to be located west of Nairn on the coast between Nairn and Whiteness.

It is proposed that a new primary treatment plant is suitable to provide the required BOD and suspended solids removal in line with Scottish Water design specification.

Sludge thickening facilities are proposed to thicken surplus sludge to 5% dry solids, suitable to be tankered to Allanfearn WwTW sludge treatment plant. This is in-line with Scottish Water's sludge strategy for the area.

The final effluent will be pumped into the Moray Firth via a long sea outfall (200mmNB) rated for a maximum flow of 40 l/s. This is to counter high tides and saline intrusion. An existing outfall in this area has been identified currently used by the distillery at Cawdor. It is not thought that this will have sufficient capacity to be used for the above flows and further investigation is required to determine whether this could be upgraded.

The outfall proposed is to discharge into the Moray Firth some distance east of Fort George. As this area of the Moray Firth will be open to sea currents and tidal effects, the final effluent will receive significant dilution. Therefore it is not anticipated that final effluent will need to be disinfected from this works.

In this section we include:

7.1.1 Introduction to Option

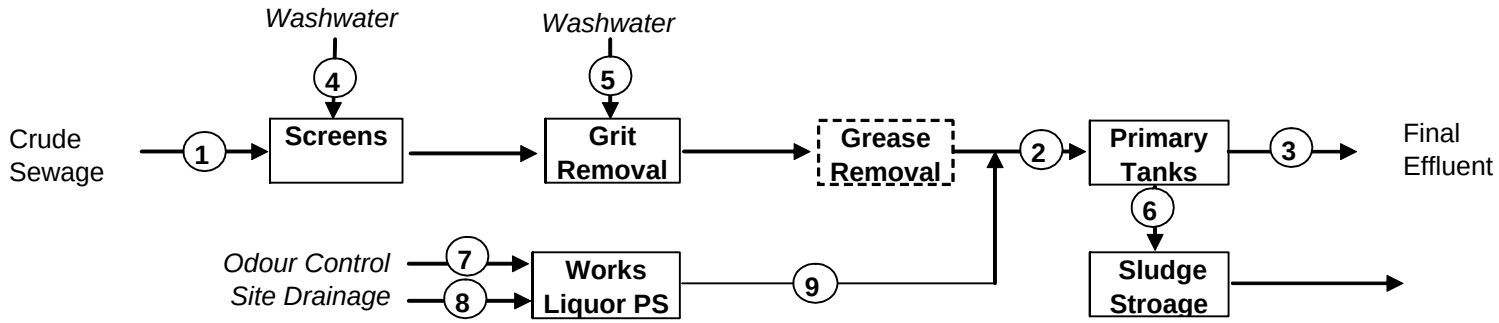
7.1.2 Specification

7.1.3 Mass Balance (Calc no. 09509_0606 Rev O)

7.1.4 Cost Summary

7.1.6 Risk Schedule

Figure 7.3 - Block diagram of Proposed New Works



Flows		1	2	3	4	5	6	7	8	9
Average	m³/d	1136	1318	1306	86	43	11	2.0	50	52
	l/s	13	16	16	1	0.5				1
Peak	m³/d	3202	3384	3372	86	43	11	2.0	50	52
	l/s	37.1	39.6	39.6	1	0.5				1.0
Loads										
BOD	kg/d	373	373	279.7	0	0	93			
SS	kg/d	454	454	227.2	0	0	227			
Concentration @ average flow										
BOD	mg/l	328	283	214	0	0	8206			
SS	mg/l	400	345	174	0	0	20000			

7.3.2 *SPECIFICATION*

REMOTE FEED PUMPING STATION

It is to be assumed that the new infrastructure in the Nairn West area will be collected and transferred to a single point where a new satellite pumping station will be constructed to transfer flows to the Nairn South Pumping Station. The pumping station will comprise of 2 no. fixed speed submersible pumps to operate as duty/standby, each rated at 5l/s @ 10m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 600m of rising main.

It is to be assumed that the new infrastructure in the Nairn South Area will be collected and transferred to a single point where a new pumping station will be constructed to transfer flows to a new works between Nairn West and Whiteness. Flows from Nairn West will also be transferred to this pumping station. The pumping station will comprise of 3 no. fixed speed submersible pumps to operate as duty/assist standby, each rated at 20l/s @ 20m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 1000m of rising main.

INLET WORKS

Raw sewage fed to the works will be screened to 6mm by two duty/standby fine screens supplied by Rotamat. Screenings are conveyed to a screenings handling units for compaction prior to discharge to a screenings skip.

Screened sewage will be de-gritted in a grit trap, provided with grit pumps for transfer of grit to a classifier where the grit is washed and compacted prior to discharge into the grit skip.

PRIMARY TREATMENT

Two circular primary tanks are proposed in line with Scottish Water design specifications to provide solids and BOD removal. Each tank is provided with a scraper bridge, pipework, valves and instrumentation.

PST DESLUDGING

Two duty/standby progressive cavity pumps operating will automatically desludge the primary tanks and transfer primary sludge to the storage tank. A duty thickener feed pump transfers primary sludge from the sludge thickener to thicken sludge to a concentration of 5% dry solids prior to being transferred to a thickened sludge storage tank.

ODOUR CONTROL

An odour control unit, with duty/standby vent fans, is to be provided for treating odourous air from the inlet channel, screen, grit plant, sludge thickener, primary sludge and thickened sludge storage tank.

LIQUOR RETURN PUMPING STATION

A new concrete sump is to be provided to house two no. duty/standby submersible pumps, including pipework, valves and instrumentation, to transfer screenings, grit and sludge liquors to the inlet channel.

SERVICE WATER (POTABLE) BOOSTER SET

A new potable water booster set will provide site wash water to hose points, inlet screen, grit classifier and sludge thickener. The set will incorporate duty/standby pumps, pipework and valves, accumulator vessel and instrumentation.

OUTFALL

Final effluent from the primary tank will collect in a new outfall pumping station which will operate at high tide to transfer flows to the Moray Firth.

A new long sea outfall (500m long, 200mm diameter) is proposed to transfer final effluent a sufficient distance into the Moray Firth to avoid the bathing waters around Nairn.

7.3.3 *Cost Summary*

NAIRN - OPTION 3

Item	Description	Price
1.1	Nairn Satellite Pumping Station	103715
1.2	Nairn No 1 Pumping Station	142931
1.3	Nairn Satellite PS Transfer Rising Main	76403
1.4	Nairn No 1 Pump Station Transfer Rising Main	127575
1.5	NAIRN WWTW - proposed new works at Nairn - 5,800 pe; primary treatment only 2 No x 15 mtr dia PST's with long outfall	3315375
1.6	UV Disinfection - NOT REQUIRED	0
1.7	1 no. New Outfall - 1000 m long x 200 mm dia.	140411
	TOTAL	**3907000**

7.3.4 *Risk Schedule*

RISK REGISTER

A96 Corridor Option Study - Nairn Option 3 (New WwTW with new sea outfall)

Risk No	Description of Risk	Description of Impact	Estimated Impact Costs on occurrence	Estimated Probability Likelihood of occurrence	Comments and possible mitigating measures
A	**Construction**				
a1	Discovery of unexpected land contamination at transfer P.S's	Time & cost implications associated with removal.	Medium	Low	Investigate during ATC phase.
a2	Unforeseen Ground Conditions	Additional costs and delay.	Medium	Medium	Investigate during ATC phase.
a3	Discovery of unexpected buried structures, obstructions, services or pipework.	Additional costs and delay.	Medium	Low	Investigate during ATC phase.
B	**Stakeholders**				
b1	Land purchase	Programme delay or make option untenable	High	High	Early land owner contact
b2	Onerous consent from SEPA	Costly asset to construct (not best value solution for Scottish Water)	High	Medium	Detailed discussions with SEPA
b3	Planning constraints (set disinfection levels on existing works)	Costly asset to construct (not best value solution for Scottish Water)	High	High	Initial consultations with planners. Design for disinfection.
b4	Long sea outfall length increased	Cost and programme delay	High	Medium	Detailed discussions with SEPA
b5	Opposition from golf course	Delay to Prog	High	Medium	Develop Stakeholder Plan, Identify and Consult early
b6	Risk of septicity and odours from early development stages	Odour nuisance, cost of cheemical dosing, inhibit performance of works	Medium	Medium	Consider design of rising mains for phased development
D	**Design**				
d1	Flow and load data accuracy	Additional cost of dealing with increased requirements.	High	Medium	Verify Flow and Loads
d2	Risk in complying with regional sludge strategy aspirations	Additional OPEX and CAPEX at sludge centre and additional transportation costs	High	Medium	Review capacity of regional sludge centres and compare with CAPEX/OPEX balance
F	**Site Specifics**				
f1					

7.4 Option 4 – Transfer Flows to New Works with New River Nairn Outfall

7.4.1 *Introduction*

This option requires a newly constructed wastewater treatment facility to be located south of Nairn near the Moss-side area. The works final effluent will require disinfection.

It is proposed that a new MBR process is suitable to provide the required high removal of BOD, suspended solids, ammonia, and final effluent disinfection. This plant should include provision for future development by allowing space for additional aeration capacity, and membrane cassettes. The works will include 6mm fine screening, 0.8mm screening, grit removal. A facility will be provided for dewatering and washing of screenings and grit removed from the process.

Sludge thickening facilities are proposed to thicken surplus sludge to 5% dry solids, suitable to be tankered to Allanfearn WwTW sludge treatment plant. This is in-line with Scottish Water's sludge strategy for the area.

The final effluent will be discharged to the River Nairn via a new outfall (200mmNB) rated for a maximum flow of 40 l/s.

As the final effluent will not receive significant dilution in the River Nairn, it is anticipated that the disinfected final effluent will also require low levels of ammonia and phosphorus.

Issues relating to the requirements for land acquisition are detailed in the risk register.

In this section we include:

7.4.1 Introduction to Option

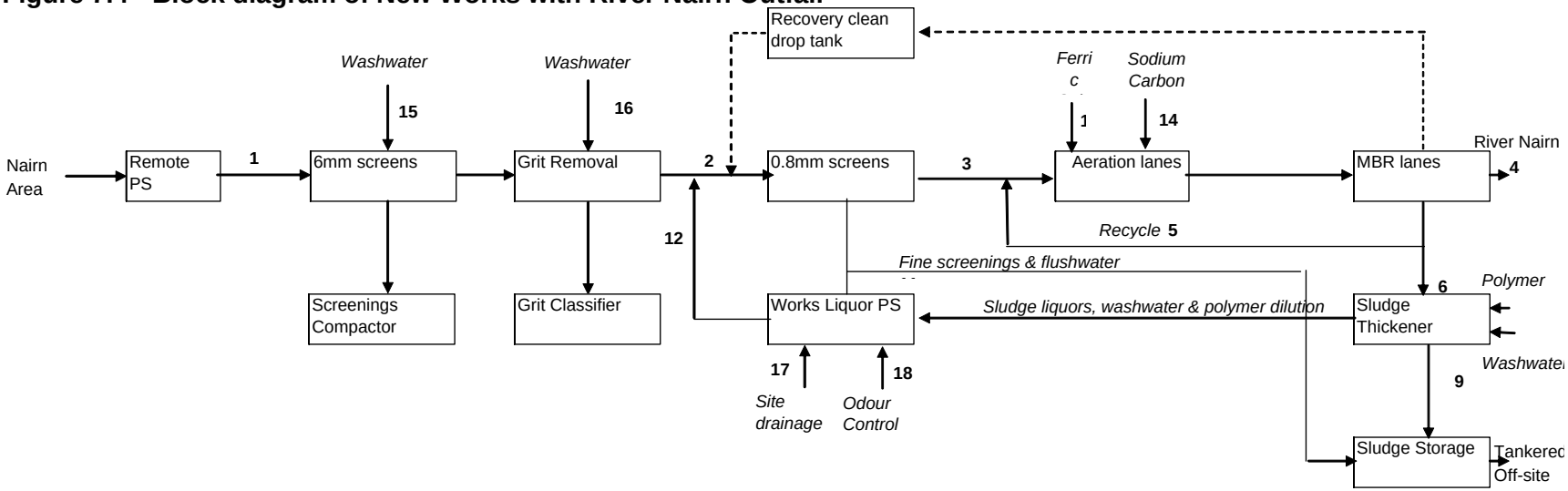
7.4.2 Specification

7.4.3 Mass Balance (Calc no. 09509_0607 Rev O)

7.4.4 Cost Summary

7.4.6 Risk Schedule

Figure 7.4 - Block diagram of New Works with River Nairn Outfall



Flows, Loads and Concentration

Flows		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Average Flow	m³/d	1,136	1,354	1,354	1,322	6,768	31	2.3	9.6	7.5	36	8	88	0.18	1.12	86	43	50	2
	l/s	13	17	17	17	83							2			1	0.50		
Peak Flow	m³/d	3,202	3,419	3,419	3,388	17,097	31	2.3	9.6	7.5	36	8	88	0.18	1.12	86	43	50	2
	l/s	37	41	41	41	203							2			1	1		
Loads																			
BOD	kg/d	373	391	391	13						18		18						
SS	kg/d	454	478	478	23		377	2.3		377	24		24	32	112				
NH3-N	kg/d	49	50	50	2						1		1						
Total P	kg/d	15	15	15	1														
Concentrations at average flow																			
BOD	mg/l	328	289	289	10						501		204						
SS	mg/l	400	353	353	18	12,000	12,000	1,000		50,000	668		272	180,600	100,000				
NH3-N	mg/l	43	37	37	2						33		14						
Total P	mg/l	13	11	11	1														

7.4.2 *SPECIFICATION*

REMOTE FEED PUMPING STATION

It is to be assumed that the new infrastructure in the Nairn West area will be collected and transferred to a single point where a new satellite pumping station will be constructed to transfer flows to the Nairn South Pumping Station. The pumping station will comprise of 2 no. fixed speed submersible pumps to operate as duty/standby, each rated at 5l/s @ 10m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 1500m of rising main.

It is to be assumed that the new infrastructure in the Nairn South Area will be collected and transferred to a single point where a new pumping station will be constructed to transfer flows to a new works to the South of Nairn. Flows from Nairn West will also be transferred to this pumping station. The pumping station will comprise of 3 no. fixed speed submersible pumps to operate as duty/assist/standby, each rated at 20l/s @ 10m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 1500m of rising main.

INLET SCREENS

Incoming raw sewage is to be screened by 2 No Rotamat screens, rated for 31 l/sec comprising 6mm screens and a 10mm emergency bypass screen will be provided. The inlet channel will be provided with an auto-sampler. The new civil structure housing the screens will be provided with odour control covers, isolation penstocks and instrumentation. Screenings will be conveyed to a screenings handling unit where dewatered screenings will be transferred to a skip.

GRIT REMOVAL PLANT

A new grit removal plant will be provided in the form of 1 No Hydro Grit King Separator c/w washwater grit lifting system (which includes isolation valve, pressure regulating valve, flow switch and actuated flow control valve), and 1 No Hydro series 4 grit classifier c/w washwater system (which includes isolation valve, pressure regulating valve, flow switch and actuated flow control valve), all rated for a maximum flow of 31l/s.

FINE SCREENS

Sewage will be further screened by 2 No Fine screens (0.8 mm) each to handle 31 l/s. Screenings will be transferred to the thickened sludge storage tank by 1 No progressive cavity screenings pumps c/w isolation valve, temperature switch and flow switch.

PROCESS AIR SYSTEM

The aeration tank is to be provided with 1 No Fine bubble diffused air system, to operate in 3 No. tanks, 8.3m long x 3.5m wide, each with 4m water depth including blower manifold and air main plus lagging.

The fine bubble diffused aeration system will be supplidd by 2 No Air blowers (1 duty / 1 standby) each complete with variable speed motors (Max :- 48 kgO2/hr @ 0.9 mbar - Avg:- 41 kgO2/hr @ 0.9m bar)

MEMBRANE BIOREACTOR

Three membrane tanks are each to be provided with 3 membrane cassettes, each with 44 modules to accommodate 5 days duration at FFT and planned maintenance and recovery cleaning for up to 24 hours. Each membrane tank is provided with actuated air/backpulse/permeate/sludge valves and pipework.

The following equipment is also provided to effect the operation of the MBR;

3 No Permeate / Backpulse positive displacement lobe pumps, comprising 4 No. pumps operating positive displacement duty/assist/assist/standby with automatically variable speed motor for forward and backwards (reversing) flow for use with final effluent.

1 No Backpulse tank, fabricated from GRP, 2.6m diameter x 4.0m high.

2 No Air scour blowers (duty/standby) each complete with variable speed motors and for the following duties:-

SLUDGE RECIRCULATION SYSTEM

Sludge is to be recirculated from the membrane tanks to the aeration tank inlet by 3 No Sludge recirculation pumps, dry well and suction centrifugal each complete with variable speed motor for use with screened, de-gritted, aerated sewage sludge (1% DS) Duty - Max: - 85 l/sec @ 8m head - Min: - 40 l/sec @ 8m head.

SAS SYSTEM

Surplus sludge is removed by a tee from the sludge recirculation main controlled by a flow meter and actuated valve. Surplus sludge is fed direct to the sludge thickener suitable to produce thickened sludge of 5% dry solids. The thickener is provided with polymer dosing, and a progressive cavity pump which transfers thickened sludge to the thickened sludge storage tank.

MEMBRANE CLEANING SYSTEM

Two chemicals are to be dosed for membrane cleaning and the following dosing equipment is to be provided.

SODIUM HYPOCHLORITE

1 No 1.5 m3 GRP Sodium Hypochlorite storage tank, 1.1m dia and complete with the following:-Inlet connection (50 NB), Outlet connection (25 NB), Overflow (50 NB), Drain (25 NB), Vent, Half opening access lid

4 No Actuated three way valves for block and bleed system c/w pipework to return sodium hypochlorite leaks back to the sodium hypochlorite storage tank.

2 No Sodium Hypochlorite dosing pumps, horizontal plunger type, with manually variable stroke for the following duty:-Max :- 1020 l/hr @ 4 bar and to be complete with the following:-Skid mounted, 2 pressure relief valves, 2 loading valves, Pulsation dampener, Pipework (15 NB), NRV, 2 ball valves manual operation, Calibration vessel, Motor Rating - 0.37 kW

CITIC ACID

1 No 1.5m3 GRP citric acid storage tank, 1.1m dia and complete with the following:-Inlet connection (50 NB),Outlet connection (25 NB), Overflow (50 NB), Drain (25 NB), Vent, Half opening access lid

2 No Citric Acid dosing pumps, horizontal plunger type, with manually variable stroke for the following duty:-

Max; - 1020 l/hr @ 4 bar, and to be complete with the following:-Skid mounted, 2 pressure relief valves, 2 loading valves, Pulsation dampener, Pipework (15 NB), NRV, 2 ball valves manual operation, Calibration vessel

4 No Actuated three way valves for block and bleed system c/w pipework to return citric acid leaks back to the citric acid storage tank.

COMPRESSORS

A compressor set is to be provided to supply air to each pneumatically actuated valve. 1 No Skid mounted air compressor package comprising 2 No. air compressors complete with acoustic enclosure, desiccant dryer, air filters, 100 litres air receiver, control panel, automatic condensate drain valves and oil/water separator.

THICKENED SLUDGE STORAGE TANK

A new glass lined epoxy coated steel tank providing 5 days storage of thickened sludge (75 m^3) is to be provided.

ODOUR CONTROL

An odour control system comprising of duty/standby vent fans is to be provided for the following process units:-

Inlet PS, Screening Skips, Grit skips, Inlet channel, Inlet screen, Grit removal, Liquor return PS, MBR feed pumping station, sludge thickener and thickened sludge tank.

RETURN WORKS LIQUORS PUMPING STATION

2 No Sludge liquor / site drainage pumps (1 duty /1 standby) submersible pumps each complete with fixed speed drive, complete with guide rails, lifting chains davit etc for a sump 6m deep (5 l/sec @ 10m head)

SERVICE WATER (POTABLE) BOOSTER SET

A potable water booster set is to be provided to deliver wash water to the inlet screen, screenings and grit handling plants, odour control plant, sludge thickener and site hose down points. The set will comprise of duty/standby pumps, pipework, valves and accumulator vessel.

BLIND TANK

A chemical blind tank is to be provided to buffer cleaning chemicals.

CHEMICAL DOSING FOR PHOSPHORUS REMOVAL

A skid mounted dosing unit comprising of duty/standby metering pumps, GRP ferric storage tank, pipework, valves and integral bund is to be provided to dose ferric to the MBR to effect phosphorus removal.

CHEMICAL DOSING FOR ALKALINITY

A skid mounted dosing unit comprising of duty/standby metering pumps, GRP Sodium Carbonate tank, pipework, valves and integral bund is to be provided to dose sodium carbonate to the MBR to affect pH control.

7.4.3 *Cost Summary*

NAIRN - OPTION 4

Item	Description	Price
1.1	Nairn Satellite Pumping Station	103715
1.2	Nairn No 1 Pumping Station	142931
1.3	Nairn Satellite PS Transfer Rising Main	1786050
1.4	Nairn No 1 Pump Station Transfer Rising Main	229635
1.5	NAIRN WwTW - new treatment plant at Nairn - 7000 p.e consent 20 BOD / 30 SS / 5 Total N + P Removal - based on a Membrane Plant.	5547633
1.6	UV Disinfection - NOT REQUIRED (Membrane Proposed)	0
1.7	1 no. Outfall - 500 m long x 200 mm dia	76624
	TOTAL	**7887000**

7.4.4 *Risk Schedule*

RISK REGISTER

A96 Corridor Option Study - Nairn Option 4 (New WwTW with River Nairn outfall)

Risk No	Description of Risk	Description of Impact	Estimated Impact Costs on occurrence	Estimated Probability Likelihood of occurrence	Comments and possible mitigating measures
A	**Construction**				
a1	Discovery of unexpected land contamination at transfer P.S.	Time & cost implications associated with removal.	Medium	Low	Investigate during ATC phase.
a2	Unforeseen Ground Conditions	Additional costs and delay.	Medium	Medium	Investigate during ATC phase.
a3	Discovery of unexpected buried structures, obstructions, services or pipework.	Additional costs and delay.	Medium	Low	Investigate during ATC phase.
a4					
B	**Stakeholders**				
b1	Construction of new outfall over private land	Programme delay	Medium	Medium	Early consultations with land owner
b2	Land purchase	Programme delay or make option untenable	High	Medium	Early land owner contact
b3	Onerous consent from SEPA	Costly asset to construct (not best value solution for Scottish Water)	Medium	Medium	Detailed discussions with SEPA
b4	Damage or interference to local environmental protection area	Programme delay	High	Low	Early consultations with SEPA. Initiation of stakeholder management plan.
b5	Risk of septicity and odours from early development stages	Odour nuisance, cost of cheemical dosing, inhibit performance of works	Medium	Medium	Consider design of rising mains for phased development
b6	Planning constraints	Costly asset to construct (not best value solution for Scottish Water)	High	High	Initial consultations with planners. Design for disinfection.
D	**Design**				
d1	Flow and load data accuracy	Additional cost of dealing with increased requirements.	High	Medium	Verify Flow and Loads
d2	Risk in complying with regional sludge strategy aspirations	Additional OPEX and CAPEX at sludge centre and additional transportation costs	High	Medium	Review capacity of regional sludge centres and compare with CAPEX/OPEX balance
F	**Site Specifics**				
f1	Impact of nearby tourist sites (eg. Campsite)	Additional costs and delay.	Medium	Medium	Initiation of stakeholder management plan.

8.0 CENTRAL AREA

8.1 Option 1 – Transfer Flows to New Works Constructed on Existing Ardersier WwTW

8.1.1 *Introduction*

There is an existing works located at Ardersier which treats approximately 27 l/s utilising a compact plant ASP. Wastewater flows from Tornagrain and the airport business park are currently pumped to this site. Final effluent from the site is pumped via a 250mm outfall pipeline into the Moray Firth. The works is located outside the village of Ardersier and can not be viewed from public areas due to natural vegetation. There is sufficient land adjacent to the works for a major works development, currently unused scrub land owned by the Ministry of Defence.

This option proposes the construction of a new works at Ardersier, upgrading of the existing infrastructure to transfer flows to the works, and potential re-use of the existing outfall. It must be noted however that due to the large increase in flows this existing outfall may need to be upgraded if this route is to be re-used.

A more likely option is that a new dedicated outfall pipeline will need to be constructed. There are two sub-options to be considered for this option which relate to the outfall destination and the need for disinfection. Option 1A is to construct a new 500m sea outfall to the west of Fort George which will require disinfection due to the low dilution in this part of the Firth. Option 1B includes the construction of a much longer 3000m outfall to stretch out to the east of Fort George, disinfection not being required due to the high dilution in this area of the Firth.

Due to the large increase in flows, and the local vicinity of dolphin hotspots and a RAMSAR site to the existing outfall, it is proposed to utilise a carbonaceous ASP plant to produce high BOD and suspended solids removal. This works will include 6mm fine screening, grit and grease removal.

Sludge thickening facilities are proposed to thicken surplus sludge to 5% dry solids, suitable to be tankered to Allanfearn WwTW sludge treatment plant. This is in-line with Scottish Water's sludge strategy for the area.

This new works could be sized to include all wastewater flows from Ardersier making the existing plant redundant. This option must be considered in detail at a future design stage should this option be taken forward. Once decommissioned, this area of land could be used as provision for future expansion.

Issue relating to land purchase and stakeholder issues are highlighted in more detail in the risk register.

In this section we include:

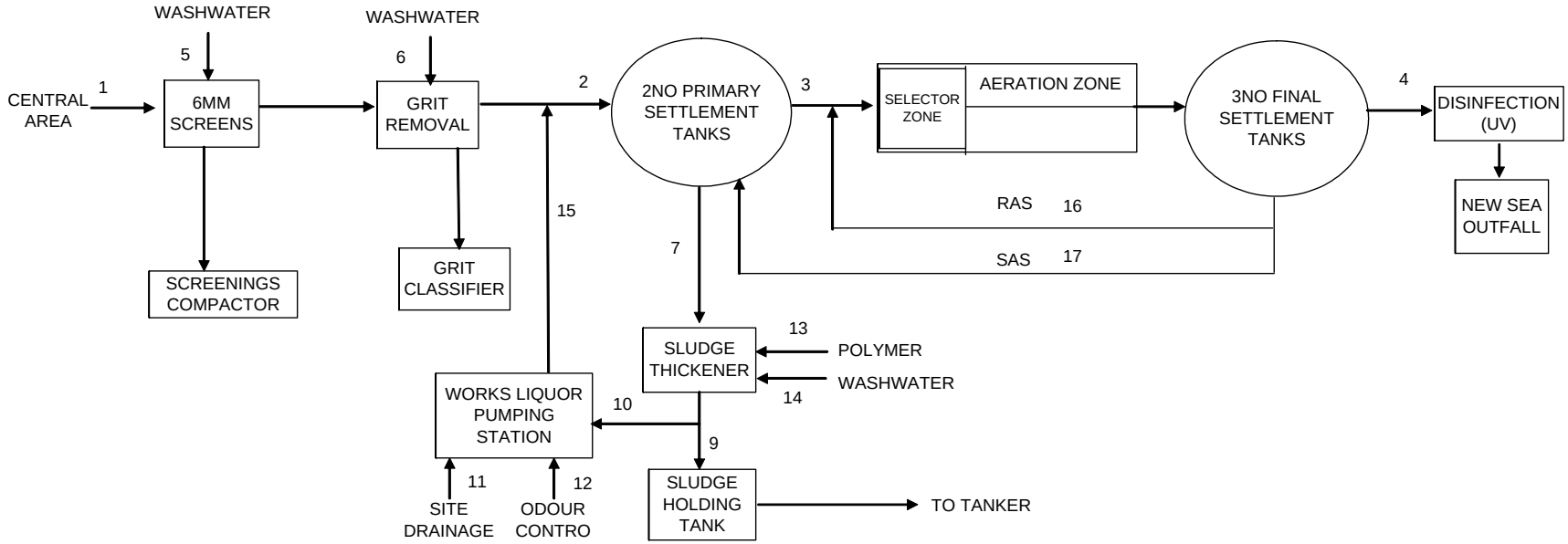
8.1.1 Introduction to Option

8.1.2 Specification

8.1.3 Cost Summary

8.1.4 Risk Schedule

Figure 8.1 - Block diagram of New Works at Ardersier



Flows		1	2	3	4	5	6	7	9	10	11	12	13	14	15	16	17
Average Flow	m³/d	2,292	2,508	2,477	2,477	86	43	31	26.0	17	50	2	8	10	87	1,247	68
	l/s	27	29	29	29	1	0.5								1.00	14	
Maximum Flow	m³/d	6,459	7,021	6,990	6,990	86	43	31	26.0	17	50	2	8	10	432	3,503	68
	l/s	75	81	81	81	1	0.5								5	41	
Loads																	
BOD	kg/d	658	710	532	25					52					52		
SS	kg/d	795	864	432	87			929.4	1,301	69			7.81		69	9,171	497
Concentrations at average flow																	
BOD	mg/l	287	283	215	10					3,000					599.92		
SS	mg/l	347	345	174	35			30,000	50,000	4,000			1,000		799.89	7,355	7,355

8.1.2 *SPECIFICATION*

REMOTE FEED PUMPING STATION

It is to be assumed that the new infrastructure in the Whiteness Head area will be collected and transferred to a single point where a new satellite pumping station will be constructed to transfer flows to the Ardersier Works. The pumping station will comprise of 3 no. fixed speed submersible pumps to operate as duty/standby, each rated at 8l/s @ 15m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 1500m of rising main.

It is to be assumed that the new infrastructure in the Ardersier Village Area will be collected and transferred to a single point where a new pumping station will be constructed to transfer flows to the Ardersier works. The pumping station will comprise of 3 no. fixed speed submersible pumps to operate as duty/assist/standby, each rated at 10l/s @ 10m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 500m of rising main.

It is to be assumed that the new infrastructure in the Tornagrain Area will be collected and transferred to a single point where a new pumping station will be constructed to transfer flows to the Ardersier works. The pumping station will comprise of 3 no. fixed speed submersible pumps to operate as duty/assist/standby, each rated at 30l/s @ 25m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 2000m of rising main.

INLET WORKS

Raw sewage fed to the works will be screened to 6mm by two duty/standby fine screens supplied by Rotamat. Screenings are conveyed to a screenings handling units for compaction prior to discharge to a screenings skip.

Screened sewage will be de-gritted in a grit trap, provided with grit pumps for transfer of grit to a classifier where the grit is washed and compacted prior to discharge into the grit skip.

PRIMARY TREATMENT

Two circular primary tanks are proposed in line with Scottish Water design specifications to provide initial solids and BOD removal. Each tank is provided with a scraper bridge, pipework, valves and instrumentation.
Two duty/standby progressive cavity pumps operating will automatically desludge the primary tanks and transfer consolidated sludge to the sludge thickener. The sludge

thickener is suitable to thicken surplus sludge to a concentration of 5% dry solids prior to being transferred to a new 130m^3 storage tank.

SECONDARY TREATMENT

A new activated sludge plant is proposed to provide the additional BOD and solids removal required to meet likely discharge consents. Primary effluent is combined with return activated sludge (RAS) in the selector tank. Flows from the selector tank are distributed between 2 aeration lanes, each 28.5m long and 2.4m wide.
Each aeration lane is provided with fine bubble diffuser grids, air pipework and isolation valves.
The outlet from the aeration tank flows to a new FST distribution chamber which splits flows between three final settlement tanks. Each tank is provided with a scraper bridge.

RAS/SAS SYSTEM
RAS is drained from the base of each FST via a dedicated actuated valve into the RAS/SAS pumping station. Two duty/standby submersible pumps transfer RAS to the selector tank of the ASP and are provided with associated pipework, valves and instrumentation. Surplus sludge is diverted from the RAS line by an actuated valve the primary tank distribution chamber for co-settlement.

ODOUR CONTROL

An odour control unit, with duty/standby vent fans, is to be provided for treating odourous air from the inlet channel, screen, grit plant, sludge thickener, and thickened sludge storage tank.

LIQUOR RETURN PUMPING STATION

A new concrete sump is to be provided to house two no. duty/standby submersible pumps, including pipework, valves and instrumentation, to transfer screenings, grit and sludge liquors to the inlet channel.

SERVICE WATER (POTABLE) BOOSTER SET

A new potable water booster set will provide site wash water to hose points, inlet screen, grit classifier and sludge thickener. The set will incorporate duty/standby pumps, pipework and valves, accumulator vessel and instrumentation.

UV TREATMENT PLANT (Option 1B)

A new UV treatment plant is to be provided for disinfection of final effluent prior to discharge to the Moray Firth. This is required for a short (500m) outfall into the Moray Firth east of Fort George. If option 1A is chosen, to construct a 3000m outfall to discharge east of Fort George, UV disinfection will not be required.

8.1.3 *Cost Summary*

CENTRAL AREA - OPTION 1 A

Item	Description	Price
1.1	Tornagrain Pumping Station	144900
1.2	Ardersier Village Pumping Station	136159
1.3	Whiteness Head Pumping Station	135844
1.4	Tornagrain Transfer Rising Main	765450
1.5	Ardersier Village Rising Main	68749
1.6	Whiteness Head Rising Main	196088
1.7	ARDERSIER WwTW - new treatment plant at Ardersier (adjacent to existing) -) - 75 l/sec 14000 pe.	5637188
1.8	UV Disinfection - NOT REQUESTED	0
1.9	1 no. x 400 mm dia x 3000 mtr Outfall	2223349
	TOTAL	**9308000**

CENTRAL AREA - OPTION 1B

Item	Description	Price
1.1	Tornagrain Pumping Station	144900
1.2	Ardersier Village Pumping Station	136159
1.3	Whiteness Head Pumping Station	135844
1.4	Tornagrain Transfer Rising Main	357210
1.5	Ardersier Village Rising Main	783169
1.6	Whiteness Head Rising Main	196324
1.7	ARDERSIER WwTW - new treatment plant at Ardersier (adjacent to existing) - 75 l/sec 14000 pe.	5637188
1.8	UV Disinfection	146625
1.9	1 no. x 400 mm dia x 500 mtr Outfall	435724
	TOTAL	**7974000**

8.1.4 *Risk Schedule*

RISK REGISTER

A96 Corridor Option Study - Central Option 1 (New Works at Ardersier WwTW)

Risk No	Description of Risk	Description of Impact	Estimated Impact Costs on occurrence	Estimated Probability Likelihood of occurrence	Comments and possible mitigating measures
A	**Construction**				
a1	Discovery of unexpected land contamination at transfer P.S.	Time & cost implications associated with removal.	Medium	Low	Investigate during ATC phase.
a2	Unforeseen Ground Conditions	Additional costs and delay.	Medium	Medium	Investigate during ATC phase.
a3	Discovery of unexpected buried structures, obstructions, services or pipework.	Additional costs and delay.	Medium	Low	Investigate during ATC phase.
B	**Stakeholders**				
b1	Land purchase	Programme delay or make option untenable	High	High	Early land owner contact
b2	Onerous consent from SEPA	Costly asset to construct (not best value solution for Scottish Water)	High	Medium	Detailed discussions with SEPA
b3	Planning constraints (set disinfection levels on existing works)	Costly asset to construct (not best value solution for Scottish Water)	High	High	Initial consultations with planners. Design for disinfection.
b4	Damage or interference to local environmental protection area	Programme delay	High	Low	Early consultations with SEPA. Initiation of stakeholder management plan.
b5	Risk of septicity and odours from early development stages	Odour nuisance, cost of chemical dosing, inhibit performance of works	Medium	Medium	Consider design of rising mains for phased development
D	**Design**				
d1	Flow and load data accuracy	Additional cost of dealing with increased requirements.	High	Medium	Verify Flow and Loads
d2	Exacerbate odour issues	Breach of planning regulations	High	Medium	Undertake odour plan
d3	Risk in complying with regional sludge strategy aspirations	Additional OPEX and CAPEX at sludge centre and additional transportation costs	High	Medium	Review capacity of regional sludge centres and compare with CAPEX/OPEX balance
F	**Site Specifics**				
f1	Interfering with existing works	Protracted programme to maintain existing works during construction	High	Medium	Careful construction methodology required
f2	Site development is adjacent to firing range (outfall through danger area)	Delay to programme whilst survey undertaken	High	Low	Stakeholder consultation, determine whether survey required before construction
f3	Interference with access to Fort George during summer	Delay due to opposition from tourist attraction	Medium	Low	Early consultation, assessment of outfall route

8.2 Option 2 – Transfer Flows to Allanfearn WwTW

8.2.1 *Introduction*

This option proposes a new collection and transfer system in the central area to pump wastewater flows to Allanfearn WwTW.

As this wastewater is from outside the PFI exclusive area, the owners of the PFI concession are not obliged to accept these flows. A further investigation into how the existing works can be upgraded to accept these flows will be required and the agreement with Scottish Water will need to be re-negotiated.

The works is constricted by special protection areas, an area of archaeological importance and a railway line, therefore expansion of the site boundary is extremely difficult.

On the basis that additional land can be acquired, a new carbonaceous ASP with UV disinfection is proposed to run in parallel with the existing works.

This works has a long sea outfall into the Moray Firth and the final effluent has UV disinfection. Further study is required to determine whether the existing outfall (and pumps) needs to be upgraded.

Value engineering opportunities may be available by combining flows with the existing works, however, this can only be considered during a detailed design phase.

More details of issues relating to land acquisition are highlighted in the risk register.

In this section we include:

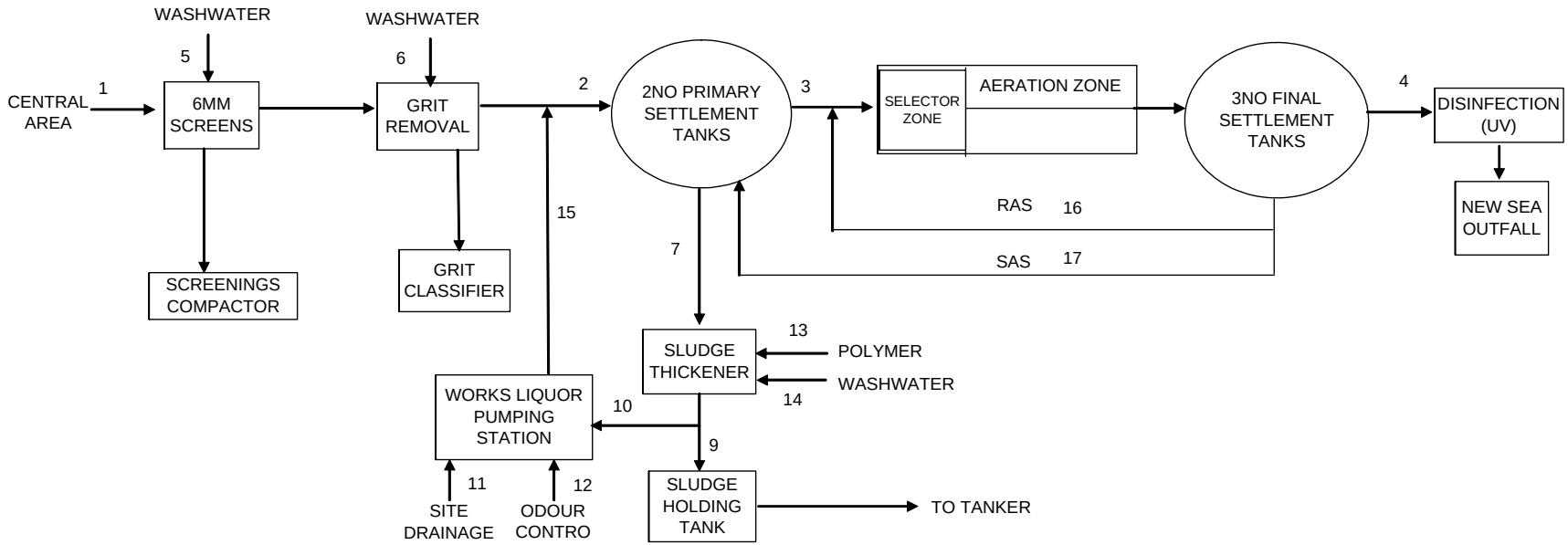
8.2.1 Introduction to Option

8.2.2 Specification

8.2.3 Cost Summary

8.2.4 Risk Schedule

Figure 8.2 - Block diagram of New Works Required at Allanfearn



Flows		1	2	3	4	5	6	7	9	10	11	12	13	14	15	16	17
Average Flow	m³/d	2,292	2,508	2,477	2,477	86	43	31	26.0	17	50	2	8	10	87	1,247	68
	l/s	27	29	29	29	1	0.5								1.00	14	
Maximum Flow	m³/d	6,459	7,021	6,990	6,990	86	43	31	26.0	17	50	2	8	10	432	3,503	68
	l/s	75	81	81	81	1	0.5								5	41	
Loads																	
BOD	kg/d	658	710	532	25					52					52		
SS	kg/d	795	864	432	87			929.4	1,301	69			7.81		69	9,171	497
Concentrations at average flow																	
BOD	mg/l	287	283	215	10					3,000					599.92		
SS	mg/l	347	345	174	35			30,000	50,000	4,000			1,000		799.89	7,355	7,355

8.2.2 *SPECIFICATION*

REMOTE FEED PUMPING STATION

It is to be assumed that the new infrastructure in the Whiteness Head area will be collected and transferred to a single point where a new satellite pumping station will be constructed to transfer flows to the Ardersier Village Pumping Station. The pumping station will comprise of 3 no. fixed speed submersible pumps to operate as duty/standby, each rated at 8l/s @ 15m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 1500m of rising main.

It is to be assumed that the new infrastructure in the Ardersier Village Area will be collected and transferred to a single point where a new pumping station will be constructed to transfer flows to the Tornagrain Pumping Station. The pumping station will comprise of 3 no. fixed speed submersible pumps to operate as duty/assist/standby, each rated at 16l/s @ 15m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 500m of rising main.

It is to be assumed that the new infrastructure in the Tornagrain Area will be collected and transferred to a single point where a new pumping station will be constructed to transfer flows to a new works at Allanfearn. The pumping station will comprise of 3 no. fixed speed submersible pumps to operate as duty/assist/standby, each rated at 50l/s @ 25m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 2000m of rising main.

INLET WORKS

Raw sewage fed to the works will be screened to 6mm by two duty/standby fine screens supplied by Rotamat. Screenings are conveyed to a screenings handling units for compaction prior to discharge to a screenings skip.

Screened sewage will be de-gritted in a grit trap, provided with grit pumps for transfer of grit to a classifier where the grit is washed and compacted prior to discharge into the grit skip.

PRIMARY TREATMENT

Two circular primary tanks (14m diameter) are proposed in line with Scottish Water design specifications to provide initial solids and BOD removal. Each tank is provided with a scraper bridge, pipework, valves and instrumentation.
Two duty/standby progressive cavity pumps operating will automatically desludge the primary tanks and transfer consolidated sludge to the sludge thickener. The sludge

thickener is suitable to thicken surplus sludge to a concentration of 5% dry solids prior to being transferred to a new 130m^3 storage tank.

SECONDARY TREATMENT

A new activated sludge plant is proposed to provide the additional BOD and solids removal required to meet likely discharge consents. Primary effluent is combined with return activated sludge (RAS) in the selector tank. Flows from the selector tank are distributed between 2 aeration lanes, each 28.5m long and 2.4m wide.
Each aeration lane is provided with fine bubble diffuser grids, air pipework and isolation valves.
The outlet from the aeration tank flows to a new FST distribution chamber which splits flows between three final settlement tanks. Each tank is provided with a scraper bridge.

RAS/SAS SYSTEM
RAS is drained from the base of each FST via a dedicated actuated valve into the RAS/SAS pumping station. Two duty/standby submersible pumps transfer RAS to the selector tank of the ASP and are provided with associated pipework, valves and instrumentation. Surplus sludge is diverted from the RAS line by an actuated valve the primary tank distribution chamber for co-settlement.

ODOUR CONTROL

An odour control unit, with duty/standby vent fans, is to be provided for treating odourous air from the inlet channel, screen, grit plant, sludge thickener, and thickened sludge storage tank.

LIQUOR RETURN PUMPING STATION

A new concrete sump is to be provided to house two no. duty/standby submersible pumps, including pipework, valves and instrumentation, to transfer screenings, grit and sludge liquors to the inlet channel.

SERVICE WATER (POTABLE) BOOSTER SET

A new potable water booster set will provide site wash water to hose points, inlet screen, grit classifier and sludge thickener. The set will incorporate duty/standby pumps, pipework and valves, accumulator vessel and instrumentation.

UV TREATMENT PLANT

A new UV treatment plant is to be provided for disinfection of final effluent prior to discharge to the Moray Firth. This is required for a short (1000m) outfall into the Moray Firth east of Fort George.

8.2.3 *Cost Summary*

CENTRAL AREA - OPTION 2

Item	Description	Price
1.1	Tornagrain Pumping Station	151200
1.2	Ardersier Village Pumping Station	132046
1.3	Whiteness Head Pumping Station	131231
1.4	Whiteness Transfer Rising Main	191363
1.5	Ardersier Village Transfer Rising Main	51030
1.6	Tornagrain Rising Main	1705961
1.7	Inverness East Pumping Station	123770
1.8	Culloden Pumping Station	123770
1.9	Inverness East Transfer Rising Main	191363
1.1	Culloden Transfer Rising Main	143168
1.11	ALLENFEARN WwTW - new treatment plant at Allenfearn (at present Allenfearn disinfects) - previous @ 26,000 PE - 20 BOD / 30 SS + NEW SIZE @ 24000 P.E. THEREFORE LEAVE AS IS	6170640
1.12	UV Disinfection	161438
1.13	1 no. x 400 mm dia x 1000 mtr Outfall	810810
	TOTAL	**10088000**

8.2.4 *Risk Schedule*

RISK REGISTER

A96 Corridor Option Study - Central Option 2 (Transfer Flows to Allanfearn WwTW)

Risk No	Description of Risk	Description of Impact	Estimated Impact Costs on occurrence	Estimated Probability Likelihood of occurrence	Comments and possible mitigating measures
A	**Construction**				
a1	Discovery of unexpected land contamination at transfer P.S.	Time & cost implications associated with removal.	Medium	Low	Investigate during ATC phase.
a2	Unforeseen Ground Conditions	Additional costs and delay.	Medium	Medium	Investigate during ATC phase.
a3	Discovery of unexpected buried structures, obstructions, services or pipework.	Additional costs and delay.	Medium	Low	Investigate during ATC phase.
B	**Stakeholders**				
b1	Planning Restrictions Noise, Buildings, cemetry, community centre	Cost and delay if constraints imposed by Local Planner.	High	Medium	Develop Stakeholder Plan, Identify and Consult early
b2	Land Owners Restricting Access or sale refusal	Cost and delay	High	Medium	Develop Stakeholder Plan, Identify and Consult early
b3	Power Supply Installation	Delay to Prog	High	Medium	Develop Stakeholder Plan, Identify and Consult early
b4	Risk of septicity and odours from early development stages	Odour nuisance, cost of cheemical dosing, inhibit performance of works	Medium	Medium	Consider design of rising mains for phased development
D	**Design**				
d1	Flow and load data accuracy	Additional cost of dealing with increased requirements.	High	Medium	Verify Flow and Loads
F	**Site Specifics**				
f1					

8.3 Option 3 – Transfer Flows to New Works with New Sea Outfall

8.3.1 *Introduction*

This option requires a newly constructed wastewater treatment facility to be located near the coast in the Fisherton area, adjacent to Inverness Airport. This location is proposed to avoid special protection areas and reduce the amount of infrastructure required to transfer flows to the works. The works final effluent is likely to require disinfection.

Due to the anticipated large flows, and other environmental issues, it is proposed to utilise a carbonaceous plant with UV disinfection. This works will include 6mm fine screening, grit and grease removal, primary tanks, aeration lanes and final settlement tanks as well as UV treatment. This technology is well known and robust to load variations, and provision can be included to allow extension to aid phased development. Flexibility will be incorporated into the design should options to transfer Inverness East and Nairn area flows be taken forward for connection into this works.

Sludge thickening facilities are proposed to thicken surplus sludge to 5% dry solids, suitable to be tankered to Allanfearn WwTW sludge treatment plant. This is in-line with Scottish Water's sludge strategy for the area.

The final effluent will be pumped into the Moray Firth via a long sea outfall (400mmNB) rated for a maximum flow of 80 l/s. This is to counter high tides and saline intrusion. An existing outfall from the airport industrial estate has been identified which could be re-used. Further investigation is required to determine the condition and capacity of this outfall, and whether it will need to be repaired or upgraded should this option be taken forward.

In this section we include:

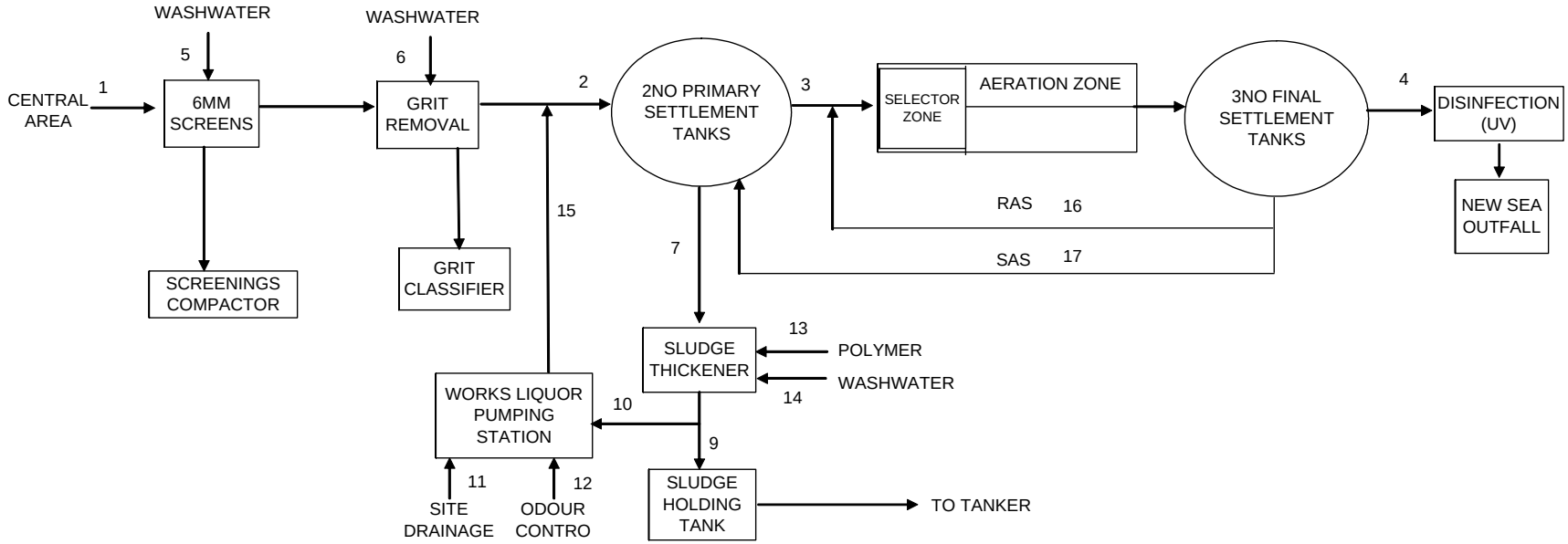
8.3.1 Introduction to Option

8.3.2 Specification

8.3.3 Cost Summary

8.3.4 Risk Schedule

Figure 8.3 - Block diagram of New Works with Moray Firth Outfall



Flows		1	2	3	4	5	6	7	9	10	11	12	13	14	15	16	17
Average Flow	m³/d	2,292	2,508	2,477	2,477	86	43	31	26.0	17	50	2	8	10	87	1,247	68
	l/s	27	29	29	29	1	0.5								1.00	14	
Maximum Flow	m³/d	6,459	7,021	6,990	6,990	86	43	31	26.0	17	50	2	8	10	432	3,503	68
	l/s	75	81	81	81	1	0.5								5	41	
Loads																	
BOD	kg/d	658	710	532	25					52					52		
SS	kg/d	795	864	432	87			929.4	1,301	69			7.81		69	9,171	497
Concentrations at average flow																	
BOD	mg/l	287	283	215	10					3,000					599.92		
SS	mg/l	347	345	174	35			30,000	50,000	4,000			1,000		799.89	7,355	7,355

8.3.2 *SPECIFICATION*

REMOTE FEED PUMPING STATION

It is to be assumed that the new infrastructure in the Whiteness Head area will be collected and transferred to a single point where a new satellite pumping station will be constructed to transfer flows to the Ardersier Village Pumping Station. The pumping station will comprise of 3 no. fixed speed submersible pumps to operate as duty/standby, each rated at 8l/s @ 15m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 1500m of rising main.

It is to be assumed that the new infrastructure in the Ardersier Village Area will be collected and transferred to a single point where a new pumping station will be constructed to transfer flows to a new works at Fisherton. The pumping station will comprise of 3 no. fixed speed submersible pumps to operate as duty/assist/standby, each rated at 20l/s @ 10m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 500m of rising main.

It is to be assumed that the new infrastructure in the Tornagrain Area will be collected and transferred to a single point where a new pumping station will be constructed to transfer flows to a new works at Fisherton. The pumping station will comprise of 3 no. fixed speed submersible pumps to operate as duty/assist/standby, each rated at 30l/s @ 25m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 2000m of rising main.

INLET WORKS

Raw sewage fed to the works will be screened to 6mm by two duty/standby fine screens supplied by Rotamat. Screenings are conveyed to a screenings handling units for compaction prior to discharge to a screenings skip.

Screened sewage will be de-gritted in a grit trap, provided with grit pumps for transfer of grit to a classifier where the grit is washed and compacted prior to discharge into the grit skip.

PRIMARY TREATMENT

Two circular primary tanks are proposed in line with Scottish Water design specifications to provide initial solids and BOD removal. Each tank is provided with a scraper bridge, pipework, valves and instrumentation.
Two duty/standby progressive cavity pumps operating will automatically desludge the primary tanks and transfer consolidated sludge to the sludge thickener. The sludge

thickener is suitable to thicken surplus sludge to a concentration of 5% dry solids prior to being transferred to a new 130m^3 storage tank.

SECONDARY TREATMENT

A new activated sludge plant is proposed to provide the additional BOD and solids removal required to meet likely discharge consents. Primary effluent is combined with return activated sludge (RAS) in the selector tank. Flows from the selector tank are distributed between 2 aeration lanes, each 28.5m long and 2.4m wide.
Each aeration lane is provided with fine bubble diffuser grids, air pipework and isolation valves.
The outlet from the aeration tank flows to a new FST distribution chamber which splits flows between three final settlement tanks. Each tank is provided with a scraper bridge.

RAS/SAS SYSTEM

RAS is drained from the base of each FST via a dedicated actuated valve into the RAS/SAS pumping station. Two duty/standby submersible pumps transfer RAS to the selector tank of the ASP and are provided with associated pipework, valves and instrumentation. Surplus sludge is diverted from the RAS line by an actuated valve the primary tank distribution chamber for co-settlement.

ODOUR CONTROL

An odour control unit, with duty/standby vent fans, is to be provided for treating odourous air from the inlet channel, screen, grit plant, sludge thickener, and thickened sludge storage tank.

LIQUOR RETURN PUMPING STATION

A new concrete sump is to be provided to house two no. duty/standby submersible pumps, including pipework, valves and instrumentation, to transfer screenings, grit and sludge liquors to the inlet channel.

SERVICE WATER (POTABLE) BOOSTER SET

A new potable water booster set will provide site wash water to hose points, inlet screen, grit classifier and sludge thickener. The set will incorporate duty/standby pumps, pipework and valves, accumulator vessel and instrumentation.

UV TREATMENT PLANT

A new UV treatment plant is to be provided for disinfection of final effluent prior to discharge to the Moray Firth. This is required for a short (1000m) outfall into the Moray Firth east of Fort George.

8.3.3 *Cost Summary*

CENTRAL AREA - OPTION 3

Item	Description	Price
1.1	Tornagrain Pumping Station	141225
1.2	Ardersier Village Pumping Station	142538
1.3	Whiteness Head Pumping Station	135844
1.4	Whiteness Transfer Rising Main	191363
1.5	Ardersier Village Transfer Rising Main	306180
1.6	Tornagrain Rising Main	267908
1.7	FISHERTON WwTW - new treatment plant at Fisherton -- 75 l/sec 14000 pe.	5637188
1.8	UV Disinfection	150938
1.9	1 no. x 300 mm dia x 500 mtr Outfall	331774
	TOTAL	**7305000**

8.3.4 *Risk Schedule*

RISK REGISTER

A96 Corridor Option Study - Central Option 3 (New Works at Fisherton)

Risk No	Description of Risk	Description of Impact	Estimated Impact Costs on occurrence	Estimated Probability Likelihood of occurrence	Comments and possible mitigating measures
A	**Construction**				
a1	Discovery of unexpected land contamination at transfer P.S.	Time & cost implications associated with removal.	Medium	Low	Investigate during ATC phase.
a2	Unforeseen Ground Conditions	Additional costs and delay.	Medium	Medium	Investigate during ATC phase.
a3	Discovery of unexpected buried structures, obstructions, services or pipework.	Additional costs and delay.	Medium	Low	Investigate during ATC phase.
B	**Stakeholders**				
b1	Land purchase	Programme delay or make option untenable	High	High	Early land owner contact
b2	Onerous consent from SEPA	Costly asset to construct (not best value solution for Scottish Water)	High	Medium	Detailed discussions with SEPA
b3	Planning constraints (set disinfection levels on existing works)	Costly asset to construct (not best value solution for Scottish Water)	High	High	Initial consultations with planners. Design for disinfection.
b4	Risk of septicity and odours from early development stages	Odour nuisance, cost of cheemical dosing, inhibit performance of works	Medium	Medium	Consider design of rising mains for phased development
b5	Over design from not knowwing SEPA constraints	Scottish Water could make incorrect investment	Low	Low	Detailed discussions with SEPA
D	**Design**				
d1	Flow and load data accuracy	Additional cost of dealing with increased requirements.	High	Medium	Verify Flow and Loads
d2	Risk in complying with regional sludge strategy aspirations	Additional OPEX and CAPEX at sludge centre and additional transportation costs	High	Medium	Review capacity of regional sludge centres and compare with CAPEX/OPEX balance
F	**Site Specifics**				
f1					

8.4 Option 4 – Transfer Flows to New Works with New River Nairn Outfall

8.4.1 *Introduction*

This option requires a newly constructed wastewater treatment facility to be located south of the Dalcross area near to the River Nairn. The works final effluent is likely to require disinfection.

It is proposed that a new MBR process is suitable to provide the required high removal of BOD, suspended solids, ammonia, and final effluent disinfection. The works will be provided with chemical dosing facilities for phosphorus removal. This plant should include provision for future development by allowing space for additional aeration capacity, and membrane cassettes. The works will include 6mm fine screening, 0.8mm screening, grit removal for preliminary treatment. A facility will be provided for dewatering and washing of screenings and grit removed from the process.

Sludge thickening facilities are proposed to thicken surplus sludge to 5% dry solids, suitable to be tankered to Allanfearn WwTW sludge treatment plant. This is in-line with Scottish Water's sludge strategy for the area.

The final effluent will be pumped to the River Nairn via a new rising main (400mmNB) rated for a maximum flow of 80 l/s. The works will need to be provided with a standby generator to prevent flooding of the sewer network during power failure conditions.

In this section we include:

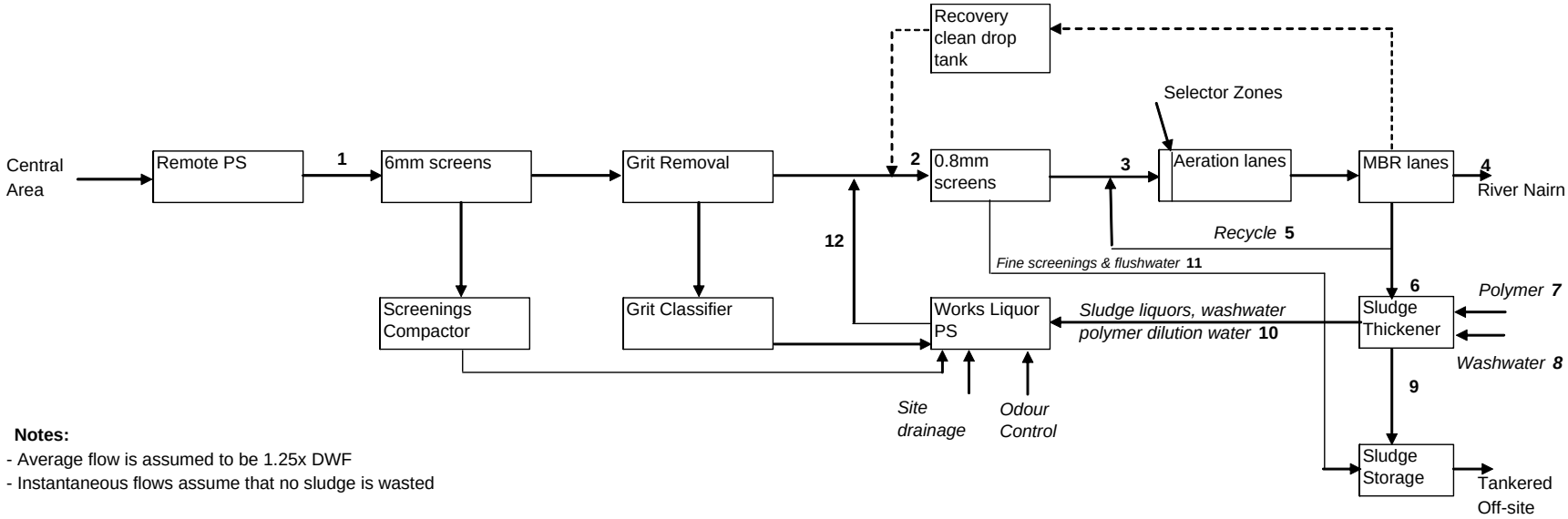
8.4.1 Introduction to Option

8.4.2 Specification

8.4.3 Cost Summary

8.4.4 Risk Schedule

Figure 8.4 - Block diagram of New Works with River Nairn Outfall



Notes:
- Average flow is assumed to be 1.25x DWF
- Instantaneous flows assume that no sludge is wasted

Flows, Loads and Concentration (Summer 2020)

Flows		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Average Flow	m³/d	2,292	2,513	15,079	2,477	12,566	36	2.6	9.6	8.6	40	30	221
	l/s	27	32	189	31	158	0						5
Maximum Flow	m³/d	6,459	6,680	40,082	6,644	33,402	36	2.6	9.6	8.6	40	30	221
	l/s	75	80	479	79	399	0						5
Loads													
BOD	kg/d	658	678	678	12	0	665				21		21
SS	kg/d	795	822	151,610	12	150,787	432	2.6		432	27		27
NH3-N	kg/d	86	87		3								1
Concentrations at average flow													
BOD	mg/l	287	270	45	5						519		93
SS	mg/l	347	327	10,055	5	12,000	12,000	1,000		50,000	692		124
NH3-N	mg/l	37	37		1								6

8.4.2 *SPECIFICATION*

REMOTE FEED PUMPING STATION

It is to be assumed that the new infrastructure in the Whiteness Head area will be collected and transferred to a single point where a new satellite pumping station will be constructed to transfer flows to the Ardersier Village Pumping Station. The pumping station will comprise of 3 no. fixed speed submersible pumps to operate as duty/standby, each rated at 8l/s @ 15m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 1500m of rising main.

It is to be assumed that the new infrastructure in the Ardersier Village Area will be collected and transferred to a single point where a new pumping station will be constructed to transfer flows to the Tornagrain Pumping Station. The pumping station will comprise of 3 no. fixed speed submersible pumps to operate as duty/assist/standby, each rated at 20l/s @ 20m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 500m of rising main.

It is to be assumed that the new infrastructure in the Tornagrain Area will be collected and transferred to a single point where a new pumping station will be constructed to transfer flows to a new works at Dalcross. The pumping station will comprise of 3 no. fixed speed submersible pumps to operate as duty/assist/standby, each rated at 50l/s @ 20m head. The total option cost includes for the control panel and instrumentation required to operate the pumps automatically, all mechanical equipment required, and all civil structures, including 2000m of rising main.

INLET SCREENS

Incoming raw sewage is to be screened by 2 No Rotamat screens, rated for 80 l/sec comprising 6mm screens and a 10mm emergency bypass screen will be provided. The inlet channel will be provided with an auto-sampler. The new civil structure housing the screens will be provided with odour control covers, isolation penstocks and instrumentation. Screenings will be conveyed to a screenings handling unit where dewatered screenings will be transferred to a skip.

GRIT REMOVAL PLANT

A new grit removal plant will be provided in the form of 1 No Hydro Grit King Separator c/w washwater grit lifting system (which includes isolation valve, pressure regulating valve, flow switch and actuated flow control valve), and 1 No Hydro series 4 grit classifier c/w washwater system (which includes isolation valve, pressure regulating valve, flow switch and actuated flow control valve), all rated for a maximum flow of 80l/s.

FINE SCREENS

Sewage will be further screened by 2 No Fine screens (0.8 mm) each to handle 80 l/s. Screenings will be transferred to the thickened sludge storage tank by 1 No progressive cavity screenings pumps c/w isolation valve, temperature switch and flow switch.

PROCESS AIR SYSTEM

The aeration tank is to be provided with 1 No Fine bubble diffused air system, to operate in 2 No. tanks, 18m long x 5m wide, each with 4m water depth including blower manifold and air main plus lagging.

The fine bubble diffused aeration system will be supplidd by 2 No Air blowers (1 duty / 1 standby) each complete with variable speed motors

MEMBRANE BIOREACTOR

Four membrane tanks are each to be provided with 3 membrane cassettes, each with 44 modules to accommodate 5 days duration at FFT and planned maintenance and recovery cleaning for up to 24 hours. Each membrane tank is provided with actuated air/backpulse/permeate/sludge valves and pipework.

The following equipment is also provided to effect the operation of the MBR;

4 No Permeate / Backpulse positive displacement lobe pumps, comprising 4 No. pumps operating positive displacement duty/assist/assist/standby with automatically variable speed motor for forward and backwards (reversing) flow for use with final effluent. (Duty - 40 l/s @ 15m head)

1 No Backpulse tank, fabricated from GRP, 2.6m diameter x 4.0m high.

2 No Air scour blowers (duty/standby) each complete with variable speed motors and for the following duties:-

SLUDGE RECIRCULATION SYSTEM

Sludge is to be recirculated from the membrane tanks to the aeration tank inlet by 3 No Sludge recirculation pumps, dry well and suction centrifugal each complete with variable speed motor for use with screened, de-gritted, aerated sewage sludge (1% DS) Duty - Max: - 200 l/sec @ 12m head - Min: - 100 l/sec @ 12m head.

SAS SYSTEM

Surplus sludge is removed by a tee from the sludge recirculation main controlled by a flow meter and actuated valve. Surplus sludge is fed direct to the sludge thickener suitable to produce thickened sludge of 5% dry solids. The thickener is provided with

polymer dosing, and a progressive cavity pump which transfers thickened sludge to the thickened sludge storage tank.

MEMBRANE CLEANING SYSTEM

Two chemicals are to be dosed for membrane cleaning and the following dosing equipment is to be provided.

SODIUM HYPOCHLORITE

1 No 1.5 m3 GRP Sodium Hypochlorite storage tank, 1.1m dia and complete with the following:-Inlet connection (50 NB), Outlet connection (25 NB), Overflow (50 NB), Drain (25 NB), Vent, Half opening access lid

4 No Actuated three way valves for block and bleed system c/w pipework to return sodium hypochlorite leaks back to the sodium hypochlorite storage tank.

2 No Sodium Hypochlorite dosing pumps, horizontal plunger type, with manually variable stroke for the following duty:-Max :- 1020 l/hr @ 4 bar and to be complete with the following:-Skid mounted, 2 pressure relief valves, 2 loading valves, Pulsation dampener, Pipework (15 NB), NRV, 2 ball valves manual operation, Calibration vessel, Motor Rating - 0.37 kW

CITIC ACID

1 No 1.5m3 GRP citric acid storage tank, 1.1m dia and complete with the following:-Inlet connection (50 NB),Outlet connection (25 NB), Overflow (50 NB), Drain (25 NB), Vent, Half opening access lid

2 No Citric Acid dosing pumps, horizontal plunger type, with manually variable stroke for the following duty:-

Max; - 1020 l/hr @ 4 bar, and to be complete with the following:-Skid mounted, 2 pressure relief valves, 2 loading valves, Pulsation dampener, Pipework (15 NB), NRV, 2 ball valves manual operation, Calibration vessel

4 No Actuated three way valves for block and bleed system c/w pipework to return citric acid leaks back to the citric acid storage tank.

COMPRESSORS

A compressor set is to be provided to supply air to each pneumatically actuated valve. 1 No Skid mounted air compressor package comprising 2 No. air compressors complete with acoustic enclosure, desiccant dryer, air filters, 150 litres air receiver, control panel, automatic condensate drain valves and oil/water separator.

THICKENED SLUDGE STORAGE TANK

A new glass lined epoxy coated steel tank providing 5 days storage of thickened sludge (215 m^3) is to be provided.

ODOUR CONTROL

An odour control system comprising of duty/standby vent fans is to be provided for the following process units:-

Inlet PS, Screening Skips, Grit skips, Inlet channel, Inlet screen, Grit removal, Liquor return PS, MBR feed pumping station, sludge thickener and thickened sludge tank.

RETURN WORKS LIQUORS PUMPING STATION

2 No Sludge liquor / site drainage pumps (1 duty /1 standby) submersible pumps each complete with fixed speed drive, complete with guide rails, lifting chains davit etc for a sump 6m deep (5 l/sec @ 10m head)

SERVICE WATER (POTABLE) BOOSTER SET

A potable water booster set is to be provided to deliver wash water to the inlet screen, screenings and grit handling plants, odour control plant, sludge thickener and site hose down points. The set will comprise of duty/standby pumps, pipework, valves and accumulator vessel.

BLIND TANK

A chemical blind tank is to be provided to buffer cleaning chemicals.

CHEMICAL DOSING FOR PHOSPHORUS REMOVAL

A skid mounted dosing unit comprising of duty/standby metering pumps, GRP ferric storage tank, pipework, valves and integral bund is to be provided to dose ferric to the MBR to affect phosphorus removal.

CHEMICAL DOSING FOR ALKALINITY

A skid mounted dosing unit comprising of duty/standby metering pumps, GRP Sodium Carbonate tank, pipework, valves and integral bund is to be provided to dose sodium carbonate to the MBR to affect pH control.

8.4.3 *Cost Summary*

CENTRAL AREA - OPTION 4

Item	Description	Price
1.1	Tornagrain Pumping Station	140302
1.2	Ardersier Village Pumping Station	142538
1.3	Whiteness Head Pumping Station	135844
1.4	Whiteness Transfer Rising Main	191363
1.5	Ardersier Village Transfer Rising Main	306180
1.6	Tornagrain Rising Main	89303
1.7	DALCROSS WwTW - new treatment plant at Dalcross -Based on Membrane Process- 75 l/sec 14000 pe.	7362390
1.8	UV Disinfection - NOT REQUIRED	0
1.9	1 no. x 350 mm dia x 500 mtr rising main to Outfall at River Nairn	349493
	TOTAL	**8718000**

8.4.4 *Risk Schedule*

RISK REGISTER

A96 Corridor Option Study - Central Option 4 (New Works at Dalcross)

Risk No	Description of Risk	Description of Impact	Estimated Impact Costs on occurrence	Estimated Probability Likelihood of occurrence	Comments and possible mitigating measures
A	**Construction**				
a1	Discovery of unexpected land contamination at transfer P.S.	Time & cost implications associated with removal.	Medium	Low	Investigate during ATC phase.
a2	Unforeseen Ground Conditions	Additional costs and delay.	Medium	Medium	Investigate during ATC phase.
a3	Discovery of unexpected buried structures, obstructions, services or pipework.	Additional costs and delay.	Medium	Low	Investigate during ATC phase.
B	**Stakeholders**				
b1	Land purchase	Programme delay or make option untenable	High	High	Early land owner contact
b2	Onerous consent from SEPA	Costly asset to construct (not best value solution for Scottish Water)	High	Medium	Detailed discussions with SEPA
b3	Planning constraints (set disinfection levels on existing works)	Costly asset to construct (not best value solution for Scottish Water)	High	High	Initial consultations with planners. Design for disinfection.
b4	Construction of new outfall over private land	Programme delay	Medium	Medium	Early consultations with land owner
b5	Risk of septicity and odours from early development stages	Odour nuisance, cost of cheemical dosing, inhibit performance of works	Medium	Medium	Consider design of rising mains for phased development
b6	Over design from not knowwing SEPA constraints	Scottish Water could make incorrect investment	Low	Low	Detailed discussions with SEPA
D	**Design**				
d1	Flow and load data accuracy	Additional cost of dealing with increased requirements.	High	Medium	Verify Flow and Loads
d2	Risk in complying with regional sludge strategy aspirations	Additional OPEX and CAPEX at sludge centre and additional transportation costs	High	Medium	Review capacity of regional sludge centres and compare with CAPEX/OPEX balance
F	**Site Specifics**				
f1					

9.0 SETTLEMENT EXPANSIONS

This section looks at the options for treating the wastewaters from the proposed settlement expansions at Sunnyside, Croy and Cawdor.

9.1 Sunnyside

Flow and Load Information

Dry Weather Flow =	74.8	m^3/day
Average Flow =	93.5	m^3/day
Peak Flow =	232	m^3/day
Biological Oxygen Demand =	29.9	kg/day
Suspended solids =	37.4	kg/day
Ammonia =	4.0	kg/day
Phosphorus =	1.2	kg/day

Note: The proposed early developments in this area are small and it is anticipated that the there will be sufficient capacity in the existing works which had a design horizon of 2025.

Option 1 – Upgrade Existing Works

It appears that space constraints have driven process selection of screens and MBR. There is a railway line adjacent to site to the East, nearby houses to the North, River Nairn to the South.
Works has been designed to reduce visual and noise impacts.

The most reasonable solution to expanding this works would appear to be extending the MBR capacity. This would involve installing another similar MBR package plant adjacent to the existing, housing additional cassettes. In order for this to be done, it is anticipated that some land would need to be reclaimed from the reed beds due to land constraints indicated above, to allow the required access to remove the membranes.
In addition, the inlet screening will need to be uprated or replaced, which may require land acquisition to the west of the plant.

Option 2 – Transfer Flows to New Works in Central Area

Due to land constraints, and the likely tight discharge consents, the current works will not be able to be expanded to accommodate significant additional flows and loads. The works can be decommissioned and turned into a transfer pumping station to consolidate these flows with a new works in the central area.

The capital costs of accommodating a relatively small flow into the central area will be lower than the expansion of the existing works. This will also reduce Scottish Water's operating costs and be more environmentally friendly.

9.2 Croy

Flow and Load Information

Dry Weather Flow =	72.8	m^3/day
Average Flow =	91.0	m^3/day
Peak Flow =	226	m^3/day
Biological Oxygen Demand =	29.1	kg/day
Suspended solids =	36.4	kg/day
Ammonia =	3.9	kg/day
Phosphorus =	1.2	kg/day

The proposed initial developments in this area are small and it is anticipated that the there will be sufficient capacity in the existing works.

Option 1 – Upgrade Existing Works

There is land available at the site entrance to provide new screening and grit removal facilities. The existing storm tanks are in poor condition and would need to be replaced. An additional sand filter and UV facility will need to be provided if the works is to be uprated to accept additional flows.

The secondary treatment will need to be developed to treat additional wastewater flows. The most suitable development would be the construction of a new compact plant to operate in parallel with the existing plant. In order to do this additional land will need to be acquired.

Option 2 – Transfer Flows to New Works in Central Area

Due to land constraints, and the likely tight discharge consents, the current works will not be able to be expanded to accommodate significant additional flows and loads. The works can be decommissioned and turned into a transfer pumping station to consolidate these flows with a new works in the central area.

The capital costs of accommodating a relatively small flow into the central area will be lower than the expansion of the existing works. This will also reduce Scottish Water's operating costs and be more environmentally friendly.

9.3 Cawdor

Flow and Load Information

Dry Weather Flow =	70.4	m^3/day
Average Flow =	88.0	m^3/day
Peak Flow =	219	m^3/day
Biological Oxygen Demand =	28.2	kg/day
Suspended solids =	35.2	kg/day
Ammonia =	3.8	kg/day
Phosphorus =	1.2	kg/day

The proposed developments in this area are small and it is anticipated that the there will be sufficient capacity in the existing works.

Option 1 – Upgrade Existing Works

The site is located within a wooded area and any site expansion would require the felling of trees. This may be an environmental consideration. If the flow to the works is to be significantly increased it is anticipated that new screening and grit removal facilities will be required. An additional sand filter and UV facility would also be required.

The main constraint is to up rate the secondary treatment for additional wastewater flows. The most suitable development would be the construction of a new compact plant to operate in parallel with the existing plant. In order to do this additional land will need to be acquired.

Option 2 – Transfer Flows to New Works in Central Area

Due to land constraints, and the likely tight discharge consents, the current works will not be able to be expanded to accommodate significant additional flows and loads. The works can be decommissioned and turned into a transfer pumping station to consolidate these flows with a new works in the central area.

The capital costs of accommodating a relatively small flow into the central area will be lower than the expansion of the existing works. This will also reduce Scottish Water's operating costs and be more environmentally friendly.

10.0 ENVIRONMENTAL CONSIDERATIONS

10.1 Introduction

A key issue in developing any of the options will be to identify, manage and mitigate the impact to the local environment.

As a means of beginning this process this section:

- Identifies the environmental considerations required for the Options:
    - Inverness East Area Options 1 & 2
    - Nairn Area Options 1, 2, 3 & 4
    - Central Area Options 1, 1A, 1B, 2, 3 & 4
    - Culloden Moor Options 1 & 2
    - Croy Options 1 & 2
    - Cawdor Options 1 & 2.
- Recommends further investigations that are likely to be required, as part of the detailed planning application, to minimise the effects on the environment.

10.2 Moray Firth and Nairn Coast Environmental Significance

Introduction

The Moray Firth is Scotland's largest firth which stretches from Duncansby Head in the North to Fraserburgh in the East. The Moray Firth area has high environmental significance and is protected through several conservation designations. These are detailed in appendix 4.

Natura 2000

Natura 2000 is a network of sites. This network is designed to conserve natural habitats and species of animals and plants which are rare, endangered or vulnerable in the European Community. In Great Britain the designation is generally operated through the SSSI mechanism.

Ramsar

Ramsar sites are wetlands that are designated under the world wide Ramsar Convention and are classed as SSSIs in Great Britain. The aim of these areas is to stem the encroachment on and loss of wetlands now and in the future, including

protection of waterfowl habitat. This is because wetlands are among the world's most productive environments and can be severely affected by alterations in land drainage.

The Moray and Nairn Coast is designated as Ramsar due to the outstanding nature conservation and scientific importance for coastal and riverine habitats, migrating geese and overwintering waders.

Special Protection Area

Special Protection Areas (SPAs) are designated under the Wild Birds Directive. SPAs are intended to safeguard the habitats of migratory and certain particularly threatened species of birds. They form part of the Natura 2000 network of sites.

The tidal mudflats in the Moray Firth area provide rich feeding grounds for migratory birds particularly during the breeding season and over winter. The area supports internationally important numbers of wildfowl and waders including greylag geese, pink footed geese and redshank during September to April and approximately 15% of the Great Britain breeding population of Osprey.

Special Area of Conservation

Special Areas of Conservation (SACs) are designated under the EU Habitats Directive. SACs are areas which have been identified as best representing the range and variety within the European Union of habitats and (non-bird) species listed on Annexes I and II to the Directive. SACs in terrestrial areas and territorial marine waters out to 12 nautical miles are designated under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended).

The primary reason for the Moray Firth SAC designation is the area supports the only known resident population of bottlenose dolphins in the North Sea and is one of two known outstanding localities in the UK. Dolphins are present all year round, and, while they range widely in the Moray Firth, they appear to favour particular areas. Also a qualifying reason for this SAC is the presence of 'sand banks which are slightly covered by sea water all the time'. The SAC aims to put in place measures that prevent deterioration to the sandbanks or the habitats that support the dolphins and to ensure that significant disturbance does not occur. Refer to the Stakeholder section regarding the Moray Firth Partnership below.

For work within a SAC or SPA an Appropriate Assessment will be required which is to consider the affects of the proposed development on an SAC or SPA. This also can extend to plans or projects outwith the boundary of the conservation area in order to determine the implications on the interest(s) protected within the site. Scottish Natural Heritage should be consulted regarding this.

Sites of Special Scientific Interest

A SSSI is the main nature conservation designation in Great Britain. These sites are special for their plants or animals or habitats, their rocks or landforms or a combination of these factors. This designation encompasses Ramsar, SPA and SAC sites and the SSSIs located in land north of Croy and Ardersier.

Operations requiring consent (ORCs) are those activities that Scottish Natural Heritage believe could damage the natural features of an SSSI and they are responsible for approving the consents. They may refuse consent to prevent an activity that could damage the natural features of an SSSI or give specific times for operations to minimise impact on the flora and fauna. Example of an ORC is 'Construction, removal or destruction of roads, tracks, walls, fences, hardstands, banks, ditches or other earthworks, or the laying, maintenance or removal of pipelines and cables, above or below ground.

Stakeholders

Moray Firth Partnership

The Moray Firth Partnership was established to preserve the environment and reduce conflict between various activities. It is a voluntary coalition of organisations and individuals, with over 600 members.

Within the Moray Firth Partnership is a SAC Management Group. This was set up to facilitate the effective management of the Moray Firth and aims to develop management measures to restore and maintain the bottlenose dolphin populations. Currently the group includes representatives from The Cromarty Firth Port Authority, The Crown Estate, Department of Trade and Industry (Oil and Gas, Fisheries Research Services (Marine Laboratory), The Highland Council, Inverness Harbour Trust, Maritime and Coastguard Agency, Moray Council, SEPA, Scottish Natural Heritage and Scottish Water (ref: www.morayfirth-partnership.org).

Scottish Natural Heritage should be consulted regarding activities within SAC, SPA and SSSI.

Further Information

Joint Nature Conservation Committee	www.jncc.gov.uk
Moray Firth Partnership	www.morayfirth-partnership.org
Ramsar Sites Database	www.wetlands.org
Royal Society for the Protection of Birds	www.rspb.org.uk
Scottish Natural Heritage	www.snh.org.uk

10.3 Inverness East Area

Option 1 – Transfer Flows to Allanfearn WwTW (PFI Concession)

The works outfall discharges to the Moray Firth within or near a Special Protection Area. It is anticipated all flow to the Moray Firth will require disinfection.

Additional flows can be injected into the existing sewer network from the adjacent development reducing the amount of new infrastructure required. The existing works is consented for a population equivalent of 112,000, therefore the anticipated additional 5,800 should not significantly effect the quality of final effluent entering the Moray Firth (on the basis that some works modifications will be carried out) and it is therefore anticipated that existing consents will be sufficient.

Further investigation is required to determine whether the existing works outfall requires upgrading.

Option 2 – Transfer Flows to a New Works in the Central Area

The collection and transfer system required will involve construction of pumping stations and rising mains. A new rising main will cross several green areas to transfer flows to a new works at Dalcross, Fisherton or Ardsersier. These will require septicity dosing and air relief valves.

The possibility of septic sewage (should septicity dosing not be provided) could cause an odour problem at the receiving works.

10.4 Nairn Area

Option 1 – Redevelop Existing Wastewater Treatment Works

The existing works discharges into a bathing water area at Nairn. It is considered that all flows into this area will need to be disinfected.

New developments to the west and south of Nairn will be provided with new collection and transfer systems which can inject flows into the existing Nairn network. There is a risk that the current network will not be suitable for additional flows of this magnitude which may lead to flooding.

The existing works is constrained in terms of expansion and it is highly likely that any works development would need to be within the current site boundary. There is little space on site for a major development and the quality of final effluent to the Moray Firth may be compromised.

An ongoing capital maintenance programme is currently being undertaken on this site, and it is thought that there are problems with the outfall pipeline, which may need repairing.

Option 2 – Transfer Flows to a New Works in the Central Area

This option is based on transferring the additional wastewater flows from Nairn to a new works to be constructed at Ardersier. The rising main required from the new collection and transfer system will pass near or through green areas and SSSI's.

Septicity dosing may be required to prevent odour problems.

Option 3 – Transfer Flows to a New Works with a New Sea Outfall

The chosen location of this works avoids special protection areas and is located to minimise the collection and transfer system requirements for the Nairn developments. A new outfall into the Moray Firth will be required and is thought to be away from the bathing water areas.

Option 4 – Transfer Flows to a New Works with a New River Nairn Outfall

The chosen site for this works minimises the collection and transfer requirements but adds significant flows to the small River Nairn. The high specification membrane plant proposed produces very high quality effluent and would serve to 'clean up' the river.

This new works, and associated inlet and outlet pipework, will need to be constructed adjacent to a SSSI area. Storm discharges will be to the River Nairn.

10.5 Central Area

Option 1 – Transfer Flows to a New Works Constructed on Existing Ardersier WwTW Site to Re-use Existing Sea Outfall

It is considered that utilising an existing outfall pipeline to avoid the need of laying a new outfall into the Moray Firth would have the least environmental impact. However, it is noted that the outfall pipeline discharges adjacent to a RAMSAR site and a prime dolphin hotspot. This is the reason for consideration of a membrane plant to produce a high quality disinfected final effluent.

The existing works is located outside the village of Ardersier and has no history of noise or odour complaints. It is anticipated that a new works development on this site would be small footprint, and be designed to reduce visual, noise and odour impacts to the benefit of local residents.

There is an existing pumping network which currently transfers flows from Tornagrain and the airport business park to the Ardersier works. It is anticipated that this network will need to be substantially upgraded which may cause some disruption to local residents. An alternative would be to construct a new pumping network that would bypass the Ardersier village. The existing storm discharge from the main works feed pumping station could be re used, which discharges into the Moray Firth away from the RAMSAR area and in a more favourable position to avoid specific dolphin hotspots.

Option 2 – Transfer Flows to a the Allanfearn PFI

The works outfall discharges to the Moray Firth within or near a Special Protection Area. This is a significant increase in flows compared to Inverness east Area option 1. It is unlikely that the any works upgrade required to accept these flows could be carried out within the existing site boundary or without the need to upgrade the existing outfall into the Moray Firth.

Option 3 – Transfer Flows to a New Works with a New Sea Outfall

The chosen location of this works avoids special protection areas and is ideally located to minimise the collection and transfer system requirements for the Nairn developments. A new outfall into the Moray Firth will be required but is likely to be adjacent to a RAMSAR area.

A membrane plant has been specified to ensure high quality disinfected final effluent enters the Moray Firth. However, the storm discharge point will also be the Moray Firth.

Option 4 – Transfer Flows to a New Works with a New River Nairn Outfall

The chosen site for this works minimises the collection and transfer requirements but adds significant flows to the small River Nairn. The high specification membrane plant proposed produces very high quality effluent and would serve to 'clean up' the river.

This new works, and associated inlet and outlet pipework, will need to be constructed adjacent to a designated green areas. A diesel standby generator will need to be provided as a suitable discharge point from the collection system can not be identified for power failure events.

10.6 Culloden Moor

Option 1 – Upgrade Existing Works

The River Nairn enters the Moray Firth in a bathing water area. It is expected that all flows discharged at Sunnyside will need to be disinfected.

It is anticipated that the treatment capacity of the reed beds, which treat storm flows prior to discharge to the River Nairn, will need to be reduced to provide land for works development. In this case new storm facilities will need to be provided.

Option 2 – Transfer Flows to New Works in Central Area

The flows and loads from this area are small relative to the design capacity of a new works to be constructed in the central area. Therefore the environmental impacts stated in section 10.5 apply.

By decommissioning this works, the discharge to the River Nairn will be removed, and the noise, odour and visual impacts will be reduced.

10.7 Croy

Option 1 – Upgrade Existing Works

The River Nairn enters the Moray Firth in a bathing water area. It is expected that all flows discharged at Croy will need to be disinfected.

Option 2 – Transfer Flows to New Works in Central Area

The flows and loads from this area are small relative to the design capacity of a new works to be constructed in the central area. Therefore the environmental impacts stated in section 10.5 apply.

By decommissioning this works, the discharge to the River Nairn will be removed, and the noise, odour and visual impacts will be reduced.

10.8 Cawdor

Option 1 – Upgrade Existing Works

The River Nairn enters the Moray Firth in a bathing water area. It is expected that all flows discharged at Cawdor will need to be disinfected.

There may be environmental issues regarding provisions for new across land pipelines to transfer flows from the areas to be developed.

Option 2 – Transfer Flows to New Works in Central Area

The flows and loads from this area are small relative to the design capacity of a new works to be constructed in the central area. Therefore the environmental impacts stated in section 10.5 apply.

By decommissioning this works, the discharge to the River Nairn will be removed, and the noise, odour and visual impacts will be reduced.

11.0 SLUDGE STRATEGY

Through development of assets to treat additional wastewater flows, there is an increased amount of sludge produced. Scottish water's regional sludge strategy has been taken into account to detail proposals for dealing with this additional sludge.

There are two regional sludge centres that service this part of Scotland. The first is a sludge treatment facility at Allanfearn WwTW and the second at Lossiemouth WwTW.

Lossiemouth WwTW is located approximately 30 miles east of Nairn. Scottish water's sludge strategy dictates that where possible, the local sludge handling facility will be used to minimise tanker movements. This policy is to reduce cost, local environment impact and health and safety risks to tanker drivers. In this case Allanfearn WwTW is the likely destination for additional sludges produced from the additional wastewaters expected from the developments in this area due to its locality.
No further consideration is to be given in this report as to the use of Lossiemouth sludge treatment facility and no investigation has been undertaken to determine headroom within this facility. However, during the early phased development and re-development of Allanfearn sludge treatment facility, Lossiemouth should be considered as a temporary alternative.

The sludge treatment plant at Allanfearn WwTW comprises of balance tanks, 2 no. belt thickeners, 2 no. digesters and cake dewatering. It is understood through discussion with the PFI concession that this facility is very near capacity. A current capital maintenance scheme is ongoing and will involve providing additional buffering capacity to account for Scottish Water tanker movements. It is not anticipated that this scheme will increase the capacity of the sludge treatment plant, only to serve to balance flows for a constant 7 day treatment period. This is due to Scottish Water tanker deliveries coinciding on certain days.

The sludge facilities at Allanfearn WwTW will need to be upgraded to provide capacity for treatment of additional sludges from the proposed developments in the area. There is currently provision on site for an additional digester, plus four large concrete storage tanks which are currently unused. By redeveloping these areas additional sludge treatment capacity can be provided.

The amount of sludge expected from the proposed new/extended works detailed in sections 6 to 8 will vary depending on the options chosen due to the different technologies required. In order to provide an indication of cost the worst case figures have been used.

In order to comply with Scottish water's sludge strategy each new/extended works will require sludge thickening. Each of the options in sections 6 to 8 have been provided with a facility to thicken site sludges to 5%DS, to be stored in a retention tank to be removed by tanker. This philosophy reduces tanker movements considerably and utilises the respective site to treat the sludge liquors.

Sludge Treatment Upgrade at Allanfearn WwTW

Additional Sludges;

Inverness East Area	= 17.5	m^3/day @ 5%DS
Nairn Area	= 21.6	m^3/day @ 5%DS
Central Area	= 26.0	m^3/day @ 5%DS
Total	= 65.1	m^3/day @ 5%DS

For clarity the treatment of the additional sludges is considered in a new side stream which will operate in parallel to the existing facilities. There may be some value engineering opportunities, such as upgrading the current liquor return pumping station, which can only be realised during detailed design.

It is proposed to use the current provision on site and provide an additional digester. A new digester will be provided with sufficient capacity, heating and mixing to comply with HACCP requirements. The HACCP requirements specify retention times and temperatures which need to be maintained in order to achieve a suitable pathogen kill.

In addition a new balance tank will be provided for imported sludges with a facility to mix with site sludges. This tank will be provided with a decant facility and 2 no duty/standby progressive cavity sludge transfer pumps to feed the digester.

Digested sludge will be transferred directly to a sludge press where it will be thickened to approximately 20%DS. Sludge liquors will gravitate to a new liquor return pumping station, housing duty/standby submersible pumps, transferring liquors back to the head of the works. Buffering capacity will be provided in this pumping station to minimise the load returned to the wastewater works.

The cake from the press is conveyed to the cake storage area for transport off site.

Risk

In addition to the risk registers in section 6, it must be noted that the load associated with the returned sludge liquors may have an adverse effect on the wastewater treatment process. Some mitigation is included in the above cost by providing some buffering capacity in the liquor return pumping station. However, this should be considered during detailed design.

12.0 PHASED DEVELOPMENT

It is not the aim of this report to review in detail the wastewater treatment proposals for phased development. However, the following section is intended to give a brief statement of initial thoughts on this matter.

All the technologies considered for the various options have been developed with phased development in mind. By considering 'modular' process units during detailed design it will be possible to develop a detailed programme of works which includes extending each works over the 35 year development period. Land purchase for new works must include provision for a works to deal with the 2041 design horizon and early works development spaced accordingly to allow for extension.

Remote Pumping Stations

During consideration of the high level pricing of the transfer pumping stations fixed speed pumps are required to prevent solids settlement in the pump sumps. Where possible, three pumps have been selected to operate as duty/assist/standby. During the initial phases of development only two pumps could be installed to transfer lower flows.

Chemical dosing has been included for septicity prevention during initial phases when rising mains are under capacity.

Central Area Infrastructure

An existing network of pumping stations transfers wastewater flows from Tornagrain, Inverness airport and Ardersier village to the existing works at Ardersier. During the early phases of development it may be cost effective to up rate the current pumps and re-use the existing infrastructure, until new infrastructure is in place. There is sufficient room on the existing site to install a temporary SAF to extend the capacity of the existing works in the interim, until a new works is constructed.

A more detailed study should be carried out to determine whether this proposal is cost effective when more detailed information of the proposed phasing is available.

Inverness East Area Infrastructure

It has not been part of our remit to investigate the available capacity in the existing sewer networks. Further interrogation of the drainage area models may reveal sufficient capacity to inject early phase development flows into the existing network.

In this situation a further study would be required to determine interim solutions for extending the existing Allanfearn works to treat the additional flows and loads. There is provision for an additional primary settlement tank which would add capacity for loads to the existing works at Allanfearn.

Nairn Area Infrastructure

It has not been part of our remit to investigate the available capacity in the existing sewer networks. Further interrogation of the drainage area models may reveal sufficient capacity to inject early phase development flows into the existing network.

In this situation a further study would be required to determine interim solutions for extending the existing Nairn works to treat the additional flows and loads.

Carbonaceous ASP

A standard carbonaceous ASP can be design with provision for future extension. Part of the aeration lanes and final settlement tanks can be constructed and commissioned. Providing adequate space is provided, additional aeration lanes and final settlement tanks can be added at a later date.

Membrane Bio-Reactor

Membrane modules are available in pre-fabricated tanks, each of which is rated for a set flow and load. Part of the MBR plant can be constructed and commissioned and further membrane modules can be added at a future date to expand the capacity of the works. If provision is provided in the amount of land available, a new works can be extended in line with the phased developments.

13.0 APPENDIX 1 – SITE VISIT REPORTS

Nairn WwTW Site Visit Report

Site: Nairn WwTW
Date: 21/06/2006
Present: D.Fawcett, K.Hayfield, M.Davidson

Plant Overview

The works accepts flow (pumped and gravity) from the Nairn catchment and caravan park and has a sea outfall. During high tides the plant experiences problems with saline intrusion causing problems with DO control. The plant is located next to a caravan park, with a golf course adjacent and future land purchasing for expansion would prove difficult.

Coarse Screens

No information

Inlet Screw Pumps

N/A

Fine Screens (6mm spacing)

2 no. J&A screens which can operate duty/assist or duty/standby. A Parkwood dewatering unit is provided for screenings handling. The screen channels are below ground level, and space is restricted. Development of this area would be extremely difficult.

Grit/Grease Removal Channel

1 no J&A grit trap with grit classifier. The screen channels are below ground level, and space is restricted. Development of this area would be extremely difficult.

Storm Tanks

A dedicated inlet flow measurement channel is provided upstream of the inlet works. FFT is controlled by a modulating penstock forcing excess flows over the storm weir to the storm tank. A new large circular concrete storage tank has been recently constructed to provide storm capacity. A pumping station returns storm flows to the head of the works.

Combined Aeration Settlement (CAS)

2 no CAS basins provide the secondary treatment for solids and BOD removal. The basins are provided with a scum removal facility, and settled sludge is pumped to the sludge treatment building. Flow is fed to the basins from a submersible pumping station adjacent to the inlet works.

Centrifugal Blowers

2 no blowers are provide to supply the process air required in the CAS basins.

Final Settlement Tanks Øm (m sidewall depth)

N/A

Overflows

No information

Fire Pump with associated main and hydrants

N/A

UV Disinfection Lamps

4 no UV channels are on site. Final effluent from the CAS basins pass through two channels before being pumped to the balance tanks. The contents of the balance tanks is bled through the 2 newer UV channels to meet the coliforms consents. The use of the balance tanks is to prevent the newer UV channels drying up during periods of no flow due to the operation of the CAS basins.

RAS Pumps and SAS Pumps

RAS is returned to the CAS basin inlet. SAS is transferred to the sludge treatment building.

Sludge Treatment

Sludge thickeners are provided to handle the CAS surplus sludge. Thickened sludge is transferred to a redundant PST tank for storage. Centrifuges produce sludge cake of 16% d.s. for transfer to Allanfearn WwTW.

Electrical Equipment (MCC, cable, switchgear, incoming supply)

MCC provided for plant operation incorporating HMI for operator interface.

Instrumentation (instruments, PLC, Telemetry)

Plant controlled by PLC within MCC. No information on telemetry.

General Condition and Performance of Plant

The condition of the equipment is generally good.

The plant fails to deal with high summer loads. The plant is design for a PE of 20,000, however it is expected that during summer months PE>30,000. A flow and load survey is imminent.

It appears that the CAS system is the wrong process for the nature of the catchment area.

Operated by (shift pattern)

Usually manned weekdays.

Manual or Auto (type of auto PLC/SCADA/Telemetry)

Plant is fully automated but requires a large degree of operator supervision.

State of maintenance

Likely to suffer as operators struggle to meet consents.

Domestic Influent/Industrial Influent

A combination of both domestic and industrial, with major contributions from tourists during the summer months.

Flow range

TBC

Capacity of existing works –

Where discharges

Moray Firth (designated bathing waters around Nairn)

Standard of Discharge/Failures

TBC

Requirements (20,30 eg)

TBC. Includes coliform consent <2000 / 100ml.

Sampling Regime

No information

Condition of Concrete/Steelwork

New structures good, old structures ok.

Sludge Handling

Details unknown but sludge thickening provided for surplus sludge.

Operating and Maintenance Costs

No information

Flow and load information obtained from site

No information

Ardersier WwTW Site Visit Report

Site: Ardersier WwTW
Date: 21/06/2006
Present: D.Fawcett, K.Hayfield, M.Davidson

Plant Overview

The works takes pumped flows from the nearby Ardersier catchment and discharges to the Moray Firth. The plant is remote, no neighbours, with a large amount of land (probably owned by MOD) around for future development. Also receives pumped flows from Dalcross area and Inverness airport industrial estate.

Coarse Screens

25mm Hand-raked bypass screen provided at inlet works.

Inlet Screw Pumps

N/A

Fine Screens (mm spacing)

1 no 6mm Rotamat Screen.

Grit/Grease Removal Channel

1 no. grit trap with associated grit classifier.

Storm Tanks

2 no. rectangular concrete tanks

Primary Settlement Tanks Øm (m sidewall depth)

N/A

Aeration Tanks

Screened sewage is fed to a compact plant by a submersible pumping station.

1 No. Conical channel as part of a compact plant. 2 no fixed speed surface aerators are provided. 1 no DO monitor is provided for DO control. DO control is provided by an actuated outlet weir penstock, which changes the DO with changing level. DO monitor reading 0.6mg/l during visit. MLSS 2700mg/l.

No operational problems reported.

Centrifugal Blowers

N/A

Final Settlement Tanks Øm (m sidewall depth)

1 no. Circular tank as part of the compact plant. Flows from FST overflow to the final effluent pumping station.

Tertiary Treatment

None

Overflows

Storm overflow provided at main works feed pumping station (500mm) to Moray Firth.

Fire Pump with associated main and hydrants

N/A

UV Disinfection Lamps

N/A

RAS Pumps and SAS Pumps

RAS returned to compact plant inlet.

Sludge Thickener Tanks Ø m

Surplus sludge pumped to a picket fence thickener. Picket fence thickener not working during site visit – not clear whether this is "doesn't work very well" or "broken and waiting for maintenance"

Electrical Equipment (MCC, cable, switchgear, incoming supply)

MCC provided for overall control of plant (incoming supply unknown)

Instrumentation (instruments, PLC, Telemetry)

DO monitor and MLSS monitor supplied in aeration lane.
Screen controlled by ultrasonic.
No HMI or evidence of PLC, whole site appears to be hardwired control.

General Condition and Performance of Plant

Concrete structures aging but M&E equipment appears in generally good condition.

Operated by (shift pattern)

Unmanned, visited once a day, 5 days a week, but appears to be visited very rarely.

Manual or Auto (type of auto PLC/SCAD/Telemetry)

Appears to be all hardwired control, telemetry outstation present.

State of maintenance

Sufficient.

Domestic Influent/Industrial Influent

Mostly domestic

Flow range

735 m3/day (approx PE = 3000)

Capacity of existing works –

Where discharges

Moray Firth

Standard of Discharge/Failures

No information

Requirements (20,30 eg)

50mg/l BOD : 50mg/l SS TBC

Sampling Regime

Unknown

Condition of Concrete/Steelwork

OK

Sludge Handling

Picket fence thickener, thickened sludge tinkered from site.

Operating and Maintenance Costs

Unknown

Flow and load information obtained from site

None

Sunnyside Culloden Moor WwTW Site Visit Report

Site: Sunnyside Culloden Moor
Date: 21/06/06
Present: D.Fawcett, K.Hayfield, M.Davidson

Plant Overview

Package MBR plant treating flows from Culloden Moor catchment and discharging to the River Nairn. Incoming flow is a combination of gravity and pumped flows.
It appears that space constraints have driven process selection of screens and MBR. There is a railway line adjacent to site to the East, nearby houses to the North, River Nairn to the South. Works has been designed to reduce visual and noise impacts.

Package plant supplied by Naston Ltd (www.naston.co.uk)

Coarse Screens

Copa Sack on storm overflow (appears to be 6mm)

Inlet Screw Pumps

N/A

Fine Screens

1 No. 6mm Haigh screens with ACE screenings handling unit
1 No. 3mm Haigh screens with ACE screenings handling unit
Note: Operators are unhappy with the screen performance.

Grit/Grease Removal Channel

N/A

Storm Tanks

No storm tanks, however, all storm flows are passed through reed beds prior to discharge to River Nairn. Ops noted that there is no indication of storm overflow, no final effluent flow measurement and the FFT flow measurement is unreliable.

Final effluent sampling point may be contaminated by storm overflow

Primary Settlement Tanks Øm (m sidewall depth)

N/A

MBR

Secondary Treatment provided by flat plate MBR. Incorporating 4 no. membrane cassettes, designed for the following parameters;
DWF 80 m3/day
FFT 240 m3/day

BOD 10 mg/l
SS 20 mg/l
NH3 5 mg/l
Total Coliforms 1000/100ml
Feacal Coliforms 100/100ml

Note: Air scour cleaning (when blowers ramp up to full speed to purge air lines) not automated. MBR operates at 9-10,000 mg/l, and there are occasional problems with foam.

Centrifugal Blowers

2 no Centrifugal Blowers operating duty/standby, each incorporating a temperature, flow and pressure switch. The blowers are rated for 180-320 m3/hr @ 100mBar. Each blower is within an acoustic enclosure to maintain a noise limit of 75 dB @ 1m. The same blowers are used for both process air (course bubble aeration) and air scour. A DO probe is housed within the MBR process tank for rudimentary blower control.

Final Settlement Tanks Øm (m sidewall depth)

N/A

Overflows

See storm tanks

Fire Pump with associated main and hydrants

N/A

UV Disinfection Lamps

N/A

RAS Pumps and SAS Pumps

2 no. RAS pumps rated for 2.3 m3/hr @ 2.5m head, are submerged within the MBR process tank, and return flows to the central anoxic zone. A tee from the RAS line is taken to the SAS tank and surplussing of sludge is controlled by an actuated valve on a timer basis. A MLSS monitor is provided within the MBR tank.

Sludge Thickener Tank

1 no 35 m3 Capacity SAS storage tank, with decant facility. Decant liquors drain to the MBR feed pumping station. The tank is provided with a high level float switch, tanker connection, and a facility for future connection of odour control. Sludge tankered away infrequently (averaging once a month).

Electrical Equipment (MCC, cable, switchgear, incoming supply)

1 no. MCC operates all equipment on site.
Incoming supply uncertain.

Instrumentation (instruments, PLC, Telemetry)

Only 2 analogue signals currently supplied to telemetry.
Instruments supplied as part of screens or MBR package, FFT magflow (100mmID) supplied between two screens (ops note unreliable).

General Condition and Performance of Plant

Recently commissioned (summer 2005), plant in very good condition. Operational problems with MBR, cake forms on membrane surface reducing flow through plant, causes premature storm discharges through reed beds. This is possibly due to shock loads from nearby Caravan Park, potentially portaloo toilet cleaning chemicals.

Operated by (shift pattern)

Unmanned site generally visited 1-2 times per day, 5 days a week, when operating ok.

Manual or Auto (type of auto PLC/SCADA/Telemetry)

Automatically controlled by PLC provided in MCC with HMI screens provided for operator interface. Cleaning operations are manual.

State of maintenance

Appears to be sufficient as new plant. Chemical cleans are carried out infrequently but it should be noted that the whole MBR must be taken off-line to perform a chemical clean.

Domestic Influent/Industrial Influent

Mainly domestic with contributions from nearby caravan park. Suspected shock loads from Caravan Park toilet cleaning chemicals.
Large summer and winter variations.

Flow range

Designed for FFT of 240 m3/day. Consented FFT to be confirmed.

Capacity of existing works –

Where discharges

River Nairn

Standard of Discharge/Failures

TBC by asset planner

Requirements (20,30 eg)

TBC by asset planner

Sampling Regime

Unknown

Condition of Concrete/Steelwork

Good

Sludge Handling

None – all SAS tankered from site (some decant liquors)

Operating and Maintenance Costs

Unknown

Flow and load information obtained from site

Treating between 8 and 10.5m^3/h during visit (08:00 – 08:30, 21/06/2006)

Croy WwTW Site Visit Report

Site: Croy WwTW
Date: 21/06/2006
Present: D.Fawcett, K.Hayfield, M.Davidson

Plant Overview

The works takes gravity flows from the nearby Croy catchment and discharges to the River Nairn.

Coarse Screens

25mm Hand-raked bypass screen provided at inlet works. A 6mm Copa sack is also installed downstream of this screen.

Inlet Screw Pumps

N/A

Fine Screens (mm spacing)

1 no 6mm Rotamat Screen retro-fitted to an existing inlet channel.

Grit/Grease Removal Channel

N/A

Storm Tanks

Flow to the works is measured by a flume and a fixed storm overflow weir is provided. Storm overflows pass to 4 no. small rectangular concrete storm tanks. These tanks appear in poor condition with large amount of algae growth. It is not clear how these tanks are drained.

Primary Settlement Tanks Øm (m sidewall depth)

N/A

Aeration Tanks

Screened sewage is fed to a compact plant by a submersible pumping station.

1 No. Conical channel as part of a compact plant. 1 no fixed speed surface aerator is provided. 1 no DO monitor is provided for DO control. DO control is provided by an actuated outlet weir penstock, which changes the DO with changing level.

Ops noted that the plant struggles to meet the DO during high loading periods.

Centrifugal Blowers

N/A

Final Settlement Tanks Øm (m sidewall depth)

1 no. Circular tank as part of the compact plant. Flows from FST overflow to the filter feed pumping station.

Tertiary Treatment

1 no Dynasand filter (COUF) provided with duty/standby air compressors and duty/standby submersible feed pumps. Ops noted that the sand filter continuously shuts down due to blockage. It appears that this could be due to a lack of a duplex filter on the incoming flow to remove leaves etc that may be blown into the FST.

Dirty backwash water flows by gravity to the aeration lane of the compact plant.

Overflows

Overflow from storm tank to River Nairn

Fire Pump with associated main and hydrants

N/A

UV Disinfection Lamps

2 no Trojan UV Channels treating effluent from sand filter.

RAS Pumps and SAS Pumps

TBC

Sludge Thickener Tanks Ø m

2 no rectangular concrete sludge tanks with filtered overflow, possibly to compact plant feed PS. Sludge tankered to Allanfearn WwTW.

Electrical Equipment (MCC, cable, switchgear, incoming supply)

MCC provided for overall control of plant (incoming supply unknown)
Local panel controlling dynasand unit and associated compressors.

Instrumentation (instruments, PLC, Telemetry)

DO monitor supplied in aeration lane.
Screen controlled by ultrasonic.
NO HMI or evidence of PLC, whole site appears to be hardwired control.

General Condition and Performance of Plant

Concrete structures aging but M&E equipment appears in generally good condition.
Filter feed P.S, sand filter and UV plant commissioned summer 2005.

Operated by (shift pattern)

Unmanned, visited once a day, 5 days a week.

Manual or Auto (type of auto PLC/SCAD/Telemetry)

Appears to be all hardwired control, no apparent telemetry outstations.

State of maintenance

Sufficient.

Domestic Influent/Industrial Influent

All domestic.

Flow range

TBC

Capacity of existing works –

Where discharges

River Nairn

Standard of Discharge/Failures

Does not meet coliform consents when filter is out of service.

Requirements (20,30 eg)

25mg/l BOD : 35mg/l SS : <2000 coliforms per 100ml

Sampling Regime

Frequent sampling during bathing water season

Condition of Concrete/Steelwork

Poor

Sludge Handling

None

Operating and Maintenance Costs

Unknown

Flow and load information obtained from site

None

Cawdor WwTW Site Visit Report

Site: Cawdor WwTW
Date: 21/06/2006
Present: D.Fawcett, K.Hayfield, M.Davidson

Plant Overview

The works takes pumped flows from the nearby Cawdor catchment, and Piperhill and surrounding area, and discharges to the River Nairn.

Coarse Screens

25mm Hand-raked bypass screen provided at inlet works.

Inlet Screw Pumps

N/A

Fine Screens (mm spacing)

1 no 6mm Rotamat Screen retro-fitted to an existing inlet channel.

Grit/Grease Removal Channel

N/A

Storm Tanks

Nothing apparent

Primary Settlement Tanks Øm (m sidewall depth)

N/A

Aeration Tanks

Screened sewage is fed to a compact plant by a submersible pumping station.

1 No. Conical channel as part of a compact plant. 2 no fixed speed surface aerators are provided. 1 no DO monitor is provided for DO control. DO control is provided by an actuated outlet weir penstock, which changes the DO with changing level. Operating at 0.5mg/l DO during visit.

Ops noted that the plant is under loaded during winter which leads to problems with pH. Lime is dosed when needed, and a pH monitor is provided for the final effluent.

Centrifugal Blowers

N/A

Final Settlement Tanks Øm (m sidewall depth)

1 no. Circular tank as part of the compact plant. Flows from FST overflow to the filter feed pumping station.

Tertiary Treatment

1 no Dynasand filter (COUF) provided with duty/standby air compressors and duty/standby submersible feed pumps. Ops noted that the sand filter continuously shuts down due to blockage. It appears that this could be due to a lack of a duplex filter on the incoming flow to remove leaves etc that may be blown into the FST. A course mesh filter is provided by appears insufficient to remove large amount of pine needles from surrounding trees.

Dirty backwash water flows by gravity to the aeration lane of the compact plant.

Overflows

Unsure

Fire Pump with associated main and hydrants

N/A

UV Disinfection Lamps

2 no Trojan UV Channels treating effluent from sand filter.

RAS Pumps and SAS Pumps

TBC

Sludge Thickener Tanks Ø m

2 no circular sludge tanks with overflow, possibly to compact plant feed PS. Sludge tankered to Allanfearn WwTW.

Electrical Equipment (MCC, cable, switchgear, incoming supply)

MCC provided for overall control of plant (incoming supply unknown)
Local panel controlling dynasand unit and associated compressors.

Instrumentation (instruments, PLC, Telemetry)

DO monitor supplied in aeration lane.
Screen controlled by ultrasonic.
NO HMI or evidence of PLC, whole site appears to be hardwired control.

General Condition and Performance of Plant

Concrete structures aging but M&E equipment appears in generally good condition.
Filter feed P.S, sand filter and UV plant commissioned summer 2005.

Operated by (shift pattern)

Unmanned, visited once a day, 5 days a week.

Manual or Auto (type of auto PLC/SCAD/Telemetry)

Appears to be all hardwired control, telemetry outstation present.

State of maintenance

Sufficient.

Domestic Influent/Industrial Influent

All domestic.

Flow range

175.4 m3/day DWF (PE = 800)
Design max flow 7.2 l/s

Capacity of existing works –

Where discharges

River Nairn

Standard of Discharge/Failures

Does not meet coliform consents when filter is out of service.

Requirements (20,30 eg)

25mg/l BOD : 35mg/l SS : <2000 coliforms/100ml.

Sampling Regime

Unknown. Frequent sampling during bathing water season.

Condition of Concrete/Steelwork

Poor

Sludge Handling

None

Operating and Maintenance Costs

Unknown

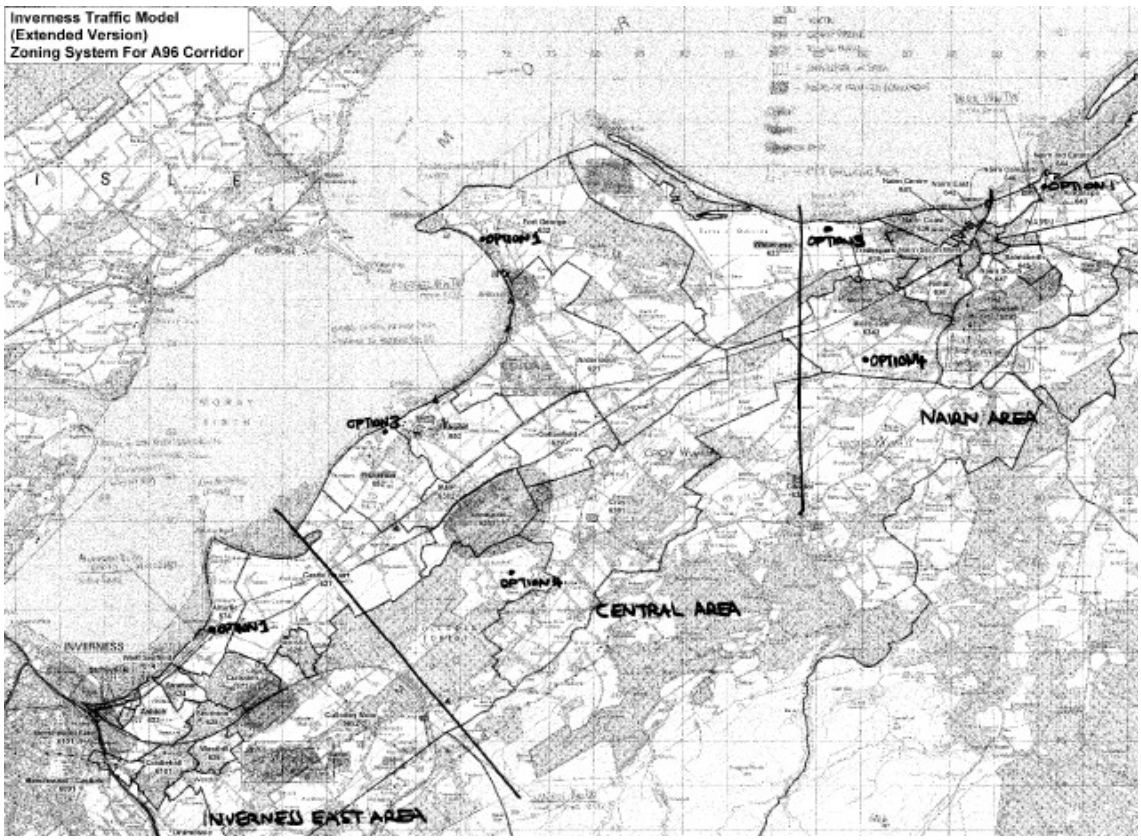
Flow and load information obtained from site

None

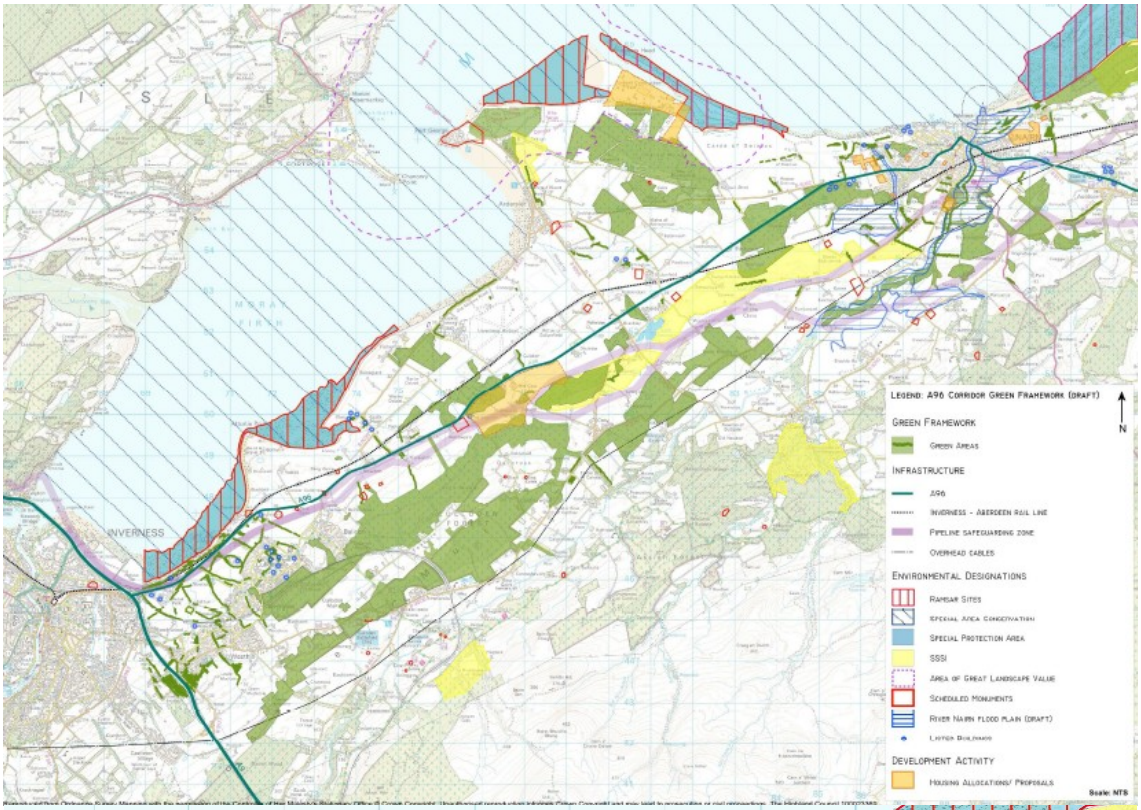
14.0 APPENDIX 2 - STAKEHOLDERS AND CONSULTEES

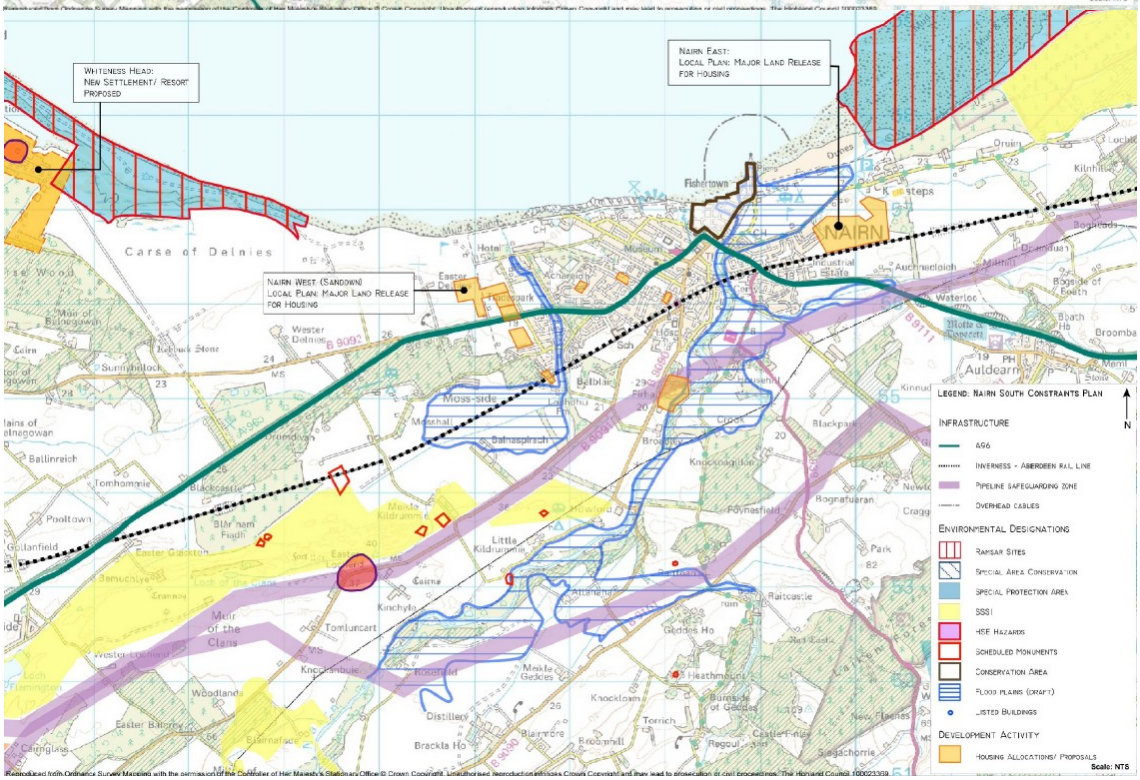
Scott Davidson DavidsonS@Halcrow.com	Halcrow	0141 552 2000 07841 364 654 (mob)
David MacKenzie Davidmackenzie2@scottishwater.co.uk	Scottish Water	0141 425 2524 07875 879462 (mob)
Steven Robertson Steven.Robertson@mottmac.com	Mott MacDonald	01463 239323 07739 643450 (mob)
Mike Greaves mike.greaves@highland.gov.uk	Highland Council	01463 702260 07971 667494 (mob)
Colin Munns Colin.Munns@scottishwater.co.uk	SW Asset Planner	01463 228245 07770 492516 (mob)
David Fraser	SW (PFI)	01463 228633 07770 492207 (mob)
Mike Davidson	SW Ops Manager	01463 228275
James Geddes (Team Leader)	Allanfearn Ops (PFI)	01463 229617 07789 720176 (mob)
David Wishart	Allanfearn (PFI) (Asset Manager)	01786 430046 07771 854275 (mob)
Pearl Mackray	SW Planning & Development Services Team Highland Council Liaison	07875 879291
Scottish Water Head Office	Balmore Road, Glasgow	0141 3555233
Stefan Walker	SW SEPA Liaison	01463 228691
Craig Evans	Developer Funded Upgrades	0141 3555233

15.0 APPENDIX 3 – OPTIONS OVERVIEW MAP



16.0 APPENDIX 4 – GREEN FRAMEWORK AND ENVIRONMENTAL CONSTRAINTS MAP





17.0 APPENDIX 5 – FLOW AND LOAD BUILD UP CALCULATION

calculation

Scientific Calculation

G:\TURNKEY\Eng_Serv\05-06\9559 A96 Wastewater Development\D_Design\D6_Scientific\[09559_0600_A - Flow and Load Build Up.xls]corridor strategy build-up

Contract No.:	09559	Calc. No.:	09559_0600
Contract Name:	A96 Corridor Development Wastewater Strategy	Revision:	A
Issued To:	A.Moore	Date:	15-Dec-06
Calculation Title:	Flow and Load Build-up	Scientist:	
Status:	For Options Report	Checked:	
		Approved:	

1.0 Introduction

Scottish Water have requested a study to be carried out to investigate options to treat additional wastewater flow that will be produced by the proposed new development along the A96 corridor between Inverness and Nairn.

The purpose of this calculation is to calculate the additional flows and loads that will be produced by the proposed development. As well as additional housing, the development will also include new schools, business areas, industrial space, food and non-food retail, leisure and health facilities.

The design data below has been supplied by the developers representatives and will be the basis of the flow and load figures. However, all the necessary information required to calculate accurate figures is not readily available and assumptions will be made in order to provide a basis for the option study.

All assumptions and associated risks will be highlighted and will be discussed in detail in the final options report.

Note that the flows calculated are average daily flows and do not take into account diurnal peaks or infiltration. This must be taken into account when designing transfer pumping stations and associated treatment works.

2.0 Design Information Received

The design information provided by the client is divided up into several different areas. However, for the purposes of this calculation, these areas will be grouped into 3 main regions: Inverness East, Nairn and Central.

The development will comprise the following:

		Inverness	Nairn	Central	Croy	Cawdor	Sunnyside
Residential	housing units	3456	2743	4595	245	237	252
Food retail	m^2	8000	2000	8000	0	0	0
Other retail	m^2	45000	20000	15000	0	0	0
Business	m^2	106400	78000	48000	0	0	0
Industry	m^2	3150	50000	71000	0	0	0
Education	m^2	61000	10000	14000	0	0	0
Hospital	m^2	2000	0	2500	0	0	0
Leisure	m^2	32000	10000	22000	0	0	0

3.0 Flow and Load Contribution

Ref: British Water code of practice. Flows and Loads. BW COP:1/05 & SW Specification

	FLOW (l)	BOD (g)	AMM (g)	**SS (g)	TotP (g)
Domestic Dwellings					
Water usage	150	60	8	75	2.5
Schools					
Non residential with canteen cooking on site	20	38	5	48	1.6

** Assumed from SS:BOD ratio	1.25	based on SW spec
*** Assumed from P:BOD ratio	0.04	based on SW spec

Hospital

500 bed hospital at Tornagrain — 650 l/bed.day

Tourism	Number	Total Rooms	Beds/room	Occupancy
Hotels	8	235	2	80%
Guesthouse	11	33	2	80%
Self catering	22	22	2	80%
Caravan/Campsite	2	240	4	60%
Overall	43	530	2.5	75%

Note that infiltration has not been taken into account as part of this calculation. This will be included as part of each individual option mass balance.

4.0 Typical sewage composition

For unknown wastewater discharges the strength of the sewage is to be assumed to be as per the following concentrations;

	Concentration mg/l		
	Weak	Medium	Strong
SS	100	220	350
BOD	110	220	400
Ammonia	12	25	50
P	4	8	15

Where information relating to the number of employees/day visitors for additional industrial/recreational areas is not available, an estimated figure from Metcalf and Eddy can be used to approximate wastewater production.

	Flows (m^3/ha.day)		
	Min	Avg	Max
Light Industrial Developments	9	11.5	14
Medium Industrial Developments	14	21	28
Large Industrial Developments	30	62.5	95
Commercial Districts	7.5	10.75	14

In order to estimate the loads for industrial/commercial areas it will be assumed that there will be a medium strength sewage produced with the above concentrations.

5.0 Inverness East Flow and Load Build Up

				AVERAGE DAILY VALUES				
				FLOW (m³)	BOD (kg)	AMM (kg)	SS (kg)	TotP (kg)
Residential units	(assume	1.98	P/house)	1026.4	410.6	54.7	513.2	17.1
Food retail				11.2	2.5	0.3	2.5	0.1
Non food retail				33.8	7.4	0.8	7.4	0.3
Business				114.4	25.2	2.9	25.2	0.9
Industry				3.6	0.8	0.1	0.8	0.0
Education				320	70.4	8.0	70.4	2.6
Health				1.5	0.3	0.0	0.3	0.0
Leisure				24.0	5.3	0.6	5.3	0.2

Total Flow and Loads for New Development	1534.9	522.4	67.5	625.1	21.2
PE Based on Section 3	10233	8707	8432	8334	8470

6.0 Nairn Flow and Load Build Up

				AVERAGE DAILY VALUES				
				FLOW (m³)	BOD (kg)	AMM (kg)	SS (kg)	TotP (kg)
Residential units	(assume	1.98	P/house)	814.7	325.9	43.4	407.3	13.6
Food retail				2.8	0.6	0.1	0.6	0.0
Non food retail				15.0	3.3	0.4	3.3	0.1
Business				83.9	18.4	2.1	18.4	0.7
Industry				57.5	12.7	1.4	12.7	0.5
Education				52	11.3	1.3	11.3	0.4
Health				0.0	0.0	0.0	0.0	0.0
Leisure				7.5	1.7	0.2	1.7	0.1

Total Flow and Loads for New Development	1032.9	373.9	48.9	455.3	15.3
PE Based on Section 3	6886	6231	6113	6071	6129

7.0 Central Area Flow and Load Build Up

				AVERAGE DAILY VALUES				
				FLOW (m³)	BOD (kg)	AMM (kg)	SS (kg)	TotP (kg)
Residential units	(assume	1.98	P/house)	1364.7	545.9	72.8	682.4	22.7
Food retail				11.2	2.5	0.3	2.5	0.1
Non food retail				11.3	2.5	0.3	2.5	0.1
Business				51.6	11.4	1.3	11.4	0.4
Industry				81.7	18.0	2.0	18.0	0.7
Education				73	2.8	0.4	3.5	0.1
Health				325.0	71.5	8.1	71.5	2.6
Leisure				16.5	3.6	0.4	3.6	0.1
Tourism				149.1	32.8	3.7	32.8	1.2
Total Flow and Loads for New Development				2083.6	658.0	85.6	795.2	26.8
PE Based on Section 3				13891	10967	10697	10603	10735

8.0 Croy Area Flow and Load Build Up

				AVERAGE DAILY VALUES				
				FLOW (m³)	BOD (kg)	AMM (kg)	SS (kg)	TotP (kg)
Residential units	(assume	1.98	P/house)	72.8	29.1	3.9	36.4	1.2
Food retail				0.0	0.0	0.0	0.0	0.0
Non food retail				0.0	0.0	0.0	0.0	0.0
Business				0.0	0.0	0.0	0.0	0.0
Industry				0.0	0.0	0.0	0.0	0.0
Education				0.0	0.0	0.0	0.0	0.0
Health				0.0	0.0	0.0	0.0	0.0
Leisure				0.0	0.0	0.0	0.0	0.0
Tourism				0.0	0.0	0.0	0.0	0.0
Total Flow and Loads for New Development				72.8	29.1	3.9	36.4	1.2
PE Based on Section 3				485	485	485	485	485

9.0 Cawdor Area Flow and Load Build Up

				AVERAGE DAILY VALUES FLOW (m³)	BOD (kg)	AMM (kg)	SS (kg)	TotP (kg)
Residential units	(assume	1.98	P/house)	70.4	28.2	3.8	35.2	1.2
Food retail				0.0	0.0	0.0	0.0	0.0
Non food retail				0.0	0.0	0.0	0.0	0.0
Business				0.0	0.0	0.0	0.0	0.0
Industry				0.0	0.0	0.0	0.0	0.0
Education				0.0	0.0	0.0	0.0	0.0
Health				0.0	0.0	0.0	0.0	0.0
Leisure				0.0	0.0	0.0	0.0	0.0
Tourism				0.0	0.0	0.0	0.0	0.0

Total Flow and Loads for New Development	70.4	28.2	3.8	35.2	1.2
PE Based on Section 3	469	469	469	469	469

10.0 Culloden Moor (Sunnyside) Area Flow and Load Build Up

				AVERAGE DAILY VALUES FLOW (m³)	BOD (kg)	AMM (kg)	SS (kg)	TotP (kg)
Residential units	(assume	1.98	P/house)	74.8	29.9	4.0	37.4	1.2
Food retail				0.0	0.0	0.0	0.0	0.0
Non food retail				0.0	0.0	0.0	0.0	0.0
Business				0.0	0.0	0.0	0.0	0.0
Industry				0.0	0.0	0.0	0.0	0.0
Education				0.0	0.0	0.0	0.0	0.0
Health				0.0	0.0	0.0	0.0	0.0
Leisure				0.0	0.0	0.0	0.0	0.0
Tourism				0.0	0.0	0.0	0.0	0.0

Total Flow and Loads for New Development	74.8	29.9	4.0	37.4	1.2
PE Based on Section 3	499	499	499	499	499